The Pine Board Project

The complete Pine Board Project. From left to right, the power supply, microphone preamplifier, and the transmitter.

A return to yesteryear with a 5 W AM transmitter.

Bob Heil, K9EID

Among my most enjoyable and meaningful pursuits as a new ham back in the mid-1950s was building audio amplifiers, modulators, VHF transmitting and receiving converters, and VHF transmitters. Many of these early projects were assembled on pine boards. It was simple to do because the devices were laid out as shown in the schematic diagrams.

As time went on, my projects advanced into scores of Heathkit products, along with aluminum Bud boxes that required learning about Greenlee punches and how to work with metal. Looking back, the projects built on scraps of wood were great for learning because I could follow the circuits visually and have a better understanding of how they worked.

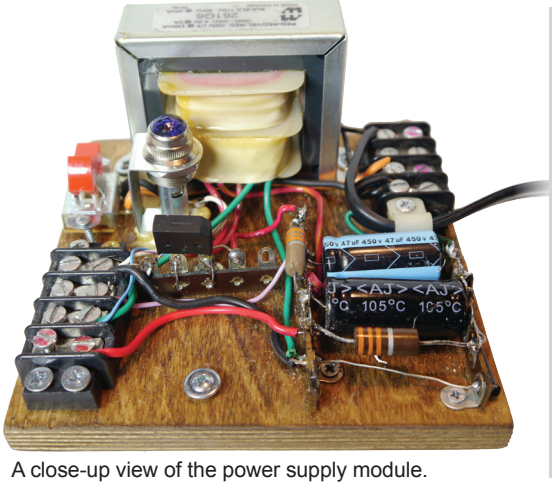
I love to share this great hobby, and I was thinking of ways to get new licensees attracted to the pleasures of building. I wanted to come up with a project that would be a great teacher and something that would not just be for static display, but a usable transmitter.

Here in the Ozarks, the MOKAM (Missouri, Kansas AM) group meets each weekday on 3885 kHz. Each Monday, we converse with our low-power vintage AM transmitters — Johnson, Harvey Wells, Heathkit, and the like. I became fascinated by the signals Richard Beckett, WØBVT, put on the air with his "Pine Board" AM transmitters that run 3 or 4 W using only vacuum tubes. Each week, he would have a different tube lineup, RF power level, and audio quality.

It occurred to me that his Pine Board transmitters were exactly what I was looking for. We made the projects part of our weekly *Ham Nation* online show, and with Richard's help, the Pine Board transmitters were a hit.

Gathering the Parts

One of the first concerns was the availability of parts. Many old-timers have junk boxes that are overflowing



A close-up view of the power supply module.

Safety Concerns

The design of the Pine Board Project is an homage to an earlier time when amateurs occasionally built homebrew projects with exposed circuitry. In those days, it was understood that working with high voltages entailed a certain level of risk.

The need to be mindful of the dangers of electricity is just as important today, but especially so with the Pine Board Project. This project exposes the builder to potentially lethal voltages, and must be operated with great care. Do not allow children, pets, or any unsupervised individuals other than yourself in proximity to this project.

While the version of the Pine Board Project shown in this article uses an open construction architecture, for safety considerations we recommend packaging the entire transmitter, preamplifier, and power supply in an enclosure of wood, metal, or plastic to prevent contact with the circuitry. — QST *Editorial Staff*

with components, but that's not so for most amateurs today. After a bit of research, I came up with several parts companies that could supply crystals, transformers, chokes, sockets, resistors, capacitors, and hardware needed to build an 80- and 40-meter AM tube transmitter. Antique Electronic Supply went so far as to put a Pine Board Project kit together with almost all the parts needed. The kit sells for $49.18 and is available at **www.tubesandmore.com/products/pine-board-am-transmitter-kit-ham-nation-bob-heil**.

Modular Design

The project is built in three separate modules: the high-voltage supply, the microphone preamplifier with two-band equalization, and the two-band transmitter. Each of these modules are designed with terminal strips that are wired to carry the B+, 6.3 V ac filament voltages, and the ground connections. If you only want to work CW, you will not need the microphone preamp module, just the power supply and transmitter.

The pine boards are available, cut to size with finished edges, from Hobby Lobby at **www.hobbylobby.com**. (The one we use most is stock number 179408, the 5 × 7 inch rectangle plaques.) Give each board a light stain, and you will be ready to build.

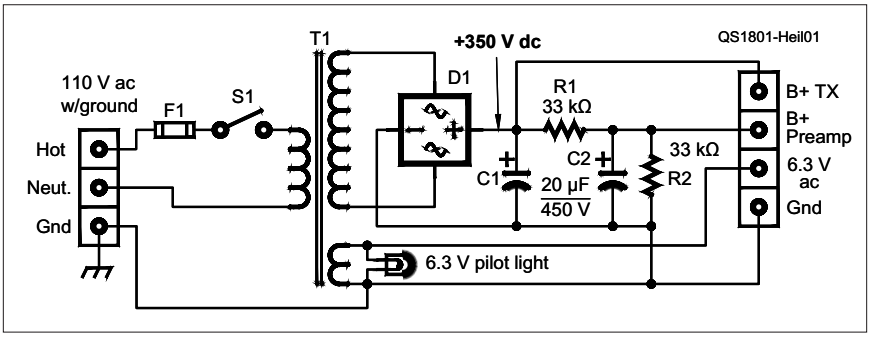


Figure 1 — The Pine Board Project power supply diagram.

C1, C2 — 20 µF, 450 V electrolytic capacitors
D1 — Bridge rectifier (**tubesandmore.com**, P-QBR-34)
F1 — Fuse, 3A
R1, R2 — 33 kΩ, 2 W resistors
S1 — SPST switch
T1 — Hammond 261G6 transformer (**tubessandmore.com**) Primary: 120 V; Secondary: 250 V and 6.3 V.

The Power Supply

The Hammond 261G6 transformer has two secondary windings: 250 V at 130 mA and a 6.3 V winding for filament (see Figure 1). The P-QBR-34 bridge rectifier provides +350 V dc from the full-wave rectifier circuit. This is followed by two 20 µF capacitors along with a voltage divider comprised of two 3.3 kΩ, 2 W resistors. One hundred and twenty volts feeds the mic preamp, while the +350 V feeds the transmitter. To complete the power supply, there is an **ON/OFF** switch in 110 V primary, as well as a pilot lamp connected to the 6 V filament leads.

Microphone Preamplifier and Equalization

A single 12AX7, which has been the vacuum tube of choice for audiophiles for decades, works well in this circuit (see Figure 2). The first stage is a high-gain preamp that feeds the second stage of the 12AX7, providing sufficient output to drive the 6V6-based Heising modulator of the transmitter.

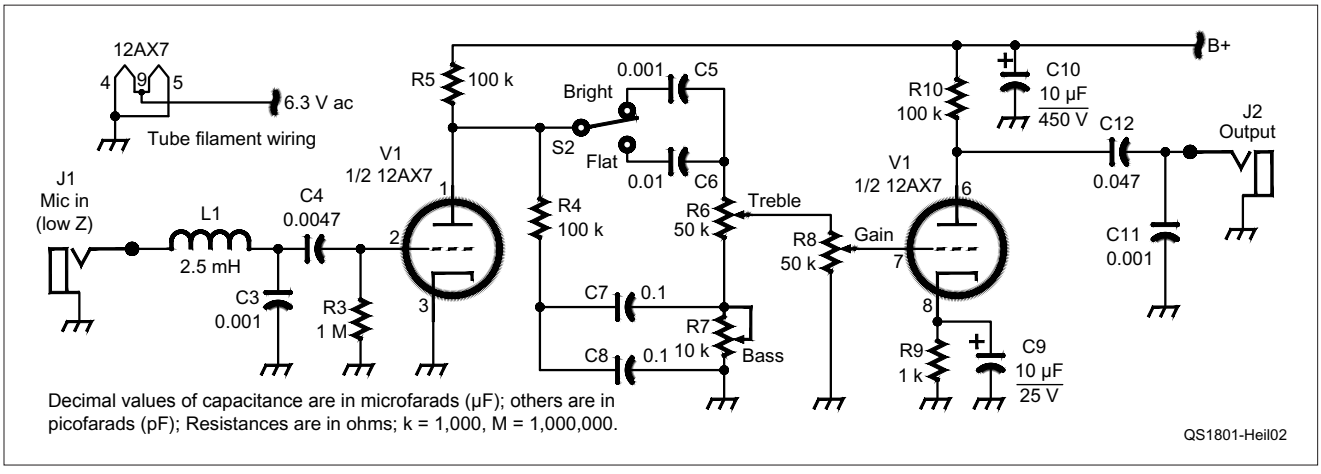


Figure 2 — The preamplifier and audio equalizer diagram.

C3, C5, C11 — 0.001 µF ceramic disc capacitor
C4 — 0.0047 µF ceramic disc capacitor
C6 — 0.01 µF ceramic disc capacitor
C7, C8 — 0.1 µF ceramic disc capacitor
C9 — 10 µF, 25 V electrolytic capacitor
C10 — 10 µF, 450 V electrolytic capacitor
C12 — 0.047 µF ceramic disc capacitor
J1, J2 — two conductor phone jacks
L1 — 2.5 mH RF choke
R3 — 1 MΩ, ½ W resistor
R4, R5, R10 — 100 kΩ, ½ W resistor
R6, R8 — 50 kΩ potentiometers
R7 — 10 kΩ potentiometer
R9 — 1 kΩ, ½ W resistor
S2 — SPDT switch
V1 — 12AX7 vacuum tube (SND Tube Sales, **www.vacuumtubes.com**)

With the addition of only eight components, we add a two-band equalizer with a treble boost that is a welcome touch for the low-power transmitter. There are not many parts to the microphone equalization preamp, but the audio from this single-stage 12AX7 is stunning. I borrowed the design from a guitar preamp I built for many of our musician friends during the 1970s. Two ¼-inch female microphone connectors are mounted on the pine board: one for the microphone input, and the second to carry the mic preamp output for the transmitter.

The Transmitter

The transmitter (see Figure 3) is designed to work on 80 and 40 meters. The plate coil is from the parts department of MFJ. Our circuit uses 41 turns of their 404-0811-1 inductor. The coil is mounted so that the last 14 turns can be shorted for resonance on 40 meters. This is our "band switch." Change the FT243 crystal to 7290 kHz, short the last 14 turns, and you are on 40 meters. It works great.

The 6AG7 tube is configured as a low-powered crystal-controlled electron-coupled oscillator. In this circuit, the screen grid serves as the "plate." Thus, the cathode, control grid, and screen grid are connected as a triode oscillator circuit. The only coupling between the oscillator and the load is through the stream of the 6AG7. Due to the "electron-coupling," any changes in the load have very little effect on the frequency-controlling circuits, so the oscillator frequency remains very stable.

The plate circuit is coupled to the **L** network through a 500 pF coupling capacitor. The purpose of the **L** network is to match the high-impedance plate circuit of the 6AG7 to a 50 Ω load. Maximum power is transmitted when the impedance of the source matches the impedance of the load. With the +350 V from the power supply, the 6AG7 output is 5 W.

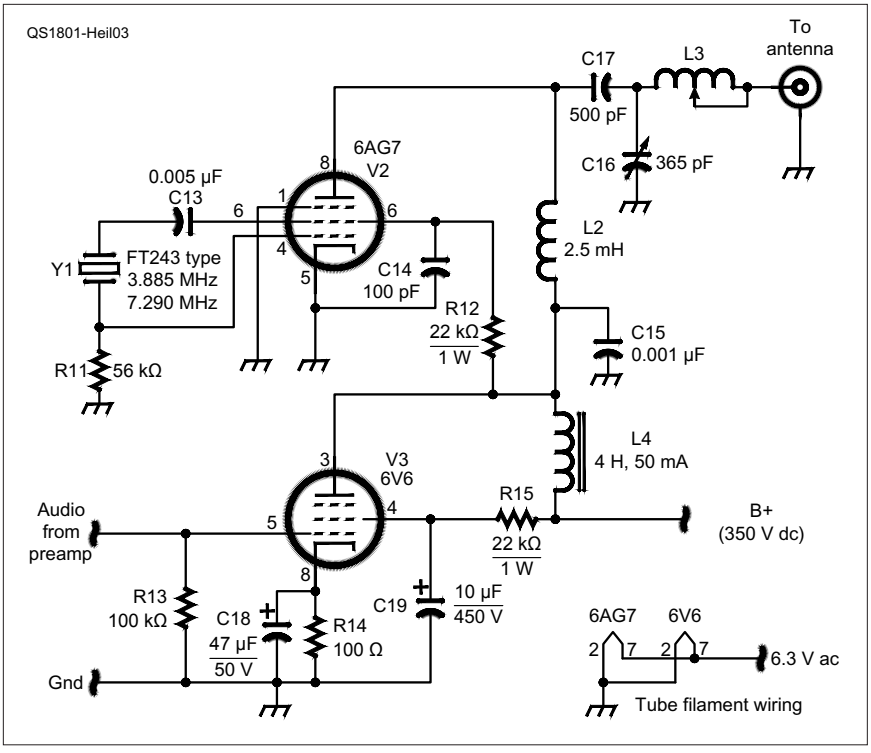
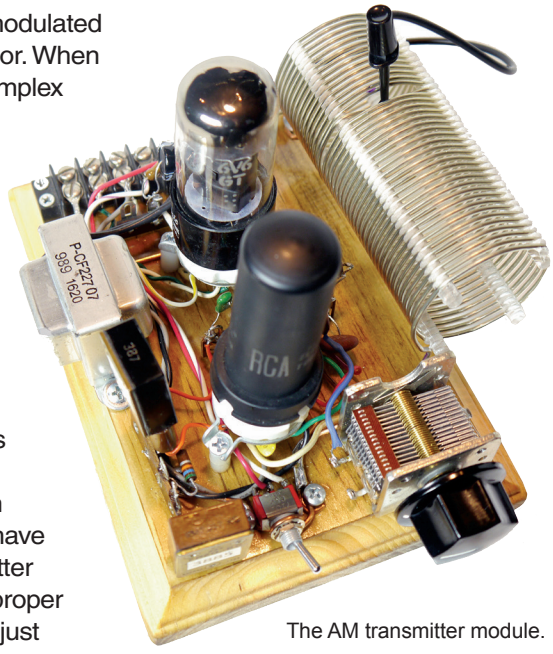


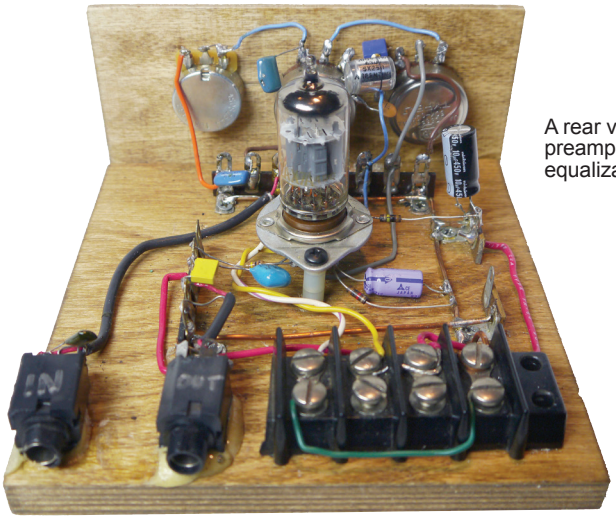
Figure 3 — Pine Board Project AM transmitter diagram.

C13 — 0.005 µF ceramic disc capacitor
C14 — 100 pF silver mica capacitor
C15 — 0.001 µF ceramic disc capacitor
C16 — 365 pF variable capacitor
C17 — 500 pF silver mica capacitor
C18 — 47 µF, 450 V electrolytic capacitor
C19 — 10 µF, 450 V electrolytic capacitor
L2 — 2.5 mH RF choke (Radio Daze, **www.radiodaze.com**)
L3 — Inductor, 1¾ inch diameter, 41 turns at 10 turns per inch (MFJ 404-0811-1)
L4 — 4 H, 50 mA RF choke (Antique Electronics, **www.tubesandmore.com**)
R11 — 56 kΩ, ½ W resistor
R12 — 22 kΩ, ½ W resistor
R13 — 100 kΩ, ½ W resistor
R14 — 100 Ω, ½ W resistor
R15 — 22 kΩ, 1 W resistor
V2 — 6AG7 vacuum tube (SND Tube Sales, **www.vacuumtubes.com**)
V3 — 6V6 vacuum tube (SND Tube Sales, **www.vacuumtubes.com**)
Y1 — Type FT243 crystal. 3.885 or 7.290 MHz would be best for AM. (**www.af4k.com**)

The transmitter is Heising modulated with a 6V6 Class A modulator. When an audio sine wave, or a complex audio waveform, coupled to Pin 5 of the 6V6 drives the grid positive, current through the choke reduces the plate voltage of the 6AG7. When the audio waveform drives Pin 5 of the 6V6 more negative, the plate of the 6AG7 goes more positive. The process results in amplitude modulating the 6AG7 carrier. The results on the morning MOKAM nets have been excellent. The transmitter produces clean audio with proper equalization, and even with just



The AM transmitter module.



A rear view of the microphone preamplifier and audio equalization module.

5 W, I work stations 150 to 200 miles throughout the Ozarks. The Pine Board Project is also a great exciter to drive my Central Electronics 600L linear amplifier to well over 200 W.

You will find detailed parts layout diagrams and low-pass filter schematics at **www.arrl.org/qst-in-depth**.

For CW Operators

Should you want to build the Pine Board Project for dedicated CW rather than AM use, the crystal-controlled transmitter would be perfect. Many of the Novice transmitters of the '50s and '60s used this and similar designs.

When you want to operate AM, you simply connect the microphone preamp/equalization module. This module can also be used for other applications, such as a mic preamp for other transmitter projects, or a microphone preamp for public address audio systems and the like.

"How To" Videos

Watch the *Ham Nation* Pine Board Project video segments online for more information. Each lasts 10 to 15 minutes. The video clips, along with all the schematics and professional drawings by Gene Workman, W4IQN, have been assembled at **https://heilsound.com/amateur-radio-post/the-pine-board-project**.

The results using this Pine Board AM transmitter on the morning MOKAM nets have been excellent. The full-bodied audio with proper equalization, and the 5 W QRP AM output, is amazing. I hope to be able to work you with your own Pine Board Project!

My thanks to Ed Pfeiffer, WB4OJM, for his assistance with this project.

Bob Heil, K9EID, licensed in 1956 as KN9EID, began his Amateur Radio career as an avid experimenter and builder of VHF equipment. Heil became involved in designing and building equipment, and in 1958, his was one of the first 1 kW 6- and 2-meter SSB stations.

As a professional theatre pipe organist at the St. Louis Fox Theatre, he learned to voice and tune massive Wurlitzer theatre organs, which taught him how to listen and mentally dissect what he heard. That ability, combined with his equipment-building skills learned from Amateur Radio, was the foundation for his career in building the first large arena sound systems for such artists as Joe Walsh, the Who, the Grateful Dead, and Peter Frampton. His company, Heil Sound, is the only manufacturer ever inducted into the Rock and Roll Hall of Fame.

In 1980, Heil turned his focus to designing more articulate microphones, headsets, and audio gear for Amateur Radio, commercial broadcast, and live concert stages. Heil continues to bring new technologies to the industry and is constantly designing new and exciting audio products. You can contact Bob at **bob@heilsound.com**.

For updates to this article, see the QST Feedback page at www.arrl.org/feedback.