

• Recent Equipment —

Heath Pawnee 2-Meter Transceiver Kit Model HW-20



ONE of the joys in amateur radio is the feeling of accomplishment when a constructional project is finished and working. The fun is not restricted to the technician who builds strictly home-built gear; it can also be enjoyed by the beginner and nontechnical ham in the form of a well-engineered kit. The HW-20 certainly falls into this category, and although a challenging letter accompanies the kit, reminding the purchaser that the kit is recommended for the "experienced kit builder," the Pawnee is really no more difficult than any other kit. It just contains more parts, more steps, requires more time, and, of course, infinitely more patience!

The HW-20 (Pawnee) is one of two v.h.f. transceiver kits, the other being the HW-10 (Shawnee). The HW-10 covers the frequency range of 49.8 to 54 Mc., and the HW-20 covers from 143.8 to 148.2 Mc. Except for the frequency coverage, both models are more or less the same in circuit features, power requirements, and panel layout.

Designed for either mobile or fixed-station use, the Pawnee is a complete 2-meter station which can be operated on a.m. phone and — much to the delight of our v.h.f. editor — has a b.f.o. and provision for c.w. keying.

Receiver Section

A block diagram of the receiver section of the HW-20 is shown in Fig. 1. The receiver starts off with a broad-band cascade r.f. amplifier, V_{1A} , a 6BS8. A parallel-tuned trap in the input circuit is tuned to reject i.f. images and the amplifier output is transformer-coupled to the first mixer,

giving the receiver's front end a high order of i.f. signal and image rejection. An r.f. gain control is located in the cathode of V_{1A} to control the sensitivity of the r.f. amplifier. The broad-band characteristics of the r.f. amplifier make tuning controls unnecessary in this stage.

A 6EA8 triode mixer, V_{2A} , combines the r.f. signal and oscillator voltage. The oscillator, V_{2B} , which is voltage regulated and crystal controlled, operates at 61 Mc. in an overtone circuit. The 61-Mc. tank circuit is in the screen grid, and a second tuned circuit at 122 Mc. is in the plate circuit. Through electron coupling in the oscillator tube, the second harmonic of the crystal frequency is picked off in the plate circuit, and this energy is capacity-coupled to the grid circuit of the first mixer, V_{2A} . The resulting first i.f. signal is between 22 and 26 Mc. To insure low-impedance r.f. paths, the r.f. amplifier, first mixer, and crystal oscillator are all mounted on a silver-plated subchassis (see photographs) which is completely enclosed by shielding.

The 22- to 26-Mc. output of the first mixer is heterodyned to the second i.f., 2 Mc. in the pentode section of the 6EA8 second mixer, V_{3A} . The tunable oscillator, the triode section of the same 6EA8, operates 2 Mc. lower than the first i.f. A temperature-compensated Clapp oscillator circuit is used, along with voltage regulation, to insure stable operation. The oscillator tuning capacitor is part of a three-gang RCVR TUNE variable capacitor which also simultaneously tunes the first-mixer plate circuit and the second-mixer grid circuit. The tuning capacitor is mounted on the chassis with its shaft at right angles to the front

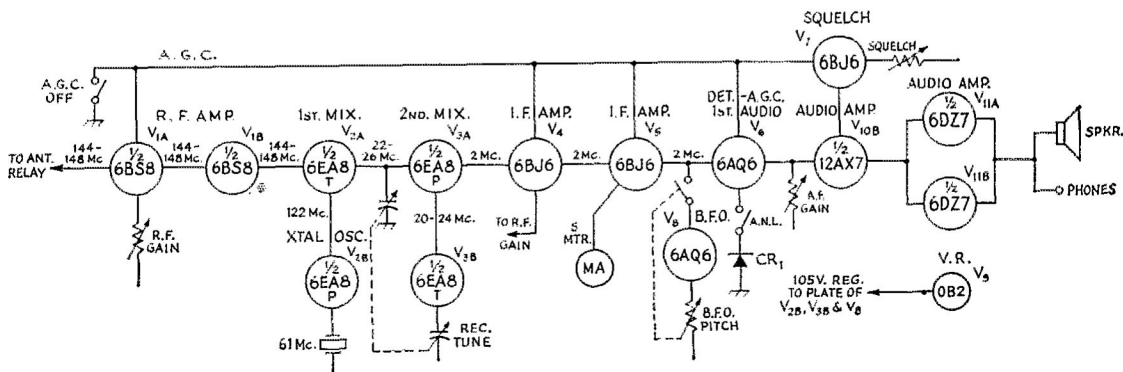


Fig. 1—Block diagram of the receiver section of the HW-20.

panel and is driven, along with the dial pointer, by a system of strings and pulleys. The dial pointer moves laterally along an illuminated slide-rule dial which is calibrated for receiver frequency at the bottom and v.f.o. frequency at the top.

Two 6BJ6s, V_4 and V_5 , amplify the 2-Mc. output from the second mixer. Six tuned circuits give an i.f. selectivity of 15 kc. at 6 db. down. The cathode of the first i.f. amplifier is in the r.f. gain-control circuit. A relative signal-strength meter is in the plate circuit of the second i.f. amplifier.

A diode section of V_6 , a 6AQ6, is used for detection and for developing a.g.c. voltage. A.g.c. is applied to the r.f. amplifier, first i.f. amplifier and a squelch tube, V_7 . The a.g.c. line can be grounded by a panel slide switch. A silicon diode, CR_1 , connected across the detector load, is used as a noise limiter. It can be turned on or off from the panel by a push-pull switch.

As mentioned earlier, provisions are included in the Pawnee for c.w. operation. The b.f.o. circuit is shown in Fig. 2. The Hartley oscillator, which can be tuned through the passband of the 2 Mc. second i.f., is controlled by varying the back bias on a silicon diode, CR_2 , which exhibits a capacitance change with a bias change. This scheme has been used before in Heathkits¹ but only in all-semiconductor circuits. The b.f.o. μ rrcn control, R_1 , located on the front panel, varies the bias on the diode and sets the oscillator frequency. This control also has a push-pull switch which turns the b.f.o. on or off. Output from the b.f.o. is capacity-coupled to the diode detector. The diode, CR_2 , comes already wired inside the b.f.o. transformer can.

Audio in the HW-20 receiver is first amplified in the triode section of the 6AQ6, which drives another triode stage, V_{10B} . A 6DZ7 dual pentode (the 6DZ7 is a tube commonly used in stereo amplifiers) in Class AB₁ push-pull furnishes about 3 watts of audio for the built-in speaker. The audio circuits incorporating V_{10B} and the 6DZ7 are common to both the receiver and transmitter sections of the Pawnee. Most of the switching between the two sections is done by a relay which is controlled by the push-to-talk switch on the microphone. The squelch tube, V_7 ,

¹ "Recent Equipment," *QST*, December, 1960, p. 32.

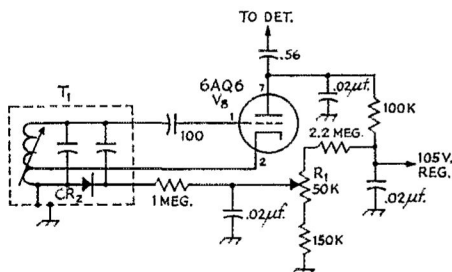
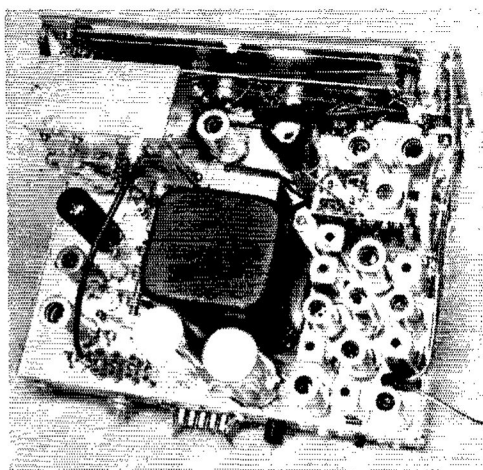


Fig. 2—Back bias on a silicon diode, CR_2 , is used to tune the b.f.o. in the HW-20. Unless otherwise indicated, capacitances are in $\mu\text{mf.}$, resistances are in ohms, resistors are $\frac{1}{2}$ watt.



Getting a complete 2-meter transmitter-receiver on a 10×12 chassis requires compact arrangement of the components, as demonstrated in this top view of the HW-20. The shielded box at the upper left of the photograph is the v.f.o. assembly. Transmitter-exciter stages are gang-tuned along with the v.f.o. through a system of gears visible at the bottom of the v.f.o. box. V.f.o. output is fed through the coaxial cable coming out from the top of the v.f.o. box, and is terminated with a phono plug which goes into a jack adjacent to the crystal sockets at the rear edge of the chassis. Power-supply components are in the center foreground, and the receiver section is at the right.

The main tuning capacitor can be identified by the large pulley at the right edge of the chassis. It is string-driven from the front panel through a system of smaller pulleys. The object mounted on top of the tuning capacitor is a screwdriver-adjusted potentiometer which is used to "zero" the S meter.

is also part of the audio system. It operates from the a.g.c. line and quiets the receiver by biasing off audio amplifier V_{10B} in the absence of a signal. The squelch threshold is adjusted by a panel SQUELCH control. This control is also a push-pull switch that turns the noise limiter on or off.

Transmitter Section

Nine tube sections are used in the r.f. and speech portion of the HW-20. The block diagram in Fig. 3 shows the lineup and job performed by each tube. The Pawnee's transmitter frequency can be controlled either by a built-in v.f.o. or by any one of four crystals (crystals are not furnished). A four-place crystal socket is accessible at the rear of the chassis and requires crystals in the 8-Mc. range. The desired crystal (or v.f.o.) can be switched into the circuit by a 5-position front-panel rotary switch.

The 8- to 8.22-Mc. v.f.o., V_{12} in Fig. 3, is a Clapp circuit which has been isolated both mechanically and electrically from the rest of the transmitter. All of the v.f.o. components are bottled up in a shielded compartment (see photographs) and all leads except for the r.f. output leave the compartment by way of feed-through capacitors. The frequency-determining components are mounted on a heavy subpanel heat-sink plate. One interesting thing Heath has done to

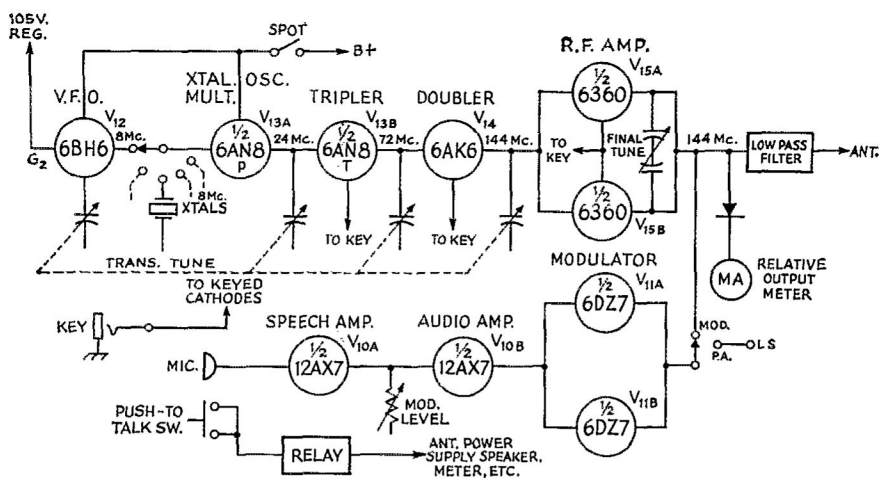


Fig. 3—Block diagram of the transmitter section of the HW-20.

stabilize the oscillator is to put the v.f.o. tube, V_{12} , inside the v.f.o. compartment. The idea is that the tube will bring the compartment up to temperature quickly and hold the temperature more or less constant. Included in the v.f.o. tuned circuit is a variable differential capacitor with fixed temperature-compensating capacitors connected to each stator. This differential capacitor can be set for various amounts of temperature compensation, depending upon the environment.

The v.f.o. tuning capacitor is a double-bearing variable, coupled to the panel XMTR TUNE control and dial pointer by strings and pulleys. The capacitor's shaft extends out the back of the v.f.o. compartment, where a combination of gears connects it to a three-gang variable capacitor which tunes several following stages. This feature allows for single-knob tuning of all the transmitter stages up to the final r.f. amplifier.

When crystal control is desired, the v.f.o. is switched out of the circuit and V_{13A} , the pentode section of a 6AN8, operates as an 8-Mc. Pierce oscillator. The plate circuit of this stage resonates at three times the crystal frequency (24 to 24.666 Mc.) and is tuned by one section of the three-gang capacitor. In the v.f.o. position, this stage operates as a tripler. A panel slide switch, labeled SPOT, applies voltage to V_{12} and V_{13A} for zero beating.

The triode (B) section of V_{13} triples the 24-Mc. signal to the 72-Mc. range. Its plate circuit is tuned by the second section of the three-gang XMTR TUNE capacitor. This stage is cathode-keyed along with the doubler, V_{14} , and the final r.f. amplifier. The doubler brings the signal up to the operating frequency in the 144- to 148-Mc. range. Its plate circuit is tuned by the third section of the XMTR TUNE capacitor.

A 6360 operates Class C push-pull in the final r.f. amplifier. It, too, has its own shielded compartment for isolation, and extensive filtering and bypassing is used on all of the d.c. leads entering the compartment. The final amplifier stage is cathode-keyed. A 100-ohm cathode resistance

protects the tube in case of loss of drive. Aside from the already-mentioned single-control XMTR TUNE knob, the final-amplifier plate-circuit tuning control, FINAL TUNE, is the only other control used in tuning the transmitter. Once it is adjusted for maximum transmitter output, it isn't necessary to change it for frequency excursions of up to about 500 kc.

The same meter used for relative signal strength in receiving is used for indicating relative transmitter output when transmitting. A semiconductor diode rectifies a sample of r.f. from the final-amplifier tank circuit and applies it to the panel meter.

Output from the final amplifier is link-coupled to the antenna circuit, and it is possible to vary the coupling by means of an adjustable link and a capacitor between the link and ground. Adjustments are made through panel holes behind the XMTR TUNE knob, which must be removed for this purpose. Once these controls have been set for a particular load (50 to 70 ohms) they usually do not need further adjustment.

Power input to the 6360 final amplifier is about 18 watts. Efficiencies of 50 per cent or better are obtainable on both phone and c.w. Our model measured about 10 watts output on c.w. and 9 watts on phone, using a Bird wattmeter and a non-reactive 50-ohm load.

A low-pass filter in the r.f. output circuit suppresses harmonics and other spurious radiations. Its cutoff frequency is about 152 Mc.

Speech Section

Tubes V_{10B} and V_{11} , the audio stages of the receiver, are also part of the speech section in the transmitter. In addition, V_{10A} , a triode section of a 12AX7, operates as a microphone speech amplifier for the high-impedance ceramic microphone furnished with the kit. Output from the speech amplifier drives V_{10B} , which is followed by the 6DZ7 push-pull modulator, operating Class AB₁. A combination output and modulation transformer matches the amplifier either to the

Class C r.f. load (transmit) or to the low-impedance built-in speaker (receive).

The audio section can also be used with an external speaker as a public-address system. This change is made by a combination push-pull switch/potentiometer located on the rear of the chassis. The switch gives a choice between either p.a. or modulator output, and the potentiometer, located in the circuit between the speech amplifier V_{10A} and the audio driver, V_{10B} , is an audio gain control for the speech section. About 10 watts of audio is available as a modulator, and about 15 watts as a public-address system. The various output levels are determined by the value of B-plus voltage applied to the 6DZ7 stage.

All of the switching between transmit and receive is done by the built-in relay, which is controlled by the microphone push-to-talk switch.

Power Supply

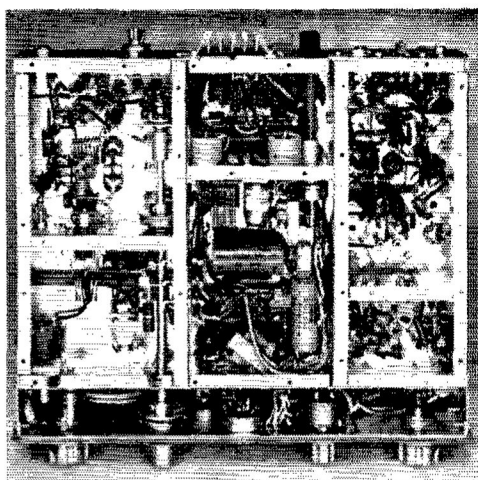
The Pawnee can be operated either from the 117-volt a.c. line, or from 6 or 12 volts d.c. In the case of d.c. operation, either positive or negative may be grounded. The three-way vibrator power supply is well filtered for hash elimination. The stepped-up voltage is rectified in a bridge circuit with semiconductor diodes. Two output voltages are developed in the supply, 125 volts d.c. for the receiver and audio sections and 250 volts d.c. for the transmitter and modulator. There is also 105 volts regulated for use on all the oscillators.

Two power cables plug in a socket at the rear of the Pawnee. One cable is wired for a.c. operation and the other is wired for either 6- or 12-volt d.c. operation. Heath furnishes an external heavy-duty relay that mounts close to the car battery and remotely controls the high current to the unit. The relay will work on both 6 or 12 volts since a dropping resistor is used in series with the relay coil on 12 volts.

Adjustment — Calibration — Operation

The Pawnee is housed in the familiar Heathkit two-tone green cabinet. There is a yoke-type mounting for mobile operation so that the unit can be hung from the dash or supported from below on the transmission hump. The microphone clip can be attached to either side of the cabinet for the operator's convenience. The built-in speaker faces out through the perforated side of the cabinet.

Arranged along the rear of the cabinet are the r.f. output connector (SO-239 type), key jack, a ground stud, power cable connector, modulator level and push-pull modulator/public address switch, phones jack (automatically disconnects the speaker when the phones are inserted), modulation monitor slide switch (provides for monitoring on-the-air modulation through the phones), and phono jack (for connecting an external speaker for the p.a. feature). A Fahnestock clip on the back of the cabinet makes a convenient holder for an Allen wrench (furnished) which fits the Allen screws in all the panel knobs.



The HW-20 chassis is divided into six compartments which are visible in this bottom view. The compartment at the lower right houses the receiver's front-end circuits, which are mounted on a silver-plated subchassis; at the top right is the remainder of the receiver except for its audio stages. The two center sections of the chassis contain the power supply, receiver audio, transmitter audio, and relay switching circuits. At the upper left is the transmitter's oscillator, multiplier and driver stages, and at the lower left is the final r.f. amplifier stage. The chassis bottom plate has been removed for this photograph.

Total time spent on the Pawnee kit, including the alignment time, ran well into 70 to 80 hours. Of course, this includes a good many hours spent in just going over the instruction manual *before* starting the kit. Except for a couple of minor errors in the manual (in the pictorial drawings), the kit went together without any real difficulties. If it were necessary to pick out the most difficult part of the project, our choice would probably be the operations related to stringing the dial cord on the various pulleys and then attaching the front panel to the chassis. Any other complaints about the constructional side of the kit would hold true for all kits in general. Such items as hardware, gears, shafts, bushings, clamps, etc., are difficult to identify since they are usually all dumped into one sack—the machine screws, nuts and washers alone are divided into half a dozen types!

Some interesting time savers are included in this kit. Screw holes on the chassis bottom plate are used as a jig for making up the correct dial cord lengths. Several long screws are temporarily placed in specific holes in the bottom plate. The dial cord is then strung between the projecting screws and the ends tied together. This results in a dial cord loop of the proper length. Another cute gimmick furnished with the kit is a plastic nut starter which, when a small metal insert is attached, doubles as an alignment tool!

Alignment of the receiver and transmitter is a simple operation even with modest test equipment. The instruction manual outlines several alignment procedures to suit the ability and test equipment of the owner. Receiver-alignment

methods include one where a v.t.v.m., sweep generator, wide-band oscilloscope and a signal generator are used. An alternate method is one that requires only a v.t.v.m. and involves using the transmitter section of the Pawnee for the signal generator. Transmitter alignment is straightforward and, if the instructions are followed to the letter, does not present any difficulty.

Probably the most tedious operation is the v.f.o. calibration and temperature-compensating adjustments. It may take several hours over a period of days or weeks to get the desired temperature stability. Our unit could be adjusted for stable operation during the first 30 to 45 minutes after a cold start, but would then begin to drift considerably. On the other hand, it could be set for long-term stability, but would drift for the first hour or so.

This writer was somewhat disappointed with the performance of the rather primitive noise limiter. Although a shunt diode limiter of this type does give some effective limiting, it does not measure up to the other outstanding features of the unit. In our unit, the various sections of the transceiver are so well shielded that in the spot position there was not enough oscillator signal

getting back to the receiver, so that it was difficult to hear the "spot" signal for zero beating.

The c.w. keying of the transmitter — even with v.f.o. control — is surprisingly stable. That there are provisions for keying and c.w. reception at all is enough reason for congratulating the manufacturer.

On the air reports concerning the "sound" of the Pawnee almost invariably laud the excellent speech quality of the unit. —E. L. C.

Heath HW-20 2-Meter Transceiver

Height: 6 inches.
Width: 12 inches.
Depth: 10 inches.
Weight: 30 pounds.
Power requirements:
Input voltage
6.3 v.d.c., 12.6 v.d.c., 117 v.a.c.
Transmit 11.5 amp. 7.5 amp. 120 watts.
Receive 8.5 amp. 4.5 amp. 60 watts.
Price class: \$200.
Manufacturer: Heath Company, Benton Harbor, Mich.

• New Apparatus

Twirl-Con—An Aid to Neater Wiring

It's not what it looks like, but it is a handy device for use in wiring and servicing radio equipment. Its name, *Twirl-Con*, is descriptive of the tool's purpose. You hold the knurled portion of the handle between your thumb and first fingers, feed a wire through the slot in the hardened-steel end, and then twirl the handle while keeping tension on the wire in the other hand. This coils up the wire so that it can be slipped over another similar wire, or over the remaining stub of the lead of a defective component that has been clipped out of the equipment being serviced.

A simple idea, but it can speed up wiring and servicing of equipment, and make a neater job of it. Particularly in the latter work, removing a component for test or replacement is often a messy job. Where several wires are soldered to a single terminal, damage may result from an attempt to unwrap soldered leads. Parts soldered to terminal boards often have only about $\frac{1}{8}$ inch of lead exposed. Once this is cut, reconnecting is all but impossible, yet parts often must be lifted

at one end to check for continuity or shorts. The *Twirl-Con* provides a simple and quick method of replacing such connections, or installing a new part. You merely twirl yourself a little sleeve of wire, slip it over the ends of the leads to be connected, and solder. Surplus wire can be left on the twirl for holding during the soldering, and then slipped off.

Twirl-Con is made by Henry N. Dittrich, W5IVU, 1101 N. East St., Edna, Texas, in two sizes, for No. 18 or No. 20 wire.

—E. P. T.

Strays

Not convinced yet that GMT is what you should use for your operating schedules? Then answer this quickly, without looking it up. If a ham in Hawaii told a ham in Anchorage that he'd work him again at 1000 local standard time, what would the schedule time be in Anchorage? (Standard Time.)

(Both Anchorage and Hawaii are on Hawaiian

— . . . —

Several members of a radio club at the University of Illinois spent all one afternoon putting up a new antenna. Just after making the final connection to the transmitter, it was discovered that not a single one of them had a valid license. Better check the expiration date on *your* license, OM!

