As the author rightly points out, this is definitely a project for the more experienced builder. W9SR certainly can take pride in this project, a clear demonstration of patience and ingenuity.

The QRP 30 Plus
A Compact 30 Meter Transceiver

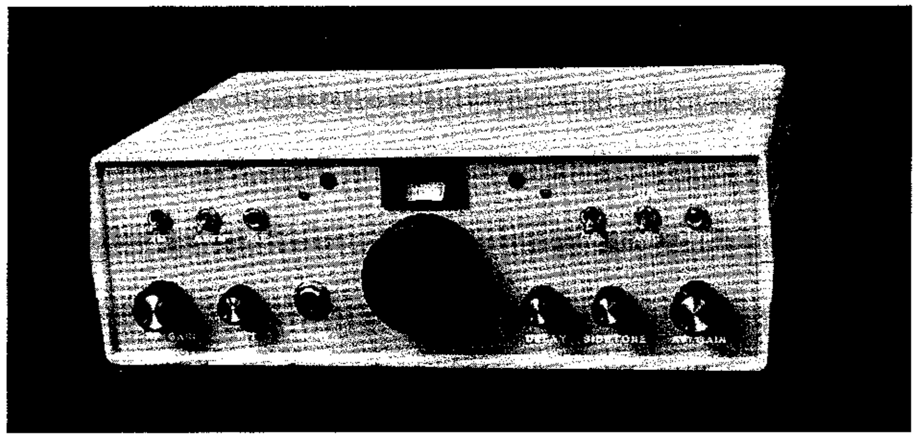
BY RICHARD W. STROUD*, W9SR

This project started innocently when I was browsing through the local fleamarket and ran across some terrific surplus plastic cabinets. I started to wonder what could be built into them. I had always been interested in QRP, and these seemed perfect for a small transceiver. I ended up using one cabinet for a 30 meter transceiver and a second cabinet for a matching 100 watt FET amplifier, which I will describe in a future article.

This project is intended primarily for the more experienced equipment builder. Although designed for only the 30 meter WARC band, this is a very complete little station with many of the bells and whistles, and it is a pleasure to operate. It is still small enough to be carried in one hand for portable use. The transceiver has a selectable RF output of either 4 or 8 watts and uses a sensitive superhet receiver with a sharply peaked audio output at about 750 Hz. By modifying the tuned circuits, the transceiver could be built for other bands.

The cabinets (Dick Smith H-2507) measure 7$^{1}/_{2}$" × 10" × 3$^{1}/_{4}$" and are presently available from several sources for three or four dollars. One source is Pembleton Electronics (1222 Progress Road, Ft. Wayne, IN 46808-1262). The cabinets have several mounting posts molded into the bottom, and these are used to support a double-sided PC board which acts as a chassis to hold heavier components and other board assemblies. Unused posts can be cut off with a pair of large cutters or a knife. Several mounting screws are supplied with the cabinet.

The original plastic panels supplied with the cabinet were discarded and the back panel replaced with a .087 thick aluminum panel. The front was replaced by a sheet of .032 aluminum covered by an engraved plastic panel, giving a total thickness of about .090 inches. These panels fit in the original groove around the front and rear inside perimeters of the cabinet. Engraved panels in several colors are available from L & C Engraving (111 W. Mill Street, Ossian, IN 46777).



The finished project—the QRP 30 Plus compact 30 meter transceiver.

The transceiver was built using surplus and readily available components. It includes an audio filter, RIT, band-edge calibrator, RF and AF gain controls, selectable sidetone level, and adjustable break-in delay. (See block diagram, fig 1.)

An on-board regulator supplies 6 volts for a MFJ 422B keyer, which I normally use with the unit.

The dynamic range of the receiver has been kept high by the use of a low-gain RF amplifier and properly terminated mixer with a local oscillator injection of about 9 dBm. An audio-controlled AGC was originally included, but in practice it was found to be unnecessary if the RF gain control is properly used, and it is not worth the added complexity.

A dual-gate MOSFET, Q1, is used as an RF amplifier. A small amount of degeneration assures stability and lowers the gain of the circuit while maintaining a good noise figure. A panel-mounted 20 dB antenna attenuator can be switched in to reduce the signal level when necessary. The first mixer is terminated by the input circuit of Q16, which is resistive and near 50 ohms.

Local oscillator injection is developed by the FET oscillator/buffer combination. The VFO frequency control is a broadcast-type variable capacitor with a 6:1 vernier drive attached. The entire VFO is inside a drawn aluminum shield can with the oscillator components on a vertical board beside the variable capacitor. The toroid inductor, T5, is attached to the board with a nylon screw and cemented after adjustment. A mylar disc is fastened to the vernier drive, and attached adhe-

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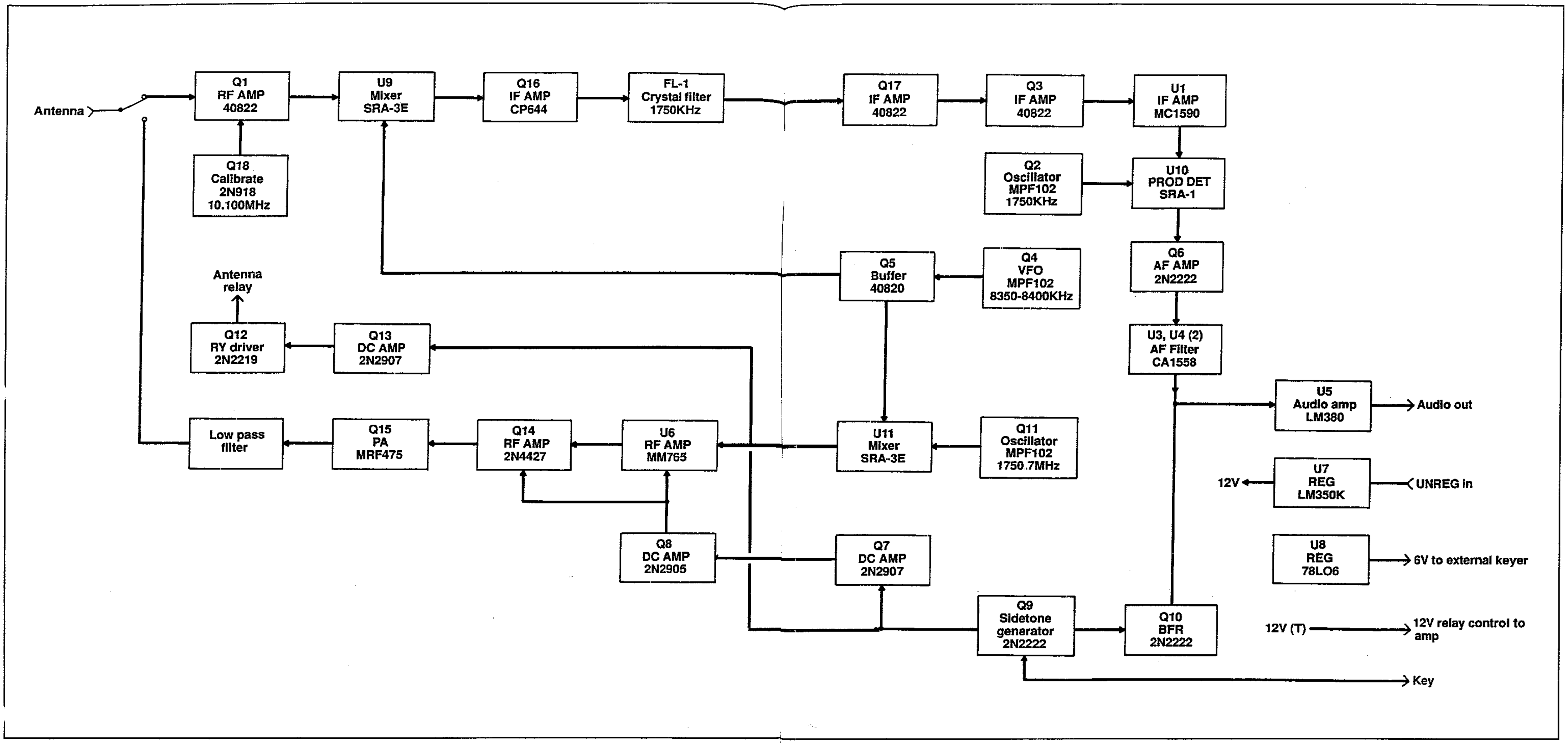

Fig. 1– Block diagram for the 30 meter QRP transceiver as described in the text. The unit was built using surplus and readily available parts.

sive paper allows hand calibration. The dial is back lighted. The oscillator is adjusted to cover the 50 kHz band, tuning from 8350 to 8400 kHz. The VFO also drives the transmit mixer, U11, at about 9 dBm. The RIT circuit, when switched on, tunes about 4 kHz each side of center frequency. This is an ideal place to use a digital readout as described by Doug DeMaw in the June 1997 issue of *CQ*. With a little ingenuity it could even be built into the transceiver. To drive the digital dial, connect its input to the receive mixer LO port through a 68 pF capacitor in series with an 820 ohm resistor.

Output of the high-level first IF amplifier, Q16, is matched to the 1750 kHz filter, FL1. This is a military surplus quartz filter, SMC 500317, presently on the surplus shelves, with a bandwidth of 3.1 kHz. This filter is followed by the audio filter, which narrows the final passband for CW work. A simple dual half-lattice filter may also be used for FL-1 as shown in fig. 3. This filter will give a more appropriate IF bandwidth of about 420 Hz.

Two dual-gate MOSFETs, with their gains controlled by the RF gain control, amplify the 1750 kHz IF signal, and it is further amplified by U1. A packaged diode mixer, U10, is used as the product detector with the injection coming from the 1.7500 MHz crystal oscillator, Q2.

The product detector output is filtered, then amplified by Q6. It was found that the RF choke in the base lead of Q6 needed to be shielded to remove a 60 cycle hum induced by the nearby power transformer. The active audio filter, U3 and U4, is peaked at 740 Hz and can be switched in at the front panel. Be sure to use 1% resistors and 5% poly capacitors in this circuit to take full advantage of the filter. Bandwidth of the filter is 94 Hz at the –3 dB points and 325 Hz at the –20 dB points.

The LM 380 audio amplifier has an output of up to a half watt. Response of the amplifier is 270 to 1700 Hz at the –3 dB points. An internal 8 ohm speaker is active unless the headphone plug is inserted or an external speaker is plugged in. The sidetone signal is added at the audio amplifier input to monitor keying.

The pierce crystal calibrator oscillates at 10.100 MHz, when switched on, to give a band-edge calibration point and to aid in initial VFO alignment.

Output of the transmit crystal oscillator, at 1.7507 MHz, is mixed with the VFO signal at U11 to develop the 10.100 to 10.150 MHz transmit frequency. This signal is filtered, and then amplified by U6 and Q14. A shield made from PC board material is positioned between the bandpass filter (T7, T8, etc.) and the final amplifier area to prevent feedback. The shield is sol-

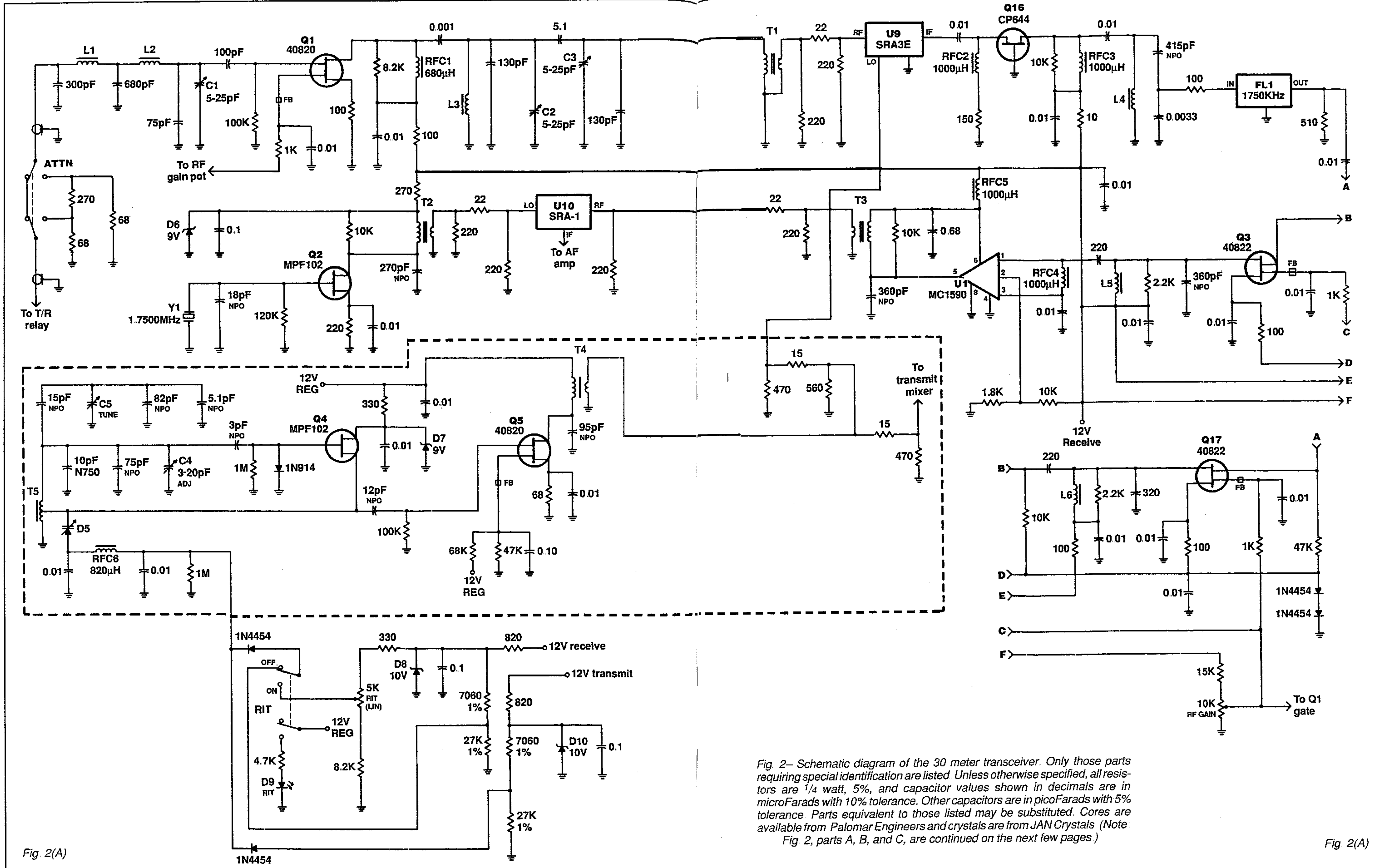

Fig. 2(A)

Fig. 2– Schematic diagram of the 30 meter transceiver. Only those parts requiring special identification are listed. Unless otherwise specified, all resistors are 1/4 watt, 5%, and capacitor values shown in decimals are in microFarads with 10% tolerance. Other capacitors are in picoFarads with 5% tolerance. Parts equivalent to those listed may be substituted. Cores are available from Palomar Engineers and crystals are from JAN Crystals (Note: Fig. 2, parts A, B, and C, are continued on the next few pages.)

Fig. 2(A)

(Continued on page 98)

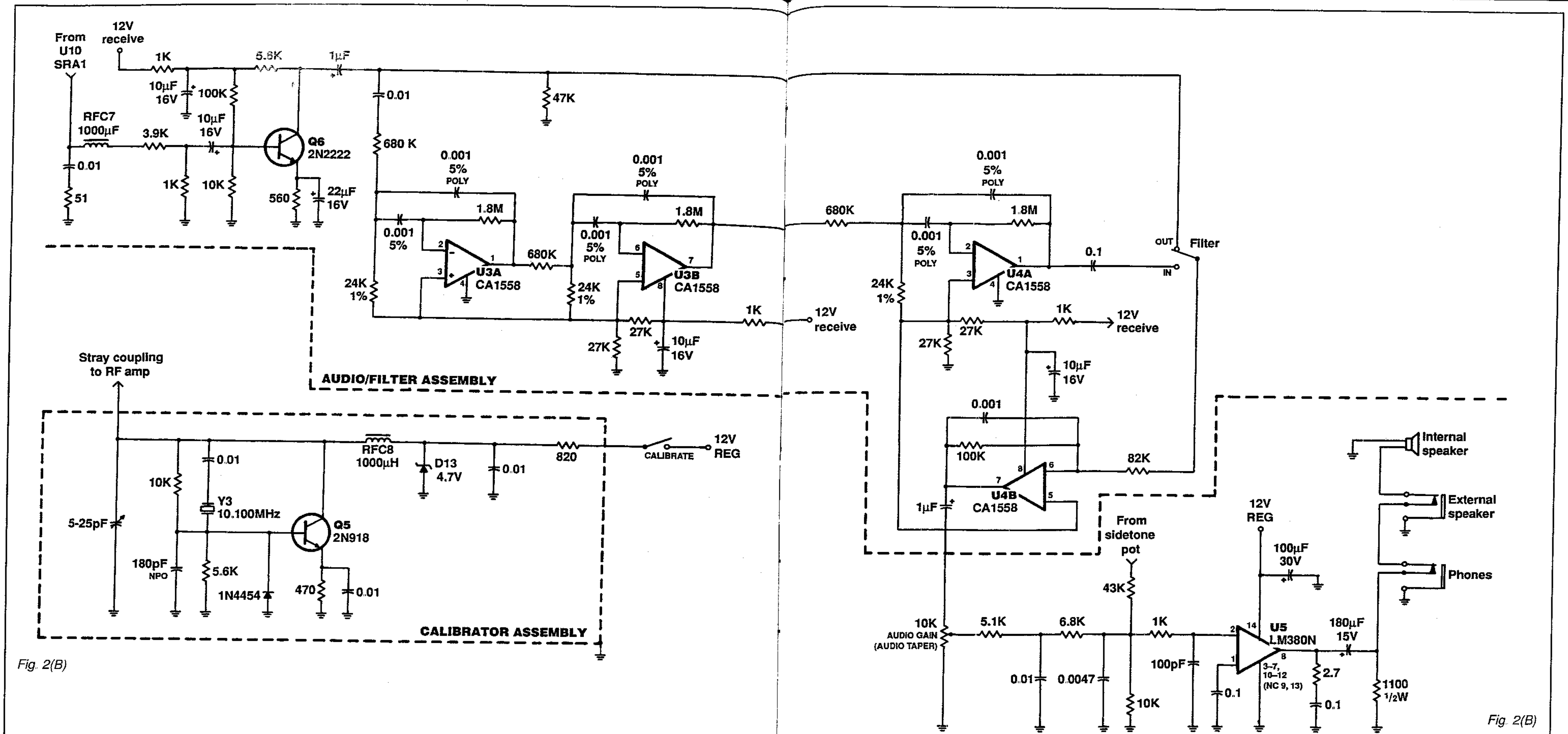

Fig. 2(B)

Parts List *(Fig. 2)*

C1, C2, C3, C6, C7: 5–25 pF miniature trimmer capacitor.
C4: 3–20 pF piston trimmer capacitor, panel-mount style, NPO.
C5: 10–205 pF broadcast-type variable capacitor, TRW 260190-5
D1, D2, D3, D4: 3 amp, 200 PIV diode, Radio Shack 276-1143.
D5: DKV 6533, MV2113 voltage variable capacitance diode
D6, D7, D12: 9 volt, 400 mw zener diode. Mouser Electronics 592-1N757A.
D8, D10: 10 volt 400 mw zener diode, Mouser Electronics 592-1N758A
D9, D11: Red LED, Radio Shack 276-026 (276-078 holder).
D13: 5 volt, 400 mw zener diode. Mouser Electronics 592-1N751A
DS1: Miniature 12 volt pilot bulb, Radio Shack 272-1092
FB: Ferrite bead, Palomar FB-1-43.
FL1: 1750 kHz USB surplus filter, SMC-500317 (see text)
L1: 12 turns #24 enam. spaced wire diameter, T50-6 core
L2: 29 turns #24 enam. close wound, T50-6 core
L3: 19 turns #24 enam. close wound, T44-6 core
L4: 60 turns #28 enam. over wound, T44-2 core
L5: 64 turns #28 enam. over wound, T44-2 core.
L6: 68 turns #28 enam. over wound, T44-2 core.
L7, L8: 12 turns #22 enam. close wound, T50-2 core
L9: 17 turns #24 enam. close wound, T50-6 core
L10: 2 turns #28 teflon insulated through BLN-68-61 binocular core
Q1, Q3, Q5, Q17: 40820, 40822, 40673 dual-gate MOSFET.
Q2, Q4, Q11: MPF102 field effect transistor
Q6, Q9, Q10: 2N2222 NPN transistor.
Q7, Q13: 2N2907 PNP transistor
Q8: 2N2905 PNP transistor.
Q12: 2N2219 NPN transistor.
Q14: 2N4427, 2N3866 NPN RF power transistor.
Q15: MRF475 NPN RF power transistor.
Q16: CP644, J309 RF junction FET
Q18: 2N918 NPN transistor.
RFC1: 680 microHenry min. choke, Mouser Electronics 434-22-681.
RFC2, RFC3, RFC4, RFC5, RFC7, RFC8: 1000 microHenry min choke, Mouser Electronics 434-22-102.
RFC6: 820 microHenry min. choke, Mouser Electronics 434-22-821
RY1: 12 volt DPDT relay, 185 ohms, Allied Control T154X-862.
T1: 19 turns #24 enam. close wound on T44-6 core, sec. 3 turns.
T2, T6: 70 turns #28 enam. over wound on T44-2 core, sec. 8 turns
T3: 64 turns #28 enam. over wound on T44-2 core, sec. 6 turns.
T4: 15 turns #24 enam. close wound on F37-61 core, sec. 2 turns.
T5: 28 turns #24 enam. close wound on T50-6 core, tap 6 turns.
T7, T8: 18 turns #22 enam. close wound on T50-6 core, sec. 3 turns
T9: Power transformer, pri 115 volts, sec. 12.6 volts, 2 amps min.
T10: 6 turns bifilar #24 enam. on F50A-61 core, space over 3/4 of form
T11: 9 turns bifilar #24 enam. on F50A-61 core, space over 3/4 of form
U1: MC1590 IC amplifier
U3, U4: CA 1558 operational amplifier
U5: LM380 IC audio amplifier.
U6: MWA 130 RF amplifier.
U7: LM350K IC adjustable regulator.
U8: 78LO6 6 volt regulator.
U9, U10, U11: Mixer, Mini Circuits SRA-3, SRA-1, or equivalent.
Y1: 1750.00 kHz crystal, 20 pF par. resonance, 25 ppm, HC 33 holder.
Y2: 1750.70 kHz crystal, 20 pF par. resonance, 25 ppm, HC 33 holder.
Y3: 10.100 MHz crystal, fundamental mode, series res. 25 ppm, HC 18 holder

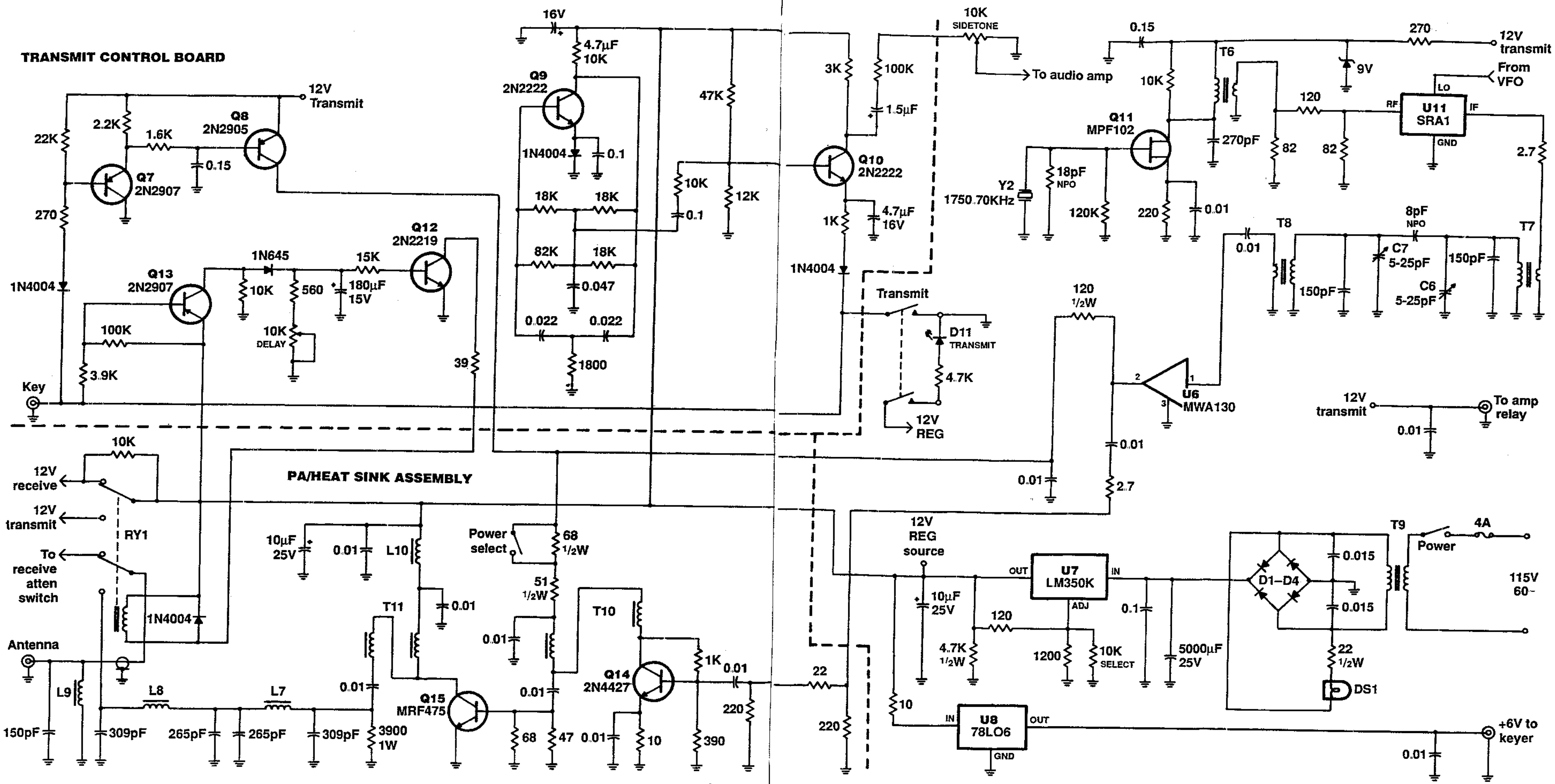
TRANSMIT CONTROL BOARD
12V Transmit
Q8 2N2905
Q7 2N2907
Q9 2N2222
Q10 2N2222
Q11 MPF102
Q12 2N2219
Q13 2N2907
Q14 2N4427
Q15 MRF475
16V
10K SIDETONE
To audio amp
12V transmit
From VFO
U11 SRA1
Y2 1750.70KHz
10K DELAY
Transmit
D11 TRANSMIT
12V REG
U6 MWA130
To amp relay
Key
PA/HEAT SINK ASSEMBLY
12V receive
12V transmit
To receive atten switch
RY1
Antenna
Power select
12V REG source
U7 LM350K
D1-D4
T9
Power
4A
115V 60~
DS1
U8 78LO6
+6V to keyer
1N4004
1N645
T6
T7
T8
T10
T11
L7
L8
L9
L10
C6 5-25pF
C7 5-25pF

Fig. 2(C)

Fig. 2(C)

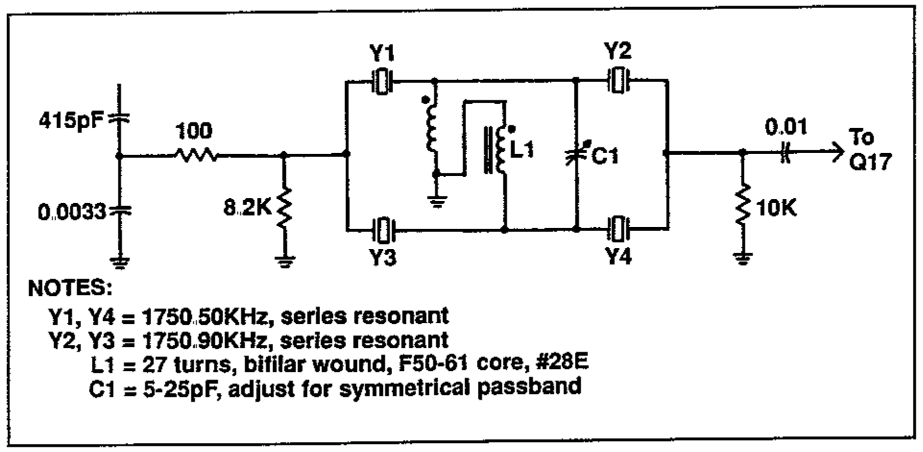

Fig. 3– An alternate filter design for FL1.

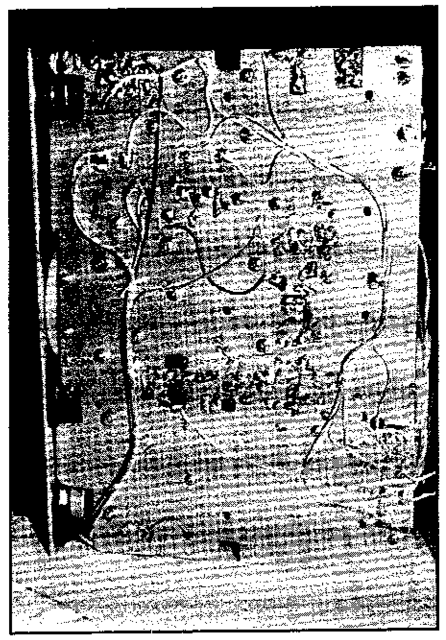

Fig. 4– Bottom view of main printed wiring board, which serves as a chassis. This is a double-sided board which is cut as necessary for clearance. Isolation pads are cut in the foil for use as tie points. Some components are mounted below the board, which is spaced about 3/8 inch above the bottom of the cabinet.

dered to the main PC board. A clip-on heat sink is used on the 2N4427 amplifier.

All transmit components after U6, as well as the changeover relay, are mounted on a vertical heat sink assembly. The rear panel is thermally connected to the heat sink by use of an aluminum spacer and screw. The MRF475 final amplifier is mounted by the tab to the heat sink assembly using a mica insulating washer and heat sink compound. The heat sink remains cool with long test periods of key-down operation and over 8 watts output.

The amplifier output is routed through the low-pass harmonic filter and relay to the antenna. Output level can be switched from 4 watts (QRP) to 8 watts at the rear panel.

The sidetone generator, operating at 750 Hz, and control circuits to key the transmitter and changeover relay are on the Transmit Control Board. This PC board is mounted above the product detector/audio filter board. These boards are spaced apart and supported from the main board by aluminum spacers and screws. The sidetone level is adjustable from the panel, as is the keying hang time.

The 12 volt power supply uses a conventional transformer and bridge rectifier. The DC output feeds a LM350K regulator. The output of this regulator is adjusted to 12 volts by selecting the value of the 10K nominal resistor connected to the "Adj" terminal. The regulator is mounted on a small heat sink using a mica insulator, heat sink compound, and insulating shoulder washers.

To adjust the transceiver is not difficult. First determine that the detector oscillator is running by listening with a receiver, or monitor with a scope at the LO terminal of the product detector. Next adjust the frequency of the VFO to cover the range of 8350 to 8400 kHz. This is done by monitoring with a receiver or counter at the

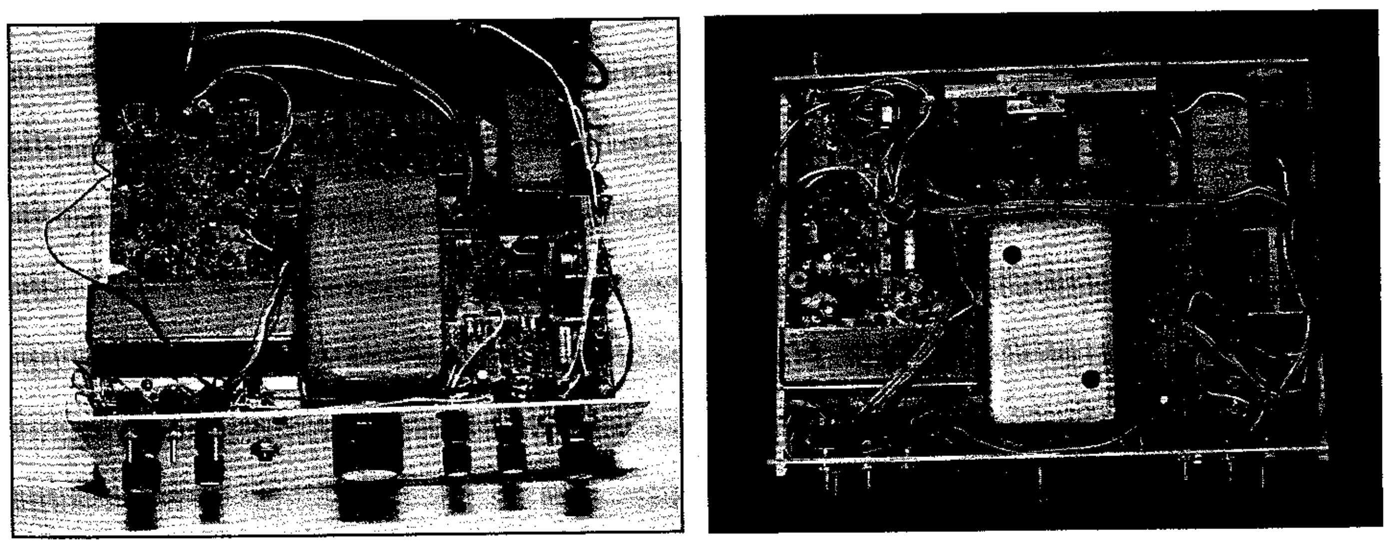

Fig. 5– (A) Top view of the transceiver during assembly. The VFO cover is temporarily protected by tape at this point. The transmitter assembly, transmit control board, and crystal calibrator are not installed in this photo. The RF/IF circuits are to the left, and the audio, regulator, and power supply circuitry is to the right. The detector, 1750 kHz crystal oscillator, and audio filter circuits are on a board which is mounted to the right of the VFO shield can. This board is supported by spacers attached to the main board. (B) The completed unit is packed fairly tight.

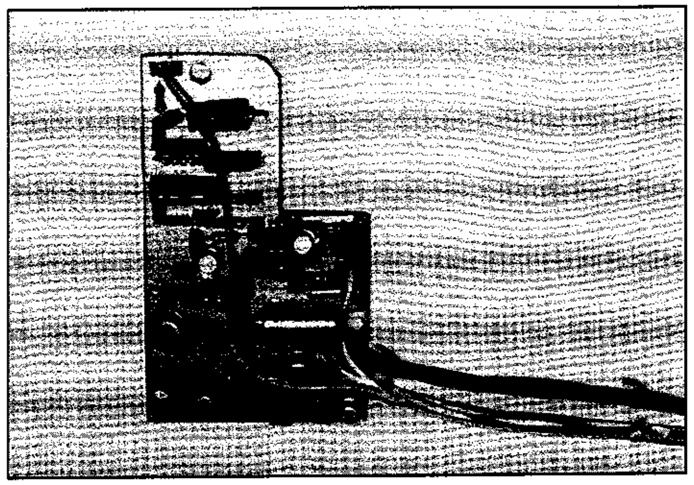

Fig. 6– Transmit control board which controls keying and transmit delay. The sidetone generator, Q9, and related components are also on this assembly. This board assembly is mounted on spacers above the detector/audio filter PC board.

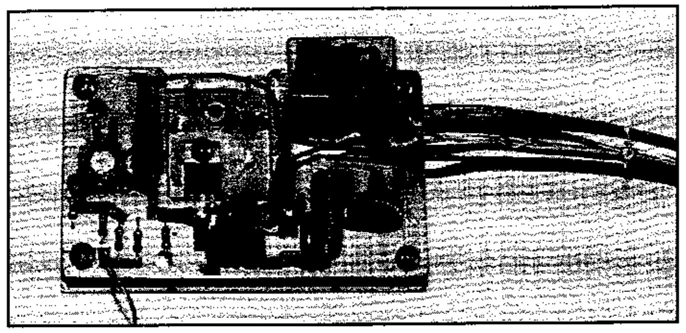

Fig. 7– Transmitter board and heat sink assembly. Q14 and Q15 circuitry is on this "U"-shaped double-sided board, as are the low-pass filter components and the changeover relay, RY1. The heat sink is 1/4 inch thick aluminum measuring 3 3/4 inches wide by 2 1/4 inches high. It is tapped on the edge for bolting to the main board. A second, smaller (1 inch by 1 1/8 inch) aluminum plate is bolted to the first, and the board is spaced away from the heat sink so the Q15 tab can be bolted to the aluminum. A mica washer, insulator, and heat sink compound are used for mounting Q15.

receiver mixer LO port. Adjust the turns of T5 slightly and adjust the piston trimmer capacitor, C4, to allow the tuning capacitor, C5, to cover the range from minimum to maximum capacity. With an on-channel signal at the antenna input, adjust C1, C2, and C3 for maximum sensitivity. You should be able to detect signals considerably below a half microvolt after alignment.

Place the unit in transmit and into a dummy load. Assure that the transmit oscillator, Q11, is functioning. Next monitor the RF output level and adjust C6 and C7 for maximum output.

Results have been gratifying, and I was surprised at the enjoyment you can have on this band using only 4 watts of output power. Many DX stations have been worked over the past year using a longwire antenna and tuner.

I wish to thank Fred Gantzer, WØAWD, for building the dial escutcheon, and Freeze Frame Photography for the photos.