A 6-Meter Kilowatt Amplifier

Editor's note: Section and figure references in this article are from the 2013 edition of the ARRL Handbook. *Although a 4CX1600B tube is used in this design, the currently available model is the 4CX1600U.*

The Svetlana 4CX1600B tube has attracted a lot of attention because of its potent capabilities and relatively low cost. Because of its high gain and its large anode dissipation capabilities, the tube has relatively large input and output capacitances—85 pF at the input and 12 pF at the output. Stray capacitance of

Fig 17.61—Photo of the front panel of the 6-meter 4CX1600B amplifier.

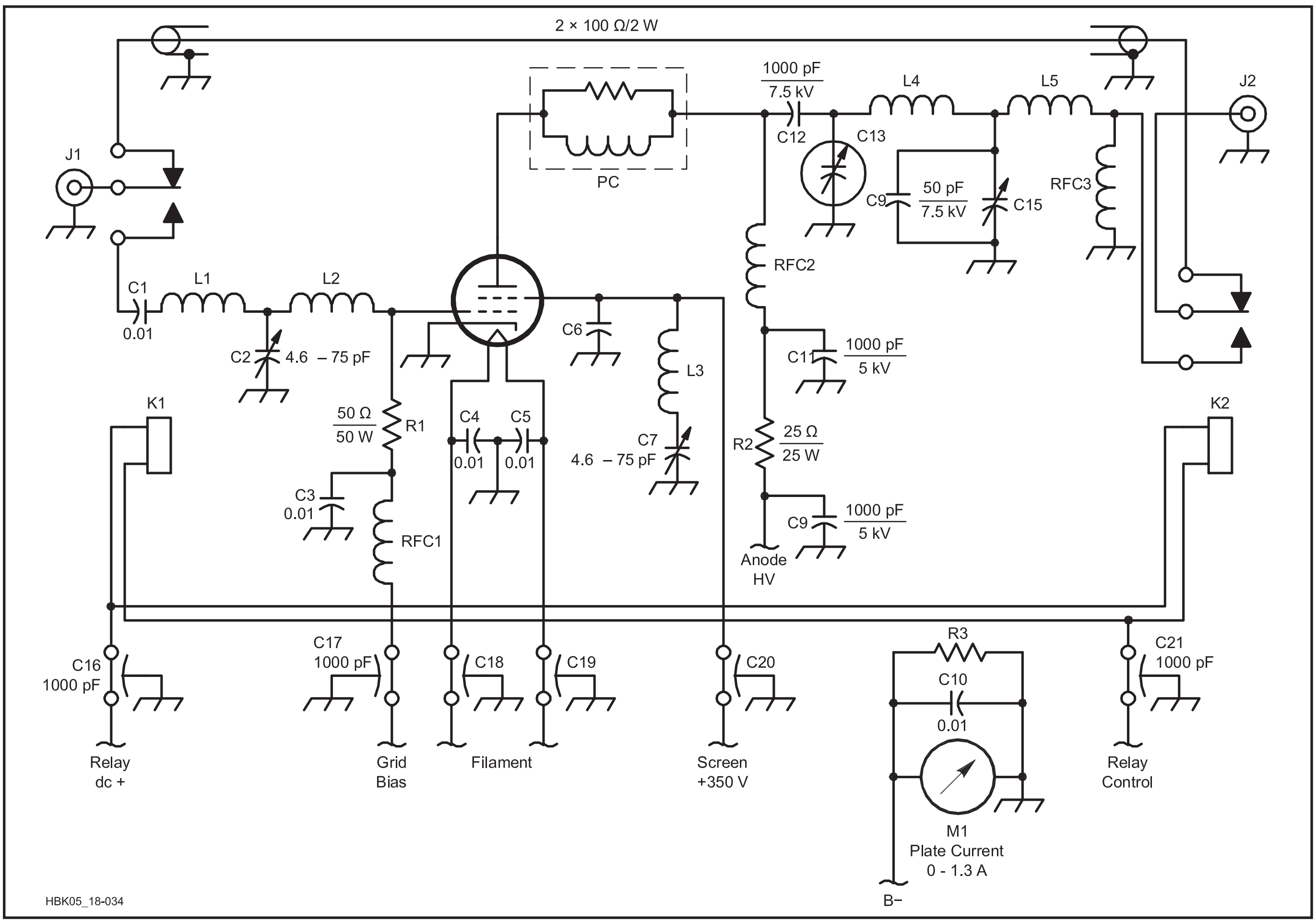

Fig 17.62—Schematic for the RF deck for the 6-meter 4CX1600B amplifier. Capacitors are disc ceramic unless noted.

C2, C7—4.6-75 pF, 500-V air-variable trimmer capacitor, APC style.
C6—Screen bypass capacitor, built into SK-3A socket.
C13—1-45 pF, 5 kV, Jennings CHV1-45-5S vacuum-variable capacitor.
C14—50 pF, 7.5 kV, NP0 ceramic doorknob capacitor.
C15—4-102 pF, 1100V, HFA-100A type air-variable capacitor.
C16, 17, 18, 19, 20, 21—1000 pF, 1 kV feedthrough capacitors.
L1—11 turns, #16, ⅜-inch diameter, 1-inch long.
L2—9 turns #16, ⅜-inch diameter, close-wound.
L3—8 turns #16, ⅜-inch diameter, ⅞-inch long.
L4—¼-inch copper tubing, 4½ turns, 1¼ inches diameter, 4½ inches long.
L5—5 turns #14, ½-inch diameter, 1⅜ inches long.
M1—0-1.3 A meter, with homemade shunt resistor, R3, across 0-10 mA movement meter.
PC—Parasitic suppressor, 2 turns #14, ½-inch diameter, shunted by two 100-Ω, 2-W carbon composition resistors in parallel.
RFC1—10 µH, grid-bias choke.
RFC2—Plate choke, 40 turns #20, ½-inch diameter, close-wound.
RFC3—Safety choke, 20 turns #20, ⅜ inch diameter.

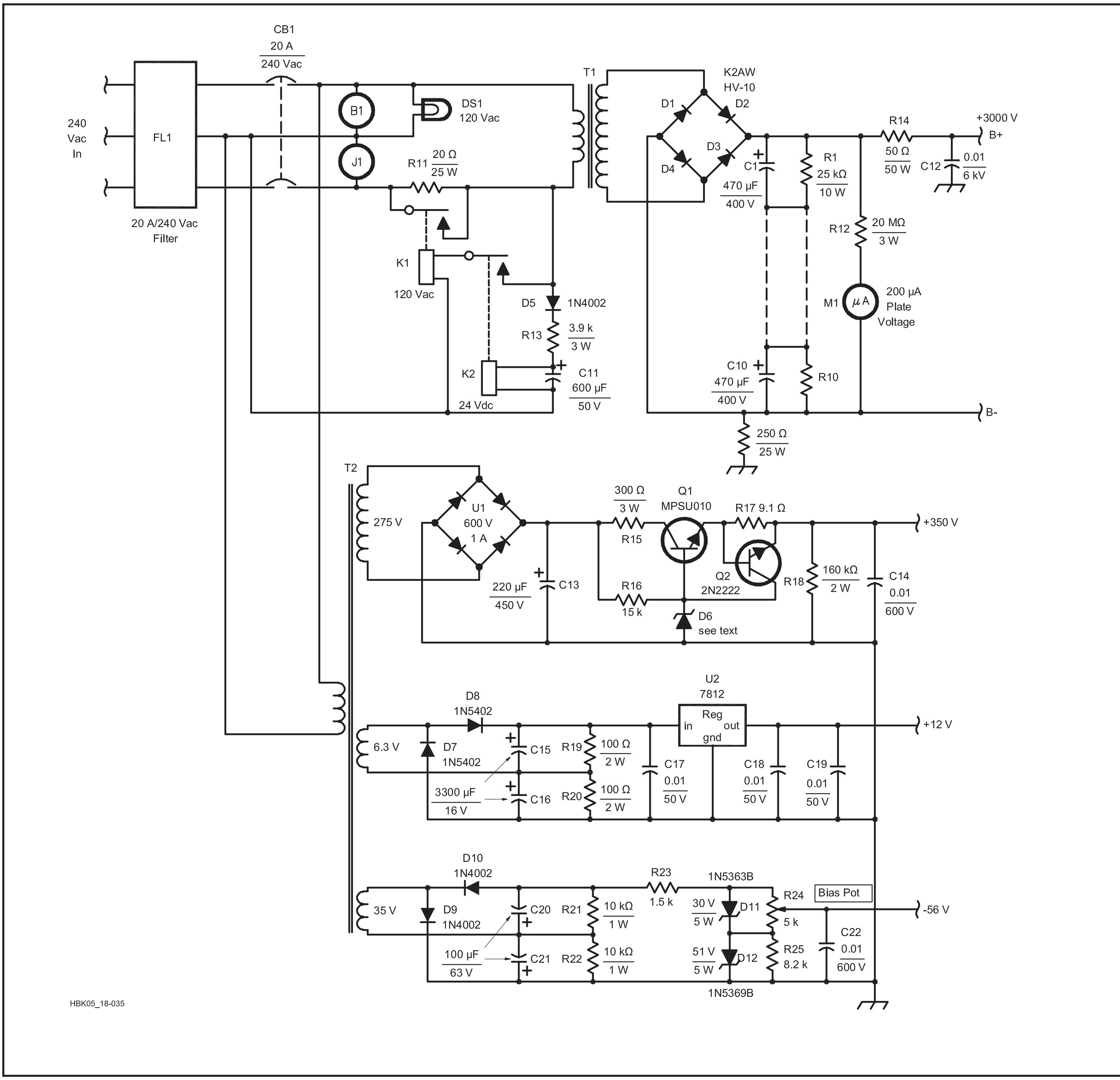

Fig 17.63— Schematic diagram of the K6GT high-voltage plate and regulated screen supply for the 6 meter 4CX1600B linear amplifier. K1 , K2 and associated circuitry provide a "step-start" characteristic to limit the power-on surge of charging current for the filter capacitors. Resistors are ½ W unless noted. Capacitors are disc ceramic unless noted and those marked with a + are electrolytic.

about 10 pF must be added in as well. On bands lower than 50 MHz, these capacitances can be dealt with satisfactorily with a broadband 50-Ω input resistor and conventional output tuning circuitry.

See the article by George Daughters, K6GT, "The Sunnyvale/Saint Petersburg Kilowatt-Plus" in 2005 and earlier Handbooks and included in the Templates section of the *Handbook CD* for details on suitable control and power-supply circuitry. This 6-meter amplifier uses the same basic design as K6GT's, except for modified in-put and output circuits in the RF deck. See **Fig 17.61**, a photograph of the front panel of the 6-meter amplifier built by the late Dick Stevens, W1QWJ.

On the 50-MHz band the tube's high input capacitance must be tuned out. The author used a T network so that the input impedance looks like a nonreactive 50 Ω to the transceiver. To keep the output tuning network's loaded Q low enough for efficient power generation, he used a 1.5 to 46 pF Jennings CHV1-45-5S vacuum-variable capacitor, in

B1 — Muffin fan (Rotron SU2A1 or similar).
C1-C10 — Filter capacitors; 470 µF, 400 V electrolytic.
C11 — 600 µF, 50 V electrolytic.
C12 — 0.01 µF, 6 kV disc ceramic.
C13 — 220 µF, 450 V electrolytic.
C14, C22 — 0.01 µF, 600 V disc ceramic.
C15, C16 — 3300 µF, 16 V electrolytic.
C17, C18, C19 — 0.01 µF, 50 V disc ceramic.
C20, C21 — 100 µF, 63 V electrolytic.
CB1 — two pole 20 A, 240 V ac circuit breaker.
D1-D4 — K2AW's HV-10 rectifier diodes.
D5, D9, D10 — 1N4002.
D6 — Zener diodes, three 1N4764A and one 1N5369B to total approximately 350 V dc.
D7, D8 — 1N5402.
D11 — Zener diode, 1N5363B (30 V, 5 W).
D12 — Zener diode, 1N5369B (51 V, 5 W).
DS1 — 120 V ac indicator lamp (red).
FL1 — 240 V ac, 20 A EMI filter.
K1 — 120 V ac DPDT relay; both poles of 240 V ac/15 A contacts in parallel.
K2 — 24 V dc relay; 120 V ac, 5 A contacts.
M1 — 200 µA meter movement.
Q1 — MPSU010.
Q2 — 2N2222.
R1-R10 — Bleeder resistors; 25 kΩ, 10 W.
R11 — 20 Ω, 25 W.
R12 — 20 M Ω, 3 W (Caddock MX430).
R13 — 3.9 k Ω, 3 W.
R14 — 50 Ω, 50 W mounted on standoff insulators.
R15 — 300 Ω, 3 W.
R18 — 160 k Ω, 2 W.
R19, R20 — 100 Ω, 2 W.
R21, R22 — 10 k Ω, 1 W.
R24 — 5 kΩ potentiometer; sets control grid bias for desired no-signal cathode current.
T1 — Plate transformer (Peter W. Dahl No. ARRL-002, contact Harbach Electronics, www.harbachelectronics.com, for equivalent parts).
T2 — Power transformer, 120 V / 275 V at 0.06 A, 6.3 V at 2 A, 35 V at 0.15 A.
U1 — 600 V, 1 A rectifier bridge.
U2 — 7812, +12 V IC voltage regulator.

a Pi-L configuration to keep harmonics low. You should use a quarter-wave shorted coaxial stub in parallel with the output RF connector to make absolutely sure that the second harmonic is reduced well below the FCC specification limits.

To guarantee stability, the author had to make sure the screen grid was kept as close as possible to RF ground. This allows the screen to do its job "screening"—this minimizes the capacitance between the control grid and the anode. He used the Svetlana SK-3A socket, which includes a built-in screen bypass capacitor, and augmented that with a 50-MHz series-tuned circuit to ground. In addition, to prevent VHF parasitics, he used a parasitic suppressor in the anode circuit.

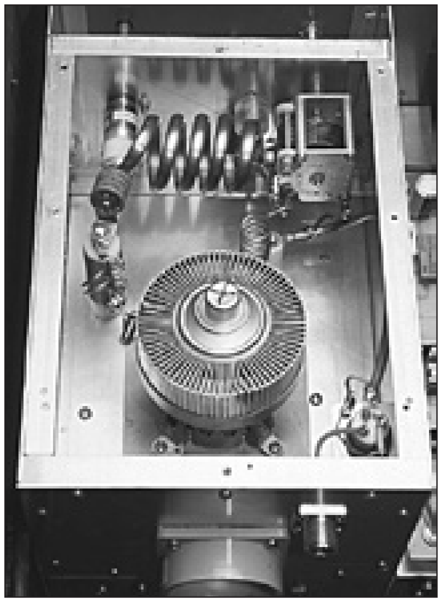

Fig 17.64—Close-up photo of the anode tank circuit for 6-meter kW amplifier. The air-cooling chimney has been removed in this photo.

Unlike the K6GT HF amplifier, this 6-meter amplifier uses no cathode degeneration. The author wanted maximum stable power gain, with less drive power needed on 6 meters. He left the SK-3A socket in stock form, with the cathode directly grounded. This amplifier requires about 25 W of drive power to produce full output.

Fig 17.62 is a schematic of the RF deck. The control and power supply circuitry are basically the same as that used in the K6GT HF amplifier, except that plate current is monitored with a meter in series with the B– lead, since the cathode in this amplifier is grounded directly. The K6GT power supply is modified by inserting a 250-Ω, 25-W power resistor to ground in place of the direct ground connection. See **Fig 17.63**. In Fig 17.62, C1 blocks grid-bias dc voltage from appearing at the transceiver, while L1, L2 and C2 make up the T-network that tunes out the input capacitance of V1. R1 is a non-reactive 50-Ω 50-W resistor.

C6 is the built-in screen bypass capacitor in the SK-3A socket, while L3 and C7 make up the series-tuned screen bypass circuit. RFC3 is a safety choke, in case blocking capacitor C12 should break down and short, which would otherwise place high voltage at the output connector.

CONSTRUCTION

Like the K6GT amplifier, this amplifier is constructed in two parts: an RF deck and a power supply. Two aluminum chassis boxes bolted together and mounted to a front panel are used to make the RF deck. **Fig 17.64** shows the 4CX1600B tube and the 6-meter output tank circuit.

Fig 17.65 shows the underside of the RF deck, with the input circuitry shown in more detail in **Fig 17.66**. The 50-Ω, 50-W noninductive power resistor is shown in Fig 17.66. Note that the tuning adjustment for the input circuit is accessed from the rear of the RF deck.

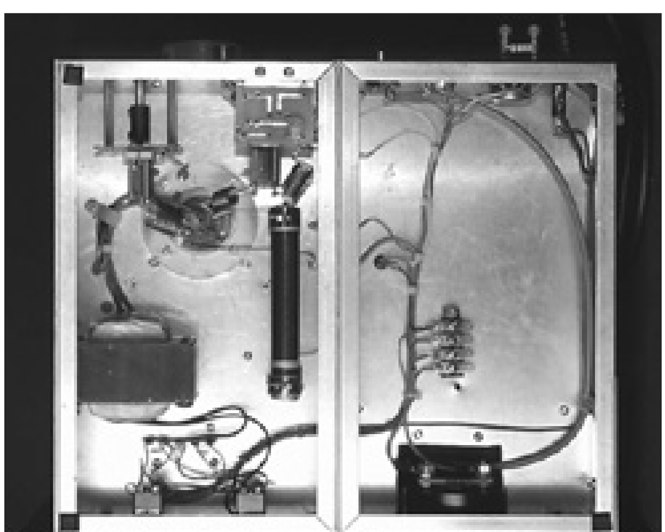

Fig 17.65—Underneath the 6-meter kW amplifier RF deck, showing on the left the tube socket and input circuitry.

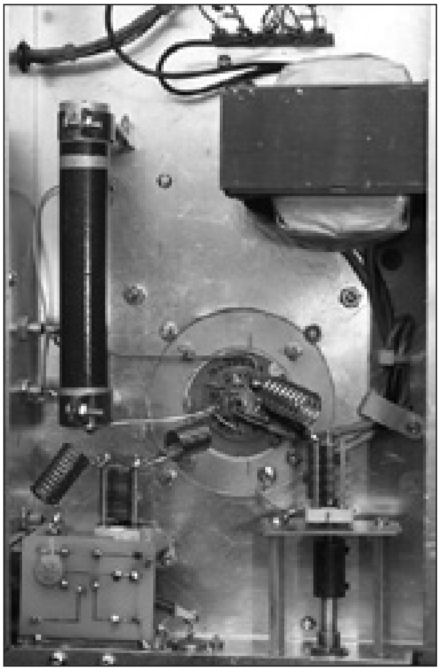

Fig 17.66—Close-up photo of the input circuitry for the 6-meter kW amplifier. Input tuning capacitor C2 is adjusted from the rear panel during operation, if necessary. The series-tuning capacitor C7 used to thoroughly ground the screen for RF is shown at the lower right. It is adjusted through a normally plugged hole in the rear panel during initial adjustment only.

AMPLIFIER ADJUSTMENT

The tune-up adjustments can be done without power applied to the amplifier and with the top and bottom covers removed. You can use readily available test instruments: an MFJ-259 SWR Analyzer and a VTVM with RF probe.

1. Activate the antenna changeover relay, either mechanically or by applying control voltage to it. Connect a 2700-Ω, ½-W carbon composition resistor from anode to ground using short leads. Connect the SWR analyzer, tuned to 50 MHz, to the output connector. Adjust plate tuning and loading controls for a 1:1 SWR. You are using the Pi-L network in reverse this way.
2. Now, connect the MFJ-259 to the input connector and adjust the input T-network for a 1:1 SWR. Some spreading of the turns of the inductor may be required.
3. Disconnect the Pi-L output network from the tube's anode, leaving the 2700-Ω carbon composition resistor from the anode still connected. Connect the RF probe of the VTVM to the anode and run your exciter at low power into the amplifier's input connector. Tune the screen series-tuned bypass circuit for a distinct dip on the VTVM. The dip will be sharp and the VTVM reading should go to zero.
4. Now, disconnect the 2700-Ω carbon resistor from the anode and replace the covers. Connect the power supply and control circuitry. When you apply power to the amplifier, you should find that only a slight tweaking of the output controls will be needed for final adjustment.