the Mohican

10-transistor multi-band portable all-wave receiver that's better than just good

By JOHN T. FRYE, W9EGV

EXPERIENCED TECHNICIANS ARE NOTOriously blasé about equipment in their respective fields. The auto mechanic takes a jaundiced view of most cars; radio and TV technicians seldom get excited about a new receiver. Now and then, however, a piece of electronic equipment comes along that wins the grudging admiration of even the most seasoned technician. The Heathkit Mohican all-band transistorized receiver (kit or wired) merits such approval on at least three counts: its clever, unusual circuit features; its excellent performance; its fulfilling of a definite need.

Using 10 transistors and 7 diodes, this receiver tunes 550 kc to 32 mc in 5 bands. Only 10 μv of signal on the broadcast band or 2 μv on other bands produce a 10-db or better signal-to-noise ratio. Selectivity is 3 kc wide at 6 db down. The receiver puts out 400 mw of audio at 10% distortion. It is powered by either eight type-C flashlight cells, which give up to 400 hours of normal service, or by an optional ac power supply that can be plugged in in place of the batteries. It has such communications receiver features as continuous bandspread, bfo, rf gain control, signal-strength meter, avc switch, automatic noise limiter, antenna tuning, phone jack and receiver muting terminals. It measures 6⅞ x 10 x 12 inches, weighs 17 pounds, and sports a telescoping antenna that extends to 50 inches high.

Interesting circuit features

Probably the first thing you'll notice in the circuit diagram is that three-terminal devices labeled "404-40" are used between i.f. transistors V4, V5, and V6 instead of conventional transformers. These are Transfilters. Details of how they operate are found in the October 1962 issue of RADIO-ELECTRONICS. They are ceramic devices that perform much like crystal lattice filters. They pass only a narrow band of frequencies to which they are permanently resonated, with a long-term stability of 0.1% for every 10 years of service. Their medium input impedance and low output impedance make them ideal for use with transistors.

404-41's are similar two-terminal ceramic devices that act as resonant bypasses with about 15 ohms of reactance at 455 kc. A single Transfilter stage using these bypasses is claimed to be equivalent to three conventional i.f. transformers.

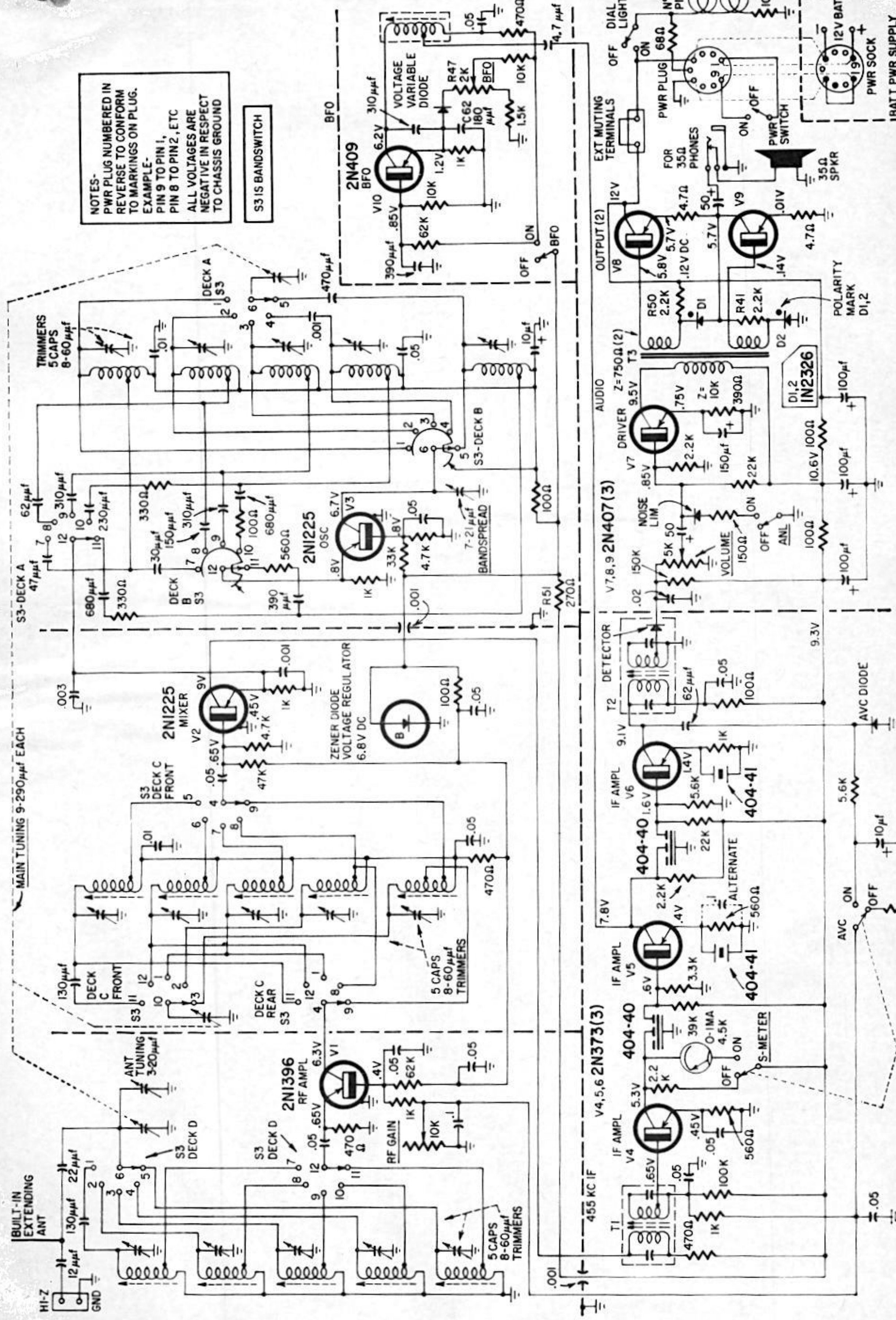
Since the Mohican uses two Transfilter stages with i.f. transformers at the input and output of the i.f. strip, it is easy to see where it gets its excellent selectivity and the good shape factor of its i.f. system—qualities it will retain for years without need for realignment.

The bfo pitch control is actually R47, a potentiometer! Notice it varies the amount of reverse bias applied to the variable voltage diode, which is effectively in parallel with C62, a part of the frequency-determining capacitance of the bfo. When reverse bias is applied to a diode, the electrons go to the positive terminal and the holes to the negative terminal, leaving a depletion area near the junction. The more voltage applied, the wider this depletion area becomes. Here we have the equivalent of a variable capacitor—two conducting "plates" separated by a variable amount of nonconducting dielectric. This capacitance effect of a reverse-biased diode is put to work to vary the frequency of the bfo through the i.f. passband.

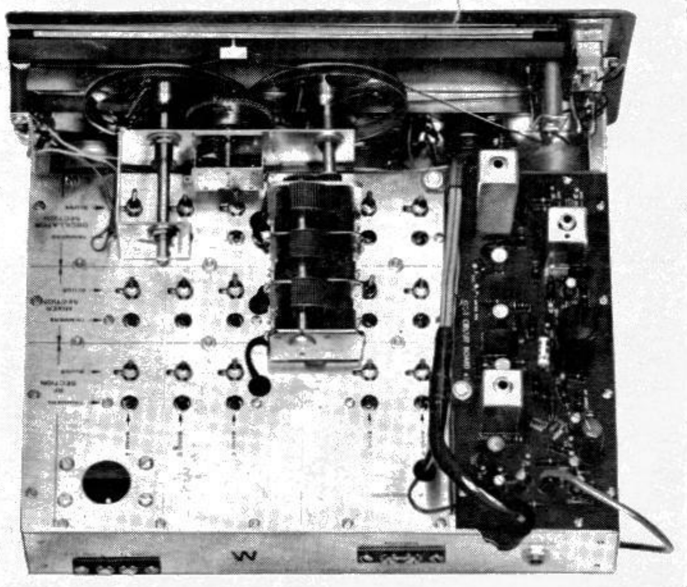
But consider this: the collector-to-base junction of a transistor is actually a back-biased diode and undergoes the same change in capacitance with a change in applied voltage. This effect, put to good use in varying the bfo frequency, is a great nuisance in high-frequency transistor circuits, for the change in capacitance with voltage variation produced by aging batteries or avc action causes serious detuning of such circuits.

The cure is a Zener. This particular Zener has a breakdown potential of 6.8 volts, and current is fed to it through current-limiting resistor R51. The combination makes a very effective voltage regulator circuit. The voltage appearing across the diode is fed to the rf amplifier, mixer, local oscillator and bfo and is maintained at very nearly 6.8 volts in spite of wide variations in supply voltage and considerable changes in current demands of these transistors.

The output circuit also has some unique features. Transistors V8 and V9 are operated in a modified push-pull class-B circuit that employs no output transformer. The 35-ohm speaker voice coil is driven alternately from V8's emitter and V9's collector. There is



Circuit of the receiver with its battery power supply.



A look under the hood.

−12 volts on V8's collector, but the voltage-divider network consisting of R41, R50, and the two 1N2326 compensating diodes places −6 volts on the base, leaving a 6-volt difference between the emitter and collector. V9 has −6 volts on the collector, and the emitter is practically grounded; so the two transistors run at the same voltage level.

The compensating diodes do two things: First, they act as nonlinear voltage regulators to maintain proper cutoff condition in the class-B stage in spite of changes in battery voltage. Second, they have a negative temperature coefficient that effectively compensates for the positive temperature coefficient of the output transistors and prevents excessive battery drain and poor quality at high temperatures.

There are other interesting features. Notice when batteries are in use the dial lamps do not light until the spring-loaded dial-lamp switch is pushed to the right. This lamp switch doubles as a battery condition indicator, for the extra load of the lamps will cause an appreciable drop in the voltage output of nearly spent batteries—a drop too great for the Zener diode to control. If switching on the lamps causes a marked change in the tuning of the receiver on one of the higher frequency bands, you need new batteries! When the ac power supply is used, the lamps are automatically connected across the supply as a stabilizing bleeder resistor and are on all the time.

The receiver even has a built-in transistor tester. Any transistor in the set can be tested in the V4 socket which has an S-meter in its collector circuit and an rf gain control to vary its base bias. If varying this control from one extreme to the other causes the meter to change by at least half-scale, the transistor in the socket may be assumed to be good.

Assembly

This is not a kit you want to, or can, put together in a couple of evenings. I have assembled many kits, including the Mohawk receiver, Apache transmitter and SB-10 SSB adapter, yet it took me a full 40 hours to assemble the GC-1A, align it and put together the ac power supply. The receiver's i.f., af and bfo circuits are on a printed-circuit board, while the rf, mixer and local oscillator circuits are hand-wired.

For those who look askance at printed circuits—often with reason—let me assure them this is a *good* printed circuit. The board is heavy, with clean circuitry well bonded to one side only. No weighty, board-flexing parts are mounted on it, and the board is rigidly supported on the main chassis by bolts around the entire perimeter. Mounting parts on the board presents no problems if the detailed instructions are followed carefully.

The critical front-end wiring is where it would be easy to goof. First, you mount all 15 slug-tuned coils and 15 trimmers on the bottom of the main chassis plate and do all possible wiring to these components. Wire lengths are specified down to ⅛ inch.

Next you mount the rf and mixer transistor sockets on one subchassis and the oscillator socket on another. Now you take apart the four-deck bandchange switch and reassemble it with the two subchassis properly spaced between the decks. Finally you bolt this whole subassembly to the main plate and solder all loose wire leads coming from the coils, sockets, etc. to the switch connections. When the finished receiver is slid into its metal cabinet, each high-frequency stage is fully shielded in its own compartment.

Points to watch

Check that reassembled bandchange switch very carefully to make sure you have each wafer properly positioned and oriented before you start connecting wires to them. It would be very easy to have one wrong, and those switch connections will not stand much unsoldering and resoldering! Follow instructions regarding lead length and lead dress exactly. Both are very important to the high frequencies handled by these circuits.

Take enough time and care to insure that both the main tuning and bandspread pointers slide freely and smoothly. This takes a little doing, but it pays off big dividends in satisfaction later.

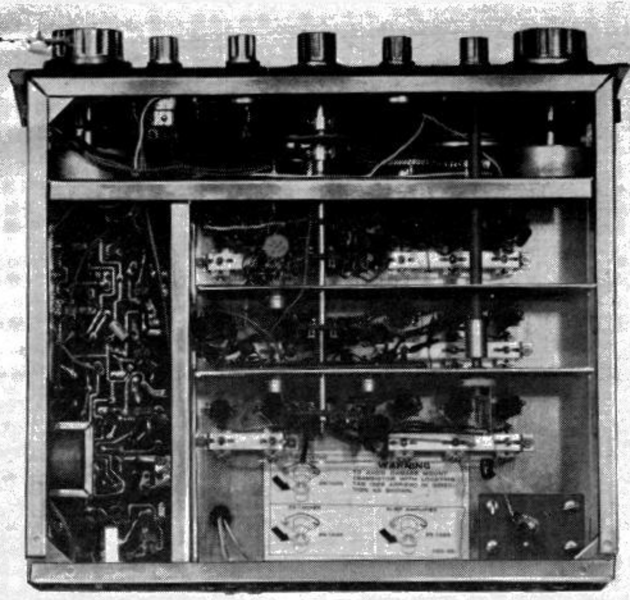
I suggest you place the receiver on a metal cookie sheet when aligning. The sheet will "stand in" for the metal bottom of the receiver cabinet. This will make things a bit easier as this metal does have some effect on alignment, especially on the higher frequencies. In aligning and checking the image frequencies, remember that the oscillator works on the high side of the signal on bands A, B, C and D, *but it is on the low side on band E*. This is easily overlooked in a rush to complete the job.

Finally, keep in mind that the slugs and trimmers of each coil interact, and you have to keep going back and forth from one end of the band to the other, adjusting the three slugs at one end and the three trimmers at the other until you can no longer get any improvement *at either end of the band*. Admittedly, this takes time and patience, but doing the aligning job right will spell the difference between a mediocre receiver and a really "hot" GC-1A.

Performance

Candidly, I did not expect too much from the Mohican. My station receiver, the Mohawk (see RADIO-ELECTRONICS, December 1958) is a specialized communications receiver tuning only the ham bands. I wanted something with which I could hear WWV transmissions, listen for out-of-the-band harmonics, and copy a few of the stronger broadcast and commercial short wave stations. In short, I wanted a second receiver that would let me see the "big-picture" of the short-wave spectrum, even though dimly, in addition to the powerful, fixed-position, narrow-field "shortwave telescopes" I already had. Experience in my service shop with many so-called multi-band transistor radios had conditioned me not to expect much on the higher frequencies.

But when I placed the Mohican atop the Mohawk and started comparing reception, I was astonished at how sensitive the GC-1A was on the 10-, 15- and 20-meter bands. I found stations on each of them that would nearly "pin" the S-meter. Undoubtedly the use of 100-mc cutoff drift transistors in the



Underchassis view shows receiver sections are shielded from each other

front end accounts for that 2-μv sensitivity, and in most receiving locations it takes a good ear to detect a difference between 2-μv and 1-μv sensitivity.

Selectivity was all it was claimed to be. I live about halfway between WLW on 700 kc and WGN on 720 kc, both running 50,000 watts. With the ordinary broadcast receiver you would never suspect there was another station between these giants. With the Mohican, however, I can pull in WOR on 710 kc at night without interference.

Encouraged by these experiences, I put a relay on the muting terminals, connected the external antenna leads to my change-over relay, and started calling CQ. I had satisfactory AM, CW and SSB contacts on all bands, 10 through 80 meters. Next, I used the Mohican as my receiver while acting as net control station for our 75-meter state traffic net into which both AM and SSB stations check—truly an acid test! I missed my product detector on SSB reception, for the rf gain control had to be backed off until the bfo could insert sufficient carrier, but I managed without too much difficulty. Incidentally, that rf gain control is needed, for many signals come in so powerfully they overload the front end if it is running wide open.

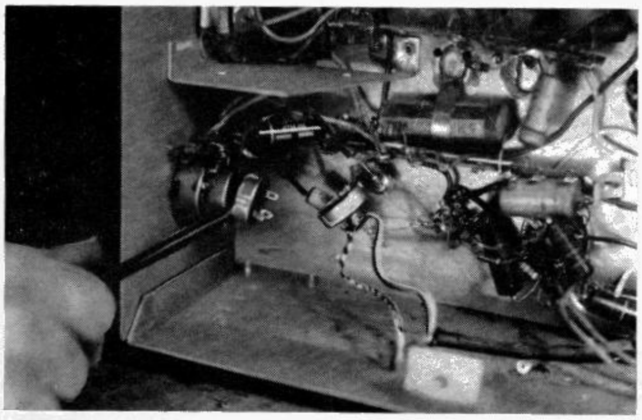
Drift presented no problem. There is some shift in frequency with a change in ambient temperature, but this is a long-term affair having nothing to do with how long the receiver has been on.

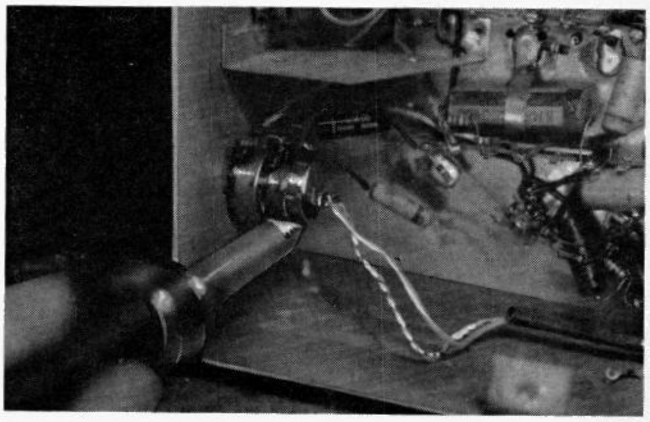
I tried the built-in telescoping antenna, a long wire, my all-band trap antenna fed with 72-ohm transmitting type ribbon and my TH-4 tri-bander beam fed with RG-8/U. Naturally reception with the 50-inch whip is not as good as with the more efficient types, especially on the lower frequencies, but it is surprisingly good. I was happily astonished to find the receiver worked very well when its high-impedance antenna terminals were connected to my low-impedance transmitting feedlines. When I used balun coils to provide better theoretical match, the improvement could not be detected on the S-meter.

I hesitate to recommend the Mohican as an *only* fixed station receiver. Under present-day crowded band conditions and the growing accent on SSB, the station receiver needs a product detector, variable selectivity, a notch filter and lots of bandspread. The bandspread tuning on the Mohican varies only the oscillator. When the bandspread pointer is moved from the set position, the oscillator can be followed with the rf stage by manipulating the antenna tuning, but the mixer stays put. For wide excursions of the bandspread pointer, this results in impaired selectivity and sensitivity. I like to leave the bandspread pointer near the set mark and do my tuning with the slow-ratio main tuning knob. The bandspread knob is used as a fine-tuning control. This retains the excellent sensitivity and selectivity of the GC-1A.

Where the Mohican really shines is as a deluxe receiver for the serious SWL and as a second, backup receiver for the ham station. The SWL fan has, in the Mohican, a receiver with portability, sensitivity, selectivity and versatility far beyond most receivers used for this purpose. With it, he is divorced from noisy power lines, he can try a wide variety of antennas, and he can receive all modes of transmission. Using only the whip antenna, I have picked up SW broadcast stations from every corner of the globe. END

Replacing the Irreplaceable Switch





Switches mounted on potentiometers and auto radio pushbutton assemblies pose a definite replacement problem. When exact replacements are not available, switch failure often necessitates replacing the whole assembly. But the cost of a replacement and the delays in getting it can lose a customer. There is a way around this:

Insert the blade of a screwdriver between the switch and the body of the control. Twist the blade until the retaining lugs straighten. Remove the switch. Take a new switch section and clip the retaining lugs on its body to 1/32 inch. This keeps them from extending into the body of the pot and interfering with the moving parts. Position the new switch in the old mounting holes and make sure the trip arm on the control rotor actuates it properly. Solder the switch in place at two or three points and reconnect it. The photos show this being done.