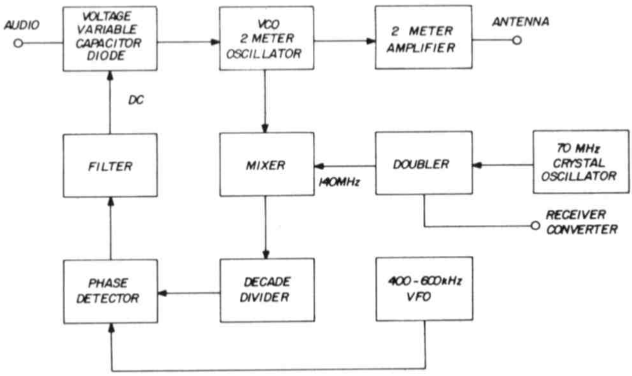


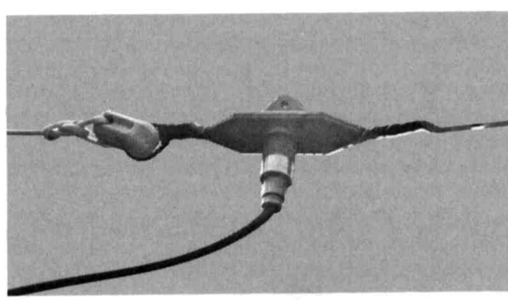
fig. 1. Two-meter phase-lock facility used by G3WXO.

column. G3WXO[2] uses a decade counter (Motorola SN7490N) and a quadruple two-input positive NAND gate (Motorola SN7400N) connected as a phase detector in the lock path (**fig. 1**). No multiplier chain is used; the fixed frequency is generated directly by a voltage-controlled two-meter oscillator. The oscillator output supplies signal to a follow-up two-meter amplifier.

A portion of the output is applied to a mixer along with a 140-MHz crystal-controlled component. The difference frequency (4-to 6-MHz range) is applied to the decade counter.

The phase-detector compares the output of the counter with the output of the low-frequency variable-frequency oscillator which is tunable from 400 to 600 kHz. This oscillator is the vfo control for the transmitter. The dc-control voltage at the output of the phase detector is applied to the voltage-controlled 2-meter oscillator by way of an appropriate filter.

A varactor-diode circuit responds to the dc-control voltage. It is possible to change the frequency of the voltage-controlled oscillator between 144 and 146 MHz by varying the frequency of the vfo. Furthermore, an audio signal can be used to frequency modulate the 2-meter oscillator directly. There is no trouble in obtaining full deviation with the center frequency held fast by the phase-lock system. In G3WXO's two-meter station the 140-MHz component is also used as local oscillator injection for his two-meter converter.

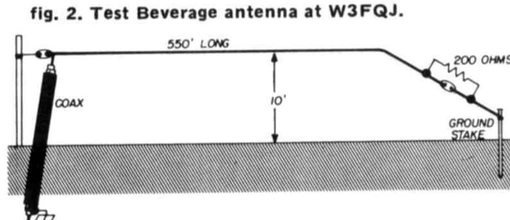


Feed end of the Beverage antenna.

beverage antenna

I covered the subject of anti-QRM receiving antennas in a previous column.[3] One of the antenna types mentioned was the Beverage. Its possibilities for receiving from a single general direction with mini-

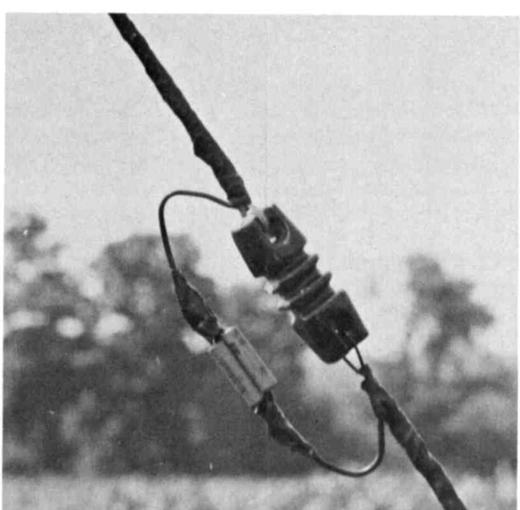
fig. 2. Test Beverage antenna at W3FQJ.



mum pickup from side and back were verified with a Beverage antenna at W3FQJ.

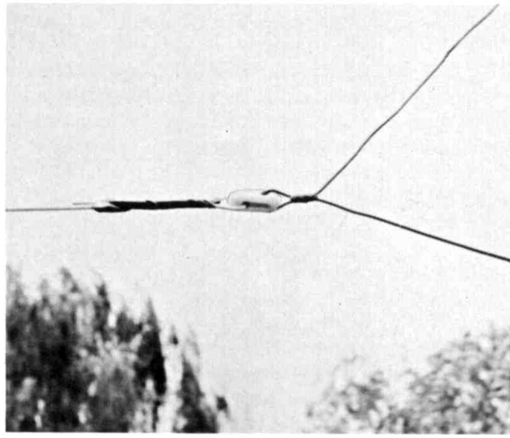
The antenna was short as Beverage types go; total length was 550 feet, **fig. 2**. Height at no point was more than 10-feet above ground. The end was terminated in a 200-ohm non-inductive resistance (three 600-ohm resistors in parallel). A ground stake was driven 4 feet into the ground. Approximately 120 feet of coaxial cable linked the feed end of the Beverage to the shack. The inner conductor of the coaxial cable was connected to the Beverage wire; no connection was made to the outer conductor at the antenna end. A coaxial switch permitted the receiver input to be switched rapidly between the Beverage antenna and the combination transmit-receive antennas used on the various amateur bands. Here are the results:

1. The Beverage antenna was highly directive off the far end. It favored low-angle long-distance signals over short-skip and local signals.



Terminated end of the Beverage antenna.

2. In general the received signal strength was lower than a good operating antenna on any specific band. However, back and especially side pickup was in most cases, less than similar pickup with the comparison antenna. That is, the ratio of the signal from desired direction over interference from other directions was higher than with the comparison antenna.



Construction used at the base angle of each element in the triangle beam.

3. Similar results were obtained on all bands 10 through 160 meters. The antenna was pointed about 15° south of west. Maximum direction therefore was directly across the continental United States and showed a definite preference for W5s, WØs and southern W6s.

Some directivity existed even on 160 meters despite the fact that the antenna should not be considered a true Beverage for this band since it is only about one wavelength long. Nevertheless, it provides a good cutback of W1 signal levels when tuning in signals from the corn-belt states. Vhf checks have yet to be made.

The Beverage antenna can also be loaded for transmitting. The best method of matching is to use the common T-network often used to match single-wire antennas to a transmitter. This network consists of two tapped coils and a single

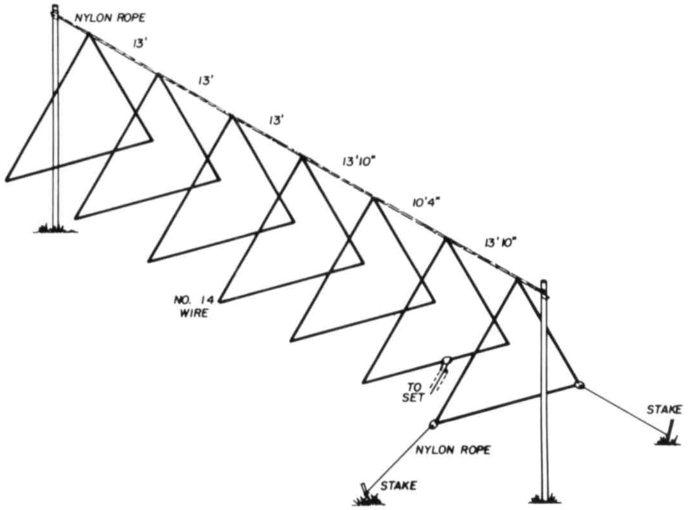
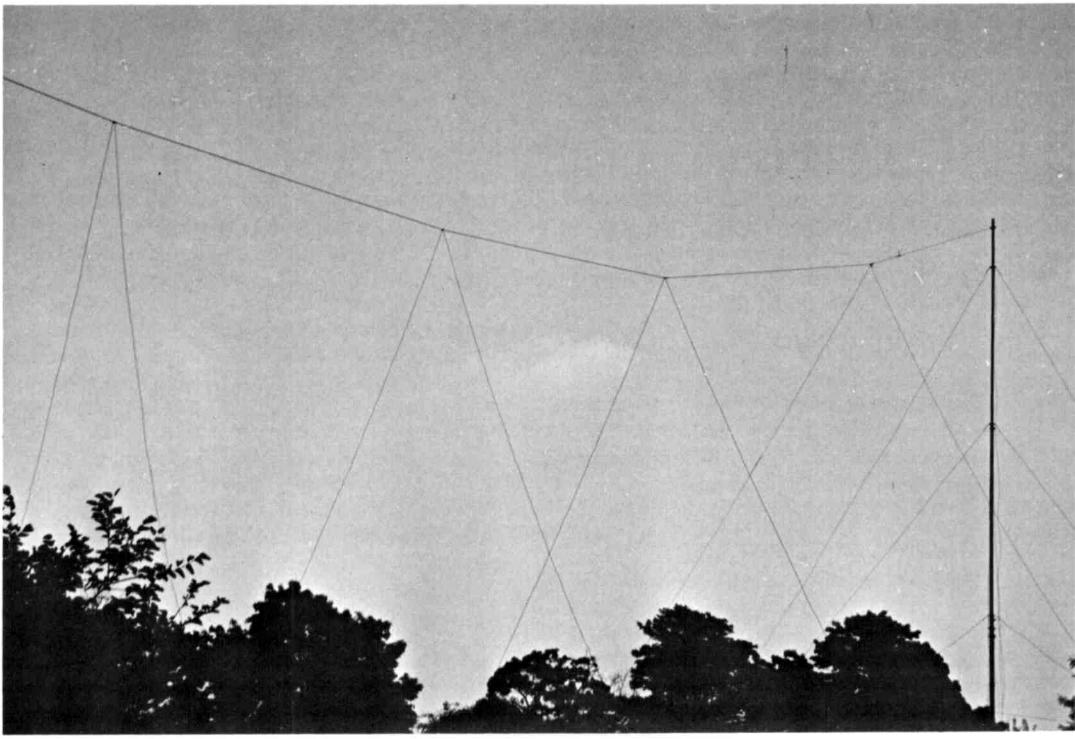


fig. 3. Seven-element 20-meter triangle beam. All elements are staked out the same as the reflector.

variable capacitor adjusted for a good match on each band. There was no trouble with loose rf in the shack with the use of coax between the transmitter and the fed end of the Beverage antenna.

Stations could be raised on each band in the favored direction despite the very low antenna. Reports would be a half S-unit to several S-units below comparison antennas. It was very difficult to raise

Four triangles of the seven-element triangle beam.



anyone off the favored angle. This latter condition checks out the reciprocity theorem, indicating very low sensitivity off the favored direction.

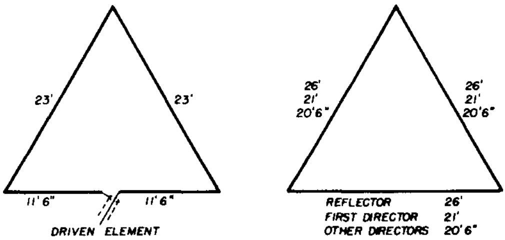


fig. 4. Dimensions of the elements used in the W3FQJ triangle 20-meter beam.

There is substantial work to be done on this style of antenna. The simple tests above just scratch the surface. Other amateurs who have done work with the Beverage indicate that the antenna should not be more than 10 feet above the ground or it will lose its low angle directivity and increase its side pickup.

There is a host of experiments to be done with various types of elaborate ground systems and the selection of length and height above ground to favor a specific band. Added height will increase signal pickup and transmit signal reports. However, just what is that optimum height which will not permit a serious cancellation of its anti-QRM characteristics when receiving?

another triangle

A high-gain beam antenna can be built at low cost with the full-wave triangle. A 20-meter seven-element triangle (driven, reflector and five directors) was constructed and suspended on nylon rope between two 40-foot telescoping TV masts, **fig. 3**. All of the closed full-wave configurations (quad, delta and triangle) perform well at low antenna heights. This is not to say that they cannot be improved upon by mounting them higher. Of the three types, however, the single-point top of the triangle is a definite advantage for low-cost storm-resistant mounting arrangements.

The seven elements were made of insulated wire. With the apex of the triangle at 40 feet off the ground the feed point of the driven triangle is readily accessible from ground level.

This antenna was positioned to favor Europe and performs well with 200 watts on a band crowded with high beam antennas and kilowatt transmitters. Raising the apex another 30 feet would permit some spectacular results with QRP power.

more phase-locked loop

Additional checks were made on the phase-locked loop circuit covered in September's "Circuits and Techniques."[4] A dc voltage-control circuit was added (**fig. 5**) to provide a means of changing the frequency of the voltage-controlled oscillator. Potentiometers replace the variable capacitors of the previous circuit. A fixed 250-pF capacitor between terminals 2 and 3 permitted tuning the

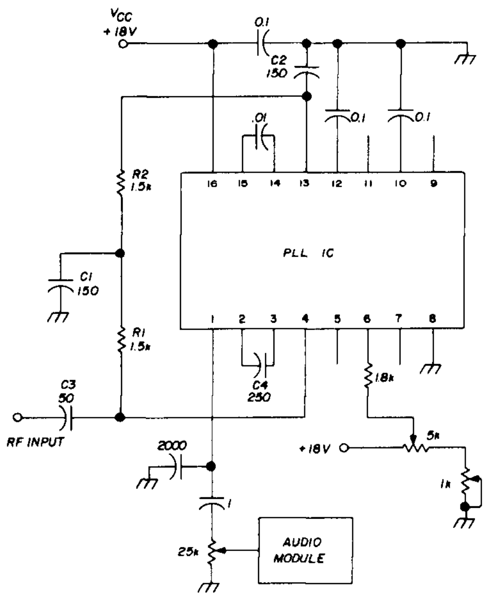


fig. 5. Phase-locked loop receiver with dc vco control.

160-meter band and the high-frequency end of the broadcast band.

Two potentiometers are connected in series as coarse and fine (bandspread) tuning controls. Excellent bandspreading can be obtained with this arrangement. For example, by using a bandspread potentiometer of several-hundred ohms, a 50-kHz segment of the 160-meter band can be spread over the entire dial. Hand-capacitance effect is virtually eliminated.

A simple fet amplifier improves the sensitivity of the receiver. Strong locals are a problem and sometimes must be trapped-out if you live in an area such as mine with a cluster of broadcast towers not too many miles away.

In one experiment, ***fig. 6****, the resonant* drain circuit was a replacement superhet rf transformer (such as Stancor 8736). The antenna winding was connected to the input of the phase-locked loop. The

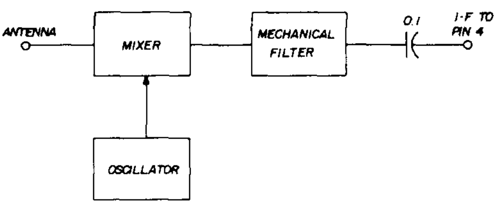


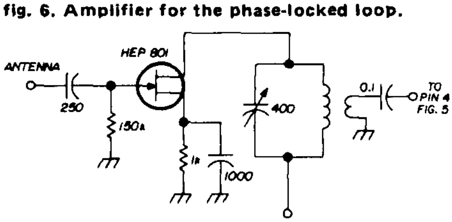
fig. 7. Use of a phase-locked loop in a superheterodyne receiver.

secondary was connected to the drain circuit of the fet. Proper adjustment of the transformer slug permitted operation on 160 meters and a large portion of the broadcast band as well.

Performance was excellent considering the simplicity of the receiver. Sensitivity was excellent with a suitable antenna; selectivity was quite good.

Selectivity is improved with the use of a mixer-oscillator ahead of the device using the phase-locked loop as an i-f amplifier and demodulator. In this arrangement a mechanical filter is placed between the mixer and the phase-locked loop, **fig. 7**.

fig. 6. Amplifier for the phase-locked loop.



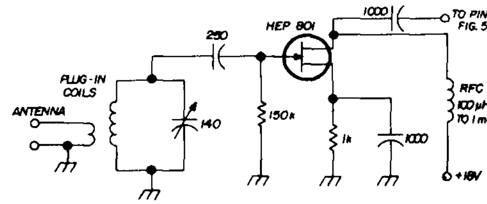


fig. 8. Multiband circuit arrangement for the phase-locked-loop receiver shown in fig. 5.

The arrangement of **fig. 8** was also checked out and gave good a-m performance on the 40-, 80- and 160-meter bands. A radio-frequency choke was connected in the drain circuit, while the resonant transformer was moved to the gate circuit. With this circuit arrangement a tapped resonant coil or plug-in coils can be used for the three bands.

By connecting a trimmer capacitor between terminals 2 and 3 of the PLL, a particular amateur or shortwave band can be located more readily. In this case one potentiometer is used to tune over the entire band and the second potentiometer is used for bandspread tuning within the band.

An amplifier is a definite aid in improving the sensitivity for this simple direct-detection receiver. It is wise not to use an amplifier that can go into self-oscillation; be certain that any amplifier with tuned input and output circuits is properly neutralized before it is connected to the input of the phase-locked loop.

references

1. R. A. Ham, "Radio Society Members Provide Vital Link in Probing Atmosphere," *Electronics Weekly* (England), June 2, 1971, page 14.
2. Jack Hum, G5UM, "Four Meters and Down, from G3WXO," *Radio Communications* (England), June, 1971, page 403.
3. Edward M. Noll, W3FQJ, "QRM-Reducing Receiving Antennas," *ham radio,* May, 1971, page 50.
4. Edward M. Noll, W3FQJ, "IC Phase-Locked Loops," *ham radio*, September, 1971, page 54.

ham radio