# Getting the Utmost from the AR88

## CALIBRATION, IF AND RF ALIGNMENT, SENSITIVITY CHECKS AND GENERAL TESTING

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*Large numbers of AR88's, of various vintages and degrees of effectiveness, are in regular use by amateurs and at commercial or experimental stations in this country and abroad. By reason of the complexity, size and weight of the AR88, it is certain that many operators—having wisely decided to leave well alone—are in fact accepting a performance far below that of which their receiver is capable. But if the experienced reader has the necessary test equipment available — and the need for experience and the proper gear must be stressed—then this article will show him how to proceed to get the utmost out of his AR88. Our contributor not only gives all the detailed information required to set about the work, but also quotes figures which will serve as a useful guide in estimating the performance of models which have not recently been given maintenance attention.—Editor.*

IN a professional capacity, the writer specialised in peaking this one type of receiver up to a performance level higher than that claimed for it by the manufacturers. Certain modifications were made, one of which was included by RCA in later models. Details of these will be given.

Working with Grade 1 precision equipment enabled exact performance data to be obtained, but as it is most unlikely that this type of equipment will be available outside the laboratory, the figures derived will serve as a guide, if not a goal. To proceed:

The receiver should first be given a general test over all bands.

There are three common faults which crop up in some receivers which have seen long service. These are: (a) Shorted .01 $\mu$F by-pass condenser to the anode of the 6K6GT output valve. In this case the whole receiver is, of course, dead. (b) Defunct 6K6GT output valve, due to running the receiver for long periods on 'phones only. This can be cured by fitting a cathode bias resistor of 100 ohms. The cathode of a normal receiver is shorted to ground: cut out this short and insert the resistor. (c) Shorted trimmer condenser in one or more of the first or second RF, Mixer or Oscillator stages. This will result in one or more dead bands, the remainder of the six bands being live. Normally, a very slight movement of the plunger of the faulty condenser will clear the fault temporarily, but the affected condenser should have its plunger removed by pushing downwards out of the chassis. It will usually be seen that a flake of the inside plating of the condenser tube has lodged across the small ceramic washer at the lower end of the plunger. This should be removed and the inside of the condenser thoroughly cleaned out with carbon tetrachloride before re-assembling.

When the receiver has been cleared of such faults and is known to be working, however inefficiently, on all bands, the first job to be done is the calibration.

### Calibration (Stage 2)

Normal calibration consists merely of feeding a 1,000 kc, 100 kc, 10 kc crystal controlled signal through loose coupling to the aerial terminal and, starting always on the HF band (No. 6), adjusting the oscillator trimmer condensers and inductance cores until every 1,000 kc, 100 kc and 10 kc mark on the dial is "spot on." Every one, that is, except 22 mc on Band 5 and 31 mc on Band 6. Owing to some minute characteristic of the tuning of the oscillator section, it is a physical impossibility to get both these frequencies to "spot" exactly. If 22 mc is on, 31 mc is off, and *vice versa*—and no amount of fiddle will change it. The best arrangement is to fix 22 mc on Band 5 and let 31 mc on Band 6 go where it likes. The discrepancy is only very small and is outside the 28 mc amateur band anyway.

Should the calibration of the receiver be very much off—so much so that no amount of trimmer and inductance adjustment will bring it right—it will be necessary to adjust the vanes of the tuning condenser oscillator section. This is the first section of the tuning condenser bank nearest the front panel.

If the condenser cover is removed it will be seen that the oscillator section is divided into two parts, one having a greater number of vanes than the other. The smaller of the two is in circuit when using Bands 4, 5 and 6, and the larger when using 1, 2 and 3. Let there now be given a word of warning: "Leave well alone" should be the watchword for all except those who have had considerable experience with oscillator calibration on this receiver. That small section of the beautifully made tuning condenser is indeed a place " where angels fear to tread." Unless the condenser has been damaged it is unlikely that physical adjustment of the vanes will be necessary, but, if it is, the procedure is as follows:

(1) *Zero BFO.* Adjust knob on BFO tuning condenser so that the pointer is exactly vertical when vanes are half-meshed. With BFO switched off and 1000 kc signal feeding into aerial, adjust main tuning condenser to zero beat: leave tuning set at this point and switch on BFO. If the heterodyne is not zero beat adjust BFO coil core L22 until signal is zero beat. Repeat until zero beat remains constant with BFO on or off, always keeping BFO tuning condenser in its mid-vertical position.

(2) *To Calibrate Receiver.* Set BFO switch on. BFO tuning condenser mid-vertical.

Tune 1000 kc signal on Band 6 at 30 mc and check all megacycle points down to 23 mc. To adjust HF end of band, tune condenser C32. To adjust LF end of band, adjust core L56. The adjustment of each one of these trimmers naturally affects the other, and the HF and LF end adjustments must be repeated several times until all megacycle points are spot on. It is at this stage that it is possible to determine whether or not any physical adjustment is necessary to the condenser vanes. Supposing 30 mc is spot on, 29 mc is 100 kc low, 28 mc is 200 kc low and 27 mc is spot on, as are all other points down to 23 mc, then this condition indicates that the tuning condenser capacity between 23 and 27 mc is correct, but from 27 to 28 mc there is too little capacity, hence the signal tunes earlier on the scale than it should for 28 and 29 mc. To increase this capacity, proceed as follows: Lightly mark in pencil the edge of the smaller group of rotor vanes where they enter the fixed vanes when the tuning condenser is set at 27 mc and again at 30 mc. *Between these points* it will be necessary to close up *very* slightly the outside rotor vane of the small group *without disturbing the setting of the remainder of that vane.* Only the slightest touch is necessary to effect a considerable alteration in the effective capacity, and extreme care must be taken if the whole calibration efficiency is not to be ruined. The only tool used by the writer, after much experiment, was the smooth end of a nail file, applied with a stroking motion. After every single touch with the tool the calibration should be checked and the trimmers C32 and L56 re-adjusted. This procedure is repeated until all megacycle points on Band 6 except 31 mc are spot on, *i.e.*, until the 1000 kc signal tunes at zero beat when the dial indication is set at any mc point from 23 mc to 30 mc.

In a perfectly calibrated receiver 31 mc will read approximately 30 to 50 kc high when all megacycle points from 23 to 30 mc inclusive are correct. In this condition 22 mc on Band 5 will also be spot on when that band has been calibrated.

When Band 6 has been adjusted as outlined above, the adjustments for Bands 5 and 4 follow in that order, using trimmers C27 and L55, and C25 and L54 respectively.

*Note*: No adjustment whatever is necessary to the condenser vanes on these bands, as they are covered entirely by the setting of the condenser for Band 6.

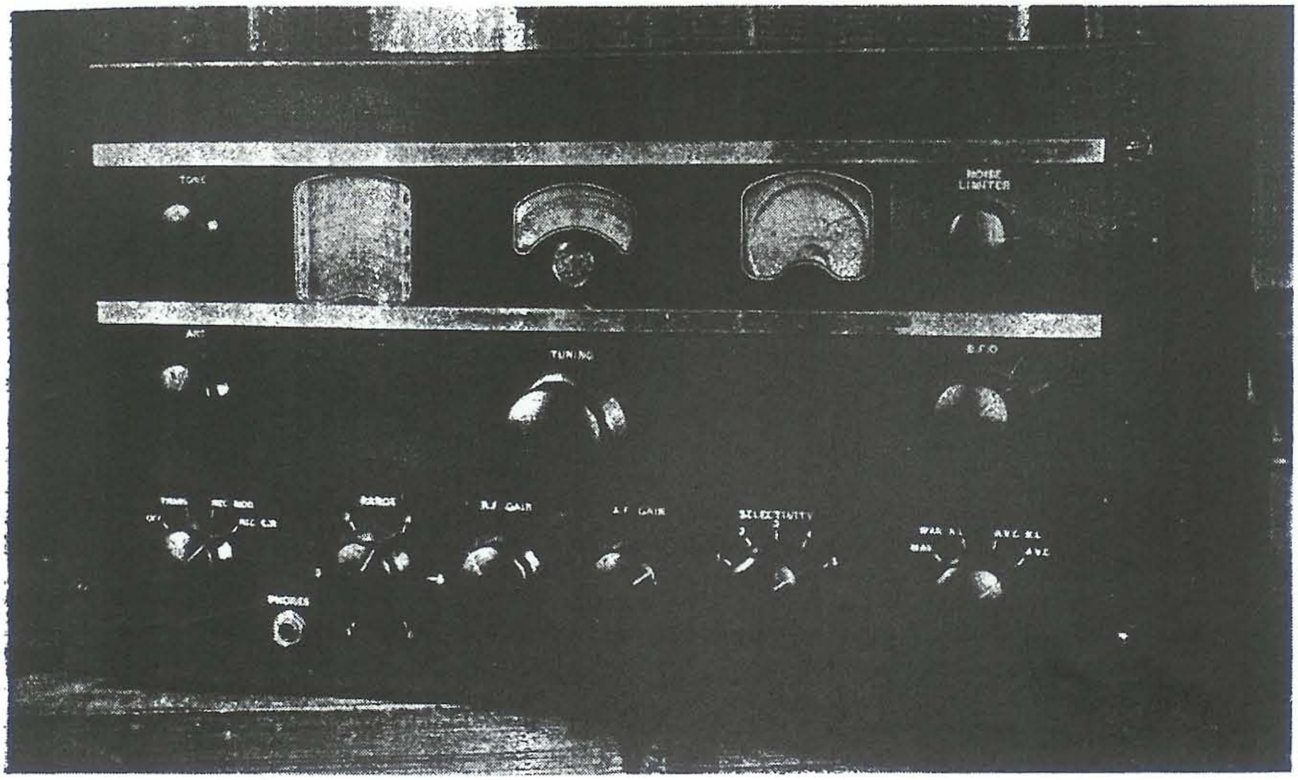
Band 3 should now be calibrated in exactly the same manner as Band 6, but using trimmers C22 and L53. Adjustments of the condenser vanes may be necessary to bring this band up to perfection, but this time the adjustment is made on the larger group of vanes of the oscillator section of the tuning condenser. A further difficulty is encountered in this operation as, unless very great care is taken not to upset the setting of the smaller group of vanes which are attached to the large group, when adjusting the large group the calibration of Band 6 will be altered and the whole of the work done up to this stage will have to be repeated in detail.

When Band 3 calibration is completed, Bands 2 and 1 may be calibrated using trimmers C19 and L52, and C16 and L51 respectively. No adjustment whatever is necessary to the condenser vanes on these bands as they are covered entirely by the setting of the condenser for Band 3.

The work of calibration is tedious and exacting, but if perfection is the aim there are no short cuts, and the job should not be undertaken at all unless time and patience can be given to it.

**IF Alignment (Stage 3)**

The one and only way to align the AR88 IF system properly is with an oscilloscope and wobbulator. It is impossible to align the 13 tuned circuits, including crystal load, by any other method, as will be appreciated. Receivers aligned by the output meter method, when checked on an oscilloscope, have shown some remarkable instances of misalignment not easy to detect in any other way.




**General appearance of the famous AR88, in use at a great many stations at home and overseas. The tuning dial is centre top, with the band indication panel on the left and the S-meter to the right.**

*IF Set-up.* The IF crystal frequency is 455 kc. The IF signal from the wobbulator set at 455 kc is fed through a .01 $\mu$F condenser to pin 5 of the 6SA7 mixer valve. The 6J5 oscillator valve is *not* removed during IF alignment. Oscilloscope input is taken from chassis and point C on IF transformer T9. Time base voltage is fed from oscilloscope to wobbulator.

***Control Settings***

| | |
|---|---|
| *On-off switch* ... ... | Rec. Mod. |
| *Band Switch, Band 1* ... | LF end. |
| *RF gain* ... ... ... | Max. |
| *Audio gain* ... ... ... | Max. |
| *Selectivity* ... ... ... | Position 3. |
| *AVC* .. .. ... ... | Position 4. |
| *Crystal Phasing Control* | C75 Half-mesh. |

*Alignment.* With oscilloscope scanning at approximately 20 per second, tune wobbulator slowly through crystal frequency until peak appears on screen. Set wobbulator so that the centre line of this peak coincides with cursor line of 'scope.

*Preliminary Check.* Switch selectivity switch to positions 1, 2, 3, 4 and 5, and note the shape and position of curves in relation to the cursor line of 'scope for each setting in turn. The curves should appear as in the sketch if the IF's are correctly aligned.

In switch positions 1 and 2 the crystal is out of circuit; it is brought in on positions 3, 4 and 5. If the IF's are off-tune, begin alignment at T9, working from there back through the various stages to T1. When making trimmer adjustments it should be remembered that any improvement or otherwise of the trace will relate only to the particular setting of the selectivity switch. It is obvious therefore that when adjustments are made with selectivity switch on, say, pos. 2, the alteration may adversely affect the trace when checked on pos. 1 or 3, and so on. The aim therefore is to adjust each of the trimmers to maintain the curve centrally on the 'scope while, at the same time, increasing the height of the peak of the curve above the base-line. One method is to trim off-centre on one trimmer and then to pull back to centre with a second trimmer, at the same time increasing the amplitude without displacing the central positioning of the curves on the remaining selectivity positions. This sounds, and is, a complicated process, but yields results in due course. Considerable range of tuning is provided by the IF iron cores, but it is not advisable to tune so that the curves are widely offset from the 'scope cursor line, as it is sometimes a long job to pull them back into position. It is an advantage to use two trimming tools and, working with the receiver turned on its left side, to tune the top and bottom trimmers at the same time. With care and attention to the curve centreing and amplitude, it is quite a straightforward job, but one which does take some time. Unless the receiver has been badly mis-used, no trouble should arise from the IF components, as the writer has yet to find the first fault in this respect. Do not be misled into thinking the IF transformer is a "dud." It is almost always your tuning which is at fault !

*Testing IF Sensitivity*. Remove oscilloscope and wobbulator leads from receiver. Connect matched output meter to output terminals at back of receiver. Set signal generator at 455 kc and feed through .01 $\mu$F condenser to pin 5 of mixer as before, and—with selectivity switch in pos. 3—rock the signal generator tuning to give maximum output on meter, then switch selectivity switch to pos. 2 for future readings. Set modulation on signal generator at 30% and feed in sufficient signal to bring output meter reading up to one watt. Read off the input on the scale of signal generator. This may be anything from 600 to 1000 microvolts on the first test. A note should be made of this figure.

Now take out the first and second RF valves (6SG7's) and removing each of the 6SG7 IF valves in turn, substitute one or other in turn of the RF valves. This should show on the output meter if the valves are all of a standard efficiency. If a substitution results in an increase in output, leaving the valve which caused the improvement in circuit. Should spare valves be available they should be tested in turn, to obtain the best team in the IF stages. If better valves have been found for the IF's the input required from the signal generator will, of course, be smaller, to give one watt output. The IF's should now be trimmed up with the substituted valves in use, using the oscilloscope as before, and the input required for one watt output again measured. This should be lower than the previous figure, but may still be around 600 to 700 microvolts. To improve this figure still further remove the 6SA7 *metal* mixer valve and substitute a 6SA7 *glass* type. If one or two of the glass ones are available, try them in turn, not forgetting to re-align with each change.

The result in almost every case is that the required IF input for one watt of output will drop *from about 600 microvolts to between 80 and 100*—which is a considerable gain.

The IF efficiency measurement is always made with selectivity switch in pos. 2, but constant checks of signal frequency are required, to be made by switching to pos. 3 and rocking generator frequency.

Once this figure is obtained with the curves central on all positions of selectivity switch, the IF's can be sealed by painting the trimmer spindles with a spot of shellac to prevent accidental rotation.

If any difficulty is found in adjusting a particular IF transformer, the signal generator should be fed through the grid of the preceding IF valve and the stage roughly aligned: the signal generator is then returned to pin 5 of the 6SA7 for final alignment.

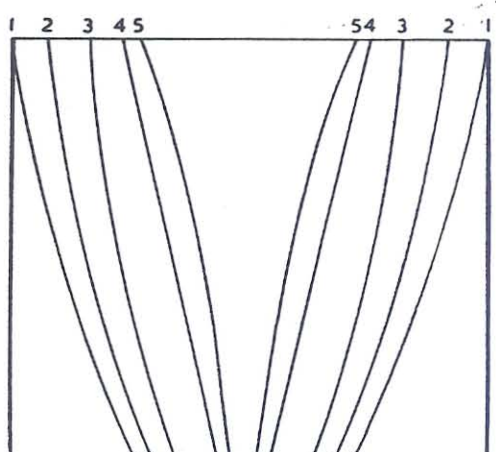
*Crystal Phasing adjustment*. Connect a high resistance sensitive DC voltmeter to point C on last IF transformer. Feed signal generator tuned to 7 kc off IF resonance to pin 5 of 6SA7 mixer, and adjust C75 for minimum response.

**Adjustment Crystal Load Circuit**

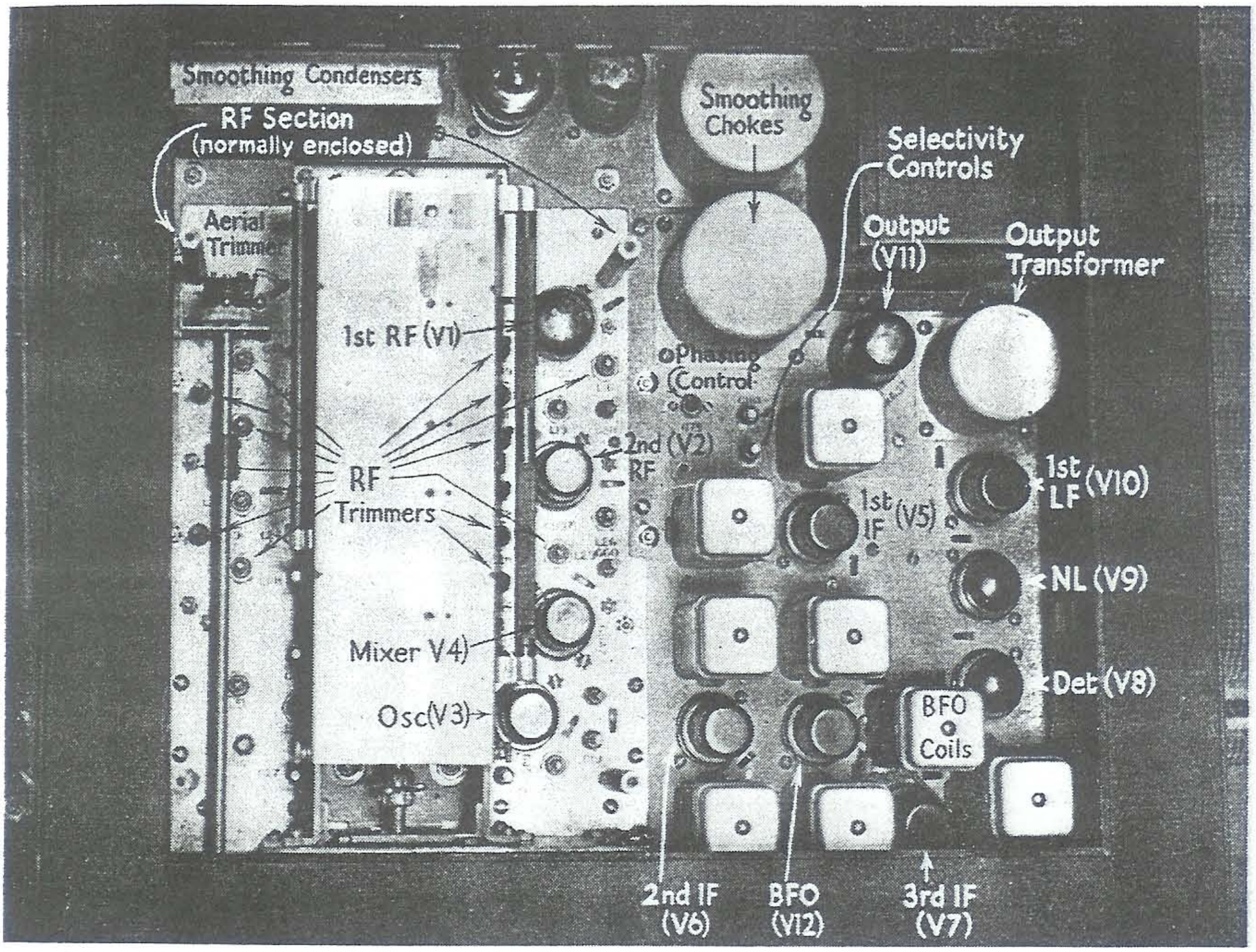
(1) With set-up as for IF alignment and selectivity switch on pos. 3, rock signal generator through IF frequency and adjust L34 for symmetrical round-topped curve. (2) With selectivity switch in pos. 4 adjust C81 for symmetrical curve. (3) With selectivity switch in pos. 5 adjust C80 for symmetrical curve, rocking signal generator as for 1 and 2.

*Wave Trap Adjustment*. With range switch on Band 1, feed a modulated signal of 455 kc into aerial and ground and adjust L57 on back of chassis for minimum output on meter or speaker.

This adjustment should be made before final RF alignment.




Selectivity curves of the AR88, of the shape to be expected if the IF circuits are correctly aligned. Numbering refers to the positions of the selectivity switch.




The AR88 with the lid open, showing chassis layout and placement of main parts. The accompanying article suggests how the receiver can be checked and adjusted for maximum performance on the amateur bands. This should not be undertaken without proper test equipment and experience in its use.

## RF Alignment (Stage 4)

Connect matched output meter to output terminals of receiver, then connect signal generator with 30% modulation *via* a 200-ohm resistor to aerial and ground. (Shorting link from other aerial terminal to ground is left in position.) The manufacturers recommend that the meter be connected across the voice coil of the speaker, but the figures quoted later in this article refer to readings on a Marconi matched output meter without speaker load.

*Control Settings*

| | |
|---|---|
| *Tone Control* ... | Fully clockwise |
| *Antenna Trimmer* | Adjusted for max. output at HF end of each band in turn. |
| *On-off Switch* ... | Rec. Mod. |
| *Range Switch* ... | To band being aligned. |
| *RF Gain* ... ... | Max. |
| *Audio Gain* ... | Max. |
| *AVC* ... ... ... | Position 4. |
| *Selectivity Switch* | Position 2. |

Begin alignment on Band 6 by feeding 30.5 mc from signal generator. Tune receiver for maximum output and adjust aerial tuning on front panel for maximum output. Adjust 1st and 2nd RF trimmers C45 and C68 carefully for maximum output. Then set signal generator to 22.5 mc and retune receiver for maximum output, but do not alter the previous setting of aerial tuning on front panel. (This is tuned for maximum at the HF end only of each band in turn, and is left so tuned when the remaining adjustments are made at the LF end of each band.) Adjust aerial inductance trimmer L12 (on back of chassis) and 1st and 2nd RF trimmers L21 and L31 for maximum output.

Repeat these adjustments at the HF and LF ends several times to obtain peak output.

The writer obtained 5 watts output for one microvolt input consistently at both ends of this band on a properly aligned receiver.

Switch off modulator from signal generator and read off the noise-level on meter. The reading should be below one watt, but if it is higher remove the 1st RF valve and substitute a 6AC7, or 717A, or 6SH7 for the 6SG7 and re-align. This should reduce the noise considerably without affecting the output with modulation on generator signal.

*Band 5.* Tune 22.4 mc generator signal on receiver, adjust aerial tuning and C43 and C66, all for maximum output. Tune 16.4 mc generator signal on receiver and adjust L10 (on back of chassis) and L20 and L30, all for maximum output. Repeat several times. Output should be between 4 and 5 watts for one microvolt input.

*Band 4.* Tune 16.4 mc generator signal on receiver and adjust aerial tuning and C41 and C64, all for maximum output. Tune 12.2 mc generator signal on receiver and adjust L8 (on back of chassis) and L19 and 29 for full output. Repeat several times. Output should be 3.5 to 4.5 watts for one microvolt input.

*Band 3.* Tune 11.5 mc generator signal on receiver, adjust aerial tuning and C39 and C62, all for full output. Tune 4.6 mc generator signal on receiver and adjust L6 (on back of chassis) and L18 and L28 for maximum output. Repeat several times. Output should be 3.0 to 3.5 watts for 1 microvolt input.

*Band 2.* Tune 4.4 mc generator signal on receiver, adjust aerial tuning and C38 and C60, all for maximum output Tune 1.7 mc generator signal on receiver, adjust L4 (on back of chassis) and L16 and L26, all for full output. Repeat several times. Output should be 2.5 to 3.5 watts for one microvolt input.

*Band 1.* Tune 1500 kc generator signal on receiver, adjust aerial tuning and C37 and C59, all for full output. Tune 550 kc generator signal on receiver and adjust L2 (on back of chassis) and L14 and L24 for maximum output. Repeat several times. Output should be 1 to 1.5 watts for input of one microvolt.

When the receiver has been tuned up to peak performance with the modifications mentioned, it may be found that IF oscillation appears, as indicated by unwanted whistles at odd places on one band, or perhaps several. To eliminate this with certainty, the writer spent many hours before finding that the trouble was caused by the close proximity to each other of the anode, screen and cathode leads of the last 6SG7 IF valve. These leads each go to .05 μF fixed condensers on the chassis front, and should be cut out and replaced by screened leads, as short as possible, with the screening braid well grounded.

Since the discovery of this cure, the manufacturers have included sceened leads at this point as a standard modification. This will therefore only apply to earlier models. Yours can be identified by the main tuning dial, which is of translucent material with figures in black. Later models (which include the modification mentioned) are provided with dials of the same material, but with alternate bands marked all black with translucent figures.

Readers wishing to fit an S-meter (5 mA f.s.d. right hand zero) will find the adjusting potentiometer in the centre back of chassis, provided with screwdriver slot.

The "D" in the AR88D indicates that provision is made in the receiver design for diversity reception. R.C.A. manufacture a standard rack to accommodate two AR88D's, and a diversity switching unit which automatically selects the most useful signal from separate aerials, and feeds this signal to one or other of the receivers. The output is therefore kept as near as possible at a constant level, irrespective of fading in one or other of the signal paths.

So, if you want to keep track of that fading DX, this is the set-up you require, and the writer does not know of a better. Before ordering, however, make sure you have an import licence, a dollar bank balance, and an aerial farm !

It is realised, of course, that much information can be obtained from the manufacturers' handbook, but the writer has tried to set out his own results and conclusions, arrived at after months of concentrated study and experiment. together with modifications which the reader may care to try out.

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### MORE ABOUT THE T2FD AERIAL

The article by G2NS in our issue for January, 1953, describing an unusually effective multi-band aerial for confined spaces developed by W3HH, has aroused a good deal of interest. Many versions of the design are now being operated by G stations, and following are some further notes on the T2FD offered by G2NS after correspondence with the States : The best angle of tilt is 30° and the optimum value of the terminating resistance is fairly critical for best results, being 390 ohms for a 300-ohm feed line, and 650 ohms for a 600-ohm line. These resistors should be non-inductive and capable of dissipating the power involved. Wire-wound resistors will do, but if they are used the system as a whole tends to become non-aperiodic and calls for changes in the method of coupling when going from band to band. High-wattage wire-wound resistors are still readily available, but carbon types are preferable if they can be obtained. It has been found in practice that a three-band version of the T2FD can be loaded up and operated efficiently on five bands.