A Planar-Triode Phono Preamp

An unlikely looking tube is the star performer in this smooth-sounding preamp **By Eric Barbour**

After having worked in tube audio as a "professional," i.e., getting paid by an actual employer that sold tubes, I've gained some useful insights into tube design. Some of this knowledge actually applies to the common circuit designs that see frequent use. More to the point, I learned the personal motivations of many designers of said equipment.

You might be surprised to learn how much of the use of a given tube is based upon pricing, not on technical merit. All of the largest OEMs of high-end audio equipment seem unwilling to pony up a large sum for development of a tube to meet their strict requirements. Instead, they prefer to constantly call tube distributors and factories and try to wheedle them into selling for a lower price. If a fraction of this effort was used to redesign their products using available tubes, all of their problems would go away.

The hobbyist has a tremendous advantage here, by simply keeping an open mind. Instead of chasing down a price that is one penny lower for Russian 6922s, he can use tubes that are readily available, and are vastly better performers than the lowly 6922. Ironically, some outstanding Russian tubes are never used in audio equipment, yet happen to be excellent for audio use.

HISTORY

The 6922/6DJ8 has been used for years in audio, because of its low cost, detailed sound qualities, and (alleged) low noise figure. I find this ironic, because it is a frame-grid triode, and there are far more sophisticated and quieter frame-grid triodes. The first frame-grid triode, in fact, was a very odd-looking tube in a metal canister—the Western Electric 416A of 1948. In spite of its very high Gm (equating to very low noise), audiophiles have no interest in it or its metal-cased cousins. Instead, they seek frame-grid types in conventional glass envelopes.

While a WE 437A can sell for as much as $600 on eBay, a 416D (a far superior device) usually sells for less than

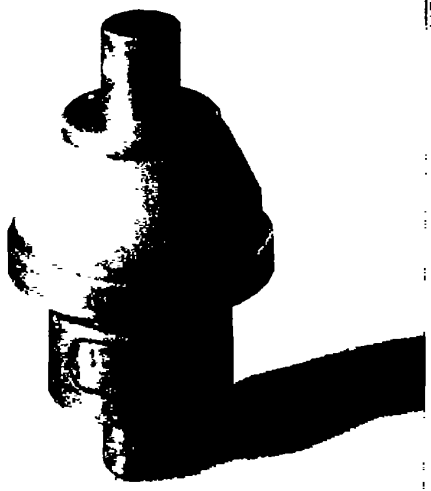

PHOTO 1: 6S17K-V tube.

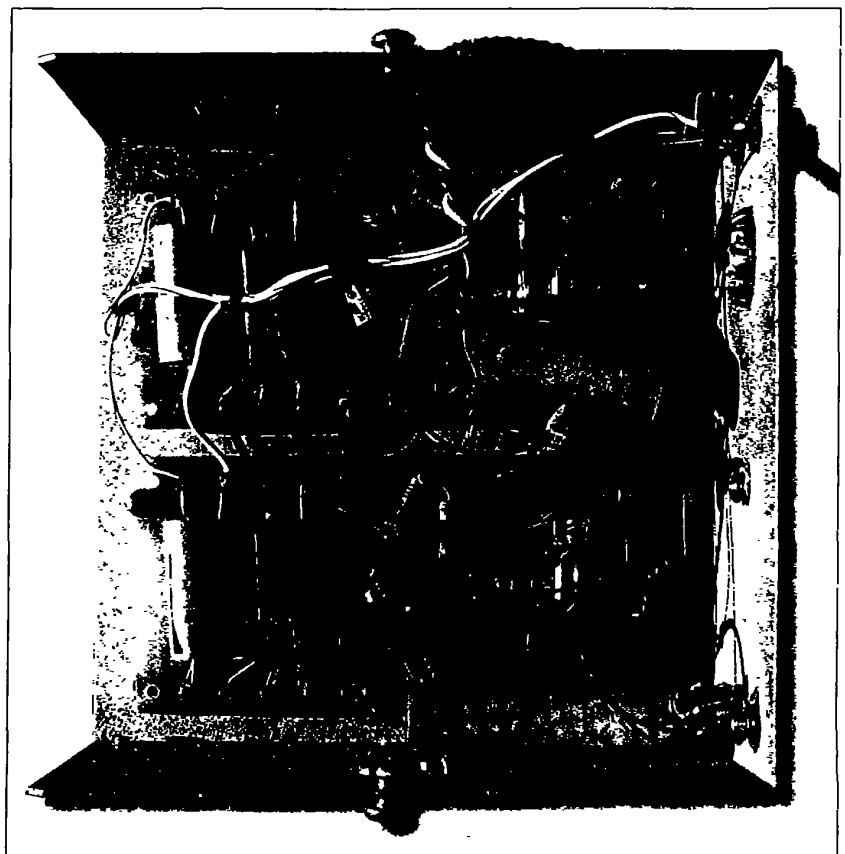

PHOTO 2: Interior of planar-triode phono preamp.

$100. Reasons? Apparently, the difficulty of finding 416-series sockets or other hardware is a factor, as well as the simple and childish fact that you can see the glow of the 437A's heater.

The 416A led to several series of ceramic-metal triodes, all having a planar structure rather than the conventional glass-tube coaxial design. A planar triode is a "sandwich" of parts, brazed together in a vacuum chamber using special tooling. For example, General Electric developed the 7077 in 1951 for low-noise RF amplifiers. In spite of the "obsolescence" of vacuum tubes, the 7077 and its descendants are still manufactured in Owensboro, Ky., by MPD, the firm that took over GE's tube manufacturing.

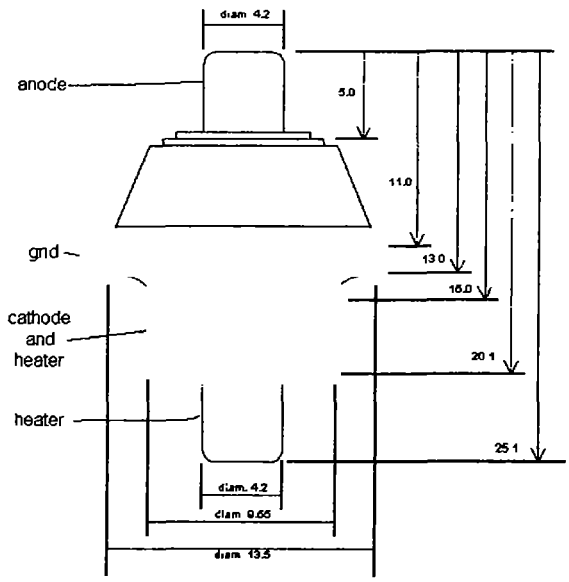

FIGURE 1: Mechanical dimensions of 6S17K-V planar triode. All dimensions in mm (not to scale).

These planar triodes are made almost exclusively for the front ends of military pulsed radars, due to the high cost of manufacturing a receiving tube in the US, especially an exotic one. Few audiophiles have ever seen a 7077, and I enjoy their expressions when they are handed one. It is the size of an aspirin tablet, and is made of white ceramic and gold-plated metal contacts. Some people have called it a "funny looking transistor."

I can guarantee that you will never see 7077s or their many derivatives in audio equipment, due to wholesale prices in the US $600-1000 region. As I said, most manufacturers of high-end audio equipment usually are only interested in reducing manufacturing costs, not producing amplifiers that sound or perform better.

AVAILABILITY

The high cost of such planars need not be an impediment to the home constructor. Many tube factories made their own planars over the years. A series of unique planar triodes was made at the Novosibirsk factory in Russia—these are similar internally to the American 7077 family, yet quite different in outward appearance. I have recently discovered that surplus Russian planars are available at very reasonable prices.

The easiest one to obtain is the 6S17K-V (usually called 6C17bB by Russian dealers). This device resembles a rocket nose-cone (*Photo 1*), not a vacuum tube. Intended for microwave frequencies, it has no base or contact pins—electrical contacts are smooth surfaces to minimize path lengths, thus reducing parasitic inductances and transmission-line effects (*Fig. 1*).

I have learned that surplus Russian tube dealers usually have a supply of 6S17K-Vs for sale for about $30 apiece. These tubes are apparently no longer manufactured, yet I understand there are tens of thousands

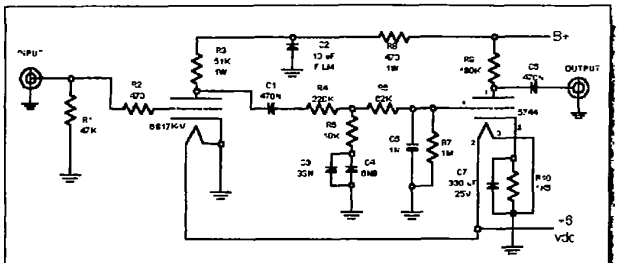

FIGURE 2: Schematic for planar-triode phono preamp. One channel shown. Other channel uses resistors R10–R20, capacitors C10–C17.

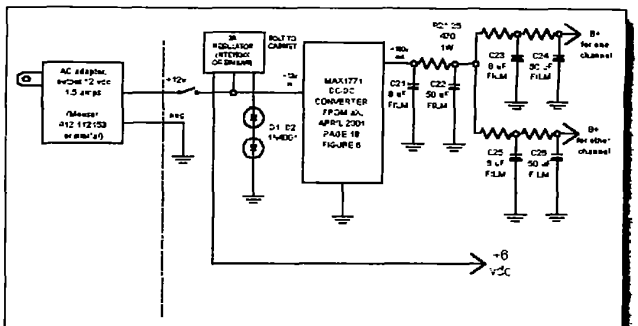

FIGURE 3: Power supply for planar-triode preamp.

available in Russia in surplus form. The price is so attractive that the tube lends itself to low-noise preamplifier design, in spite of the need to fabricate a special mounting assembly with spring contacts.

PREAMP

I constructed a basic zero-feedback phono stage with a 6S17K-V as the input amplifier, feeding a passive equalization section (*Fig. 2*). Because the 6S17K-V has its cathode connected to one side of its heater, a clean source of DC heater power is recommended. The output stage is made with a subminiature triode, type 5744 (also available in Russian form under the number 6C7bB).

Examination of the 6S17K-V plate curves indicated a plate resistance in the center of the curve area of approximately 13.2kΩ. The data indicates 2kΩ as the usual load, for RF amplifier service. In audio design, you need to minimize distortion, and commonly this happens at the expense of output impedance. For small-signal triodes, a load of approximately four times the plate resistance is a standard practice. Thus, a suitable anode load impedance would be 51kΩ.

The heater-cathode connection seems to complicate biasing. However, after running the tube in a breadboard, I found that it generates so much self-bias that its cathode could be directly grounded. The grid, with a 47k resistor to ground, then floats at approximately 0.5V below ground, and with a B+ of 140V and a 51k resistor for anode loading, the anode idled at approximately 50–60V—one-half the B+ supply. This is apparently caused by secondary emis-

sion and other grid effects, sometimes collectively called "contact potential." Thus, no biasing network or negative bias voltage was needed.

The EQ circuit is a classic which has been used many times. My previous experience with it was in my nuvistor phono preamp (*Glass Audio* 4/93, p. 6). Because of the very high voltage gain of the 6S17K-V, you can dispense with one whole gain stage. The output subminiature-tube stage provides moderate gain and a reasonably low output impedance.

CONSTRUCTION

Each channel was constructed on a custom IAG terminal board. The special mounting requirements of the 6S17K-V required some ingenuity.

I drilled holes in the IAG boards next to the location of the tube, as it is laid down on the board. A #4 screw and nut at each location holds a small contact finger cut from brass shim stock. The contact is bent to firmly contact the appropriate ring on the tube. If this is done properly, all the contacts will be solid, and the tube will be very firmly held in place. The submin tubes had long wire leads, which were wrapped around convenient turret terminals.

I mounted the two channel boards in

6S17K-V CHARACTERISTICS

Heater: 6.3V 300mA
Anode voltage, maximum: 200V DC
Cathode current, maximum: 11mA
Anode dissipation, max: 2W
Grid dissipation, max: 0.1W
Transconductance: 14mA/V (14ms)
Mu, approximate: 80–185
Noise figure at 3GHz: 16.5dB
Microphony noise, max: 30mV (with anode load 2kΩ)
Input capacitance: 3pF
Output capacitance: 0.015pF
Grid-anode capacitance: 1.5pF

SUPPLIERS

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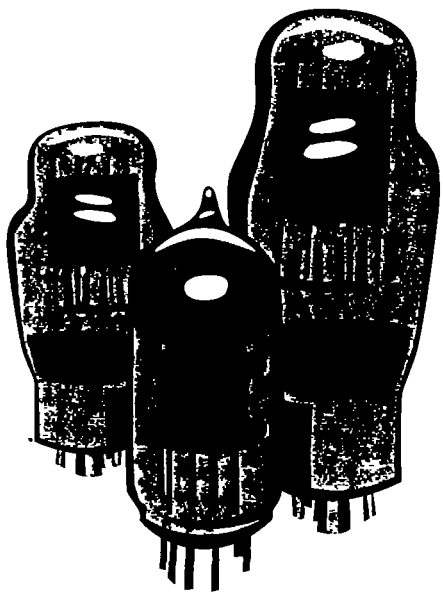

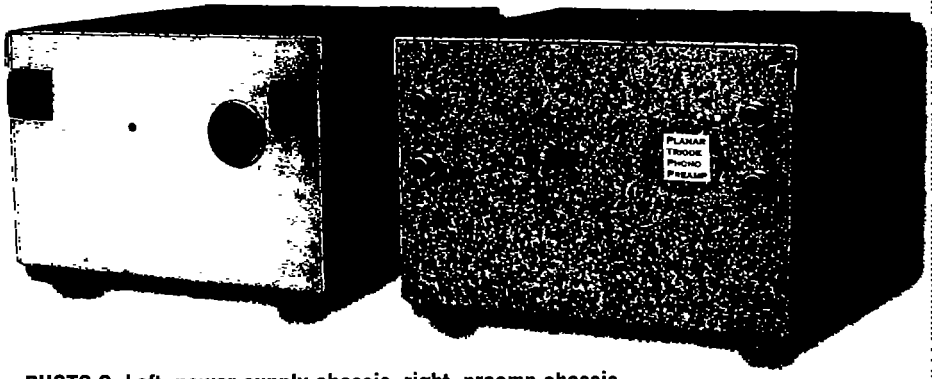

PHOTO 3: Left, power-supply chassis; right, preamp chassis.

a massive mild-steel box, which appears to be a surplus electrical enclosure (*Photo 2*). In spite of past claims that aluminum enclosures result in better sound, you need proper magnetic shielding here, so a steel cabinet is called for.

The power supply, which provides a great deal of filtering for low noise, is in a separate cabinet (*Photo 3*). This was a good place to apply one of the circuits developed for my switching-supply article (April 2001 *aX*), so I used Fig. 6, the supply based around a Maxim MAX1771 and a small transformer intended for making high voltage for electronic automotive ignition (*Fig. 3*). This supply easily makes about +100V at 15mA, plenty for this circuit. By using heavy filtering and decoupling, the need for separate voltage sources for the two channels and for active regulation (often an additional source of noise) is eliminated.

I measured the B+ supply under load and found that with no signal into the preamp, noise and hum on the B+ line was less than 5µV. A three-terminal regulator drops the +12V to approximately 6V for heater power. This IC is a 5V device—by using the old trick of forward-biased diodes between its return line and ground, the actual voltage is boosted to about 6.2V DC.

The +12V is obtainable from any suitable AC-DC plug-in power pack, or from a bench supply. This scheme even raises the possibility of a tube audio system powered from a 12V battery, making its use in an RV reasonable. (Provided the turntable is not used while the RV is in motion, of course.)

How does it sound? Very clean and transparent, much like my *GA* nuvistor preamp...and with a major improvement: the planar triodes are very nonmicrophonic, while nuvistors are notorious for having microphony problems. I mounted my previous nuvistor preamp's PC board on rubber shock mounts for a very good reason: high amplifier volumes easily gave a feedback howl. This circuit does not appear to need such mounting considerations.

I believe that this preamp gives some very costly and finicky commercial preamps a serious run for their money. Building this project will both save a large sum of money and permanently eliminate the audiophile's need to plug 6922s into a preamp and tap them each to find one that is less microphonic than the others. ❖

PARTS LIST

(R1–R10 and C1–C7 are for one channel: R11–R20 and C11–C17 for the other. All resistors ½W metal film unless noted; all capacitors 150V or greater metalized film unless noted.)

R1, R11	47k
R2, R12, R8, R18, R21–R25	470, 1W
R3, R13	51k, 1W
R4, R14	220k
R5, R15	10k
R6, R16	62k
R7, R17	1MΩ
R9, R19	180k
R10, R20	1k5
C1, C10, C6, C16	470n
C2, C12	10µF
C3, C13	33n
C4, C14	6.8n
C5, C15	1n
C7, C17	330µF 25V electrolytic
D1, D2	1N4001
Regulator	2A large TO220 package (NTE1934X or similar)
DC-DC converter	see text

Misc: (2) steel enclosures, AC adapter (Mouser 412-112153 or similar), SPST power switch rated 2 amps or more, (4) RCA panel-mount connectors, (2) IAG custom breadboards, wire.