THE COLLINS 51J-4 RECEIVER

DALLAS LANKFORD

In this era of small, light weight, synthesized, high dynamic range, all solid state, microprocessor controlled communications receivers with hundreds of memories, why would anyone want a 30 year old, big, heavy, mechanically tuned, all tube receiver? If outstanding immunity from overloading (due to multiple tuned circuits before and after the RF amplifier), a wide choice of suitable AM bandwidths (approximately 6, 3.5, 3.1, and 2.5 kHz at 6 db down), bandwidth filters with shape factors of better than 1:2 and ultimate rejection of better than 60 db (typically better than 80 db), and excellent audio are important considerations to you, or even if you just want to own a classic piece of history, then the Collins 51J-4 might be the receiver for you.

The Collins 51J series of communication receivers (51J-1, J-2, J-3, and J-4) were designed in the late 1940's and built from about 1949 until the early 1960's. The 51J-4 was the fourth and last model of the 51J series, and was from about 1952 to 1962. It was the only one with provision for mechanical filters as standard equipment, although the others could be retrofitted with mechanical filters. In fact, a J-4 is essentially a J-3 with a mechanical filter conversion kit (and an internal IF gain control potentiometer R187). There were also military versions of the J-3 and J-4, namely the R-388 and R-388A respectively. Because of the similarity of the 51J series and R-388 series receivers, I have structured this review of the 51J-4 so that it can serve as a review of them all. In other words, this is actually a generic review of the 51J series of communications receivers, with additional information specific to each of the models, including my hands-on experiences with the J-4.

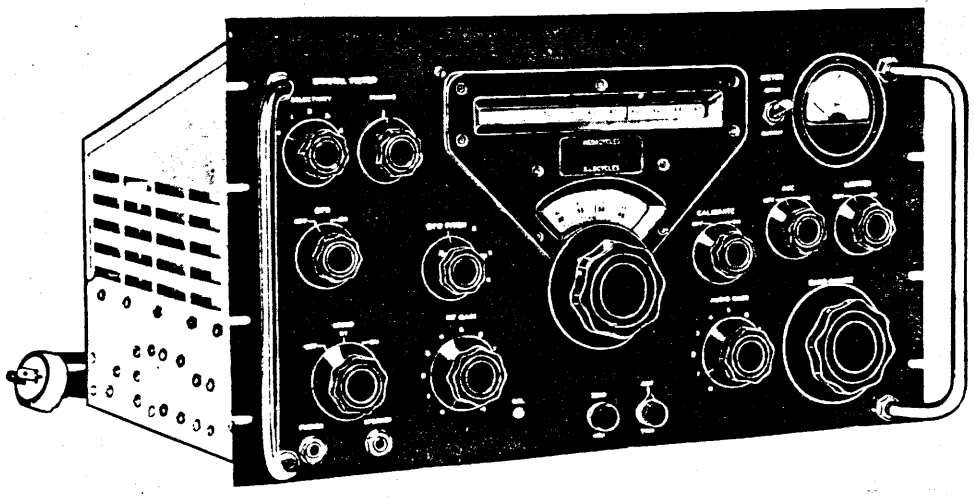

FIGURE 1. Sketch of the 51J-4

The 51J series receivers tune 0.5 to 30.5 MHz in 30 bands of 1 MHz each with about 30 kHz of over range at each end, beginning with band 1, 0.5-1.5 MHz, and ending with band 30, 29.5-30.5 MHz. The tuning rate is 100 kHz per turn of the KILOCYCLE TUNING knob, or 10 turns per MHz. The front panel controls are RF GAIN, AUDIO GAIN, BFO ON-OFF, CALIBRATE ON-OFF, BFO PITCH, AVC ON-OFF, LIMITER IN-OUT, ANT. TRIM, CRYSTAL FILTER SELECTIVITY 0(off)-1-2-3-4, CRYSTAL FILTER PHASING, OFF-ON-STANDBY, BAND CHANGE, KILOCYCLE TUNING, ZERO ADJ., METER INPUT (signal level)-OUTPUT (audio level), CAL. (100 kHz calibrator screwdriver adjust), and in the J-4 a mechanical filter selector 1-3-6 (1.4, 3.1, and 6.0 kHz bandwidths) for optional mechanical filters. A J-4 could be purchased with 3, 2, 1, or no mechanical filters. When no mechanical filters were used, a J-4 was equipped with a plug-in IF transformer and the 5-position crystal filter was used for selectivity. The J-1 did not have an antenna trimmer or front panel

calibrator screwdriver adjustment. I do not know about the J-2. The J-3 and R-388 controls are identical to the J-4 except for the mechanical filter selector and R187 IF GAIN adjustment, a slotted shaft pot with lock nut mounted on the chassis beside the BFO shaft. The J-4 tubes are (2) 6AK5, (3) 6BE6, (8) 6BA6, (2) 12AX7, 12AU7, 6AQ5, 5V4, and OA2. The 51J series receivers weigh about 43 pounds without a cabinet, and require 10.5" high and 13.5" deep mounting space. The width is standard 19" rack mount. A front panel artist's sketch, front panel line drawing, and block diagram are provided in Figures 1, 2, and 3.

The front panel artist's sketch, taken from a J-4 manual, does not show the front tag. I modified the line drawing, taken from a R-388 manual, to show the position of the front tag above the escutcheon, and to show the mechanical filter selector lever. Mechanical filter selection is accomplished with a lever and hollow shaft arrangement. The BFO pitch shaft passes through the hollow mechanical filter selector shaft, and the mechanical filter selector lever is partly behind the BFO knob. The antenna trimmer was also added as an afterthought (the J-1 had none); note the small knob and poor placement. Otherwise, the controls are well placed and easy to use. The dual function S-meter reads both signal level (0 to 100 dB) and audio level (-10 to +6 dB relative to 6 mW). The meter switch is a momentary toggle switch which normally selects signal level.

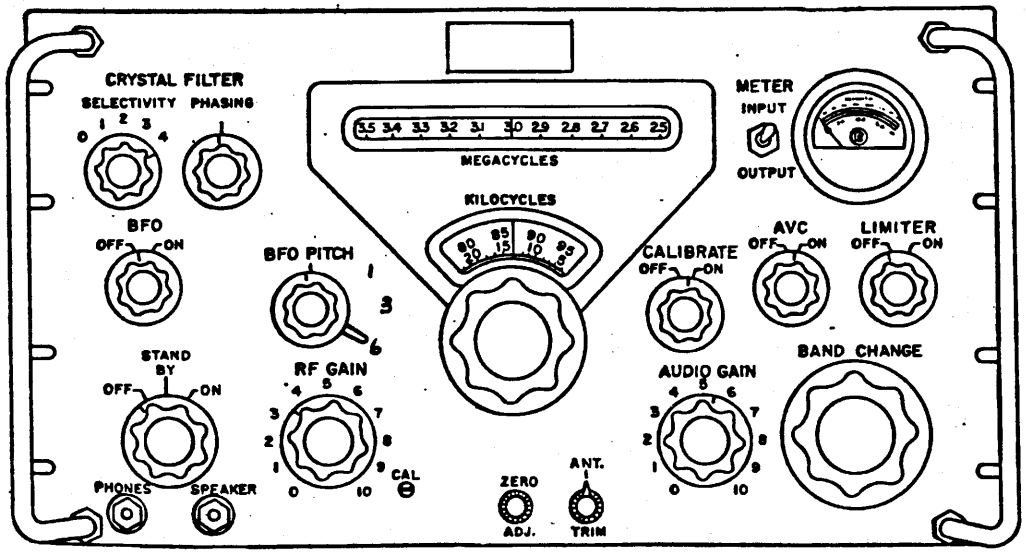

FIGURE 2. 51J-4 Front Panel

The block diagram shows the general circuit features of the J-4. It is triple conversion on band 1, with crystal controlled first and second oscillators, single conversion on bands 2 and 3, and double conversion on bands 4 - 30 with crystal controlled first oscillator. The crystal controlled oscillator(s) and temperature compensated PTO (VFO) make the 51J series receivers exceptionally stable after they have warmed up for about an hour. When used in a centrally heated and cooled house or apartment, drift is typically no more than a few Hz per day.

How does the J-4 stack up against our favorite boat anchor, the R-390A? Quite well, and in some cases slightly ahead. The J-4 has no expensive and difficult to find ballast tube. Based on my experience with a sample of two J-4's, they seem to have somewhat less warm up drift then 390A's I have used. Once warmed up, both are rock solid. The 43 pound J-4 weight is a definite plus, about half that of a 390A. J-4 audio output is 4 ohms for speakers or 600 ohms for line output, and J-4 audio quality seems better than 390A audio quality. One J-4 I have used has annoying spurs which seem to be IF feedthrough and harmonics at 0.5, 1.0, 1.5 MHz, and so on, with decreasing intensity up to about 4.5 MHz. The 500 kHz harmonic spurs are caused by missing top and bottom dust covers (because the spurs go away when I use dust covers borrowed from another J-4). So I recommend that you avoid any 51J series receiver without dust covers.

Neither the J-4 nor the 390A has a clear win with regard to selectivity bandwidths. The 6.0 kHz J-4 filter seems optimal for pleasure listening on the SW bands or when there is little or no adjacent channel interference. (I wish the 390A had a 6 kHz filter in place of its 8 kHz filter.) The 3.1 kHz J-4 filter is adequate for difficult DX situations. The J-4 crystal filter may be switched off (position 0) or set to bandwidths of approximately 3-4 kHz, 1.25-1.6 kHz, 0.5-0.7 kHz, or 0.3-0.5 kHz (positions 1-4) in conjunction with the 6.0 kHz mechanical filter. Narrower bandwidths are obtained with the 3.1 kHz and 1.4 kHz mechanical filters. For example, with the 3.1 kHz mechanical filter, the J-4 manual specifies the crystal filter position 1 selectivity as 2.25-2.75 kHz. So you

have a wider choice of selectivity options than you might think. There is one big advantage to the J-4 mechanical filters. They are plug-in style, as opposed to the solder-in style of 390A mechanical filters. So it is much easier to replace a J-4 mechanical filter if one goes bad. The J-4 crystal phasing control is the best I have used. It is better than the standard Hammarlund crystal filter, and functions just like a notch filter, which gives the J-4 an edge over the 390A in some situations.

The J-4 has only one AGC attack and release time, and it is difficult to convert it to a SSB receiver and retain its AM capabilities. The J-4 does not have a narrow audio filter, though one could be added outboard. The J-4 BFO pitch knob is not calibrated, as it is on the 390A, so it is not as easy to set the BFO frequency at the edge of the filter bandpass. Thus, a 390A with Cornelius SSB mod is a clear winner in the CW and SSB categories. The single AGC attack and release times may make the J-4 less attractive to some SWL's because to obtain acceptable reception quality for strongly fading signals, either the RF gain must be reduced or the AGC must be turned off and manual RF gain control used. In fact, the 0.05 second attack and release time is not satisfactory for even moderately fading SW signals. So a 390A is a clear winner with its 3 attack and release times. However, I don't consider the J-4 AGC problem to be a serious defect. It doesn't bother me to reduce the RF gain or use manual gain control.

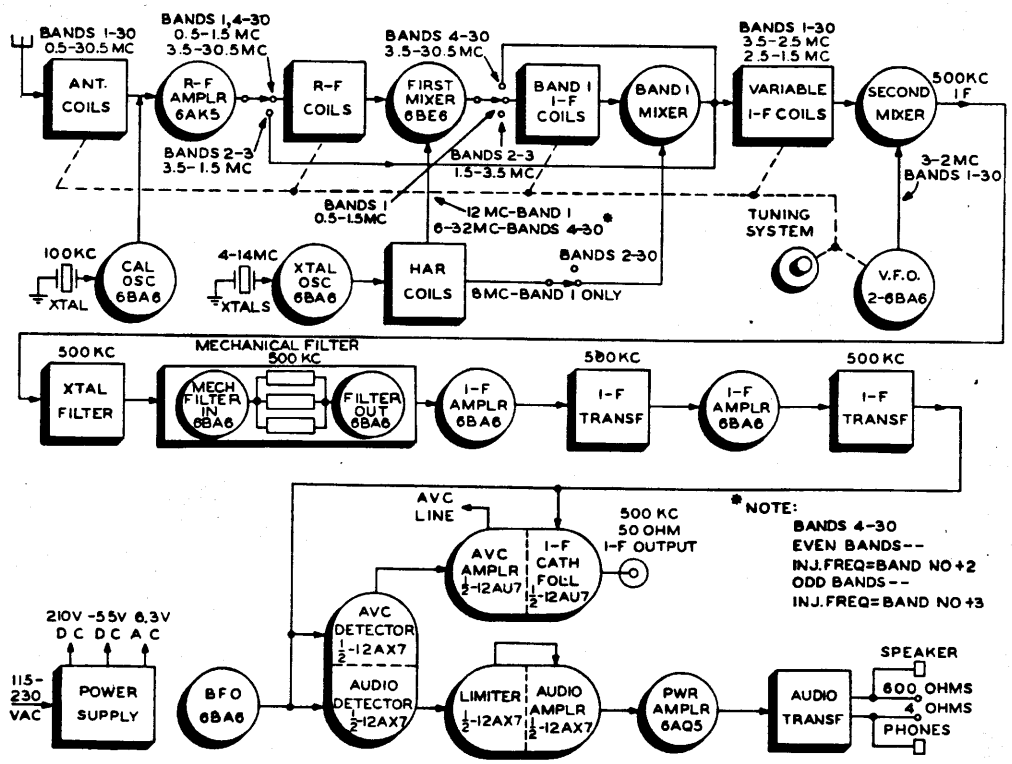

FIGURE 3. 51J-4 Block Diagram

Both J-4's I have used have a slight amount of backlash in the KILOCYCLE tuning which I believe is due to the coupler which connects the KCS and PTO shaft. The coupler resembles a 390A Oldham coupler, but without anti-backlash spring (or spring shafts in case you wanted to add a spring), and with set screws rather than non-mar clamps. For ease of PTO adjustment with no backlash, the 390A comes out ahead.

The PTO end points are adjustable for both J-4's and 390A's. This feature is important because as some PTO's aged, the 1 MHz tuning range expanded, resulting in inaccurate frequency readings. For reasons which I will not discuss here, 390A PTO end point alignment is much easier then J-4 PTO end point alignment. In addition, I have never encountered a 390A PTO which could not be aligned, and initially some of them had end points expanded by as much as 12 kHz. While I was writing this review, I had the opportunity to work on a third J-4 with a PTO which had end points spread 15 kHz, and which could not be aligned. Some library research revealed that this is a common problem with 51J series PTO's. For example, a December 1969 *Ham Radio* article,

"New Life For The Collins 51J Receiver VFO," stated that many 51J PTO's had spread beyond the ability of the end point adjustment inductor to bring back into alignment, and discussed a difficult procedure for modifying some 51J PTO's to extend the end point adjustment range. Because the end points of the PTO's in my two J-4's are within 0.5 kHz of exact alignment, and have plenty of range left in their end point adjustments, I have concluded that there are two kinds of 51J series PTO's, "good" and "bad." Consequently, I would advise against buying a 51J series receiver with a PTO which has end points spread more than 2 or 3 kHz.

Both have IF outputs, 455 kHz for a 390A and 500 kHz for a J-4. So you can add external IF processing, like a Hammarlund HC-10 converter which would give you more bandwidths and SSB with a product detector. The J-4 has plastic knobs, plastic KCS dial, and a Bakelite drum covered with a decal for the MCS dial. The J-4 MCS dial is difficult to read because of poor bulb positioning and glare reflected from the glass window. Also, the J-4 MCS dial decal commonly flakes off. For viewing ease and dial durability the 390A is by far the winner.

Most J-4 front panels are St. James gray (it looks black to me) with white silk screened lettering. The paint is finely textured, somewhat like black wrinkle varnish which the military used on much of its gear. The J-4 was also available in a light gray, "FAA green," and perhaps other special order colors. I have not seen any of the other colors, but I doubt they are as appealing to the eye as the St. James gray. A St. James gray J-4 is a black beauty.

Collins made a matching cabinet for the J-4, but apparently few J-4's were originally purchased with one. I liked my first J-4 so much that I bought it a new Bud cabinet. Unfortunately, the cabinet required modifications (which I will not describe here) to provide adequate ventilation and proper alignment of the rack mount screws. Because of the cost, about $150 for a new Bud cabinet, and the labor involved to modify the cabinet, you are better off getting a J-4 with a matching cabinet even if it means a lengthy search and paying a premium price.

DXers generally use headphones. But nowadays most headphones are low impedance, while most tube receivers have high impedance headphone outputs. The J-4 manual rates the headphone output at 4 ohms. That is probably a mistake, because in the same sentence the manual rates the speaker impedance as 600 ohms. You can use low impedance headphones directly with a J-4, but you will hear annoying 60 Hz hum with no antenna connected and the audio gain set at minimum. At normal listening levels there will be enough residual 60 Hz hum to cause fatigue after long DX sessions. To eliminate this residual hum, I match audio impedances with a Calectro D1-740 Universal Tube Type Output Transformer which has primary taps of 1000 or 4500 ohms, and secondary taps of 4 or 8 ohms, and is rated at 50 - 10,000 Hz, 4 watts. Any audio transformer with similar specifications could be used. The transformer is mounted in a small metal box, with the 1000 ohm primary and 8 ohm secondary wired to standard 1/4" mono headphone jacks. Radio Shack 6' audio cable with standard 1/4" headphone plugs are used to connect my home made impedance matching adapter to my receivers. I currently use Radio Shack Lightweight Monaural Headphones, catalog no. 20-210A, 80 milliwatt, 20 - 20,000 hz, 16 ohms. With the impedance matching adapter I get hum-free, near hi-fi quality audio using the 6 kHz bandwidth filter. Audio quality for narrower bandwidths is as good as any I have heard. The headphone impedance problem is not unique to the J-4. I have used an impedance matching transformer with many tube type receivers, and it has always improved audio quality, sometimes dramatically.

An excellent speaker for use with a J-4 is the Collins Type 312-A, Model 109. It measures 14.75" by 12" by 9.625" (W by H by D), is all metal, is painted St. James gray, and has a 10" speaker. The resulting audio quality is as good as any I have ever heard from a communications receiver speaker, with the exception of a R-390A driving an AMSD-1 phase locked loop synchronous product detector followed by a hi-fi amplifier and hi-fi speakers. In fairness to other receivers, much of the audio quality is due to the 312-A speaker. For example, with the 312-A speaker an HQ-180A sounds almost as good as a J-4. And the same is true for a 390A using the 312-A and an impedance matching audio transformer connected to the local audio output. If you can't find a 312-A speaker, I would recommend a Radio Shack speaker, one rated at 8 ohms and about 10 watts. I have used an ugly Radio Shack #40-1227A Indoor/Outdoor speaker in a plastic case for about 8 years. It sounds almost as good as a 312-A.

The J-4 was not designed as a SSB or CW receiver, but rather as a premier AM receiver, which it still is. Nevertheless, the J-4 can be used effectively for SSB or CW reception if you are willing to turn down the RF gain, turn up the audio gain, and use the RF gain control to adjust the signal levels of SSB or CW signals. For best SSB reception you should adjust the BFO pitch so that the BFO frequency is at one or the other edge of the mechanical filter skirt depending on whether you are listening to USB or LSB.

Tuning SSB and CW signals with a J-4 is inconvenient because you must constantly adjust controls as you tune around. Or is it? The J-4 has a 500 kHz IF output jack which can be used to feed SSB converters, such as the Hammarlund HC-10. Because the IF output of a J-4 is a whopping 12 volts peak to peak you will need to add a 2.7 K ohm half watt resistor in series with the J-4 output and HC-10 input to prevent overloading the HC-10. With the dropping resistor, a J-4 and HC-10 combination is excellent for SSB and CW, and enhances AM reception. For

those of you who are not familiar with the HC-10, it is essentially the IF strip and audio circuitry of a Hammarlund HQ-180, and includes a notch filter, bandwidths of 6, 4, 3, 2, 1, and 0.5 kHz, three AGC release times, IF vernier fine tuning, and a product detector.

A tube type receiver like the 51J-4 often beats a solid state receiver in two DXing situations: DXing signals which are at or in the background noise (on all bands), and DXing the MW band. For example, John Tow said in his *Proceedings '88* review of the R-390A, "An in-the-noise signal on another radio will have a slightly improved signal-to-noise ratio on the '390; the audio is cleaner, making reception of difficult signals less tiring." I agree with John. I don't know why the R-390A is better than all other receivers in this regard, but it is. I'll take John's remark one step farther. Good tube receivers, such as the J-4, generally produce slightly better audio for signals at or in the noise than good solid state receivers. I am told that the NRD-525 is the equal of any tube type receiver in this regard, but I'll have to hear it to believe it (excuse me, 525 owners).

To illustrate how a tube type receiver can beat a solid state receiver for MW DXing, let me quote from Chuck Hutton's Drake R7 Review in *DX News* **47**, 1 (Oct. 8, 1979). "The second criticism is their choice in broadbanding the input state at MW frequencies. While this is OK at HF where no practical, attainable amount of input selectivity will protect the receiver from strong signals only 10 or 20 kHz away, this is not the case at MW freqs. A good preselector has enough selectivity to be of great help to the urban MW DX'er. In practical terms, this means that the R7 was able to defeat the 390A between 720 and 800 kHz where super-local WSB is a terror, if and only if the R7 was tuned so close to WSB that the 390A's input selectivity was of no use. That is, 740 was DXable on the R7 but not on the 390A but 720, 730, 770, and 780 were generally better on the 390A. The broadbanded RF input on the R7 also led to a handful of spurs from locals that were totally unheard on other receivers. This was true only on the Beverages, so it is possible that under less severe conditions the problem may disappear." The other receivers mentioned above included a SPR-4, a FRG-7 with 3 kHz filter, a HQ-129X with 2 mechanical filters, a HQ-180A, and a RF-4800. A J-4 has three tuned circuits before the first mixer, just like a 390A, so a J-4 can be expected to perform similarly in high RF urban environments on the BCB.

Another category where a J-4 often beats a solid state receiver (at least an unmodified one) is IF filtering, including number of AM bandwidths, appropriate bandwidths, and skirt selectivity. For example, I was flabbergasted when I read John Bryant's criticism of the stock filters in a draft of his NRD-525 review. I think I might explode if I fired up my new $1200 receiver and discovered that the 6 kHz wide filter let all sorts of QRM under the filter skirts on both sides, and the 2 kHz narrow filter was unacceptably mushy with ECSS techniques. I have not measured stopband (ultimate) rejection for the J-4 mechanical filters, but I can assure you that a J-4 front end will wilt long before adjacent channel interference makes it through the skirts.

The dynamic range of a receiver is an important measure of its ability to handle strong signals. However, the dynamic range values given by manufacturers and reviewers often do not tell the complete story. For example, several years ago as part of their catalog, Sherwood Engineering included a number of laboratory measurements for many top receivers. There it was pointed out that receiver manufacturers typically measure dynamic range with two signals spaced 20 kHz or more apart. However, in difficult AM listening situations, carriers are much closer together, sometimes as little as 2 kHz apart. So Sherwood measured the dynamic range twice for each receiver, once at 20 kHz, and a second time at 2 kHz test signal separations, and called these measurements wide and narrow dynamic ranges. The results were revealing. For an R-390A the wide and narrow dynamic ranges were 81 dB and 79 dB respectively, while for an NRD-515 they were 95 dB (wide) and 77 dB (narrow). Both an R-70 and an R71A measured 86 dB (wide) and 62 dB (narrow). A Drake R-7 measured 97 dB (at 100 kHz spacing) and 75 dB (narrow). The J-4 was not included in Sherwood's list.

To determine the dynamic range of my J-4's and other receivers, I built a hybrid coupler and measured their dynamic ranges. One J-4 measured 80 dB (wide), and the other measured 83 dB (wide) at 1200 kHz. Strangely, I got much lower narrow dynamic range measurements for my 390A than reported by Sherwood, and lower wide dynamic range measurements on the higher (SW) bands for all of my receivers. Perhaps my home made hybrid coupler does not have the high port isolation required for narrow dynamic range measurements or for wide dynamic range measurements at higher frequencies. But in any case, with regard to overloading, a J-4 is generally the equal of any solid state receiver, and perhaps slightly superior for DXing in some difficult situations, such as for MW splits.

If you hear it, it's there. That's what Kevin Atkins said about the R-390A in *Proceedings 88*, referring to immunity from overloading. A J-4 has a dynamic range virtually identical to a 390A, and consequently is similarly free from overloading. However, excellent strong signal handling performance is not sufficient to guarantee that if you hear it, it's there. Images, IF feedthrough, IF harmonics, spurious mixing products, and other phenomena can produce a phantom signal where there should be none. A cryptic line in the J-4 manual (Section 1.3, Reference Data), "Spurious Frequency Response: down at least 40 dB," prompted me to measure J-4 spurious frequency responses.

With a J-4 tuned to various frequencies in band 1 (.5 - 1.5 MHz), spurious responses varying from 55 to 75 dB down were found in the 2.5 - 3.5 MHz frequency range. Study of the J-4 conversion scheme suggested that band 1 spurs are IF feedthrough to the variable second IF (3.5 - 2.5 MHz), or images of the variable first IF (11.5 - 10.5 MHz) due to a spurious 8 MHz oscillator injection, or both. A loop antenna, which is used by most serious MW DXers, would eliminate any such spurs. Except when using precision equipment to generate and measure them, I have never heard any band 1 spurs, even with a long wire antenna. For bands 2 - 7, all spurs were down about 95 dB or more. This means you should never hear a signal on a J-4 between 1.5 and 7.5 MHz which is not really there, except with a signal generator in a laboratory setting. For bands 8 - 15, all spurs were down about 70 dB or more. This means it is unlikely that you would ever hear a signal on a J-4 between 7.5 and 15.5 MHz which is not really there. The spurs for bands 4 - 15 are all images of the variable first IF (even bands: 2.5 - 1.5 MHz, odd bands: 3.5 - 2.5 MHz). In my opinion, the 31 meter band is the only international SW broadcast band where images might be a problem, and then only if you lived next door to a ham who operated a kilowatt transmitter in the 20 meter ham band. I have searched for 20 meter images in the 31 meter band, but have never found any. For bands 16 - 30, the spurs are stronger and more numerous. Not only are there images, like those for bands 4 - 15, but also there are other strong spurs closer to the fundamental frequency. I did not attempt to determine the causes of the additional spurs, or to measure the levels of all spurs for bands 16 - 30. Although some were no more than 45 dB down, I doubt that they would be a problem for DXers in most listening situations because there are few S-meter pinning signals above 15.5 MHz. However, if total freedom from spurious responses in the 15.5 - 30.5 MHz frequency range is an important consideration for you, then a J-4 may not be adequate for your needs.

It is curious that 51J-4's have not been more popular with BCB and SW DXers. One reason may be price. In Ray Moore's book, *Communications Receivers*, a price of $1099 is stated, but no year is given. Ray told me that the $1099 price is for 1955, and that his records show J-4's sold for $1208 in 1958 and $1464 in 1962. Those prices are well over twice the price of an HQ-180A during the period both were produced. Even today a 51J-4 often commands a premium price, especially if it is complete and in excellent physical and electrical condition. East coast hamfest prices are typically $300 - $400 for a J-4 in good condition with all three mechanical filters, but without the matching cabinet. Hamfest prices tend to be less in some other regions, and considerably less for J-4's in below average condition or missing some of the mechanical filters. In addition to hamfests, J-4's are bought and sold through the Ham Trader Yellow Sheets; send a SASE to P.O. Box 15142, Seattle, WA 98115 for subscription information.

Some of the information in this review was taken from my "Collins 51J-4 Review" which appeared in *DX News* **56**, 1 (Oct. 3, 1988), revised version in *The Hollow State Newsletter* **20** (Fall 1988), from my "Collins 51J-4 Technical Notes" which appeared in *DX News* **56**, 13 (Dec. 26, 1988), and from my "More Collins 51J-4 Technical Notes which has been submitted to *DX News* for publication. Reprints of my *DX News* articles are available from the National Radio Club, Publications Center, P.O. Box 164, Mannsville, NY 13661; send them a SASE for ordering information.

Owning a classic tube receiver like the J-4 is not for everyone. For openers, *you* will probably have to overhaul, repair, align, and maintain it because there is virtually no one who does this type of work any more as a business. Before you rush out and buy a J-4, I strongly urge you to get copies of my longer reviews mentioned above. They include detailed descriptions of special tools (such as spline wrenches, which are needed to do even minor maintenance and repairs and without which you can strip set screw sockets), RF (front end) alignment, IF alignment, dial cord replacement, PTO end point adjustment, replacement of mechanical filters (including types, availability, and prices), additional information on dynamic range, Bud CR-1740 cabinet modifications, and more.