The Racal RA17 Communications Receiver

Reviewed by

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A front panel view of the Racal RA17 Receiver.

THE RA17 is a 23 valve triple conversion receiver. The way in which the front end is arranged provides a complete departure from the usual as does the frequency changing circuitry.

It will be seen from the block diagram (Fig. 1) that signals arriving at the grid of Mixer No. 1 are combined with the output of Oscillator No. 1, the resultant i.f. being the difference between these two frequencies. The output of Oscillator No. 1, is also mixed with the harmonics of a 1 Mc/s crystal oscillator in Mixer No. 4, but a band-pass filter only allows the passing of the resultant beat which falls within ± 150 kc/s of 37·5 Mc/s, all other beat frequencies being ineffective. The first oscillator is tuned in steps of 1 Mc/s ± 150 kc/s: any attempt to set up at any other frequency results in no output from the filter. The 37·5 Mc/s output is combined with the first i.f. in Mixer No. 2 to give an output in the second i.f. band between 2 and 3 Mc/s.

To illustrate this in detail, take the case of a signal at Mixer No. 1 on say 3·5 Mc/s. Oscillator No. 1 will be set to 43·5 Mc/s (calibrated as 3 Mc/s) the resultant first i.f. being 40 Mc/s; mixing this signal with 37·5 Mc/s gives a second i.f. of 2·5 Mc/s.

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The frequency stability of this section is automatically perfect. For example any drift in the first oscillator which would produce a rise in the first i.f. will also give a rise in the 37·5 Mc/s output of Mixer No. 4 and so correct the output of Mixer No. 2 back to 2·5 Mc/s.

The frequency of the first oscillator has only to be set within fairly broad limits, and the dial, which is the small aperture on the front panel, is calibrated in Mc/s from 0 to 29. Band changing thus requires no switching or turrets, with all their possibilities of bad contacts, etc.

> The author of this article has been using a Racal type RA17 receiver for the past few months. He describes it as the "ultimate" in communications receiver design.

It can now be seen that all signals arriving at the grid of Mixer No. 3 will be within the range 2 to 3 Mc/s. These signals are mixed with the output of Oscillator No. 2, which is tunable over a range of 2·1 to 3·1 Mc/s. This range never has to be changed. Oscillator No. 2 is very stable and is

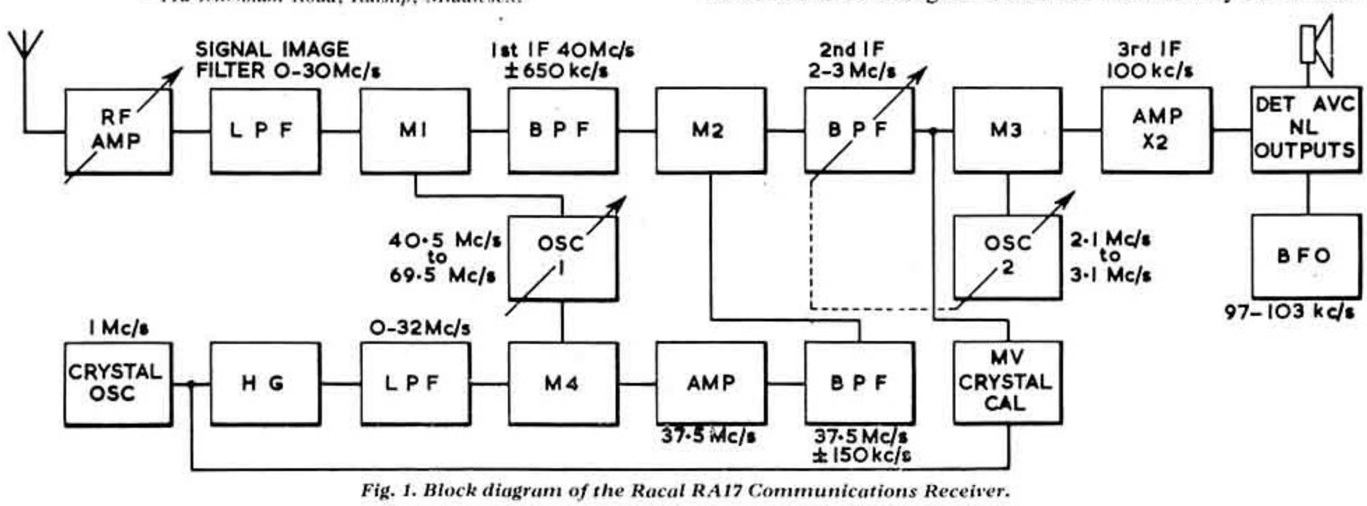


Fig. 1. Block diagram of the Racal RA17 Communications Receiver.

temperature compensated; it is tuned over the 1 Mc/s range by the main tuning drive, which actuates the long film strip dial showing in the top window on the panel. This film is calibrated in 1 kc/s divisions and can easily be read to within 500 c/s. The cursor is movable and can be set accurately at any 100 kc/s point with the aid of harmonics from the 1 Mc/s crystal via a multivibrator.

Stability and Mechanical Construction

The total drift from cold is given by the makers as being within 1500 c/s in three hours and thereafter within 150 c/s, but in the writer's experience stability is very much better than even these figures suggest. Such stability would be useless unless the mechanical construction was in keeping, while with two variable oscillators and one crystal oscillator, the screening must be just about perfect to eliminate all the possible beat frequencies that could occur. The chassis is a solid casting including all screening on the underside. The upper side of the chassis is also well screened and here again several sections are castings. It is possible to tune in WWV to zero beat on 25 Mc/s, and then pick up the whole receiver by the handles without any change in note being observable.

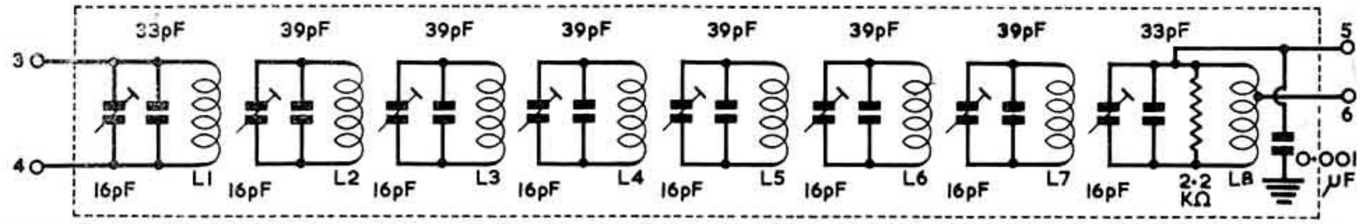


Fig. 2. The 40 Mc/s band-pass filter. The only coupling between the component parts is by the stray coupling between the tuned circuits.

The circuit from the aerial to the grid of the r.f. amplifier has a broad band position, with a tuned input as an alternative which is useful in the presence of strong local signals as it allows the r.f. input to be tuned " on the nose." There is no interstage tuning, either at signal frequency or at the first intermediate frequency. Instead band-pass filters are used. The circuit of the 40 Mc/s filter is shown in Fig. 2. The only coupling between the separate tuned circuits is electro-magnetic. The second i.f. has a tuned band-pass filter ganged to the Oscillator No. 2 control.

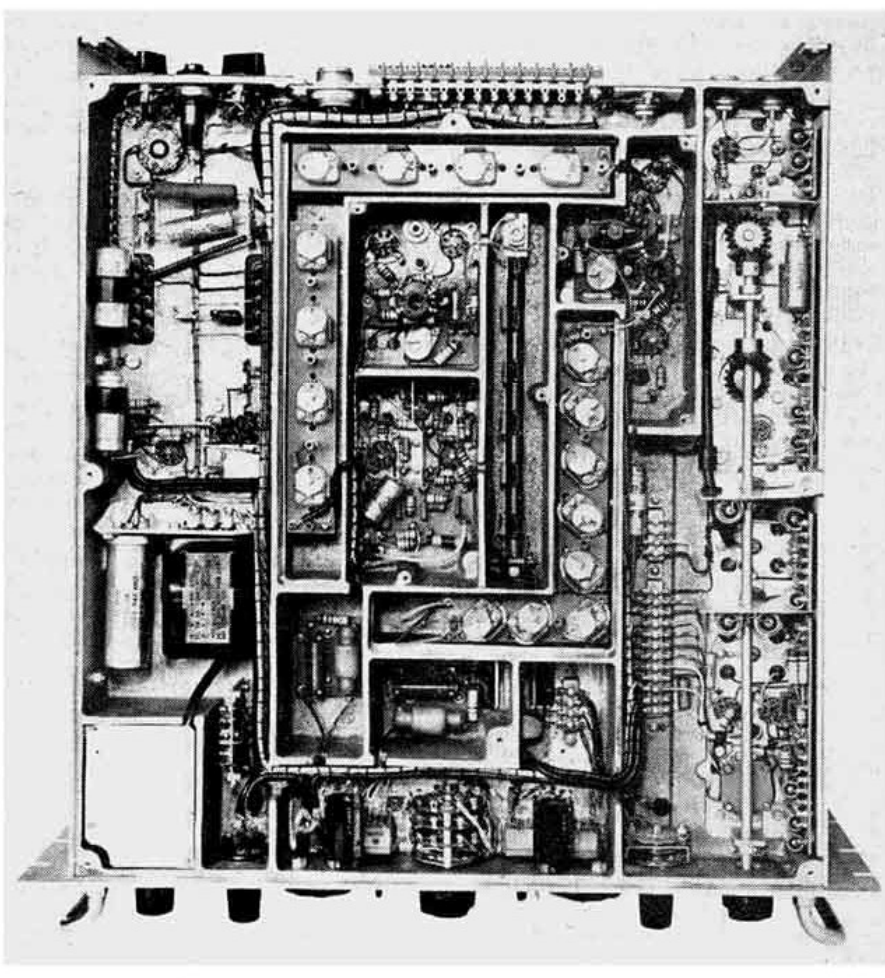
Controls

There is no continuously variable r.f. gain control, but an

Following Mixer No. 3 is a two stage 100 kc/s i.f. amplifier, controlled by either a.v.c. or manual gain control. The interstage coupling (Fig. 3) includes fixed tuned band-pass filters giving three different widths (at 6db down) of 8 kc/s, 3 kc/s and 1·2 kc/s plus crystal lattice filters for 750 c/s, 300 c/s and 100 c/s. The skirts of the response curves are really sharp (Fig. 4) and it has been found possible to receive a.m. phone on whichever sideband is required to combat the severest QRM. On c.w. the reception is truly single signal; the only trouble when the receiver is in the 100 c/s position is to find stations which will stay within the pass band!

The i.f. amplifier is followed by a diode detector, diode a.v.c. valve, a good noise limiter, a.v.c. time constant diode and the output stages. Two separate output stages are used to provide several different output impedances, one of which is controlled independently of the main audio gain control. The audio outputs are brought out at the rear, as is also the a.v.c. line and h.t. line. There are also two outputs at 100 kc/s via a buffer amplifier, and an output from the 1 Mc/s oscillator.

The b.f.o. is of the required stability to match the rest of the receiver and can be set up to ±3 kc/s off tune. It is calibrated in kilocycles.



A view of the cast chassis from below showing the screening.

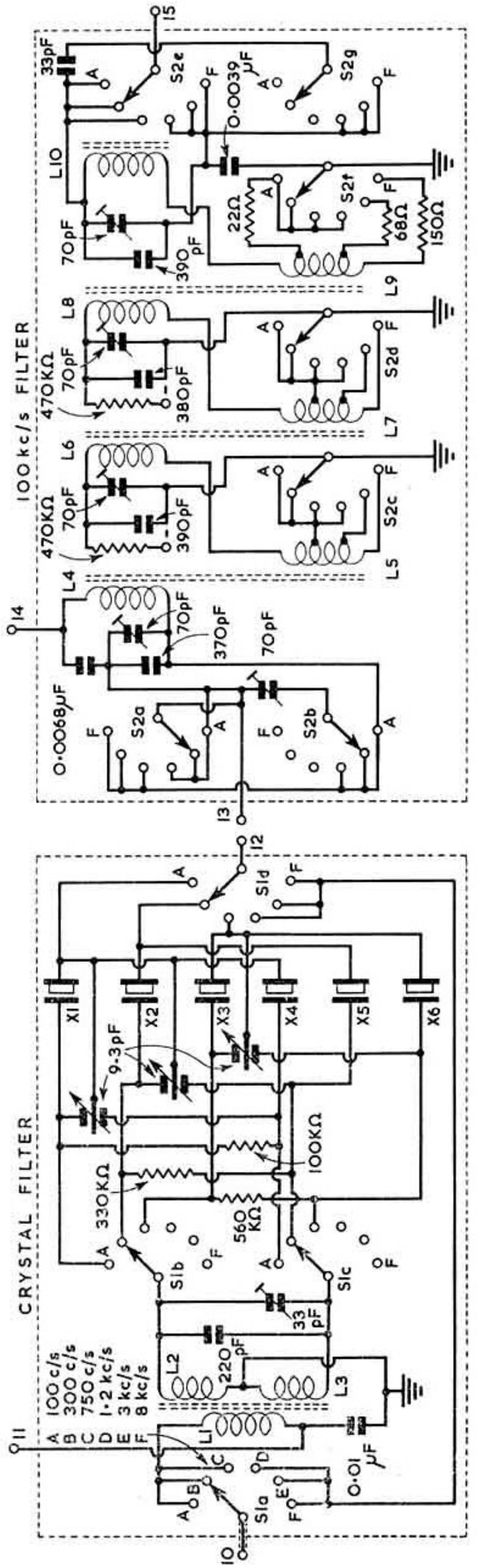


Fig. 3. The 100 kc/s interstage coupling.

r.f. attenuator is provided giving five steps of attenuation. The gain of the 100 kc/s i.f. stage is adjustable from a panel control when the a.v.c. is off.

The main function switch has five positions: OFF or STANDBY (when the main h.t. line to the front end is cut), MANUAL GAIN, A.V.C., CAL. (when 100 kc/s check points are available) and CHECK B.F.O. (when in addition to the 100 kc/s check the b.f.o. can be set to zero).

As can be seen from the photograph at the beginning of this article, the front panel is complete with a meter, reading at the turn of a switch, either R.F. (diode current), s units (calibrated in 4 db steps up from 1·25 μV) or AUDIO (rectified volts in a 600 ohms load) and a monitor speaker, which has been found to give very good speech quality for amateur communication.

The arrangement of the controls on the front panel is very good and they all fall conveniently to hand, once the feel of the receiver has been experienced. One thing which does want getting used to is the distance one has to tune; when an

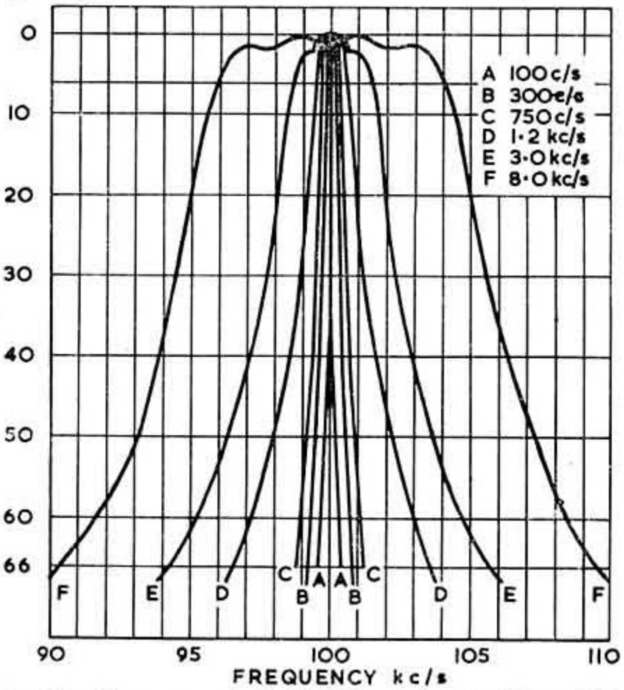


Fig. 4. Selectivity curves of the RA17 in various positions of the selectivity control.

operator says he will QSY 20 kc/s one has to tune a couple of inches away, passing perhaps a dozen other stations on the way! The tuning rate is constant, irrespective of the frequency in use, and 6 in. of scale is used for each 100 kc/s and one revolution of the drive control. On the amateur bands the actual amount of scale is as follows: 1·8 to 2 Mc/s = 12 in.; 3·5 to 3·8 Mc/s = 18 in.; 7·0 to 7·15 Mc/s = 9 in.; 14·0 to 14·35 Mc/s = 21 in.; 21·0 to 21·45 Mc/s = 27 in.; 28·0 to 30 Mc/s = 10 ft. (yes, feet!).

The aerial input is 75 ohms unbalanced, and the sensitivity is given by the makers as 1μV on c.w. or 3·5 μV on 30 per cent. modulated a.m. for a 20 db signal-to-noise ratio. S1 on the meter is set at 1·25 μV input but a.m. phone signals well below this value are easily readable if the external noise will permit.

Amateur Use

From the purely amateur point of view there are some small items to mention apart from the price, which is somewhat high by normal standards. The 28-30 Mc/s band is covered in two separate ranges, but this does not in fact present much difficulty, as the frequency accuracy does not

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To make the last two bends (the short sides) the slots in the tool are used, the previously bent sides being in line with one edge of the tool and an appropriate slot, as shown

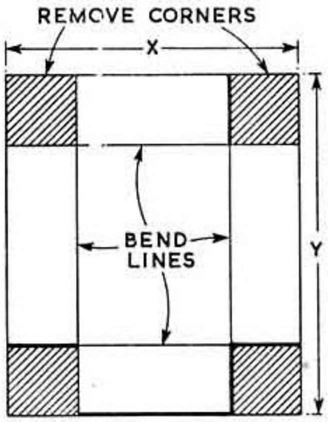
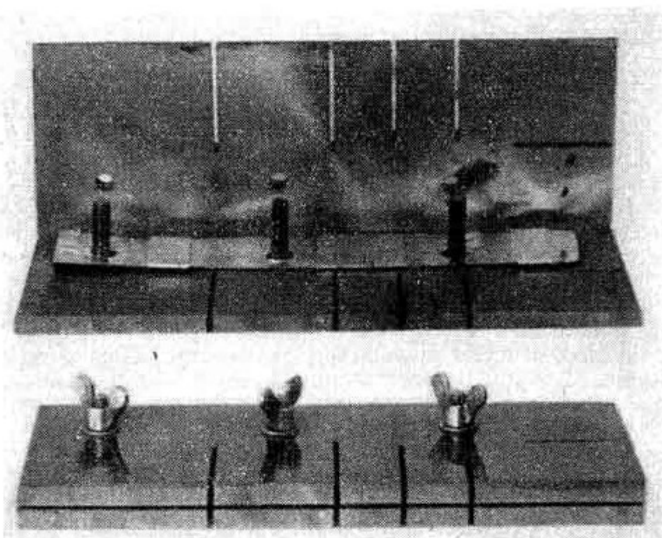


Fig. 2. Method of marking out the aluminium sheet from which a chassis is to be made. The dimensions X and Y are equal to the width and length of the chassis respectively plus twice the depth. The shaded portions are the corners which have to be cut out before bending commences.

in the photograph at the beginning of this article. If care is taken, a neatly bent chassis will result.

The same type of tool can be made from wood if desired, thought it will obviously not last so long as the bending edges will wear more quickly. However, they could be planed down from time to time. It is advisable to use plywood, eleven ply ⅝ in. thick being suitable.



Two views of the tool. Below, closed; above, opened to show the pieces of aluminum and tin placed between the plates.

Acknowledgments

The writer expresses his thanks to Mr. H. T. Stott, Chief Designer of A. F. Bulgin Ltd., for helpful suggestions in the design of this tool which is similar to one in use in the Bulgin Laboratory.

Racal RA17 Receiver (Continued from page 213)

of course depend on careful setting of the Mc/s control. The other point is that on occasion it would be useful to have the i.f. gain control available and still keep the a.v.c. in circuit. Later models do, in fact, incorporate this modification, which is particularly useful when receiving s.s.b. The stability of the receiver and the steep sides to the i.f. response curve make s.s.b. signals as easy to tune as a.m. on conventional receivers, with the exception that manual control of gain has to be made when there is a large difference in the strengths of different stations in a "round table."

Although the RA17 is adequate, so far as stability is concerned, for the reception of s.s.b., there is the usual inefficiency of the diode detector and b.f.o. injection. Racal have now available a separate s.s.b. adaptor, type RA63, which takes its input from the 100 kc/s i.f. strip of the RA17. The 100 kc/s signal is mixed with a stable oscillator of 82 kc/s, variable ± 1 kc/s, the output at 18 kc/s (centre frequency) being fed into either an upper or lower sideband multi-section band-pass filter, followed by a product detector, with a carrier re-insertion oscillator on 18 kc/s, a further output stage and built-in speaker similar to that in the RA17. The adaptor is suitable for the reception of s.s.b.s.c., s.s.b. with pilot carrier, or single sideband reception of a.m. It is constructed on a standard 3½ in. rack panel and has a self-contained power supply. The writer has not yet had the opportunity of using the RA63, but hopes to do so in the near future.

The makers of the RA17 are the Racal Engineering Co. Ltd. of Bracknell, Berks, to whom the writer expresses his thanks for providing the photographs and for assistance in preparing this article.

Two Useful Switching Circuits (Continued from page 214)

necessary to connect a 15 p.f. by-pass condenser direct from the valve cathode to an earth connection close to the valve, in order to prevent certain self-oscillation effects which took place in V3 due to the switch and its associated wiring. These effects were manifested by a considerable drop in the anode current of the stage concerned and were present in both 6AG7 and 5763

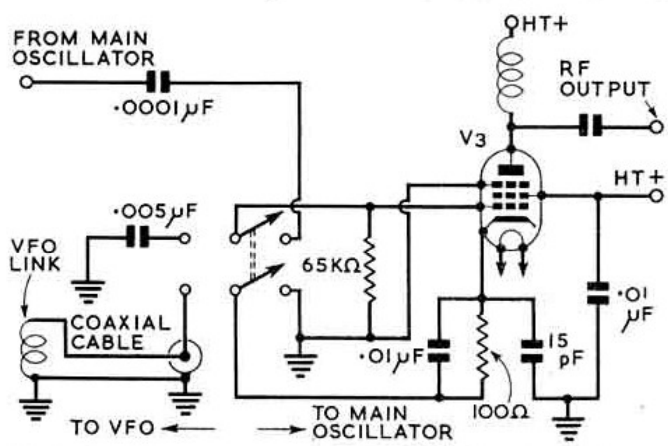


Fig. 3. Switching arrangement for selection of main oscillator or table top v.f.o.

types. It was thought at first that the long path of the cathode return to earth, via the coaxial cable and the link, was directly responsible, but this was proved to be incorrect as the self-oscillation effects persisted when the coaxial cable was removed and the socket connection on the transmitter panel shorted to earth. The 15 p.f. by-pass condenser provided a complete cure, at the cost of a little drop in r.f. output which was not serious on the lower frequencies.

Can You Help?

● E. A. Kimber (B.R.S. 17722), Tone Bridge Cottage, Creech St. Michael, Taunton, Somerset, who requires the crystal frequencies required in the R.1392/P.104 receiver to cover the 2m band and information on converting the crystal oscillator to v.f.o.?