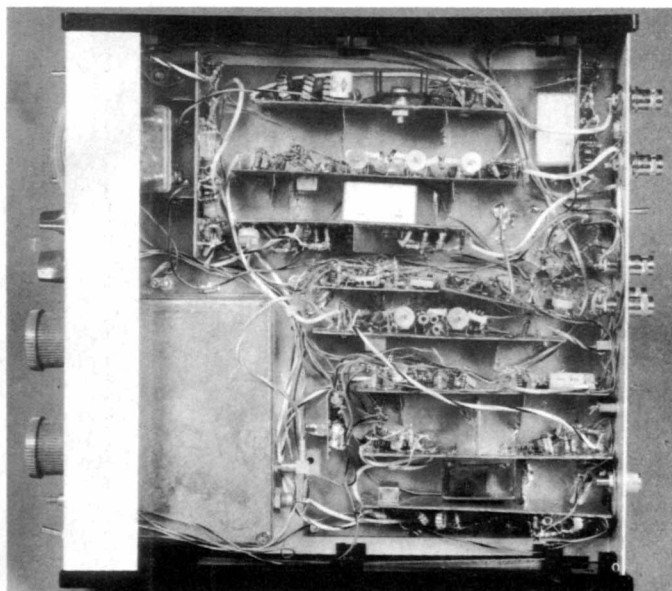


A QRP SSB/CW Transceiver for 14 MHz

Part 2[†]: This month, W7ZOI rounds out his description of a 1- or 10-W SSB/CW rig with details on its transmitter, TR switching and optional speech processor.

By Wes Hayward, W7ZOI
7700 SW Danielle Ave
Beaverton, OR 97005



SSB generation occurs in the circuit shown in Fig 4. A microphone amplifier (Q16-U6) supplies audio to an MC1496 balanced modulator (U7). One-microfarad capacitors (C6-C8) are used at the output of the audio amplifier and at several positions in the balanced modulator. (Originally, 10- or 22- μ F units were used, but these caused the system to respond slowly during TR transitions.)

The modulator output is applied to Q11, a 2N3904 IF amplifier. This stage terminates the transmitter crystal filter and provides a convenient place for CW carrier injection. Another IF amplifier (Q12-Q13) follows the crystal filter. The TX GAIN control, R5, is set for an output of -10 dBm from Q13. This level is applied to the transmit mixer, or to the speech processor described later.

Fig 5 shows more of the transmitter. SSB energy at -10 dBm drives the transmit mixer, U8, another diode ring mixer. The 5-MHz VFO signal is amplified to +10 dBm for the mixer by Q17 and Q18. A 3-dB pad terminates the mixer, with the signal continuing to a three-pole, LC, band-pass filter. The first stage in the output-amplifier chain is Q21, a 2N5179 feedback amplifier with an output of +2 dBm. This signal is looped through a coaxial-cable jumper on the transceiver rear panel for use with VHF transverters.

The driver, Q22, a 2N5859, is capable of about +20 dBm output. Transceiver output is obtained from Q23, an IRF511 HEXFET[®] PA operating at the 1-watt-output level. This power level is a little low for use on the air with dipoles, but is too high for many transverter applications.

Louder-Signal Options

Two additional circuits, shown in Fig 6, round out the SSB system. The first, at Fig 6A, is an IF speech processor. The cable between T8 and transmit mixer U8 is broken

and applied to the processor. The processor is driven with a -10 dBm signal. This signal is clipped with parallel, reverse-connected, hot-carrier diodes (D11 and D12). The intermodulation products generated by the clipping are rejected by an additional crystal filter (FL3). The signal is then amplified back to the original -10 dBm level by Q27 and Q28. This circuit generates about 10 dB of clipping. Reports and measurements made on the clipped signal indicate good quality, a potential problem area with many speech processing systems.

Fig 6B shows a 10-watt-output FET power amplifier. The FET that I used (an M/A-COM DV2880T) is no longer available, but is similar to the Motorola MRF138. Alternatively, one could obtain several watts of output from another IRF511.⁸ The TR switching in the transceiver is set up for an outboard PA.

Summary

This was a very enjoyable project, and one that I would recommend for other experimenters. The 20-meter phone band, however, can be a little intimidating for the QRP enthusiast.

A rig like this can probably be built and adjusted by those with only modest test equipment. A 15-MHz oscilloscope served as my test-equipment workhorse during construction of this project. A home-brew spectrum analyzer also served as a very useful tool, but is not required. Fig 7 shows the transceiver's CW output spectrum. The 270- Ω resistor and 0.56 μ F capacitor associated with the base of Q20, Fig 6, provide CW rise and fall times of 1 and 1.5 ms, respectively. Careful measurement of signal levels during construction helps to keep the system spectrally clean.

Most of the transceiver's components are contained in ugly-constructed modules, with the exception of the VFO (lower left) and panel-mounted controls and jacks.

Acknowledgments

The author gratefully acknowledges the photographic assistance of Dee Lynch, KA7NPN, and technical discussions with Jeff Damm, WA7MLH.

Fig 4—The transceiver SSB generator. Resistors are $\frac{1}{4}$ W, carbon film; unless otherwise indicated, capacitors are monolithic or disc ceramic.

C9—60-pF, ceramic-dielectric trimmer. C10, C11—35-pF, ceramic-dielectric trimmer.

FL2—9-MHz transmit filter, 2.5 kHz wide at -6 dB (KVG XF-9A).

T7—Broadband transformer: Primary, 10 bifilar turns of no. 28 enam wire on FT-37-43 toroidal, ferrite core; secondary, 3 turns of no. 28 enam wire over the primary. Observe phasing.

Y2—8998.5-kHz crystal (KVG XF-901 suitable).

Fig 5—The transmit mixer, driver, final amplifier and associated circuits. Unless otherwise indicated, resistors are $\frac{1}{4}$ W, carbon film, and capacitors are monolithic or disc ceramic.

C12-C14—60-pF mica- or ceramic-dielectric trimmer.

D13—1-A, 600-PIV diode.

K1—12-V dc relay.

L7-L9—20 turns of no. 24 enam wire on a T-44-6 toroidal, powdered-iron core.

L10—15- μ H choke.

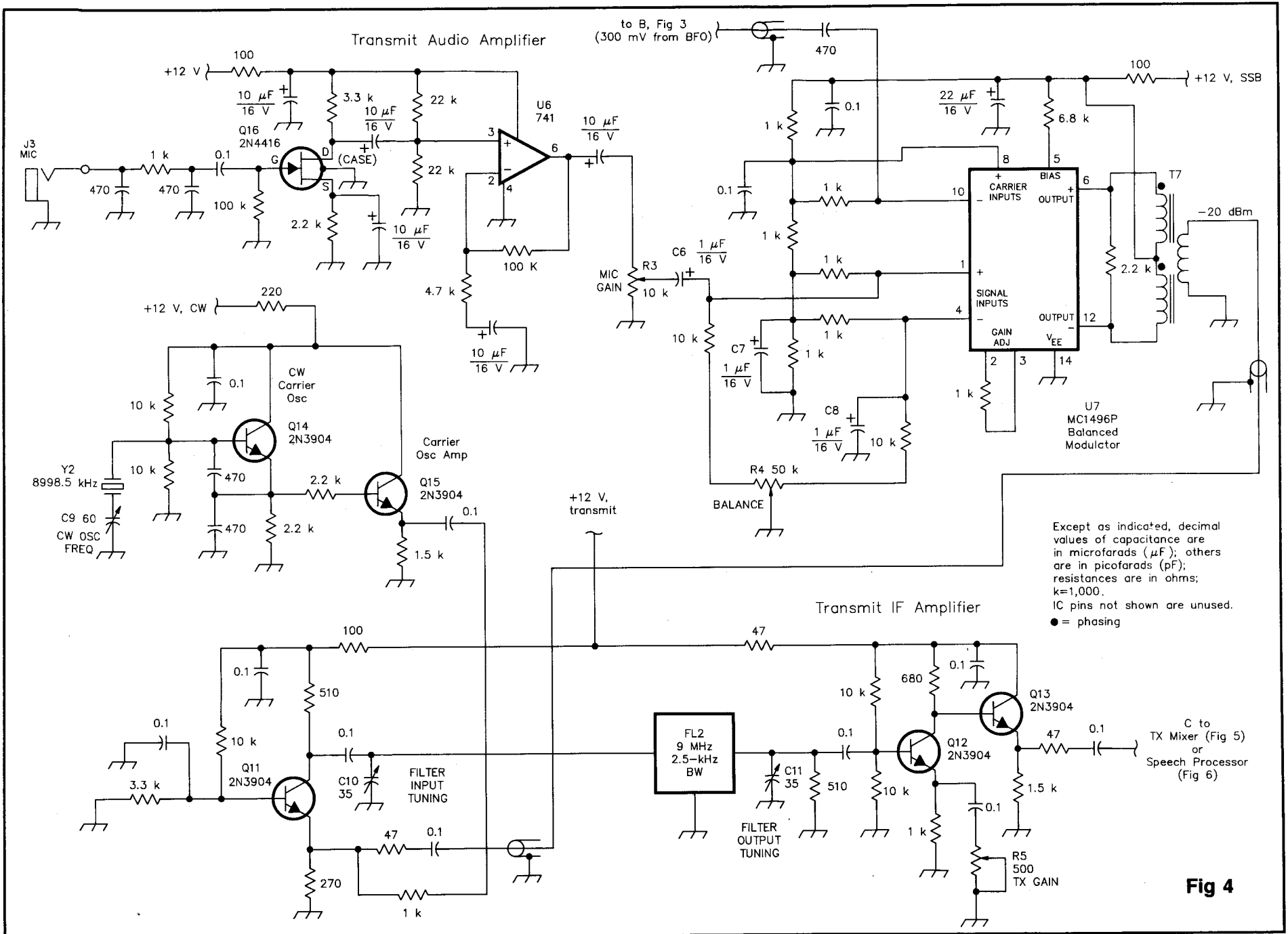
L11-L13—14 turns of no. 24 enam wire on a T-50-6 toroidal, powdered-iron core.

T8—Broadband transformer: Primary, 15 turns of no. 28 enam wire on an FT-37-43 ferrite, toroidal core; secondary, 4 turns of no. 28 enam wire over the primary.

T9, T10—Broadband transformer: 10 bifilar turns of no. 28 enam wire on an FT-37-43 ferrite, toroidal core. Observe phasing.

[†]Part 1 of this article appeared in *QST*, December 1989, pp 18-21.

⁸W. Hayward and J. Damm, "Stable HEXFET[®] RF Power Amplifiers," Technical Correspondence, *QST*, Nov 1989, pp 38-39.



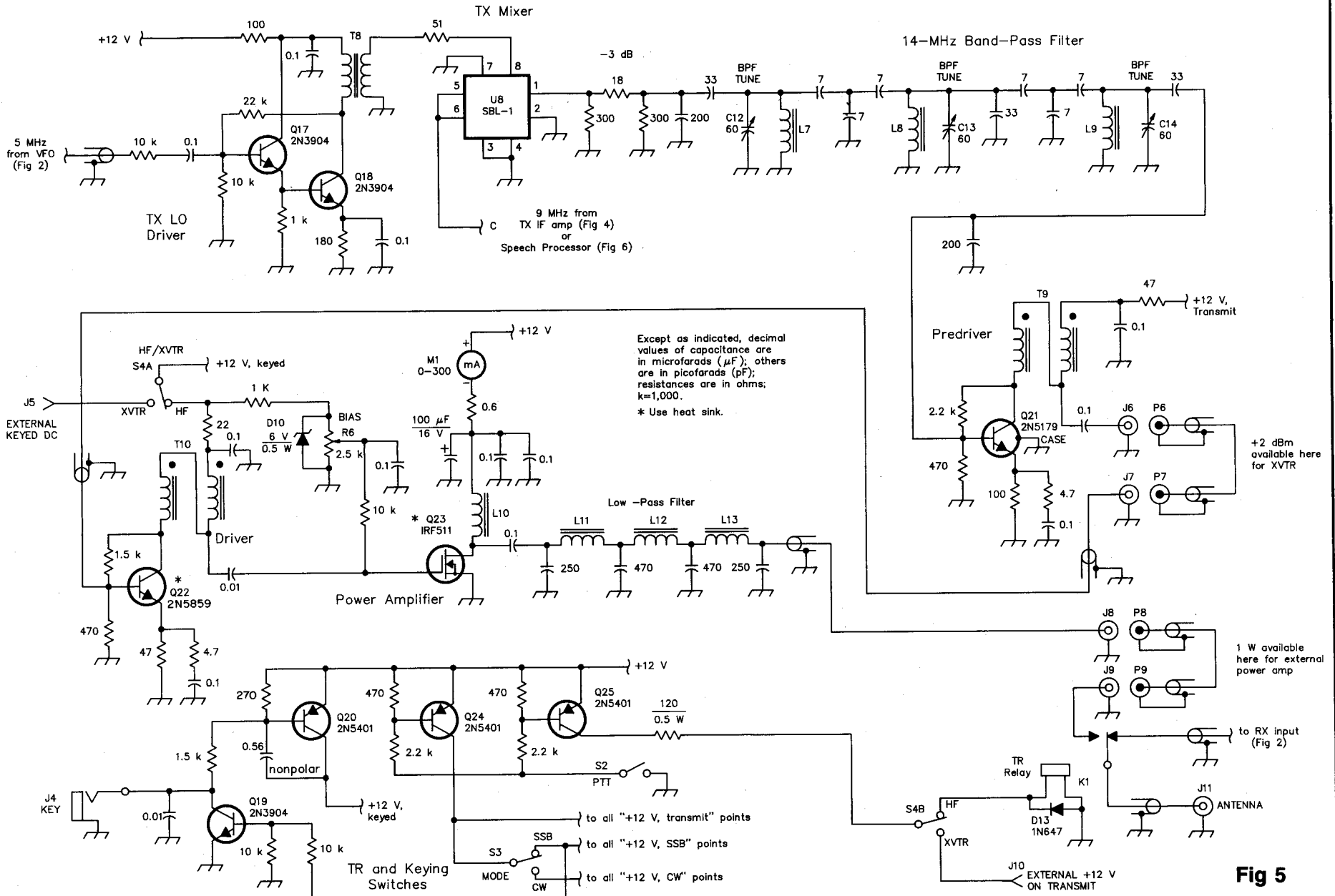
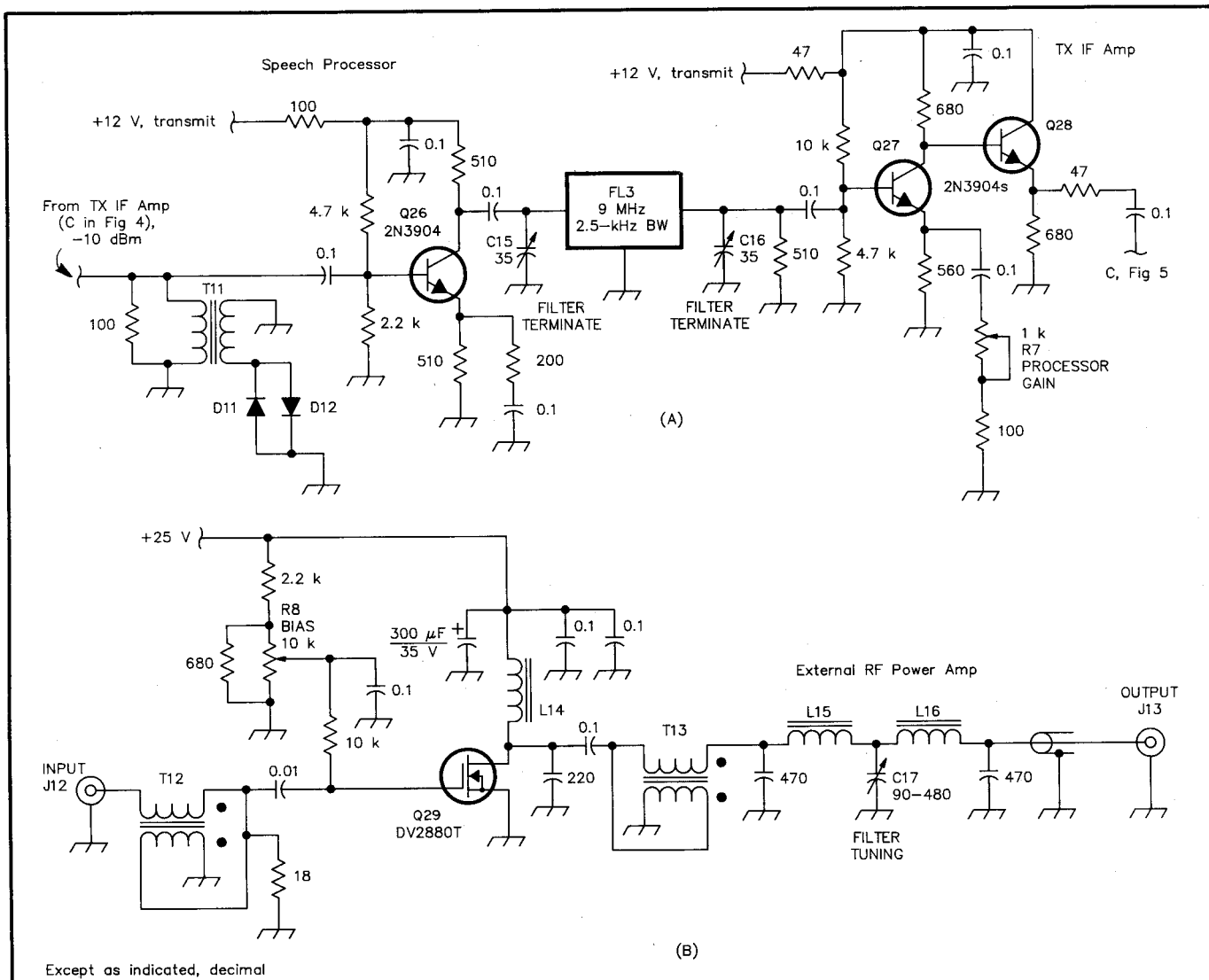


Fig 5



Except as indicated, decimal values of capacitance are in microfarads (μF); others are in picofarads (pF); resistances are in ohms; k=1,000.

Fig 6—The optional speech processor (A) and outboard power amplifier (B) circuits. Unless otherwise indicated, resistors are $\frac{1}{4}$ W, carbon film, and capacitors are monolithic or disc ceramic.
C15, C16—35-pF, ceramic-dielectric trimmer.
C17—90- to 480-pF, mica-dielectric trimmer.
D11, D12—Hot-carrier diode, HP-5082-2672 suitable.
FL3—9-MHz transmit filter, 2.5 kHz wide at -6 dB (KVG XF-9A).
L14—50 turns of no. 26 enam wire on a T-68-2 toroidal, powdered-iron core.
L15, L16—19 turns of no. 20 enam wire on a T-50-6 toroidal, powdered-iron core.
T11—Broadband transformer: Primary, 3 turns of no. 28 enam wire over secondary; secondary, 16 turns of no. 28 enam wire on an FT-37-43 toroidal, ferrite core.
T12—Broadband transformer: 7 bifilar turns of no. 22 enam wire on an FT-50-43 toroidal, ferrite core. Observe phasing.
T13—Broadband transformer: 11 bifilar turns of no. 18 enam wire on an FT-82-61, toroidal, ferrite core. Observe phasing.

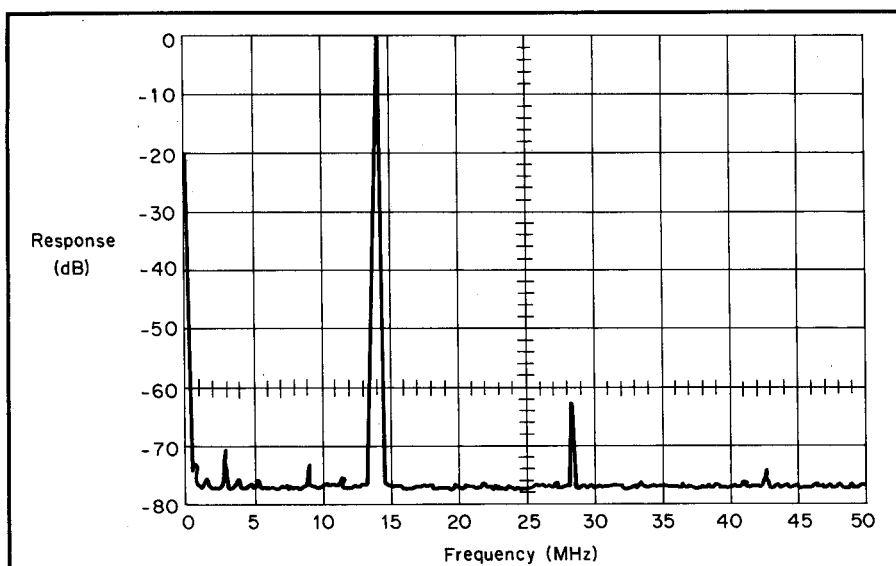


Fig 7—The transceiver's output spectrum contains a second-harmonic component 63 dB below its 1-W CW output. The major nonharmonic spurious response is a 2:1 spur near 1.5 MHz ($[2 \times \text{VFO}] - \text{IF}$); this component is -70 dBc. The spike at far left is the spectrum analyzer's "zero-spur." An external 20-dB pad in the coaxial line provided extra protection for the analyzer, a Tektronix 2756P. The spectrum-analyzer measurements were provided by Stan Griffiths, W7NI. The transceiver complies with current FCC specifications for spectral purity.