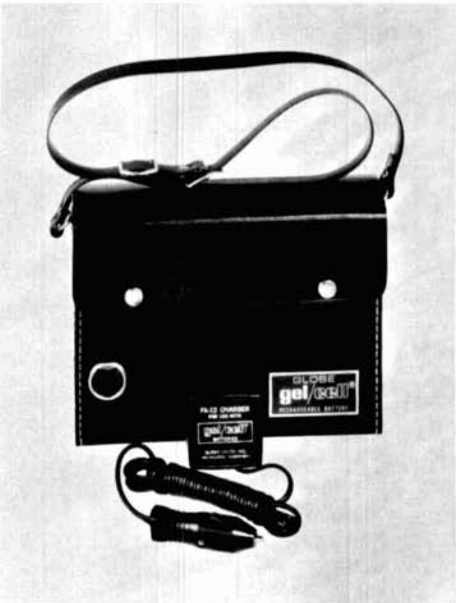


fig. 3. For portable use you may want to use a rechargeable Gel/Cel battery made by Globe Battery, Milwaukee, Wisconsin.

50 close-spaced turns of number-24 enameled copper wire. There are two binding posts positioned on each side of the toroid. Later you may wish to operate on other bands and they provide an easy means of changing coils for multiband operation. The two trimmer capacitors are mounted near the coil so they can be easily adjusted while observing the readings on the output indicator.

You may wish to drive the two-stage transmitter with a variable-frequency oscillator connected to the vfo input binding posts, **fig. 1**. For this mode of operation you need only remove the crystal from its socket.

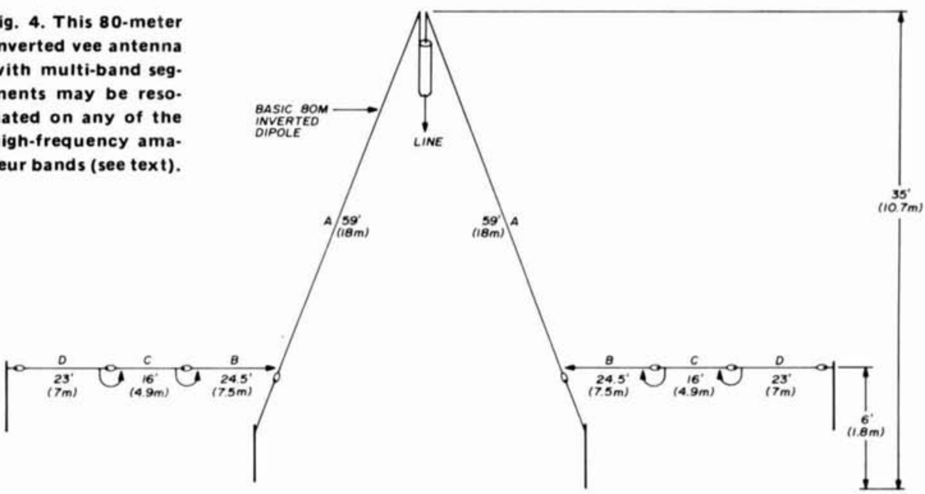
tuneup

To check out the transmitter, first insert the crystal and the two fets. Arrange the supply voltage so as to apply power, initially, to the oscillator only. Connect the 1-mA meter across the gate resistor R4.

Turn on the oscillator stage. Note that there is an indication on the meter. This indicates that the oscillator is operating and there is adequate drive to the amplifier, enough to draw gate current. Meter reading is low and approximately 0.1 mA. Note that if the crystal is removed from its socket, the current reading falls to zero. Also, if the amplifier fet is removed from its socket the meter reading falls to zero.

Insert the 50 mA meter in the supply line to the drain of the amplifier. Adjust capacitor C5 for near maximum setting. Apply power to both stages. Now tune capacitor C4 through its range. Note the

fig. 4. This 80-meter inverted vee antenna with multi-band segments may be resonated on any of the high-frequency amateur bands (see text).



dip in the drain current as the output circuit is tuned through resonance.

Transfer the 1-mA meter to the indicator circuit (across capacitor C8), connect a 68-ohm resistor across the amplifier output, and turn on the transmitter. Adjust capacitor C4 for maximum meter reading. Now adjust capacitor C5 for best output. Jockey back and forth between C4 and C5 until maximum output is obtained.

Jot down the output meter readings and the drain current reading, and calculate the dc power input to the amplifier

$$P_{IN} = V_{DD}\ I_D$$

Typical dc input power is 480 milliwatts (24 V x 20 mA).

Now connect an oscilloscope across the output. Note the good quality of the generated 80-meter sinewave. Key the transmitter, noting the influence on the oscilloscope pattern and the drain and output current meter readings. Tune the transmitter in on your receiver. Check out the keying quality of the CW signal.

Remove the 68-ohm resistor which is across the output, disconnect the oscilloscope, and connect your 80-meter dipole antenna across the output. Retune

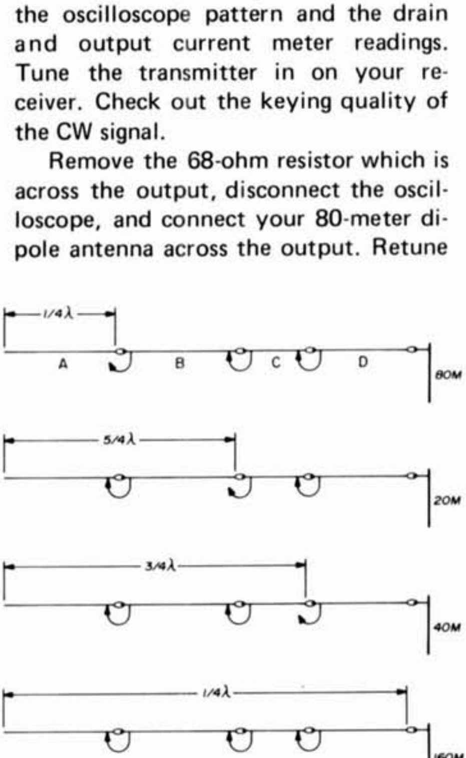


fig. 5. How to use the basic antenna system of fig. 4 on four bands by using jumpers.

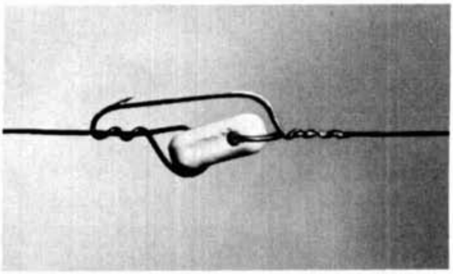


fig. 6. Installing a simple jumper wire across the antenna insulator to adjust resonance.

the transmitter. If your antenna system matches properly there should be very little change in drain current or the output meter reading. If your antenna is not resonant to exactly the crystal frequency the meter readings might not be the same. You are now ready to operate your fet QRP transmitter. Initial W3FQJ contacts with this little rig were with W2UEZ and W2UUV/1.

The rig can also be operated portable using the Globe Gel/Cel 4.5AH 12-volt battery. This convenient battery can be supplied with its own charger or it can be charged from a small solar energy converter, **fig. 3**.

single antenna – four bands

In my solid-state and QRP experiments I needed a single good performing, one-transmission-line test antenna for the 20-, 40-, 80- and 160-meter bands. In addition, it should be possible to resonate the antenna to any frequency in any band. For good performance there should be a current loop at the top of the antenna for each band. For convenience it is helpful to make all resonant frequency and band changes from the ground level and without letting a mast down or putting it back up. A bit of walking to make changes was welcome rather than frowned upon.

The Inverted-Vee antenna was selected because current maxima could be positioned at the apex for each band by proper selection of leg length. At the same time all changes in resonant leg length could be made from ground level. This is accomplished by making each leg length some odd multiple of an electrical quarter wavelength, reflecting a low impedance to the feedpoint at the apex. The final antenna operated as an inverted dipole on 80 and 160; a 3/2λ Inverted-Vee on 40; and 5/2λ on 20.

A general plan of the antenna is shown in **fig. 4**. The 80-meter segment is a conventional inverted dipole with its apex about 35 feet (11m) up at W3FQJ, with wire ends reaching down to 4 to 5 feet (1 to 1.5m) above ground level. From these accessible ends the legs of the antenna span out horizontally at the same level.

Segment B, approximately 25-feet (7.6m) long, when added to segment A with a jumper in each leg sets up the 5/2λ antenna on 20 meters. Additional 15-foot (4.5m) segments jumpered onto leg ends establishes a 3/2λ on 40. Finally, about 25 additional feet (7.6m) provide a half-wavelength antenna on 160 meters. The legs do not necessarily have to run straight away. When necessary they can be tilted away from the plane of the Inverted-Vee by as much as 40 to 60° to permit accommodation to the mounting site.

The arrangement of each leg of this antenna is shown in **fig. 5**, showing the jumper open or closed plan for four-band operation. All of this can be done conveniently from ground level. The photograph of **fig. 6** shows how a jumper is closed across a standard ceramic insulator.

table 1. Free-space dimensions (f in MHz).

1/2 wavelength	492/f (feet)	150/f (meters)
3/2 wavelength	1496/f (feet)	450/f (meters)
5/2 wavelength	2460/f (feet)	750/f (meters)
7/2 wavelength	3444/f (feet)	1050/f (meters)

Free-space dimensions for a sequence of odd quarter-wavelength segments is shown in **table 1**. These free-space lengths must be shortened to obtain an electrical resonance with a wire antenna. The following formulas are normally used to find the length of a quarter-wavelength dipole leg:

$$\text{leg length (feet)} = \frac{234}{f_{MHz}}$$

$$\text{leg length (meters)} = \frac{71.3}{f_{MHz}}$$

This works for most amateur bands. However, when building a 160-meter antenna recently I found the leg length was more closely given by $228/f_{MHz}$ (feet) or $69.5/f_{MHz}$ (meters), possibly showing the close-to-ground influence.

By experiment I have found that the leg-length equations for 3/4 wavelength are $752/f_{MHz}$ (feet) and $221/f_{MHz}$ (meters); for 5/4 wavelength the equations are $1210/f_{MHz}$ (feet) and $369/f_{MHz}$ (meters). These equations should get you into each of the desired bands. However, some length ad-

table 2. Design equations and resonant points for inverted-vee antenna shown in fig. 4.

band	antenna	equations		measured resonance
160 M	1/4 wavelength	228/MHz (feet)	69.5/MHz (meters)	1850 kHz
80 M	1/4 wavelength	234/MHz (feet)	71.3/MHz (meters)	3930 kHz
40 M	3/4 wavelength	725/MHz (feet)	221/MHz (meters)	7290 kHz
20 M	5/4 wavelength	1210/MHz (feet)	369/MHz (meters)	14340 kHz

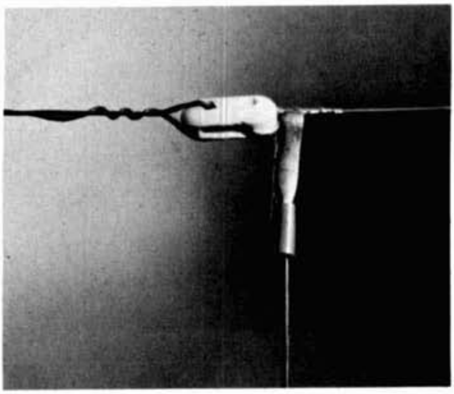


fig. 7. Resonating to a spot frequency in any band may be accomplished with short clip-on sections.

justments will undoubtedly be necessary for resonance at your preferred frequency as variables inevitably creep into any antenna installation.

Resonating to a spot frequency within any one band can be handled with clip-on sections, **fig. 7**. In using the idea of the clip-on section, dimension the antenna segments to the high end of each band. For example, the 80-meter inverted dipole is resonated near 3.95 MHz. Two clip-on sections of proper length can then be used to resonate the dipole to any lower frequency in the same band. For the case in point clip-on lengths of 4 feet (1.2 meter) tune the antenna to resonance at 3.6 MHz.

The dimensions given in **fig. 4** are the final practical values. Data for them are given in **table 2**. Of course, you may wish to cut the antenna segments for resonance at the center of the phone segment of each of the bands. If you decide to do this, a single pair of clip-ons for each band can then be used to lower antenna resonance into the CW band.

reference

1. Ed Noll, W3FQJ, "Solar Power," *ham radio*, November, 1974, page 52.

ham radio