Product Review Column from *QST* Magazine

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Conducted By Paul K. Pagel,* N1FB

Icom IC-740 HF Transceiver

ICOM IC-740 HF Transceiver, Serial No. 01721

Manufacturer's Claimed Specifications	*Measured in ARRL Lab*
Frequency coverage: 1.8-2.0, 3.5-4.0, 7-7.3, 10.0-10.5, 14.0-14.35, 18.0-18.5 (receive only), 21.0-21.45, 24.5-25.0 (receive only), 28.0-29.7 MHz.	As specified.
Modes of operation: Ssb, cw, RTTY and fm (with an optional fm unit installed).	As specified; the fm unit was not supplied with the review unit.
Readout: 6-digit, 100-Hz resolution.	1/2-in. high, 6-digit fluorescent-blue display.
kHz/turn of knob: Not specified.	100/10/1.
Frequency resolution: 100 Hz.	As specified.
Backlash: Not specified.	Nil.
RIT range: Not specified.	± 800 Hz.
S-meter sensitivity: Not specified.	W/o preamp (band, μV) — 80 m, 9.6; 40 m, 15; 20 m, 16; 15 m, 13.5; 10 m, 11.
Transmitter rf power input: 200 W cw; 200-W PEP, ssb; adjustable.	Greater than 100-W output, except on 160 m (90 W), 80 m (95 W) and 40 m (95 W).
Harmonic suppression: Better than 50 dB.	−57 dB (see photo).
Third-order IMD: Not specified.	−30 dB (see photo).
Spurious suppression: Better than 50 dB.	−63 dB (see photo).
Receiver sensitivity: Less than 0.15 μV for 10 dB S+N/N with preamp on; 0.3 μV for 10 dB S+N/N with preamp off.	Receiver dynamics measured with optional FL-45 500-Hz cw filter:

	Preamp Off	*Preamp On*
Noise floor (MDS) dBm:	−133	−141
Blocking DR (dB):	130	125
Two-tone, 3rd-order IMD DR, worst case (dB):	95	94
Third-order intercept:	+ 9.5	− 0.5

Color: Black and gray.
Size (HWD): 4.2 × 11.7 × 14. in. (107 × 297 × 356 mm).
Weight: 17.6 lb (8 kg).

Amateur Radio equipment has changed drastically in the past decade! Back in 1973, equipment designers were toiling over how to improve such things as oscillator stability and image rejection. Also, their efforts included trying to produce high-performance, low-cost transceivers for the limited-size amateur market. In the late '70s, this market mushroomed, largely because of the influx of disheartened CB operators. This increase in market size allowed manufacturers to develop quality equipment for sale at a reasonable price. Also, during this period, the state of the art in communications electronics equipment improved significantly, but there were still deficiencies, specifically in receiver performance.

In much of the Amateur Radio literature there was talk of improving receiver dynamic range.[1] The ability of a receiver to tolerate large signal levels is important to the consumer. Manufacturers responded to this market demand and, by 1980, were producing equipment with excellent dynamic-range figures.

The challenge of the '80s will be to produce a fully synthesized hf transceiver that is low in cost and has a low-noise frequency synthesizer. Much of today's amateur equipment uses digital frequency synthesis; the advent of LSI synthesizer and microcontroller (dedicated computer) ICs greatly simplifies circuit designs. But the new problems associated with synthesizer circuitry are by no means simple.[2] Digital frequency synthesizers inherently generate noise that is superimposed on the output signal; this noise can mask weak signals present in a receiver passband or cause QRM to nearby stations while transmitting.

The IC-740 features most of the "bells and whistles" found on competitive products, small size and all-band coverage. The most important feature, in my opinion, is the high-performance, low-noise receiver section.

Basic Features

Receiver

Frequency coverage of the transceiver includes all the amateur bands (WARC bands, too!) from 1.8 through 30 MHz. Passband tuning (PBT) and i-f shift (IF) functions are adjusted by front-panel controls, although they are not available independently. The agc decay time is set by a potentiometer rather than a switch; this should satisfy those who are not happy with a "two-speed" control. Two noise-blanker switches control the blanking level and the pulse width — narrow for ignition-type noise and wide for "woodpecker-type" QRM. Other unique receiver functions include an rf notch filter, an audio squelch control that works in all modes, an audio tone control and a switchable 10-dB gain broadband preamplifier. The remaining controls and jacks are listed in Table 1.

Transmitter

Emission type is selected by the MODE switch, which can select between NORmal or REVerse sideband (lsb on 1.8 through 10 MHz, usb on 14 through 28 MHz), cw, fm (with the optional fm unit installed) or RTTY. True fsk is used during RTTY operation; the user must supply a pair of "dry contacts" to key the radio. On ssb, an rf-type speech compressor circuit can be activated by the COMP button. A new feature cropping up these days is an rf-power control that works in all modes; the '740 includes this

[1]W. Hayward, "More Thoughts on Receiver Performance Specification," Technical Correspondence, *QST*, Nov. 1979, p. 48, and Burwasser, "Reducing Intermodulation Distortion in High-Frequency Receivers," *Ham Radio*, March 1977.
[2]A. Helfrick, "The Universal Synthesizer," *QST*, Sept. 1981.

*Assistant Technical Editor

Table 1
Additional Front- and Rear-Panel Controls and Connections

Front Panel	*Rear Panel*
METER switch	Accessory socket (Molex)
VOX switch	Power socket (Molex)
VOX DELAY control	Antenna connector (PL-259)
VOX GAIN/KEYER speed control	Memory backup terminal
POWER switch	T-R control jack
T-R switch (MOX)	External alc jack
+0.5-MHz switch (for 10-meter operation)	Transverter jack (T-R)
AF GAIN control	Receiver input jack
RF GAIN control	Receiver output jack
MIC GAIN control	RTTY keying jack
PHONES jack (1/4-inch phone)	Key jack (1/4-inch phone)
MIC jack (multi-pin)	External speaker jack (1/8-inch phone)
Incremental tuning control	
RIT and XIT switches	

Jacks are phono types unless otherwise specified.

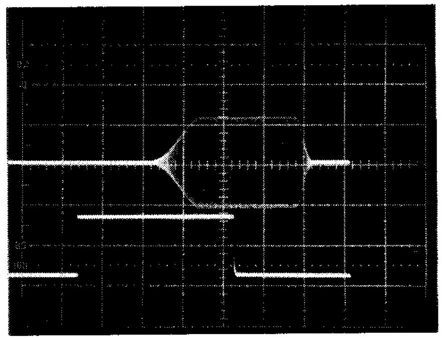

Fig. 3 — Cw keying waveform of the IC-740. Upper trace is the actual key closure; lower trace is the rf envelope. Each horizontal division is 5 ms. This keyed wave has a rapid fall time, which *may* cause key clicks.

feature. Another front-panel control sets the speed of a built-in electronic keyer (which is an option).

Several other functions are controlled by knobs mounted flush with the top of the cabinet. These include a MONITOR switch, which lets the user hear the transmitted signal; a MARKER switch and calibration control for an optional crystal calibrator; a FREQUENCY SET control that allows minor adjustment of the dial calibration; and the ANTI-VOX potentiometer.

Frequency Control

In keeping with the ICOM tradition, this transceiver incorporates a chopper-type optical counter dial and three speed-selector push buttons to select an operating frequency. Each pulse from the counter dial will step the frequency synthesizer 10 Hz, 100 Hz or 1 kHz, depending on the selected speed. An additional button provides a lock fuction that electronically turns off the counter dial. Two "VFOs" are built into the transceiver; they may be used independently or combined for split-frequency operation. A one-frequency memory is available.

Circuit Highlights

To describe the entire transceiver circuitry is beyond the scope of this column. Rather, I will highlight specific design areas that influence the overall performance.

The receiver front-end design is typical of today's high-performance equipment — band-pass filters followed by a doubly balanced diode-ring mixer. A switchable 10-dB-gain MOSFET preamplifier improves the receiver noise figure (sensitivity) on the higher hf bands. Note in the specification table that the receiver input intercept (P_i) drops 10 dB when the preamp is switched in; this means the ability to tolerate large input signals has decreased. This switchable preamp feature allows the user to choose between best sensitivity and best strong-signal performance — a choice not found in equipment that uses a simple attenuator.

A dual-conversion system allows the user to select several i-f filters. In the standard model, a 2.3-kHz crystal filter is used at the first i-f (9 MHz) and a ceramic 3-kHz filter is used at the second i-f (455 kHz). Several optional filters are available that increase the ssb-filter shape factor (by changing the second i-f filter to a crystal type) and narrow the cw bandwidth (by replacing the first i-f cw filter with a narrower bandwidth crystal type unit).

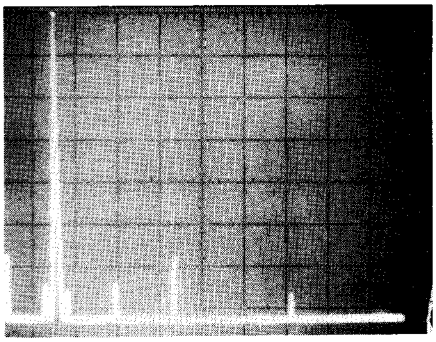

Fig. 1 — Spectral display of the IC-740. This is the worst-case condition, operating with 105-W output on 14 MHz. Each vertical division is 10 dB, and each horizontal division is 10 MHz. The IC-740 complies with current FCC specifications for spectral purity.

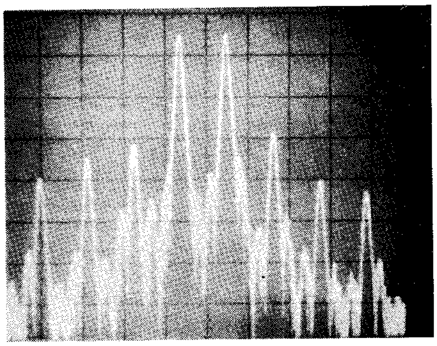

Fig. 2 — Spectral display of the IC-740 output during two-tone IMD test. Third-order products are 30 dB below PEP, and fifth-order products are 40 dB down. Vertical divisions are each 10 dB, and horizontal divisions are each 1 kHz. The transceiver was operated at the rated input power on the 14-MHz band.

Probably the most significant portion of the transceiver design is the frequency synthesizer. In this unit there are two PLL systems: one is used to generate the HFO injection signals, and the other generates the VFO signals.

Checkout and On-the-Air Performance

When the '740 arrived at Hq., I was anxious to see how it performed in the lab (other transceivers with frequency synthesizers have been reviewed and many have a poor synthesizer design, which results in a noisy receiver). To my delight, the receiver performance is impressive; in fact, the dynamic range figures shown in the specification table are better than those of some analog VFO transceivers. Receiver mixing and synthesizer products are nonevident. Of course, the supreme test for any piece of equipment is an on-the-air evaluation.

The first performance test came during the ARRL November SS cw contest. As always, signals were loud. No evidence of blocking or overload was noted. I noticed several signals with noise modulation on their carriers. These stations were probably using synthesized equipment; I'm sure the IC-740 was not at fault.

Although the "electronic" performance of the radio is impressive, the human engineering leaves much to be desired. The front-panel knobs are small; my large fingers found them hard to manipulate. Many of the functions are mounted using concentric control knobs; this makes the situation more difficult. The cw filter is available only when passband tuning is engaged; this requires the operator to press two buttons to change one function, and since there are no indicator lights, it is sometimes hard to discern why the cw filter is not working.

The cw waveform photograph looks great, but the sidetone is so mushy sounding that dots and dashes run together at speeds above 50 wpm. Most of the time I used my keyer sidetone for monitoring. Also the S-meter sensitivity is quite high.

Overall Thoughts

ICOM has done a superb job with the '740. Their experience in designing synthesized equipment has paid off; I have seen very few amateur products that are comparable. Don't let the small size of the unit fool you; it packs a lot of electronics in a small space. In fact, an optional *built-in* ac-operated power supply is available. Those potential buyers with large hands should play with the radio before purchasing one. Price classes: IC-740, $1099; FL-44 2.3-kHz second i-f ssb filter, $159; FL-45 500-Hz cw filter, $59.50; PS15 external power supply, $149; PS-740 internal power supply, $160. For more information on the IC-740 HF Transceiver, contact ICOM America, Inc., 2112 116th Ave. N.E., Bellevue, WA 98004 — *Gerry Hull, AK4L*

Yaesu FT-730R 440-MHz FM Transceiver

Manufacturer's Claimed Specifications	*Measured in ARRL Lab*
Frequency coverage: 440-449.975 MHz.	440-449.975 MHz.
Synthesizer steps: 25 and 100 kHz.	25 and 100 kHz.
Power output: 10 W.	15 W.
Mode of operation: F3 (fm).	Fm.
Spurious emissions: −60 dB or better.	Better than −64 dB.
Antenna connector: Type N.	Type N.
Receiver type: Double-conversion superheterodyne.	
First i-f: 46.255 MHz.	
Second i-f: 455 kHz.	
Sensitivity: 0.25 μV for 12-dB SINAD.	0.2 μV for 20-dB quieting.
Squelch sensitivity: 1 μV for 30 dB S/N.	0.56 μV for 30-dB quieting; 0.085 μV minimum, 0.34 μV maximum.
Selectivity: ±7.5 kHz (−6 dB), ±15 kHz (−60 dB).	
Audio output: 1 W into 8 ohms.	2 W @ 10% THD.
Audio output impedance: 8 ohms.	
Power requirements: 13.8-V dc (negative ground).	
Current consumption: 3 A on transmit (10-W rf output); 0.3 A on receive.	3.6 A (15-W output). 265 mA (squelched).
Case size (HWD): 2 × 5.9 × 7.1 in.†	2 × 5.9 × 7.1 in.
Weight: 3 lb 5 oz.	

†mm = in. × 25.4; kg = lb × 0.454

YAESU FT-730R 440-MHz FM TRANSCEIVER

□ Fm transceivers for the vhf and uhf amateur bands are becoming more compact and versatile with advances in the state of the technical art. Rigs not much larger than you would expect for hand-held use are available for mobile (and fixed-station) operation, providing power outputs in the 10- to 15-W class. And they are packed with features that will amaze you if you haven't kept up with what has become available recently. The FT-730R is one such rig.

At first glance, the '730 may look just another fm transceiver. The case is finished in a dark gray, almost black enamel. The rig sports a 1.4-in. edgewise D'Arsonval type of S meter that doubles as a relative-power-output meter.[3] In operation, the meter scale, with its red and black markings, is illuminated from behind. To the left of the meter is the digital frequency readout. This is a liquid-crystal type of display, with five 1/4-in. numerals displaying frequency to the nearest 100 Hz. This is a newly developed readout device with wide-angle viewing, and is also illuminated from behind. When power is removed, the black numerals disappear, leaving the frosty-gray area clear. Between the readout and the S meter are two LEDs, one above the other. The upper red LED indicates ON AIR, and the lower green LED indicates BUSY when the squelch has been opened.

[3]mm = in. × 25.4

The usual ± transmit frequency offset switch is located at the upper left of the front panel. Directly below are concentric VOLume and SQUELch controls. To the right, below the frequency readout, is a large knob, obviously for frequency tuning. A multiposition MEMORY switch indicates some type of memory capability. The seven-pin microphone connector may seem a bit strange if you consider the need for only audio, PTT and common lines. There are also eight push buttons with various labels on the front panel, a clue that there are additional features. A 3-inch built-in speaker is located at the bottom of the enclosure, with a miniature phone jack on the rear panel for an external speaker.

Operating Features

But behind the neatly arranged front panel are all kinds of features that are not immediately apparent at first glance. The '730R is microprocessor controlled. In part, that's why the manufacturer can pack so many features into such a small space. The rig has 10 memories and two VFOs for frequency selection. A small lithium battery provides power to hold all 12 frequencies in memory when the rig is turned off or disconnected from the 13.8-V supply. (Life expectancy of the battery is five years or more.)

The frequency displayed on the indicator is that of actual operation, except that the first two digits (44) are omitted. In other words, add 440 MHz to the readout indication to get the actual operating frequency. A three-position rotary switch labeled RPT controls the transmitting-frequency offset. With simplex operation (center position of the switch), the readout remains unchanged when going from receive to transmit. At the right and left positions of the switch, the transmitter offset is plus and minus 5 MHz, respectively. The readout changes to indicate the transmitting frequency during offset transmissions. Provisions are also made for split-frequency operation, by receiving on a memory channel and transmitting on a VFO frequency (while following the instruction you set up with the offset switch). In this way, an almost unlimited number of frequency combinations may be used in split operation.

The '730R has a "goof-proof" feature, too. If by chance you have selected a frequency and an offset combination that would place your transmitted signal *outside* the 440- to 449.975-MHz frequency range, depressing the PTT switch on the microphone does nothing except display an E on the readout. Meanwhile, the transceiver remains in the receive mode.

Frequency Selection

With 10 memories and two VFOs, you might think that selecting desired frequencies would be a confusing or perhaps cumbersome process. Not so! In manual VFO operation, the appropriate VFO (A or B) is selected with a push switch. When pushed once, this switch locks itself in the IN position for one VFO. When pushed again, the switch unlocks and returns to the OUT position for the other VFO. It's as simple as that. Meanwhile, the frequency that was last selected on the unused VFO is held in memory, and is available instantly, merely by returning to that VFO.

VFO tuning is done with the main tuning knob. This is not a continuously variable control, but has closely spaced detents — 50 per knob revolution, to be exact. There is no

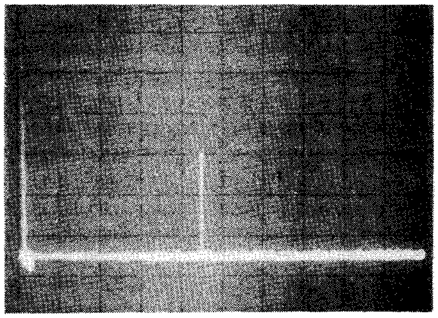

Fig. 4 — Spectral display of the Yaesu FT-730R. Vertical divisions are each 10 dB; horizontal divisions are each 100 MHz. Output power is approximately 15 W at a frequency of 448.775 MHz. The fundamental has been reduced in amplitude approximately 40 dB by means of notch cavities; this prevents analyzer overload.

mechanical stop on this control; it may be turned indefinitely in either direction. Switching to the next detent position changes the frequency by one step. The frequency steps are selectable at the front panel with a STEP push switch, either 25-kHz or 100-kHz increments. This switch is a momentary type, not a locking switch. For rapid frequency changes from one end of the band to the other, the 100-kHz steps are useful. Then, pushing the STEP switch toggles operation to provide 25-kHz steps for "fine tuning." The instrument continues to step in 25-kHz increments until the STEP switch is again depressed, when it returns to 100. The direction of frequency tuning is conventional — clockwise rotation of the knob to select higher frequencies, and counterclockwise for lower frequencies. There are no provisions to tune to frequencies that are not multiples of 25 kHz.

The 10 memories are selected with a rotary switch. Any VFO frequency may be stored in memory, merely by pushing a switch labeled M. (The previous content of that memory is lost when a frequency is stored.) Recalling a frequency from memory requires only pushing a "memory recall" switch and selecting the appropriate memory with the rotary selector switch. The transmitting-frequency offset functions are the same with memory frequencies as with VFO operation. This allows you to set up the memories on the output frequencies of repeaters in your area, and transmit in normal offset operation to hit the repeater input frequencies. With this feature, the operator who spends most of his time on only a few repeaters will have little use for the VFOs except for storing frequencies in memory. But, of course, two VFOs are nice to have.

Earlier, I mentioned a seven-pin microphone connector. Those extra pins provide for frequency-scanning operation, controlled from the microphone. Two switches, labeled UP and DWN, control this feature. During VFO operation, a momentary push of either switch shifts the frequency up or down by one frequency step. Operation is exactly the same as moving the main tuning knob by one detent position. But if either switch is held down for approximately one second, the entire frequency range of the rig is scanned automatically, either in 25- or 100-kHz steps, as controlled by the STEP switch.

A three-position slide switch on the rear panel permits you to select momentary interruption of the scanning on either a busy channel or else a clear channel, or to scan continuously without interruption. Let's say you set the '730R up to scan in 25-kHz increments for a busy channel. Scanning will start from the VFO frequency that is displayed when you initiate scanning, and proceed in the frequency direction according to which control switch you pushed. The scanning will continue until a frequency is tuned where a signal of sufficient strength to open the receiver squelch is found. Scanning will pause automatically for approximately five seconds, and then resume.

During that five-second period, you can halt the scanning operation by depressing the UP or the DWN switch or the microphone PTT switch. Now you are ready to transmit on that frequency (or an offset from that frequency) immediately, if you so desire. This is a handy feature if you are looking for signals on the band. Scanning of the entire 10-MHz range without momentary halts requires about 40 seconds. If no signals are found, the scanning progresses from the bottom of the frequency range to the top, and returns to the bottom of the range without delay to continue upward again (or vice versa, if you are scanning downward in frequency).

But that's not all the scanning you can do. If you wish, you can scan only the frequencies retained in the 10 memories. All the features mentioned above, except frequency steps, are available in memory scanning, too. This is superb if you want to search only your favorite repeater frequencies for activity.

VFO A or B, or readiness for memory scanning, is selected from the front panel. Actual scanning is controlled from the microphone only; there is no provision to initiate or terminate scanning from the front panel.

The '730R has yet another useful feature called priority channel operation. Using a VFO and a memory, this feature lets you listen on a frequency you select with the VFO, but provides automatic checking of the memory frequency for activity every five seconds. If the memory frequency is busy (or clear, as selected by the three-position slide switch), the scanner will halt on the memory channel. Otherwise, it will return immediately to the VFO frequency, and hardly a word of what is being said will be missed.

The FT-730R comes with yet other features. One is a tone-burst generator. When activated with a two position rear-panel slide switch (ON and OFF), an 1800-Hz tone having a duration of approximately 0.5 second is keyed each time the PTT switch is activated. For longer bursts, a front-panel CALL switch provides for manual control of the burst duration.

An optional feature contained in the review unit is a tone-squelch decoder. Many repeaters operate with such decoders on their input frequencies, perhaps more commonly known as PL® operation. A front-panel push switch on the '730R activates this feature to prevent unwanted signals from breaking the receiver squelch. An encoder in the equipment provides the subaudible tone at all times during transmission.

As shown in the title photo, a mounting stand for using the '730R at a base station is available. An accessory FP-80 ac-operated power supply is also offered. For mobile operation, a universal bracket is supplied for under-dash mounting. The transceiver may be removed from the bracket merely by unsnapping a locking bar and sliding the rig forward. Mobile installation requires a vehicle with a negative ground. Power connection is made through a keyed, two-pin plug, supplied with leads for interconnection to the power source.

The FT-730R is manufactured by Yaesu Electronics Corp., P.O. Box 49, Paramount, CA 90723, tel. 213-633-4007. The price class is $399. Various versions of the FT-730 are manufactured for use in countries other than the U.S. and Canada. These models offer various features, such as a frequency coverage that is 10 MHz lower and a different tone call frequency. — *Jerry Hall, K1TD*

FOX-TANGO 2.1-kHz KENWOOD TS-830S TRANSCEIVER FILTER MODIFICATION

☐ For the past two years, I have used a TS-830S transceiver at my home station. The variable bandwidth tuning (VBT) and IF SHIFT controls are extremely valuable for the elimination of adjacent-channel interference. On cw, these controls eliminate just about any QRM encountered.

On ssb, however, the stock Kenwood filters didn't perform as well as I expected. In fact, while operating on a crowded band, I noticed many instances in which using the VBT and IF SHIFT controls together wouldn't put a dent in the QRM! Since most of my operating time is spent on cw, this problem didn't disturb me too much. When a serious operation in November Sweepstakes was undertaken, however, the shortcoming of the standard filters became apparent.

A few weeks after the contest, I noticed a Fox-Tango advertisement in *QST*. A single Fox-Tango 1.8-kHz filter worked very well in my TS-520S several years ago, so the twin 2.1-kHz filter TS-830 modification was extremely appealing to me.

The filter modification comes with several photocopied pages of instructions to assist in the installation of the filters. The documentation is rather extensive; in fact, *too* much information is supplied. A prospective modifier *may* become discouraged after reading the complete package. The modification is relatively simple to perform, so don't feel intimidated by the pages of paperwork!

Modification installation is fairly straightforward, but care should be used during the operation. Screws that hold the i-f board in place must be removed and the board tilted 90° to allow unsoldering and removal of the stock filters. Exercise care during this operation, as the circuit board traces in this area are narrow and close together. The filters supplied for this modification are *not* direct plug-in replacements for the stock filters, so it is necessary to mount them elsewhere in the transceiver.

Instructions suggest mounting the new filters on top of the existing cw filter (if installed) with double-sided tape. Suitable tape is supplied with the kit. This approach didn't appeal to me, so I placed them on a piece of perforated board. This board is mounted on the chassis, just to the left of the power transformer.

Connections between the filter terminals and the i-f board were made with RG-174/U coaxial cable (supplied). The supplied cable length is sufficient for filter installation atop the cw filters, per instructions, but more was required for my installation.

Filter installation took approximately four hours. Much of this time was spent fabricating the filter mounting board and realigning the i-f after installation. Realignment is not required, but highly recommended. If an rf signal generator is available, follow the i-f alignment

Table 2
Receiver Performance

Specification	*Before*	*After*
MDS		
80 Meters	−129 dBm	−133 dBm
20 Meters	−130 dBm	−133.5 dBm
IMD D.R.		
80 Meters (low)	85 dB	88 dB
80 Meters (high)	78 dB	81 dB
20 Meters (low)	83 dB	88.5 dB
20 Meters (high)	77 dB	81 dB
Third-Order Intercept		
80 Meters (low)	− 1.5 dBm	− 1 dBm
80 Meters (high)	−12 dBm	−11.5 dBm
20 Meters (low)	− 5.5 dBm	− 1 dBm
20 Meters (high)	−14.5 dBm	−12 dBm

procedure in the TS-830 *service* manual. If either is not available, the procedure in the user's manual will suffice.

Overall, I'm pleased with the performance of the "new" '830. The band-pass response curves of a stock TS-830, one with a new 2.1 kHz *first* i-f filter (standard second i-f filter) and one with *both* new 2.1-kHz filters, are shown in Fig. 5. Measured −60 dB bandwidth of the unmodified '830 was 3.4 kHz. After modification, the measured bandwidth at −60 dB is 2.7 kHz — a 700-Hz improvement.

Receiver performance characteristics (before and after) are shown in Table 2. An approximate 3-dB improvement in two-tone dynamic range and third-order intercept is noted. This, in addition to the narrowed bandwidth, made the necessary work worthwhile.

The FTK-830 modification is available from Fox-Tango Corporation, Box 15944T, West Palm Beach, FL 33406. Price Class: $150. — *Michael B. Kaczynski, W1OD*

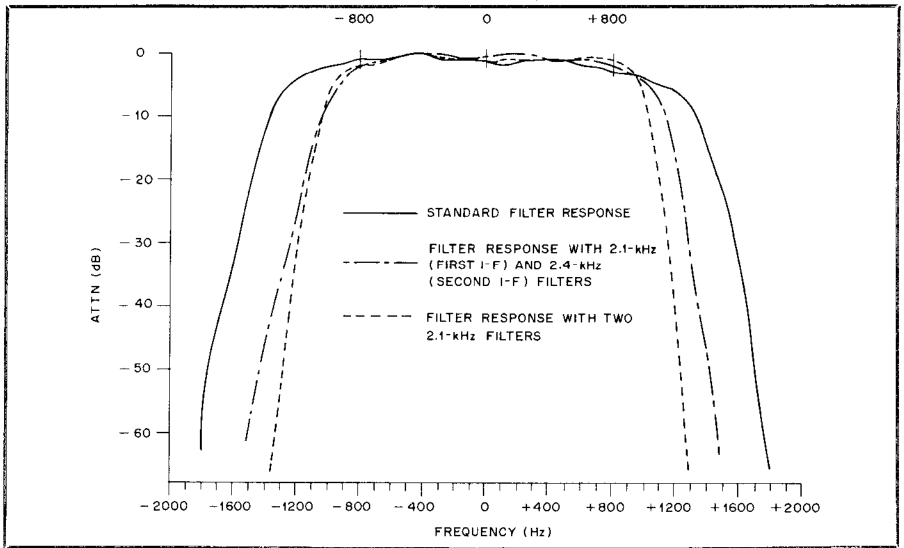

Fig. 5 — Filter response curves for the TS-830S with and without the Fox-Tango filters.

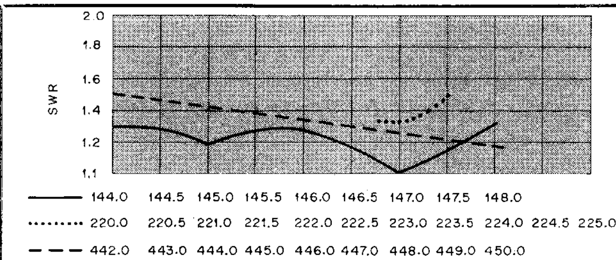

Fig. 6 — SWR curves for the KLM AP-144DIII antenna.

KLM AP-144DIII BASE STATION VHF ANTENNA

☐ Some hams may think that once they have seen a few base-station antennas for 2 meters, all such antennas are basically similar. The KLM AP-144DIII is different.

This antenna is a collinear, double 5/8-wavelength vertical for the 2-meter band that also incorporates a discone antenna for 70-cm (440-450 MHz) operation. The feed point is weatherproof, being housed within a machined aluminum hub. A sealed static-charge arrestor is fitted to the feed point. KLM claims the arrestor will offer some degree of protection to the transceiver in the event of static buildup.

All the parts and the machining of the KLM AP-144DIII are of a high standard, and everything fit together beautifully during construction. The clearly written instructions include excellent exploded drawings of the antenna, especially of the feed-point housing. Several reducing adapters are provided for the feed point to accommodate different sizes of coaxial cable. Coaxial cable ranging in size from RG-58/U to slightly larger than RG-8/U can be used. I am feeding the review model with RG-8/U. Two small tubes of silicone sealant are provided in the kit, along with specific details for weatherproofing the antenna. I used only half of one tube to seal the antenna; this leaves plenty of sealant for other uses around the shack. In all, complete assembly of the antenna took about one hour, with an overnight wait for the sealant to set.

At my QTH, the antenna is mounted atop the tower at a height of 75 feet. The antenna performs better than another commercially manufactured collinear that it replaced. For purposes of comparison, I used a distant (95 mi) 2-meter repeater in northwestern Massachusetts. Before I installed the new antenna, my signals into that repeater were marginal, and the repeater output would scarcely open the squelch of my transceiver. The first QSO with the new antenna netted me a signal report of almost full quieting; I now could copy the repeater S 3 to S 4. Overall, the improvement was immediate and gratifying. SWR checked across the 2-meter fm band is shown in Fig. 6. Worst case, it is less than 1.5:1. SWR on 440-450 MHz slopes from 1.5:1 to near unity. Signal reports on 440-450 MHz were excellent through the local repeater, as well. Although the antenna instructions provide for some adjustment of antenna length for minimizing SWR, none was necessary.

The SWR chart for typical operation, supplied by KLM, suggests that the AP-144DIII can be used on the 220-MHz fm band with a reasonable SWR, although KLM makes no claims to that effect. I decided to try operation on 220 MHz, and I'm pleased to report that this antenna appears to operate on that band with an SWR of approximately 1.5:1. The frequencies used were three standard 220-MHz repeater pairs and 223.50-MHz simplex. The entire 220-MHz fm band was not checked, inasmuch as the rig I used is a crystal-controlled unit. This three-band capability should definitely interest many active vhf ops.

The KLM AP-144DIII appears to be a well-engineered antenna. Materials and finish are first-rate; performance has been excellent on 144, 220 and 440-450 MHz. It certainly is nice to put up a two-band vhf vertical antenna and find you've got operation on an extra band (220 MHz) along for the ride! The AP-144DIII is imported by KLM Electronics, P.O. Box 816, Morgan Hill, CA 95037. Price class: $112. The same antenna, less the uhf discone, is available in the $99 price class as the AP-144DII. — *Sandy Gerli, AC1Y*

WEST JERSEY COMMUNICATIONS PRODUCTS 80-METER "BN CAGE" ANTENNA

☐ Many amateurs would like to find an antenna that provides coverage of the entire 80-meter band with an SWR of 1.5:1 or less. Solid-state rigs reduce power output if the SWR is much higher than this. Of course, you can use a Transmatch to present the required low SWR to your rig, but that seems to be an unnecessary set of controls to manipulate. The advantage of a "no tune" rig is, after all, being able to tune from one end of the band to the other without adjusting any controls.

The cage antenna has been around since the early days of radio, and was discussed in *QST* articles in recent times.[4,5] The idea behind the cage antenna is really quite simple. As the length-to-diameter ratio of an antenna element decreases, the resonant length for a given frequency will decrease. The antenna bandwidth will also increase. This principle is more evident in higher-frequency designs, where aluminum tubing is often used for the radiating elements. It is impractical, however, to use large-enough diameter tubing on 160, 80 or 40 meters. One

[4]A. Harbach, "Broad-Band 80-Meter Antenna," *QST*, Dec. 1980, p. 36.
[5]J. Hall, "The Search for a Simple, Broadband 80-Meter Dipole," *QST*, April 1983, p. 22.

method of producing an antenna element of large effective diameter is to space a number of wires around the perimeter of a cylinder. At the ends of the cylinder, or cage, the wires can be brought to a point in a conical taper, and joined.

There are a number of parameters that will affect the feed-point impedance and bandwidth of the cage. The size and number of wires, the diameter of the cage and the length of the taper are all important. WJCP has experimented with all of these parameters, and appears to have balanced them in a workable design.

The 80-meter antenna kit comes in a box 10-1/2 inches on a side and weighing about 18 pounds.[6] It includes everything you will need to put the antenna together, except some basic tools. In the box you will find eight molded-plastic spreaders, a spool of no. 14 enameled wire (approximately 800 feet) and 100 feet of coaxial cable with a PL-259 on one end and pigtails ready to connect to the antenna on the other. You will also find 50 feet of 1/8-inch Nylon rope, center and end insulators, and all required hardware. Even a small piece of emery cloth for removing the enamel insulation from the ends of the antenna wire and a small packet of Noalox® compound for use with the aluminum cable connectors are included. The coaxial cable is about the size of RG-59/U, but is sold by Channel Master and is specified to have a characteristic impedance of 67.2 ohms.

The instructions that come with this antenna are detailed and seem to cover all aspects of construction. The manufacturer recommends that you read them through at least once before beginning work. I certainly agree that this is a good idea. It is much easier to understand each step when you are aware of what will have to be done next.

One person could build the antenna, but a helper sure is nice, at least for measuring and cutting the wires. Mike Kaczynski, W1OD, assisted me with most of the construction. At one point you are directed to secure a collet 11 inches from the end of each wire. This is to prevent the last spacer from sliding on the wire when the conical taper is formed at the end. The instructions suggest that you use a crimp tool or ordinary gas (slip-joint) pliers to crimp the collet in place. (These collets look like crimp-on wire connectors.) We found it impossible to dent the ones supplied, even with a large pair of pliers. Ultimately, we had to resort to using a hammer and a piece of scrap iron to crimp the collets in place.

I found the insulation coating on the wire to be quite heavy, and I needed about three times as much emery cloth as had been supplied to complete the job of stripping the wire ends. A pocket knife could be used to scrape the enamel off, but the danger with this procedure is that you may nick the wire, causing it to break after the antenna is up.

As the four ends of the cage sections are completed, you are instructed to twist the six wires together, apply a *thin* coating of Noalox and tighten an aluminum cable clamp over them. The manufacturer suggests that you may want to solder the wires together first. I would say this is a required step if you want the electrical connection to be maintained. The amount of Noalox supplied really is insufficient to cover the wires. A few years ago, I purchased a container of this compound at an electrical supply store. It is inexpensive, and I apply a liberal coat to all exposed connections. The investment for a container of Noalox would be worthwhile for most hams involved in antenna work. Total assembly time for the cage was about three hours.

Deployment and Performance

The first real snag in the operation came when Mike and I went to move the entire assembly into position to put it in the air. The antenna weighs only about 15 pounds, but to hold the entire length off the ground by pulling on the ends, 100 pounds or more force is needed! If any part of the antenna is allowed to touch the ground while you are moving it, the spreaders will roll, twisting the cage wires together. Believe me, it is very difficult to get all of the twists out once this happens! A third person to hold the center insulator would be a great help for moving the antenna.

Initially, one end of the dipole was attached to a 40-foot tower atop the ARRL Headquarters building and the other end sloped down to a tree. The feed line was brought in to Hq. club station W1INF, and the SWR curve was plotted. A Bird Model 43 wattmeter was used to make these measurements. We found it necessary to prop the center insulator with a wooden pole to hold it about 10 feet above the corner of the building. This resulted in the SWR curve shown in Fig. 7. The curve compares favorably with the manufacturer's claim of an SWR of 1.5:1 or less over the entire band.

The amount of sideways pull exerted on a tower with the antenna in this configuration is quite large. Any additional tug on the antenna, or a slight breeze, would cause the tower to sway noticeably. We did not leave the cage up this way for very long! If you want to support the antenna from your tower, I would recommend that you hang the center insulator from an arm off the tower.

After carefully coiling the antenna wires to prevent kinks or tangles, I took it home for further evaluation. My yard has two tall maple trees in the center. There is no way to support an antenna above those trees, so I decided to use a branch of one of them as a center support. About half of one side of the dipole goes through the top branches of this tree, about 30 feet off the ground. One end is tied off to the peak of my house roof and the other is supported by another maple tree. One problem that developed is a tendency for the wires to twist once the cage is in the air. This may be a result of having "rolled" the antenna earlier when we tried to move it. Even though this arrangement would have to be considered less than ideal, a check of the SWR curve revealed it to still be less than 2:1 over the entire 80-meter band. Not bad!

The real question about any new antenna is, "How does it perform compared to the old antenna?" In many cases, such a comparison is difficult because the old antenna is taken down to make room for the new one. My comparison antenna was a 135-foot inverted L fed through a Transmatch. I did not have to take this antenna down, and was able to switch between the two conveniently. The inverted L is mostly horizontal, also goes through part of a maple tree, and is about the same height as the cage dipole. This should permit a reasonable comparison to be made. Received signals are two to three "S" units stronger on the cage antenna. Transmitted signal reports indicate the same results. For a while, I had a hard time convincing some of my friends on the Eastern Pennsylvania Emergency Phone and Traffic Net that I had not moved back to PA! The cage antenna made a definite improvement in my 80-meter antenna system.

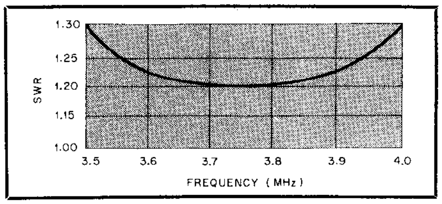

Fig. 7 — SWR curve for the 80-meter "BN Cage" antenna.

One ordeal I was not able to put this antenna through during the review period was the test of a typical New England ice storm. Several Headquarters staffers have virtually guaranteed me that this antenna will come down in such a storm. Their feeling is that the weight of the ice build-up on the cage wires will break either the support rope or the wires themselves. My own feeling is that ice is not going to build up on the wires. The insulating coat is quite smooth, and any water or ice just seems to fall off. One snowstorm did stick to the coaxial cables, the inverted L wire and even to my Cushcraft R3 vertical. The snow built up to about two inches in diameter. The cage wires remained clear, however. This seems to support my feeling, but I'll have to wait for a real ice storm to know for sure.

Specifications

A few things about the antenna specifications are worth mentioning. Our measured SWR curve does not go as low at the center of the band as the manufacturer suggests it should. After some thought, I realized that the 67.2-Ω coaxial-cable impedance would provide some mismatch to the Bird wattmeter and transmitter, which are designed to operate into a 50-Ω resistive load. Under these conditions, the feed line will act like an impedance transformer, and the impedance seen by the transmitter and wattmeter will depend on line length and the degree of mismatch at both ends. The measured SWR will not necessarily be the actual SWR caused by a mismatch at the antenna. Of course, there are many other factors that will influence the SWR measurement, but I found these few thoughts shed some light on one aspect of the problem.

The 80-meter cage antenna has a wind-loading surface area of about 2.5 ft^2. In an 80-mph wind, this would produce about 60 pounds of force on the antenna. Add this to the 100 pounds or so of force needed just to hold the antenna up without unreasonable sag, and you will realize that a couple of very sturdy end supports are required. This should reinforce what I said earlier about not using your tower as an end support.

The manufacturer claims the coaxial cable supplied with the antenna will handle 1000 W, but I did not test this capability because I do not have an amplifier. A few calculations indicate that this should be reasonable power for a cable this size to handle.

Besides the 80-meter antenna, WJCP also has cage antennas for 160 and 40 meters. If you like to operate at both ends of these bands and want an antenna that will cover the entire band with a low SWR, then I recommend the "BN Cage" antennas. They are available from West Jersey Communications Products, 932 Oakland Ave., Burlington, NJ 08016. Price class: 160-meter cage, $180; 80-meter cage, $100; 40/15-meter cage, $80. — *Larry Wolfgang, WA3VIL*

[6] mm = in. × 25.4; m = ft × 0.3048; kg = lb × 0.454.