Recent Equipment

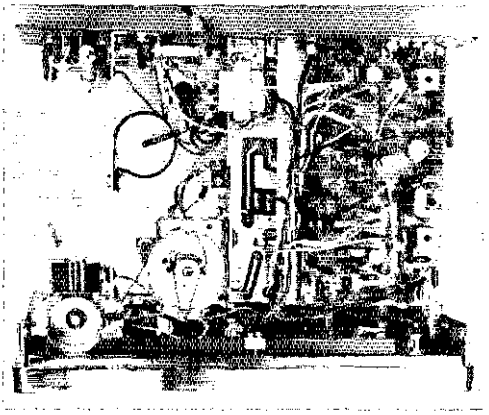
To acquaint you with the technical features of current amateur gear.

The Heath GR-78 Receiver

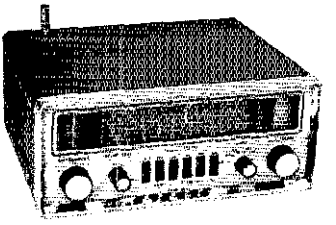
ABOUT TEN years ago the Heath Company brought out its "Mohican" transistorized portable receiver kit,[1] quite an innovation for its day. That model has now been discontinued in favor of a newer version, the GR-78. By comparison it certainly merits a number of "plus" marks – expecially those for selectivity, avoidance of cross-talk, compactness/portability, and mighty attractive appearance.

The unit covers 200 kHz to 30 Megs in six bands. Aside from its short-wave general coverage, and ham bandspread, it is useful also for lf marine-band listening (tho there's not too much to be heard there by us inland folks these days) as well as a bc portable for the summer cottage or beach. It has good sensitivity and surprising selectivity – in the rf section as well as i-fs. It is more compact, adding to its main purpose of portability. An internal "Ni-Cad" battery will keep it running any reasonable number of hours a day if kept plugged into house power for automatic charging; or for straight in-the-field operation, more than 8 hours (in our tests, at least) without revitalization. Charging – as well as full-time operation – can also be accomplished by connection to a 12-V car battery. An integral, collapsible whip antenna makes the unit completely self-sufficient – tho naturally connection to a separate antenna improves the reception considerably. Audio power probably wouldn't satisfy a rock-and-roll teenager, but is quite adequate for any normal purpose. Sideband reception is good, though you won't find an "upper" or "lower" switch; the BFO is right at the i-f center. And it is a rather handsome piece of gear; the most hard-hearted XYL would have difficulty faulting its appearance in any room of the house.

[1] *QST*, December 1960, page 32.



Top view of the GR-78. The basic receiver board is at the right, accomodating the i-f, second conversion oscillator, detectors, BFO and audio circuits. A larger board, underneath and only partly visible, serves as a patch panel between the various sections.



Circuit Features

The block diagram in Fig. 1 shows the general set-up. All circuitry is of course solid-state. There are thirteen silicon and two germanium transistors. Five of the former are FETs, with dual-gate types employed at appropriate points (rf amp., mixers, product detector) to help avoid cross-modulation and overloading – somewhat of a problem in the earlier Mohican.[2]

Selectivity is attained primarily through the use of four tiny ceramic passband filters, twice the number used in the Mohican; the spec is 7 kHz at 6 dB down, which is a good compromise to cover both bc reception and ham sideband. Moreover, they need no attention in the alignment process, and the book says they will hold adjustment for ten years or so. Two detector circuits perform their special functions – a simple diode for a-m; an FET product job for cw and sideband, with the BFO signal fed to gate 2. Agc action is provided at two points. A portion of the i-f signal is rectified by a 2N3694 and this transistor, in turn, controls the gain of the first i-f amplifier. In addition, when the incoming signal rises above a preset level, agc voltage from a pair of diodes is applied to gate 2 of the rf amplifier to further reduce the overall receiver gain.

A double-conversion system is used on the top band[3] only, 18 to 30 MHz, to reduce images from direct use of the basic 455 kHz i-f. A portion of the circuit is shown in Fig. 2. In all band-switch positions but F, the basic mixer FET produces 455 kHz output which is fed to G1 of a dual-gate FET

[2] The Mohican used bipolar transistors throughout, and bipolar transistors do not have the dynamic-range capability of FETs.

[3] With apologies to our G friends, to whom 160 meters is "top" band.

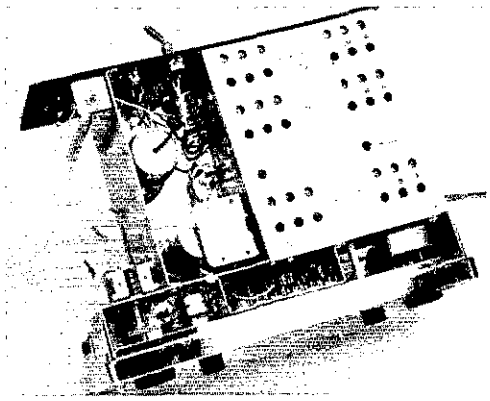
(40673); in the F position the output is at 4.034 MHz – the local oscillator being that much higher in frequency than the incoming signal. The same band-switch position also connects power to a conversion oscillator (2N3694), crystal-controlled at 3579 kHz, whose output goes to G2 of the 40673. The two signals (3579 and 4034) combine to produce the necessary 455 kHz, which continues on its way through the ceramic filters.

Assembly

The unit is in modular form. Four printed-circuit boards – antenna, rf, mixer, oscillator – plug into a large panel furnishing power and the "patching" between sections, which are well-shielded. All this makes for ease of wiring and assembly and – should the occasion arise – servicing.

Up to the test stage, a total of 14 1/2 hours was required for assembly. A more careful workman might require additional time, since the writer seldom goes through the proper preliminaries of parts counting and sorting, but instead sooner or later mutters a few four-letter words to describe the Heath Company and its missing part – then later finds the part was just where the instructions said it was.

In a unit as compact as this, some of the soldering processes get a bit delicate, but not beyond average ability if suitable care is taken. We found only the mounting of trimmer capacitors tricky; again, if one relies on the instructions rather than his own judgement, he'll make out okay. In other words, the instruction manual is up to the usual Heath first-rate standards.



With the bottom cover removed, alignment is normally accomplished by adjustment of only the trimmer capacitors. Coil slugs can also be adjusted, but this is not usually required. The open area in the center includes the main tuning capacitor and the Ni-Cad battery. The vacant space at the right is room for the speaker, mounted on the top-and-sides cover.

Alignment and Operation

The receiver can be aligned with or without test instruments. We tried "without" first, and found it an extremely simple procedure – mostly because the ceramic i-f filters need no adjusting. Oscillator-trimmer settings did take a bit of time to provide accurate dial calibration. In fact on one band, 3.0 to 7.5 MHz, we had to resort to coil-slug adjust-

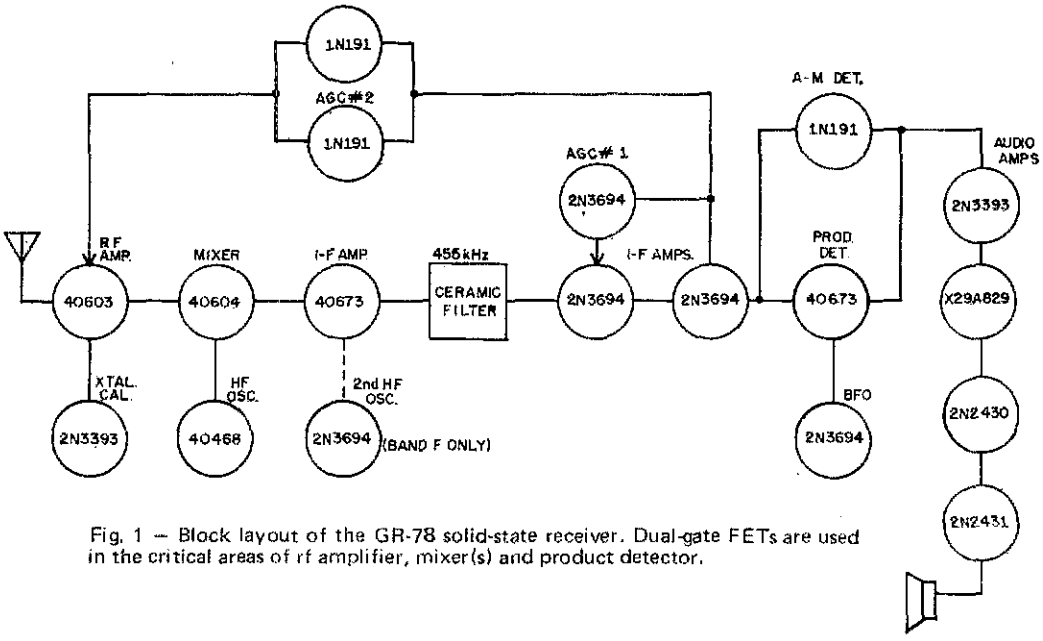


Fig. 1 – Block layout of the GR-78 solid-state receiver. Dual-gate FETs are used in the critical areas of rf amplifier, mixer(s) and product detector.

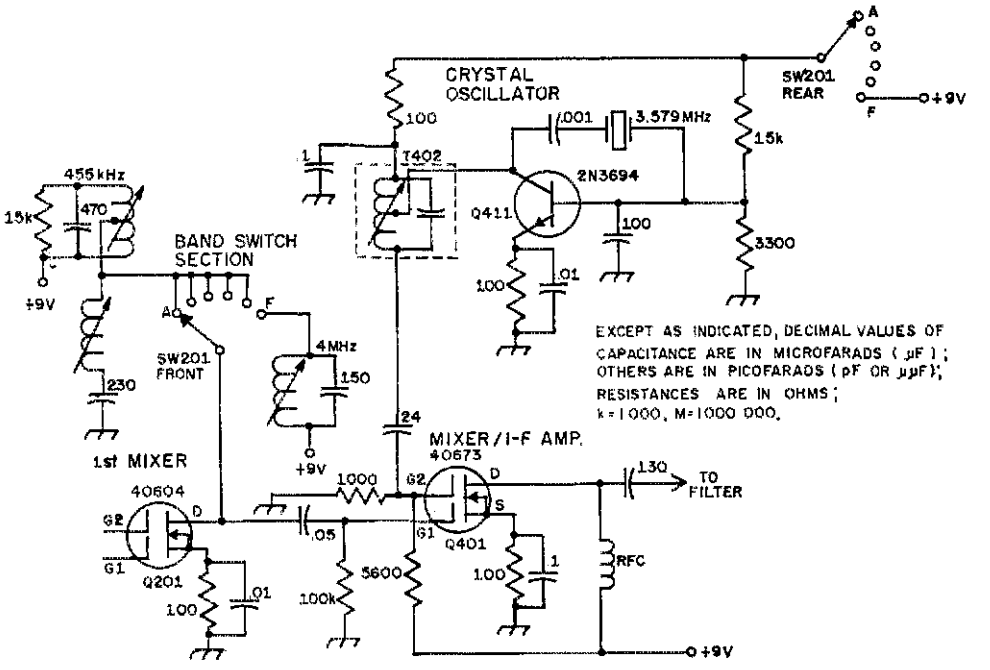


Fig. 2 — Dual conversion is used on the highest-frequency band, 18 to 30 MHz. Normally the output at 455 kHz from the drain of the first mixer is simply fed to gate 1 of a 40673 i-f amplifier. When the band switch is turned to F, however, the first hf oscillator operates 4.034 MHz (rather than 455 kHz) higher than the desired incoming signal; at the same time a 3.579 crystal oscillator is activated and its energy fed to gate 2 of the 40673 — which then becomes a second mixer instead of a straight-through i-f amplifier.

ment to obtain proper calibration — and one isn't supposed to do that without instruments. A later check with a signal generator, however, showed that the initial alignment was overall, more than adequate.

Despite the use of an FET rf amplifier that is tapped down on the first-stage coils, self-oscillation (with rf gain full on) was at first a troublesome problem, solved by redressing a couple of leads to the main variable capacitor and slipping braid over them, with the braid soldered to nearby ground lugs. Use of small-diameter coax might even be better.

The only significant difficulty encountered was in the bandspread setup. First of all, for an old low-end-of-80 cw man (and there are still a few of us left) it is nigh impossible to read the dial unless you (1) set the unit on an eye-level shelf, or equip it with propped-up front, or (2) crouch down with your chin on the operating table. The top of the bandspread dial is effectively hidden from view in any other situation.

But more important, once you set the main dial to the desired band edge and start tuning the bandspread knob, the overall receiver gain rapidly goes to pot. The reason is that the bandspread variable is a single-section capacitor,tuning only the oscillator. This arrangement was used in the Mohican also, but apparently the greater selectivity of the GR-78 causes tracking problems. The difficulty arises to only a slight degree at 15 and 10 meters, but on 80, for example, tuning 100 kHz from the peaked position requires about double the signal strength to obtain the same output.

A partial solution is to peak the antenna and rf trimmers with the bandspread set at center scale. Or one can set the main dial close to the desired frequency and then "zero in" with the bandspread with little or no loss of gain. A much better solution, if it doesn't produce feedback, would be a 3-gang capacitor to replace the single unit now used for bandspread; there is cabinet room. (We may just try it later.)

Otherwise, operation is satisfactory. A 500-kHz calibrator helps locate yourself on the dial, especially if you haven't matched the readout exactly. The flywheel on the main tuning knob provides a fairly smooth "feel." Two dial lights operate from a spring-return rocker switch for momentary use at night.

Final Comments

This is not an expensive unit; one doesn't expect or get R-390 performance. W1CUT's review of the old Mohican included the comments, "These measurements (about 7 inches high, 12 wide, 10 deep) represent about the smallest practical size one would want without sacrificing dial area, knob size, and so on." The newer model has been lowered in chassis height so that the earlier

3-inch-high dial is now squished to 1 1/2 inches. It is a compromise between compactness and operating convenience.

A beginner should find the GR-78 wholly satisfactory as a basic station receiver. For a more experienced amateur it could be a good standby and general-coverage receiver to supplement the ham-band-only units most of us have these days, as well as having the convenience of completely portable operation when desired. In addition, it would be reassuring to know that in case of power outage for disaster or whatever reasons, you have an operating receiver that can go anywhere. – *W1LVQ.*

Heathkit GR-78 Receiver

Height: 4 3/4 inches for chassis, plus 1 1/2 more for antenna tip.
Width: 11 1/2 inches.
Depth: 9 inches.
Weight: 10 pounds.
Price Class: $130.
Manufacturer: Heath Company, Benton Harbor, MI 49022.

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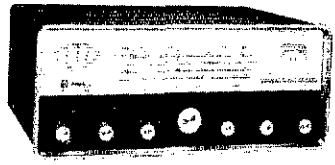
The Knight-Kit R-195 Receiver



AN EXAMPLE of straightforward solid-state circuit design is seen in the Knight R-195 kit receiver. This 13-transistor superheterodyne receiver employs a standard single-conversion lineup with a 455-kHz i-f. It provides coverage from 200 to 420 kHz on its lowest band, then permits continuous coverage from 550 kHz to 30 MHz on its four remaining bands.

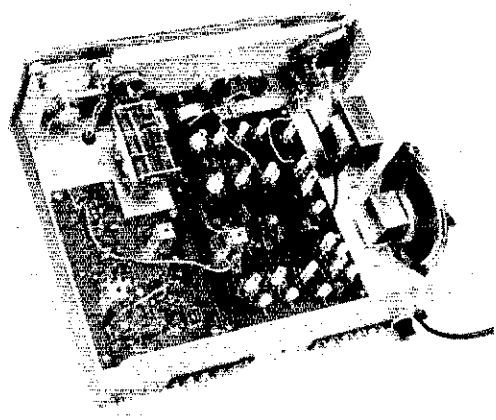
Ceramic filters are used to set the i-f bandwidth at 2.5 kHz at the 6-dB points on the i-f response curve. Though this bandwidth is suitable for ssb reception, it tends to restrict the fidelity when listening to the broadcast band. Cw reception is satisfactory at this bandwidth, and if additional cw selectivity is desired it should be a simple matter to add an outboard passive filter.[1]

The kit comes with complete assembly instructions, and there are no baffling procedures to follow when putting the unit together. This writer required approximately 15 hours to build the receiver. The alignment took one hour to complete.

Modern circuit design is used in the front-end section of the equipment – JFETs being put to work in the rf amplifier, mixer, and local oscillator. A common-gate hookup is used in the rf stage. The source is tapped down on the input tuned circuit to assure an impedance match and resonable selectivity. A second tuned circuit provides added selectivity. It is used in the drain of Q1, and the signal from it is coupled to the gate of the mixer, Q2, through a 0.005-μF capacitor.

A Hartley oscillator is used at Q3. Its output is taken from the oscillator source tap and is fed to the source terminal of the mixer, across its 51,000-ohm source-bias resistor.

The ceramic i-f filters mentioned earlier are used as coupling elements between the three bipolar i-f stages. An i-f transformer couples the third i-f stage to a diode detector for a-m reception. The mode switch on the front panel selects audio output from a bipolar-transistor product detector during ssb or cw reception. In the ssb/cw position another section of the same switch applies operating voltage to the BFO and product detector to activate those two stages. Audio output from the detector in use is coupled to a four-stage audio amplifier which in turn operates the built-in speaker or an externally-connected pair of headphones.



This top-chassis view of the receiver shows the front-end circuit-board module extending across the center section of the chassis. The three-gang bandset capacitor is near the front panel at the left end of the chassis. Directly below it is the i-f/detector circuit board. The band-spread tuning capacitor is visible at the upper right of the photo, ahead of the power transformer.

[1] McCoy "A Solid-State Selectoroid," *QST*, May 1970.