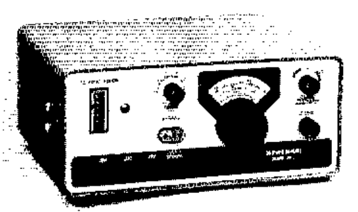
allowing the operator to cw transceive without having to listen to an uncomfortably high beat note.

Both transmitter and receiver use dual-ratio main-tuning knobs. The inner knob is used for fast frequency excursions and the outer one provides fine tuning. In the author's opinion, VFO accuracy leaves something to be desired. An inaccuracy of one or two kHz per 25 kHz on the cw bands is not uncommon. Accuracy is greatest on the phone bands. Changing from cw band to cw band is, at best, a time-consuming chore. Although the 600-T instruction manual is complete and informative, the receiver manual lacks a circuit diagram. It is assumed this is a simple oversight by Swan! – *W1GNC and WA1PID*

QST —— QST —— QST

Heath HW-7 CW QRP Transceiver



PRACTICES OF PAST eras seem to return and tantalize the radio amateur from time to time. The remarkable curtain call for fm as a mode of communication is a sparkling example. Still another, and one that stirs nostalgia, is "straight key night," held each year. It would be difficult to pinpoint the stimulus that has incited so many radio amateurs into activity in the once-necessary QRP field, but testimony to the popularity of low-power operation is evident when listening to the phone and cw portions of our hf bands. Perhaps the QRP enthusiast is motivated in part by one philosophy of the day. . . a retreat from material wealth and status. The trend is toward a less complicated way of life, or so it seems, where simplicity is the life style. The application of personal skills seems to be of greater value to some than is the need to acquire recognition through affluence and showmanship. Certainly the QRP operator must exhibit unusual operating skill if he is to compete successfully with his QRO fellows. A QRP rig isn't likely to be regarded as a status symbol in one's shack; the size and the cost (both modest) negate such a possibility. For some, things have become too easy with respect to working WAS, WAC, or DXCC. Big antennas and high power will get the job done quickly if the operator is skilled and courteous, but the challenge does not sharpen one's appetite quite so markedly as when operating in the QRP class.

Heath Company has put QRP operation within the reach of anyone willing to invest less than $75, and their HW-7 provides for operation on 40, 20, and 15 meters. The package is small enough to be tucked under the owner's arm and carried to a camp site, picnic spot, or friend's home. The transceiver can be powered by batteries (12 V) or an ac-operated dc supply. Maximum current taken by the unit is approximately 400 mA during transmit periods. Because of the low duty cycle of cw operation the camper should be able to do plenty of operating with a lantern battery or similar source. Rf power output is in the 2-watt class on all three bands. Shades of the 01A vacuum tube! We *are* being haunted by our past!

Some Early Problems

The specific unit treated in this review came in kit form and was assembled by the writer. Some significant problems with the performance of the transmitter and receiver sections became manifest during initial testing. It was possible to tune the PA in such a manner as to obtain spurious output at 28, 14, 12, and 7 MHz during 15-meter operation. The peak in relative rf-output reading was so poorly defined that it was not possible to tell which peak was the desired one (21 MHz).

While testing the receiver it was observed that strong hf-band commercial stations tended to blanket the amateur band being listened to, despite careful peaking of the front end. Similarly, blanketing from nearby bc-band stations occurred when using antennas other than beams or resonant verticals.

A number of circuit modifications were made by the writer, and the difficulties were cleared up one at a time. The matter was called to the attention of the engineering staff at Heath. After considerable dialogue with the Heath engineers by phone and letter, three of them came to Newington to consult with the ARRL technical staff in an effort to investigate and resolve the problems.

The flaw in the transmitter turned out simply to be a defective component (Zener-diode clamp in the collector circuit of the PA stage). Once it was replaced, the instability and spurious-output problems were resolved. Some of the circuit changes recommended were adopted by Heath and are being offered to early-model owners in a modification kit. The ARRL Hq. staff was much impressed with Heath's concern over the questions raised, and with the dispatch in which they came east to resolve the problem. The remainder of this report deals with performance after the circuit modifications were made.

Circuit Features

Reception is provided by a direct-conversion receiver that has a dual-gate MOSFET product detector as a front end. A single-tuned circuit

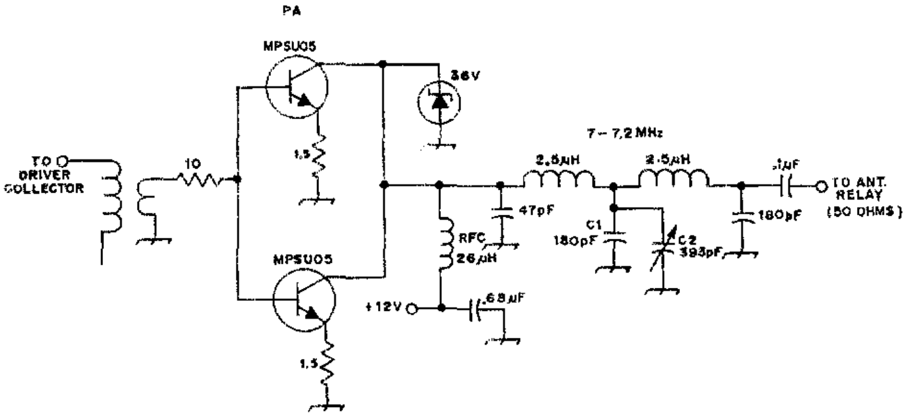


Fig. 1 – Schematic diagram of the HW-7 PA circuit. The band-switch arrangement is not shown so that the illustration can be simplified. Constants given are for 40-meter operation. Fixed-value capacitor C1 is used during 40-meter operation. Only C2 is in the circuit when the transmitter is used on 20 and 15 meters. The Zener diode at the PA collectors limits sine-wave peaks in that part of the circuit, thus preventing the safe collector-to-emitter voltage from being exceeded. Without the diode in the circuit the PA can break into self-oscillation and the MPSUO5s can be destroyed when the key is closed. The 1.5-ohm ballast resistors in the emitter returns protect the transistors from damage that could result during thermal runaway, and they help to equalize the currents drawn by the two devices.

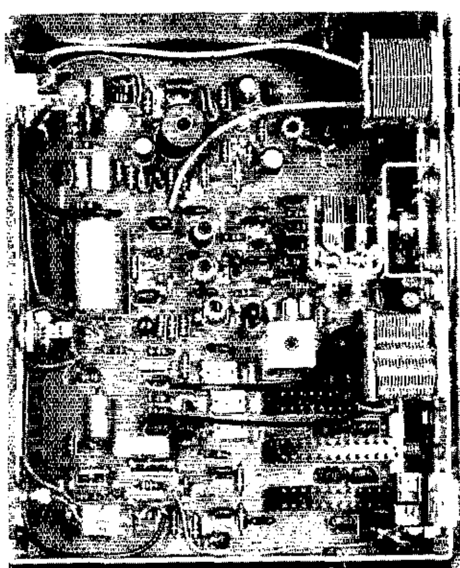
provides the selectivity for that stage. It is tuned to resonance in each band by means of a 393-pF variable capacitor, thus eliminating the need for a band switch in that part of the circuit. This panel-mounted control is labeled PRESELECTOR, though this seems to represent a misnomer of sorts since it is purely a peaking control.

The oscillator chain for the transmitter VFO serves double duty to provide a tunable BFO, the output of which is injected into gate 2 of the MOSFET detector. Injection occurs at the frequency of reception in each band covered by the HW-7. The fundamental frequencies of the VFO are 3.5 and 7 MHz. VFO energy is multiplied in frequency to 14 and 21 MHz (VFO operating at 7 MHz) for operation on 20 and 15 meters. During 40-meter use the VFO operates at 3.5 MHz and its output is multiplied to 7 MHz.

Overall receiver selectivity is established by an *m*-derived low-pass filter in the audio line between the product detector and the af amplifier. Though the HW-7 is a cw transceiver, selectivity is set for ssb reception (approximately 2 kHz, and with broad skirts). The reviewer was able to sharpen the response by changing the value of capacitance at each port of the filter. The .02-μF value at each terminal was changed to 0.22 μF, and this provided cw selectivity without impairing the level of audio output.

The filtered audio is amplified to headphone level (no speaker with this rig) by means of an audio IC which has the capability of 120 dB of amplification. The receiver is designed to work into high-impedance headphones.

The receiver is quite microphonic when its front end is peaked for the band of operation. This



View of the interior of the HW-7 (top). The push-button switch assembly is at the lower right. A dual-section variable (center right) is used to tune the VFO. The variable capacitor just below the split-stator one is the PA tuning control. The remaining variable capacitor (upper right) is for peaking the receiver front end. The rear panel of the cabinet (left) contains the power socket, key jack, antenna connector, and headphone receptacle.

is not a troublesome trait provided one does not bump the cabinet while listening to weak signals. The instruction manual mentions this condition and states that it is "typical" with this type receiver. No technical explanation is offered, however. Receiver sensitivity seems to be quite good despite the fact that no rf amplifier is used. Measurements made with a G.R. Model 80 signal generator indicate that 0.2 μV from the generator will produce a plainly audible cw note in the headphones. Normally, the man-made and atmospheric noise levels exceed that amount on the hf bands.

Performance

Transmitter performance is quite good. No chirp or hum has been noted on the transmitted signal, and only a slight click can be detected during keying intervals. The VFO is very stable during both the transmit and receive functions, mechanically and electrically. A precision ball drive is used to control the tuning capacitor in the VFO. No backlash can be detected, and tuning is smooth and easy. The dial is calibrated in 5-kHz steps. Tracking is within 2 kHz over any 100-kHz spread checked by this reviewer.

Provision is made for VFO or crystal control of the transmitter. Push-button switches located on the front panel enable the operator to choose VFO or crystal operation. The same row of switches contains those used to select the band of operation. A meter is mounted on the front panel. It indicates relative rf output during tune-up and operation.

Spurious and harmonic outputs are down at least 25 dB from the desired frequency. A clean sine wave was observed on a Tektronix 453 scope while operating the transmitter into a 50-ohm load. The relative freedom from unwanted output energy no doubt results from the use of a semi-tunable half-wave filter PA tank circuit (Fig. 1). The network has been designed for medium Q. This, plus the fact that a half-wave filter serves as a low-pass device, does much toward reducing harmonic output. Each end of the network is terminated by fixed values of capacitance. The center of the half-wave filter has a variable capacitor connected in parallel with a fixed-value capacitor. The variable enables the operator to tune the circuit to resonance at the frequency of operation without materially disturbing the impedance-matching characteristics of the network. Toroidal inductors are used in the circuit.

Since a direct-conversion receiver does not provide single-signal reception, the transmitter VFO must be offset by approximately one kHz on the *correct* side of zero beat on the received signal. The offset occurs automatically when shifting from transmit to receive, but the operator must tune in the received signal so that the beat note is on the *high-frequency* side of zero beat to assure that that transmitter signal is heard by the station being worked. It doesn't take long to adjust to this principle, so it should not present a significant problem to the buyer.

The HW-7 features a break-in delay circuit that contains a pc-board control for adjusting the length of the delay period. This circuit is akin to most of the VOX circuits found in cw/ssb transceivers. Its purpose is to prevent the antenna changeover relay (also built in) from cycling each time a code character is sent. When the relay is closed there is no audio output from the receiver and the sidetone monitor is heard in the phones each time the key is closed. The sidetone signal is *quite* loud, requiring that the operator turn down the af gain of the receiver during transmit lest he become distracted by the unusually high output level. This inconvenience could no doubt be remedied by cutting down the amount of sidetone energy supplied to the audio amplifier in the receiver. Installation of an internal sidetone level control should not be a major undertaking, though we have not tried it.

At first glance one might conclude that the HW-7 is a "Hot Water 12" (Heath HW-12) which has been subjected to the rituals of the head hunters. It closely resembles its larger brother in decor. The current two-tone green color scheme used by Heath Company has been applied to the HW-7. The knobs are made of dark green plastic, and are somewhat tiny for this operator's comfort . . . particularly for use on the front-end peaking control. The tuning rate is quite fast, and one can quickly pass the desired peak when adjusting with so small a knob.

The customary ruggedness of design is reflected in the cabinet and panels of the HW-7. Heavy-gauge aluminum is used for those parts. Most of the components are mounted on a single circuit board – an aid to fast assembly. The kit went together in 5-1/2 hours. Checkout and alignment required another hour.

Some Concluding Remarks

Those who have not tried low-power operation may find themselves wondering why a company would tool up to produce a package such as the HW-7. Well, plenty of good solid contacts can be made at the QRP level. While using the equipment described here the writer worked 28 states during five hours of casual band hopping. The antenna was an L-shaped, end-fed, 90-foot wire, approximately 35 feet above ground at its highest point.

(Continued on page 56)

Heath HW-7 Transceiver

Dimensions (HWD) and Weight: 4-1/4 × 9-1/4 × 8-1/2 inches, 4 pounds, 8 ounces.
Power Requirements: 13 V dc, 450 mA; ac supply available.
Transmitter Power Output: 2 watts or better.
Receiver Sensitivity: Readable signal, 1 μV or less.
Selectivity: 2 kHz at 6 dB down.
Price Class: $70. AC Power Supply: $15.
Manufacturer: Heath Company, Benton Harbor, MI 49022.

the next line of contour is higher or lower by looking over to the bold lines of contour and determining by the numbers which appear every so often in them, if we follow the line around until we find it. If it is higher or lower, we then subtract or add 50 feet to the bold figure until we arrive at the line closest to our mark.

On a scratch pad make a list of radials, starting with 0 degree true north. Going clockwise, put the numbers one to five under each radial degree, see Fig. 3. Next to each number put the height above sea level at each point. Add all the columns of numbers and divide by eight. You will now have the average of all the 40 points.

If you are using the 7-1/2-minute maps, which are much more detailed, you will have to fold back or cut off the borders on all four sides. Use the map that shows the site and follow the same procedure as in the large map above, except draw a line to the border on the quadrangle rather than to a scale of 10 miles. Next, take one of the adjoining maps and butt this map against the one which has the site on it. You may have two to four maps butted together to get one 10-mile radial. You may wish to work on one radial at a time, so that you will have enough room for the maps you are working with. All the other steps will be the same as with the large map.

The figure we have is the average height above sea level of the ground at our site. We must make one further calculation to determine the HAAT. First, determine the height above mean sea level at the site. For example, let's suppose that the site of the installation is 900 feet above mean sea level and let's assume the antenna is on a tower and the center of radiation of the antenna is 100 feet above the site. This means that our center of radiation is 1000 feet above *mean* (or average) sea level. Next, assume that our 40 check points average out to 800 feet. All we need do is subtract 800 from 1000. This means that our height above *average* terrain is 200 feet.

The last thing we have to do is to make all this information presentable to the FCC. We have several ways to do this. One is to take a fiber-tipped marker and darken all our penciled-in lines, properly label them and neatly list the computations for each radial on a separate sheet of paper. Submit both the maps and the computations with your form 610 or form 610B if for a club, military or recreation station.

Figuring Your ERP

In order to figure your effective radiated power there are several steps that must be followed. First, determine the power output from the repeater transmitter. This measurement should be made directly at the transmitter between the rig and any duplexers or other devices in the line. A wattmeter can be used for this measurement. Next subtract the loss through any device such as a duplexer that is in the line. The loss figures for such devices are usually measured in dB so this figure must be converted to power and subtracted from the output figure. Determine the exact length of the feed line and subtract the feed-line loss. Feed-line loss can be determined from the manufacturer's catalog or from charts in *The Radio Amateur's Handbook*. You now know the amount of power that is reaching the feed point of the antenna. This power, times the gain factor of the antenna used, equals the effective radiated power. The FCC also requires that radiation patterns of the installation be provided. These can be either mathematical computations; range measurements, or both. Also, in lieu of the foregoing, manufacturers' specifications for particular antennas may be submitted, provided the manufacturers' data has been filed previously with the Chief, Amateur and Citizens Division, and approved by the Commission. QST

Recent Equipment

(Continued from page 50)

The worst signal report was RST 449. The majority of the reports fell in the 579 to 599 class. Solid contacts were made on all three bands (several times) from Newington with stations on the West Coast of the U.S.A. Europeans were worked from the same East Coast location on 20 meters while using a sloping dipole with its center just 20 feet above ground. Answers to CQs run approximately 65 percent during normal band conditions. When answering another station's CQ the odds have been somewhat better – about 80 percent. It's anyone's guess what would happen if the rig were connected to a beam antenna!

One thing that the HW-7 does not like is to be used with an end-fed wire antenna if the high-impedance part of it is near the rig. Even if a Transmatch is used to provide a 50-ohm termination for the transceiver the proximity of the wire with respect to the unit introduces a most annoying 60-Hz hum in the receiver when the front end is peaked. This happens only if an ac-operated dc supply is being used. No problems were noted during operation with batteries. The hum problem is worst at the highest frequency of operation (15 meters). No difficulties were experienced when working with coaxial-fed beams and dipoles.

Power output was measured in rms volts across a 50-ohm dummy load: at 7.1 MHz, 11 V (2.5 W); at 14.1 MHz, 10.25 V (2.2 W); at 21.1 MHz, 10 V (2.1 W). These values were confirmed when making pk-pk voltage checks with a Tektronix 453 scope.

In view of the low price and versatility of the HW-7 transceiver the writer believes the equipment to be a bargain. It may seem that $35 per watt is a rather high price to pay, but you're getting a receiver too! The few shortcomings mentioned here are no greater in percentage than those found in some of the high-priced, esoteric transceivers on today's market. The HW-7 may be your key to getting in on the QRP fun. – *W1CER*