THE RACAL RA-17 COMMUNICATIONS RECEIVER

Bruce Portzer

Tube type receivers continue to have a significant cult following in the DX hobby. The "high end" models in particular seem to have the most lasting popularity. Receivers like the Collins R-390A and Hammarlund HQ-180A were excellent performers when introduced, and still are. Another receiver in that category which was relatively unknown among DX hobbyists until a few years ago is the Racal RA-17.

The Racal Company is a well-respected British electronics manufacturer, roughly equivalent to U.S. companies like Motorola and Hewlett-Packard. Racal has been a major supplier of military and industrial communication and other electronics systems for decades. Its communications equipment has long ranked near the top in quality and reputation. Racal isn't that well known in hobby circles simply because its equipment is so expensive that few DXers can afford it. We've therefore had to wait for its gear to appear on the surplus market before many of us can try it out.

The Racal RA-17 was originally designed in the late 1950's, and continued to be built and sold through the late 1960's. When it first came out, the RA-17 represented the state of the art in receiver design. It was the first receiver to use the Wadley loop circuit. This enabled the set to provide a frequency readout with 1 kHz resolution all the way from 500 kHz to 30 MHz. This was a vast improvement over the "slide rule" accuracy of most sets of that era. The results were and still are pretty impressive. It wasn't until the mid 1970's that the Wadley loop circuit showed up in the Barlow-Wadley XCR-30, the Yaesu FRG-7 and other hobby receivers. Until then, very few other receivers provided that sort of frequency resolution. The only other major 1960's vintage receiver with 1 kHz resolution was the R-390 series receiver. The R390 had digital readout, but the mechanical tuning arrangement and readout were more cumbersome to operate and maintain.

Nowadays, frequency synthesizers and digital readouts have made the Wadley loop nearly obsolete, but in the 1960's it was a godsend for those who could pay the price. When introduced it had a price tag of about a thousand dollars. That's the equivalent of over $4000 in today's dollars. The high price, of course, placed the receiver out of reach of most hobbyists back then, but government and commercial buyers found good use for them. Mine, for example, saw 15 or 20 years service at the FCC monitoring station in Ferndale, Washington, before it was sold as government surplus in the mid 1980's. Around that time, the Canadian government unloaded a large number of RA-17s, which Don Moman bought and resold to Canadian DXers. I'm not sure how many were made, but the manual for mine says it was received 12-15-67 and has serial number 251.

There seem to be several variations of the receiver. Moman found receivers with C2/C3 suffixes to be earlier versions, and C12/C13 suffixes to be later versions. The latter had improved selectivity due to an added tuned circuit in the front end. The manual for mine says the RA-17UC is the same as the RA-17UA except for a product detector in lieu of the BFO. There are also the Racal RA-117 and RA-6117; both are similar to the RA-17 with a few internal circuit changes.

WHAT DOES IT LOOK LIKE?

The receiver is quite large. It's designed for 19" rack mounting, and is about 10" high and 18" deep. The weight is about 67 lbs. Original purchasers had the option of either getting the receiver with a cabinet or without one. The receiver is very solidly constructed; it is the only receiver I've seen with a cast aluminum chassis. The internal circuitry is very well shielded. All components are securely mounted and appear to have been top quality for their time. Best of all, the kilohertz readout is on several feet of 35 mm film, with 0.6 inches for every 10 kHz and markings every kHz. The manual claims the readout is equivalent to 145 feet for the 0.5 to 30 MHz spectrum!

Figure one is a layout of the front panel. The front panel controls include:

Power on/off: Self explanatory. The receiver can operate from either 120 or 240 volt AC, depending on how you wire the transformer.

R.f. range and r.f. tune: These controls tune the front end r.f. amplifier. You switch the range control to the band of interest and then use the tune control to peak the signal. The range switch has a [illegible] position to bypass the tuned circuits.

Attenuator: A 5 position switch which reduces incoming signals from 0 to 40 db in 10 db steps.

Megahertz and kilohertz tuning knobs and displays: These controls are used to tune the receiver to the desired frequency. Their operation is discussed a little later in this article. Like many other receivers, the hairline marker for "KHz" can be moved to adjust for minor calibration and tracking errors. The "MHz" tuning control can be locked into place to prevent inadvertent movement.

Bandwidth: Selects among 0.1, 0.3, 1.2, 3.0, 6.5, and 13 kHz bandwidth in the final i.f. stage. The first two bandwidths use crystal filters, the others use L-C filters.

Mode: Selects either standby, AGC (operating with automatic gain control switched in), MGC (operation with AGC disabled), calibrate (enables the 100 kHz crystal calibrator), or BFO check.

AF gain: Adjusts the audio output to the headphone jack(s), front panel speaker, and external speaker jacks.

BFO tune: Tunes the beat frequency oscillator up to 5 kHz above or below the received frequency.

RF/IF gain: Adjusts the gain of the r.f stage and the i.f. stages. On some earlier versions, this control only adjusts the i.f. stage gain. The control works in both the AGC and MGC modes.

AGC long/short: Selects between long and short attack/decay times on the automatic gain control circuitry.

Audio level: Adjusts one of the rear panel audio outputs for driving external amplifiers, tape recorders, or other external audio devices.

Limiter: Enables/disables the noise limiter circuit. The limiter works extremely well on some types of electrical noise, as well as plain ordinary static crashes. Occasionally it provides clear copy on a station that was otherwise buried in a loud buzz. On the other hand, it can also distort received audio; this can be alleviated somewhat by adjusting the r.f./i.f. gain control.

Speaker: A 2-inch speaker which can be disabled by an adjacent toggle switch. Missing from some versions.

Headphone jack(s): Depending on the version, there are one or two headphone jacks.

Meter: The meter can function as an r.f. level, "S", or a.f. level meter, as selected by an adjacent switch.

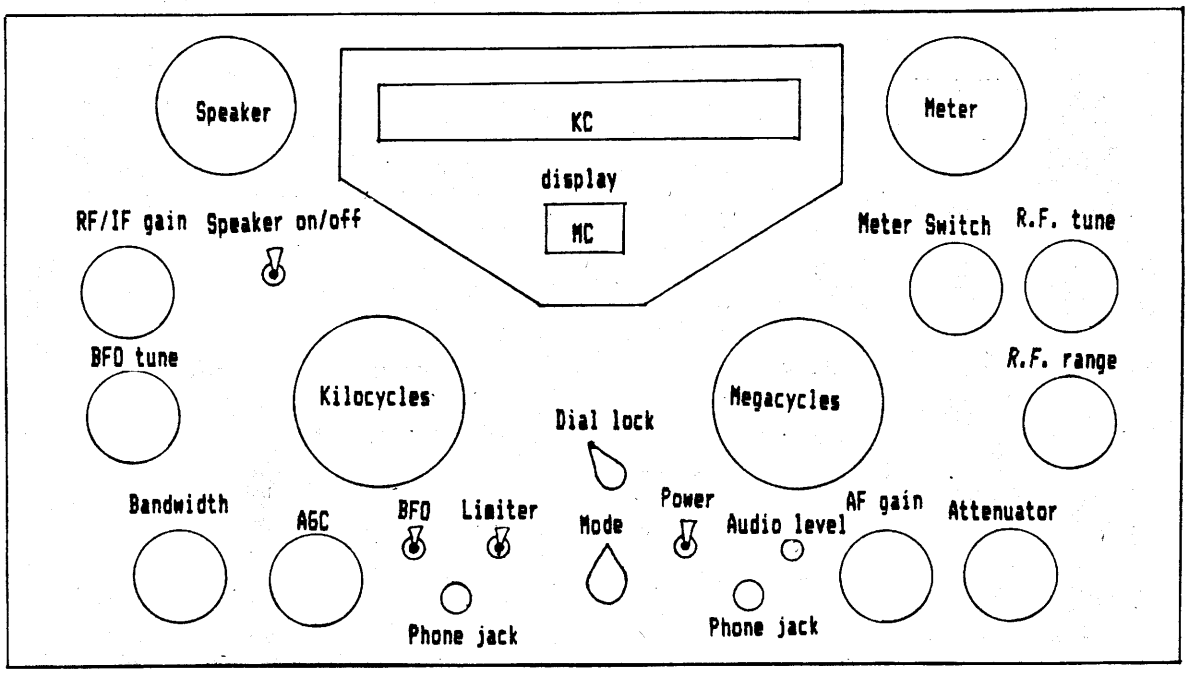
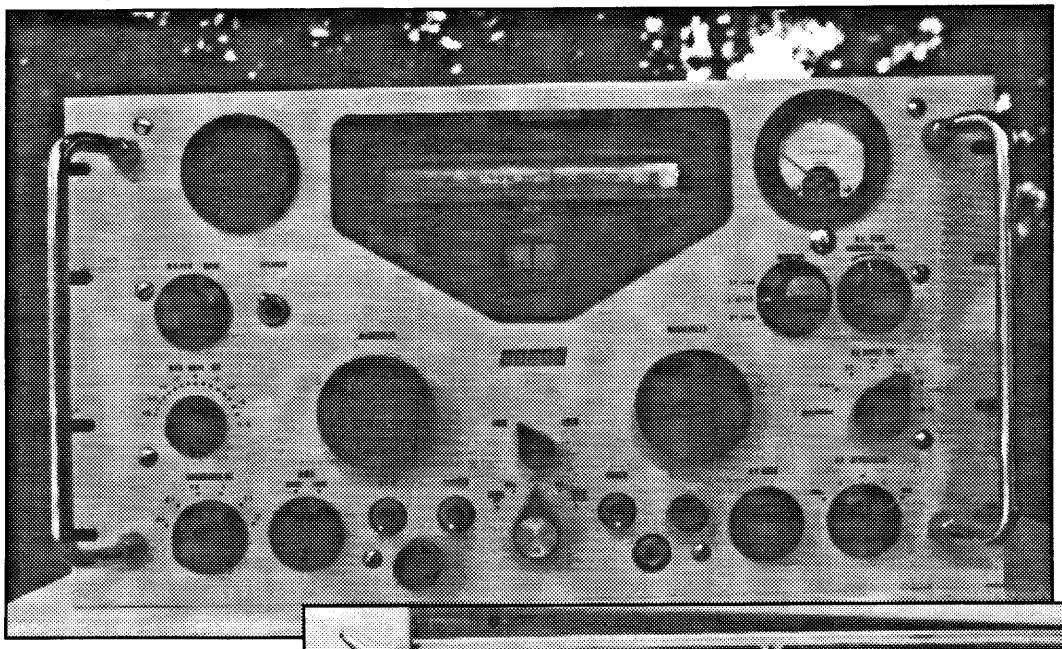
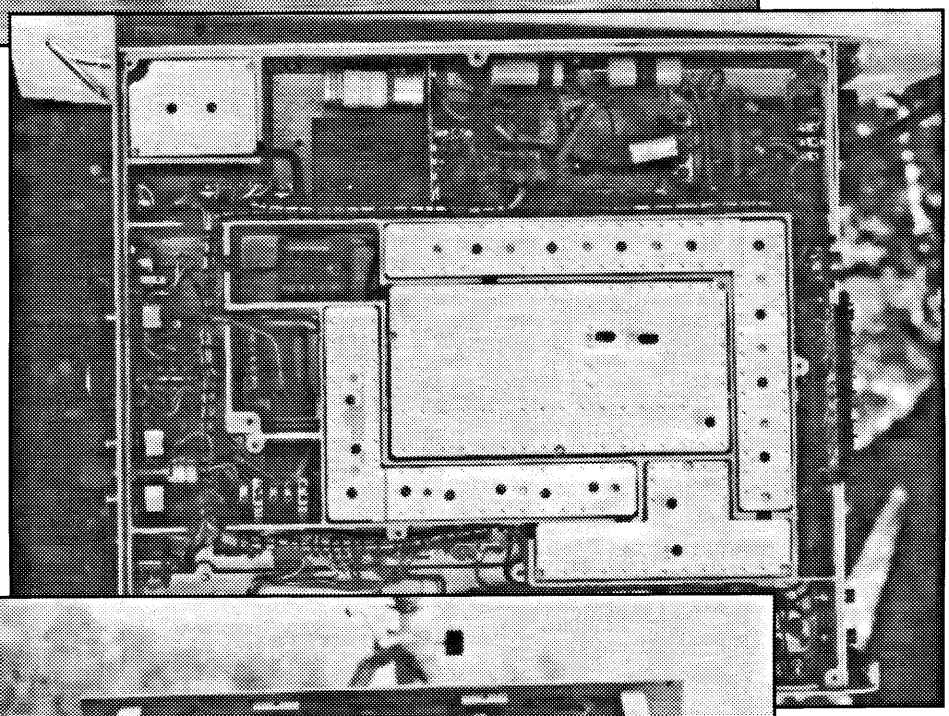


Figure 1

THE RACAL RA-17

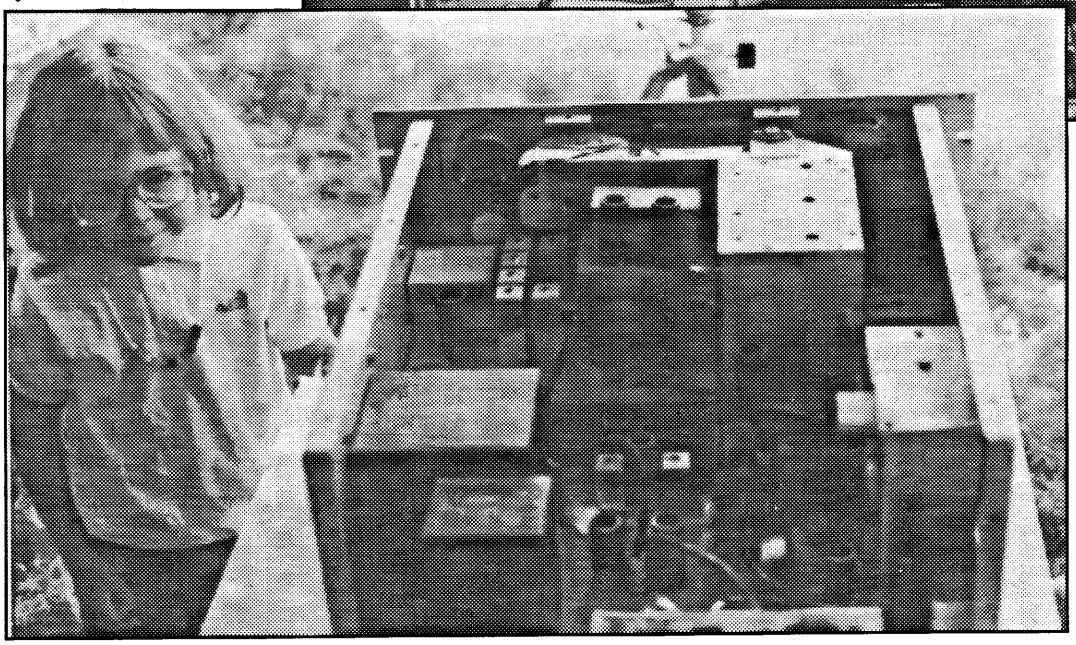


Front Panel

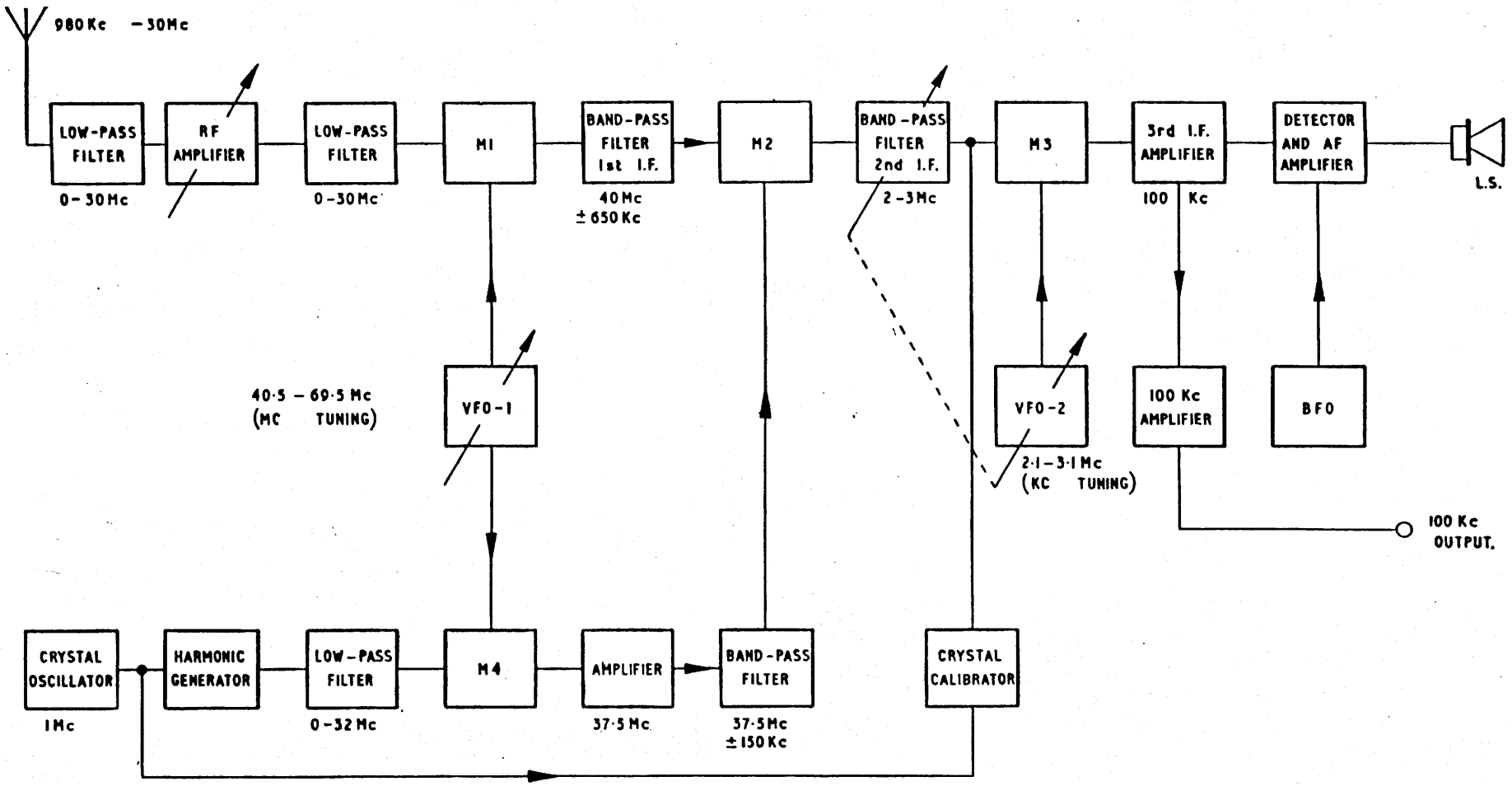


The bottom side

Photos and captions
by Staff



Teresa Portzer demonstrates the RA-17



BLOCK DIAGRAM OF THE RECEIVER

Figure 2

Some versions have other front panel controls, apparently for specialized user needs. Mine has a potentiometer with on-off switch in lieu of the second headphone jack. As near as I can tell, it functions as a fine tuning control (although it could conceivably be a form of passband or R-I-T tuning).

The rear of the receiver has a terminal strip with three fixed level audio outputs (3 mW, 600 ohms), one adjustable audio output (maximum level 10 mW, 600 ohms), the AGC line, and one speaker output rated for 1 watt into 3 ohms. The antenna input has an input impedance of 75 ohms. Mine had a type "N" connector, which I replaced with the more common UHF type connector. There are two BNC jacks with the output of the 100 kHz final i.f. stage. There is also an input for an external 1 MHz crystal oscillator (replacing the internal oscillator), an output for the internal 1 MHz oscillator, r.f. connections for an optional longwave converter (Racal model RA-137), and 220 volt DC output for the RA-137 or other external equipment.

The receiver takes a small amount of getting used to, but once you learn how to use it, it's easy to operate. It's ideal for those who like to tweak several knobs when tuning in a station. You won't enjoy this receiver if all you want to do is punch in the frequency and forget about it. First you set the megahertz control to the band you want to listen to, then use the kilohertz knob to select the rest of the frequency, then adjust the r.f. range and r.f. tune control. To tune in 1290 kHz, set the MHz control for "1" and the kHz control for "290". Then select the r.f. range control to "1-2 MHz", and adjust the r.f. tune control to peak the signal. It's possible to peak it on the wrong signal if there's a strong station on a nearby frequency, but with some practice and sometimes using the attenuator, you can get the hang of it. The other controls are more or less the same as you'd find on any other receiver.

Figure two is a block diagram of the receiver. Incoming signals pass through a 30 MHz low pass filter and a step attenuator. They then pass through an r.f. amplifier, which is tuned with a 7 position band switch and variable capacitor. The r.f stage uses a 6ES8 dual triode. The two halves of the tube are cascaded to form a two stage amplifier to "utilize the low noise high gain characteristics of the tube", as the manufacturer puts it. The r.f. stage output then passes through a second 30 MHz low pass filter. Racal was obviously very concerned about keeping stray VHF signals out of the receiver. The reasons will become ever more obvious in a moment.

The output from the r.f. stage is then mixed with the output of VFO-1 in a mixer stage utilizing a 6688, a tube known for its excellent intermodulation performance. The output from the mixer then passes through a 40 MHz first i.f. stage, which has a bandwidth of 1300 kHz.

In the meantime, the output from VFO-1 also mixes with harmonics of a 1 MHz crystal oscillator, which is amplified and filtered through a bandpass filter centered on 37.5 MHz. This signal then mixes with the output of the 40 MHz first i.f. in a second mixer stage, which also utilizes a 6688 type tube. The output of the second mixer is then about 1 MHz wide, centered on 2.5 MHz.

The above two paragraphs describe the process by which the receiver selects the "megahertz" tuning. The megahertz tuning knob tunes VFO-1. The output is mixed with a stable reference signal (a crystal oscillator), and in effect mixes twice with incoming signals, so the resulting output is quite reliable and stable. This is the Wadley loop.

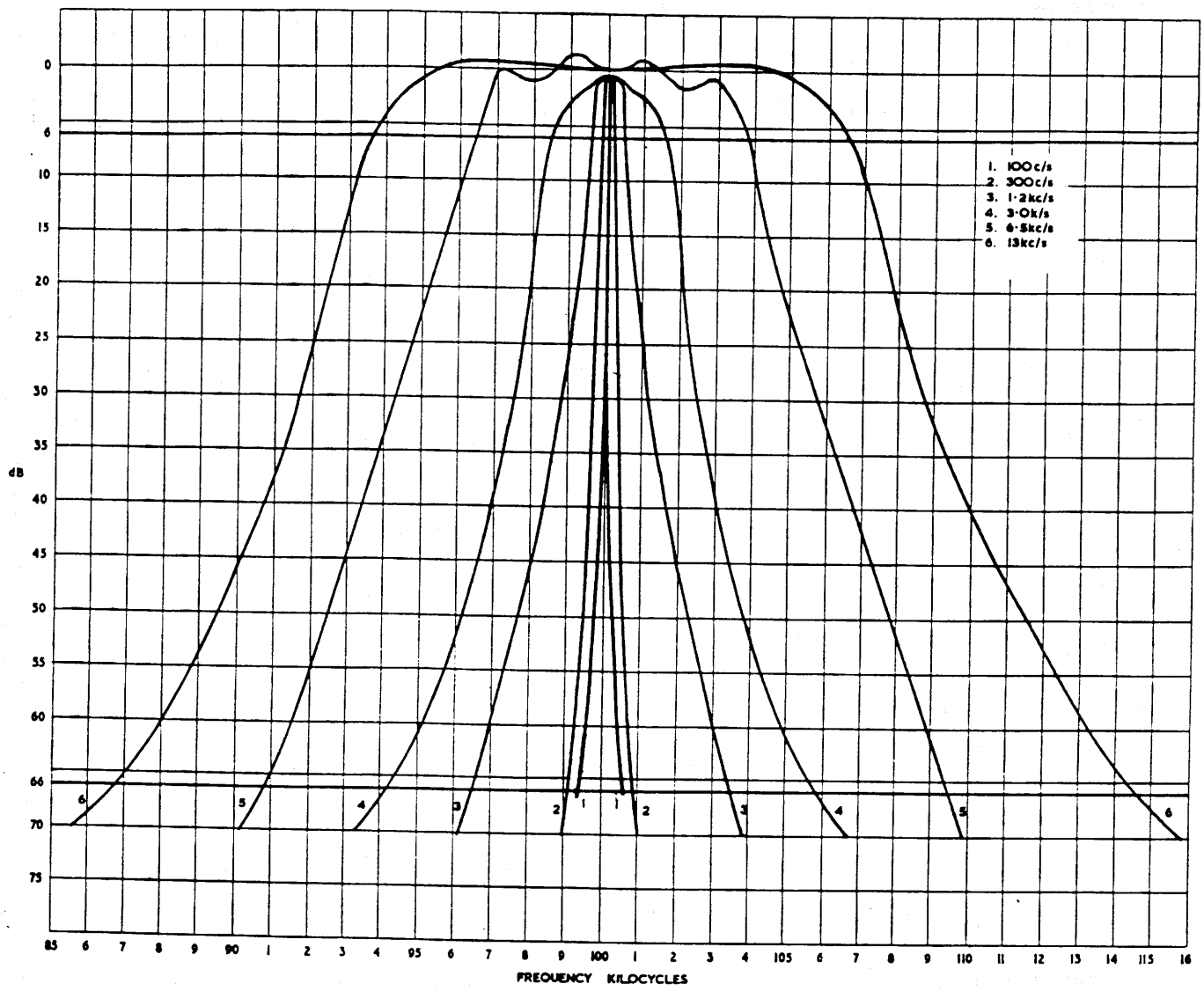
The second mixer down-converts the signals for the second i.f. stage, which is tunable from 2 to 3 MHz, and gives you the "kilohertz" portion of the tuning. The output from the second i.f. is down-converted to the 100 kHz third i.f., which in turn is followed by a diode detector for AM, and BFO or (on some versions) product detector for CW/SSB. There are also noise limiter, AGC, and audio output stages to complete the receiver. All this is done with 23 tubes. For those interested, Figure 3 is the selectivity curves from the receiver manual. It's possible to get better selectivity with mechanical, crystal, or ceramic filters, but for L-C type filtering, the bandpass is pretty good.

Because of the complexity of this circuit, Racal went to great lengths to filter and shield the heck out of everything in the receiver. A stray signal somewhere in the chain could have produced any number of spurious responses or other performance anomalies in the receiver. The receiver was, after all, built for government agencies and commercial users who had the money to spend. As a result, individual stages are physically compartmentalized in their own housing or a channel in the cast aluminum chassis. Extra band pass and low pass filter stages were included in the receiving chain. Feedthrough capacitors and ferrite beads were used extensively, particularly on power busses and wiring passing between stages.

HOW WELL DOES IT WORK?

My observations are based on published specifications, general impressions, and side by side comparisons with other receivers.

Sensitivity: The manual gives sensitivity as 1.5 uV for an 18 db signal to noise ratio, using a 30% modulated A2 (carrier modulated with a single tone) in a 3 kHz bandwidth, throughout its tuning range. By comparison, the published sensitivity for the five kilobuck Icom R-9000 is 1.0 uV for a 10 db S/N AM signal above 1.8 MHz and 6.3 uV from 0.5 to 1.8 MHz. In terms of original published specs, the edge actually goes to the Racal, especially on the medium wave broadcast frequencies. Moman found he could detect signals as low as 0.1 uV all the way down to 540 kHz. I have no reason to dispute the Racal's published sensitivity. In side-by side tests, the Racal, an FRG-7, and an HQ-180A were all able to receive the same stations on medium and shortwave. The Racal, however, had a tendency to load down a 4 foot medium wave loop, making it very difficult (and sometimes impossible) to peak signals on the AM broadcast band. The loop has since been placed in mothballs. A Radio West amplified ferrite loop works very well with it on medium wave.



TYPICAL SELECTIVITY CURVES

Figure 3

Selectivity: From a practical standpoint, I found the Racal's selectivity to be superior to that of an HQ-180A and an FRG-7 modified with a Collins 2.1 kHz mechanical filter. I thought the HQ-180A had good selectivity until I used it side-by-side with the Racal. When listening 10 kHz from strong locals on the AM broadcast band, such as KLSY-1540 and KMPS-1300, the Racal typically had listenable signals with occasional audio spikes from the locals, while the '180 had signals that were being severely trashed by the locals. This test was done by switching back and forth between the same antenna, with the HQ-180A selectivity set for 2 kHz and the Racal set at 3 kHz. Unfortunately, the next narrower selectivity setting for the Racal is 1.2 kHz, which is too narrow for useable listening. However, the 3 kHz selectivity setting is sharp enough to be more than acceptable under all but the most severe circumstances. Oddly enough, David Clark, who also owns both receivers, reached the opposite conclusion. The difference may be due to differences in performance of the individual receivers. My Racal is a later (C12A) version.

The performance compared with the FRG-7 was similar to that of the HQ-180A.

Audio Quality: Frequency response is specified as 250-6000 Hz +/- 4db, with the receiver selectivity in the 13 kHz position. Distortion is under 5 percent with 1 watt output. Overall, that's not bad for a communications receiver; the AM section of many stereo systems isn't that good. It's great for program listening with selectivity set at 6 or 13 kHz, and is still pretty good in the 3 kHz position, provided you use an external speaker. It gets even better if you run one of the external audio outputs into a stereo amplifier. The internal 2" speaker leaves something

to be desired in terms of quality, but it's listenable. In side by side tests, I found the audio quality better than from the HQ-180A, but not as good as from the FRG-7. (I'm one of the seemingly few people who thinks audio from solid state receivers is better than that from tube receivers!)

Overloading, spurious signals, etc: The receiver will overload on strong local medium wave signals if you don't have the r.f. stage tuned properly. Sometimes I have to set the attenuator for 20 db or more to prevent the loop or the r.f. tuning control from peaking on the wrong signal on the medium wave band. Once the two controls are properly peaked, I don't have a problem. Overloading doesn't appear to occur at all on shortwave.

There appears to be almost no internal mixing from strong locals on the medium wave (AM) broadcast band, using a longwire or other broadbanded antenna. The short wave bands are almost clear of spurious signals from local AM or FM broadcasters. I'm relatively close to several high powered FM & TV transmitters, so nearly all of my receivers have some spots on the dial with bits of scratchy audio from one or more local FM broadcasters. The Racal isn't totally immune to this problem, but the problem is less severe than other receivers I own.

Overall, the Racal is more immune to these problems than other receivers I have used. Given all the filtering and shielding in the receiver, this is not surprising.

Readout Accuracy and Stability: Wonderful, at least for a receiver of that vintage. You have to adjust the marker on the kHz readout to maintain complete accuracy from one end of the dial to the other. But it's less of a problem than on other comparable receivers I've used. The maximum variation I've encountered in any 1 MHz band is about +/-2 kHz. Obviously, the accuracy is not as good as a synthesized receiver, but that's the way it goes. I haven't noticed any problem with drifting; not surprising since the specified stability is 50 Hz/hour after warmup.

LONGWAVE CONVERTER

An optional longwave converter, the RA-137, was designed for use with the receiver. Most R-17s available on the used/surplus market seem to have the longwave converter included with it. The converter tunes from 10 to 980 kHz, and is designed specifically for use with the RA-17 and one or two other Racal receivers. The converter requires external DC power and a local oscillator signal provided by the RA-17 or another source, plus 120 volt AC power. The output of the converter is 2-3 MHz, and feeds directly into the input of the second i.f. stage of the RA-17. For reasons I haven't figured out, my LW converter becomes insensitive with a longwire as you tune lower in frequency, unless you use a matching network or a longer longwire. Nick Hall-Patch, however, has the same model converter (minus the RA-17) and hasn't experienced this problem with it. Otherwise, the longwave converter works well with little in the way of spurious signals from local AM broadcasters.

SUMMARY

This is a receiver that was ruggedly built. Mine is still in good condition after years and years of daily use by the FCC. By contrast, the tuning knobs on my FRG-7 and HQ-180A (since sold) have required frequent tightening to keep them from falling off. I've owned the receiver for about five or six years and have had only one problem with it, a capacitor that went bad. Otherwise, it's continued to work just fine.

The receiver provides excellent performance. Sensitivity, selectivity, overload immunity, and audio quality are all equal to or better than that offered by contemporary communications receivers costing several hundred dollars. It "handles" well, if you don't mind tweaking about four knobs every time you make a major frequency change.

The going price for the receiver is about $150-200. For that amount, you get a solidly built, good performing tube-type receiver with probably the best analog readout ever made. For slightly more money, you can buy a Sony 2010 with many of the modern bells and whistles: digital readout, memory channels, synchronous detection, compact size, portability, and other niceties. But from what I can tell, the Racal provides you with better sensitivity, overload immunity, and selectivity. The tradeoffs between this vintage of receiver and more modern receivers lie in cost, performance, and convenience features (such as digital readout and memory channels). A Racal RA-17 scores well on the first two considerations, but not the third. There is also the less tangible mystique which surrounds this and other older high quality receivers like the SP-600 and R-390A. Their appeal is similar to owning a vintage automobile. After all, a '57 Chevy lacks a lot of really nice modern features, but most of us tend to say "oh wow" when we see one in good condition.

I must admit I enjoy this receiver. It's lots of fun to operate a "classic" receiver, sort of like driving a '67 Mercedes.

REFERENCES

1 "A New Receiver Tuning Principle", QST, March 1958

2. Racal RA-17UA Operating and Maintenance Manual, Racal Communications Inc., 1967
3. Portzer, Bruce, "The Racal RA-17", IRCA DX Monitor, January 7, 1989, page 2.
4. Moman, Don, "Racal RA-17 Communications Receiver", CIDX Messenger, July 1984, page 33.
5. Whitacre, Bill, "Racal RA-17: The Ultimate or Just Another Old Receiver?", NASWA FRENDX, August 1978, page 3.