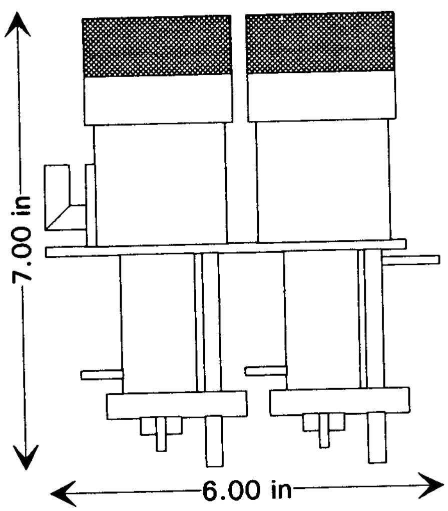
1296 Power Amplifier Notes by N4MW

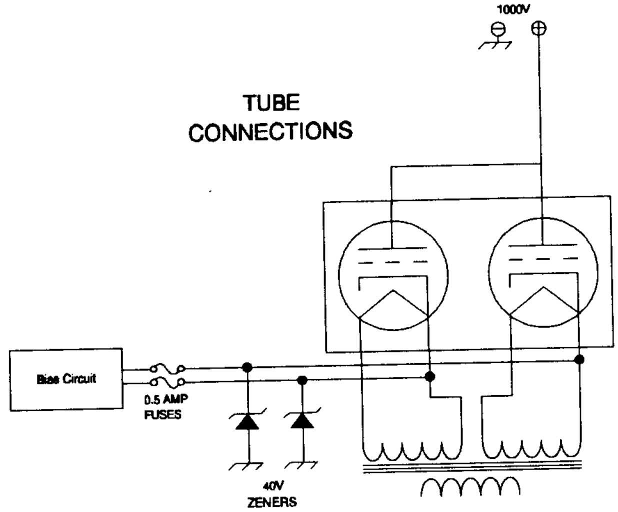
This is a description of my semi-homebrew 1296 power amp. The amplifier I built is water cooled. I will elaborate on each part.

The amplifier relies on a two tube cavity assembly removed from an FAA TACAN ground station. These stations were modernized a few years ago, replacing the 2C39s and klystrons with solid state equivalents. Charlie Chennault WA5YOU generously provided me with a set of cavities, retaining one for eventual use himself. I seems that these cavities might be rare indeed based on the limited number of installations which generated them; however, I know that others have obtained them, including KA5TQY and W5RCI. I have encountered two more sets of cavities at hamfests going for from $2 to $20. Even if you can not find these cavities, the same results can be achieved using commercial or home-brew cavities from Hy-Spec and N6CA and the like.

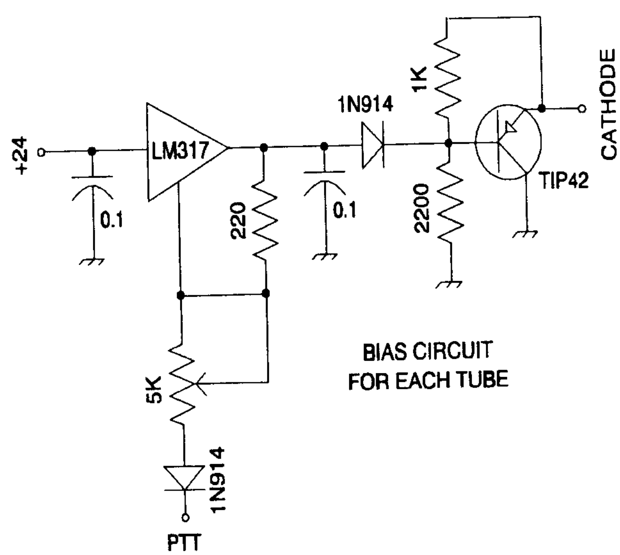


WANTED: TACAN CAVITIES

The bias circuit, lifted from a NTMS Feedpoint article by KE7CX, originated in the ARRL Handbook article on the N6CA amplifier. It consists of an LM317 variable voltage regulator driving a TIP42 pass transistor. Standby bias is provided by allowing the regulator to float. Since my amplifier uses two tubes, two bias circuits were constructed.



The tube connections are very straightforward. High voltage connects to the single wire emerging from the anode decoupling filter included with the cavities. Filaments connect to the solder terminals at the tuner ends. The cathode is the connection emerging from the side of the cathode sleeve. The other side of the filament power connects to the solder terminal on the extreme end of the cathode sleeve. I installed the 40V Zener diodes directly from the cathode solder terminal to ground on the cavity assembly. A solder lug under one of the existing screws holding the cathode sleeve in place was used to provide a ground point. I substituted a series of lower voltage zeners for the 40 V one specified. Using what Radio Shack carries, two 15 V and a 9.1 V in series come close enough, with plenty of dissipation.



AC power is fused at 1.5 amp and is switched to the cooling pump, filament transformer and DC supply. The DC supply is a dual 12 volt unit connected to provide both +12 and +24 volts. +24 powers the bias circuit. The +12 powers the PTT relay. Also provided is a switched, unfused AC connection for the external plate supply, which is separately fused. An LED is included to indicate when power is on.

The PTT relay coil is connected to +12 and a phono jack. An anti-kickback diode is installed across the relay coil per standard practice. One normally open contact grounds both PTT terminals on the bias circuit. Another normally open contact is connected to another phono jack (not currently used). Two other contact sets on the 4PDT are available as spares. In case you have not discovered it, double stick foam tape makes mounting such things as relays very easy. This tape is available from Radio Shack, but a huge supply can be obtained economically from large office suppliers such as Office Max. Double stick foam tape can save a lot of mounting time.

The high voltage supply I used is a unit HyGain produced in the 80s to power a sweep tube CB amplifier product line sold under many customized names (such as "Big Jon"). I bought my supply from Big Jon himself when his business folded. The supply is identical to those produced by HyGain for the Galaxy HF transceiver line. It supplies 12 volts AC for the filaments, -100 volts or so for bias, and +850 volts under heavy load. The unloaded voltage on my unit is +990! A word of caution: My unit had remained new in the box for over 10 years. Not wishing to trust the electrolytic capacitors under this condition, I connected a 60 watt light bulb in series with the AC primary when first applying power. The lamp lit up half way for a few minutes, then tapered off to a dull glow. Applying full power after that seemed to be safe. The moral here is not to overlook some of these old HF transceiver supplies at hamfests. They can be used as I have to power cavity amplifiers. But please do be careful.

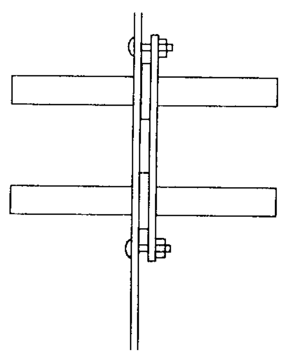
A time delay circuit to keep the high voltage off until the filaments have warmed up would be nice. I may add that later. For now, simply turning the amplifier filaments on does apply high voltage, but the tubes remain biased to cutoff until the PTT is enabled.

I include a meter not shown on the circuit diagram. The meter (250 ma) can be inserted just ahead of the cathode fuses. One trick is to use a microammeter with shunts. The shunts can be left in place and the meter switched between tubes using a DPDT switch. I cheated a bit and used 10 ohm 3 watt resistors in place of the shunts. 250 milliamps across 10 ohms develops 2.5 volts. Using a 100 microamp meter as a voltmeter with 2.5 volts full scale required a 25K series resistor. I used this technique in case I convert to a digital panel meter display later on.

As for mechanical packaging, I used a gutted HP style instrument case. The case was for a 3.5 inch rack mounted useless gadget with a depth of about 12 inches. Although it might be hard to duplicate, the result is a neat small amplifier which uses a minimum amount of rack height.

Water cooling is used for this amplifier, since the power level drastically exceeds the design intent of the original air cooled amplifier. I found a circulating pump (medical?) which was small enough to build into the amplifier enclosure. Coolant lines are brought into and out of the enclosure through two nipples. These were made from two inch lengths of 1/4 inch brass hobby tubing. I punched 1/4 inch holes in the centers of two pennies and soldered the tubes to the holes. These assemblies protrude through two 1/4 inch holes in the back of the enclosure. A rectangular plate with matching holes for the nipples is used to clamp the penny sides to the inside of the back panel of the enclosure. 1/4 inch inside diameter plastic tubing is used to make internal connections as well as to connect to the coolant reservoir. I use distilled water available for $0.85 per gallon from the grocery store for coolant. For convenience, I constructed another dual pass through tubing nipple assembly onto the cap of a distilled water jug. This makes it easy to swap to a new jug as required. The tube liquid cooling adapters I used are the commercial Spectrum units which I won as a door prize at Microwave Update '92, but the pipe cap equivalents should also work.

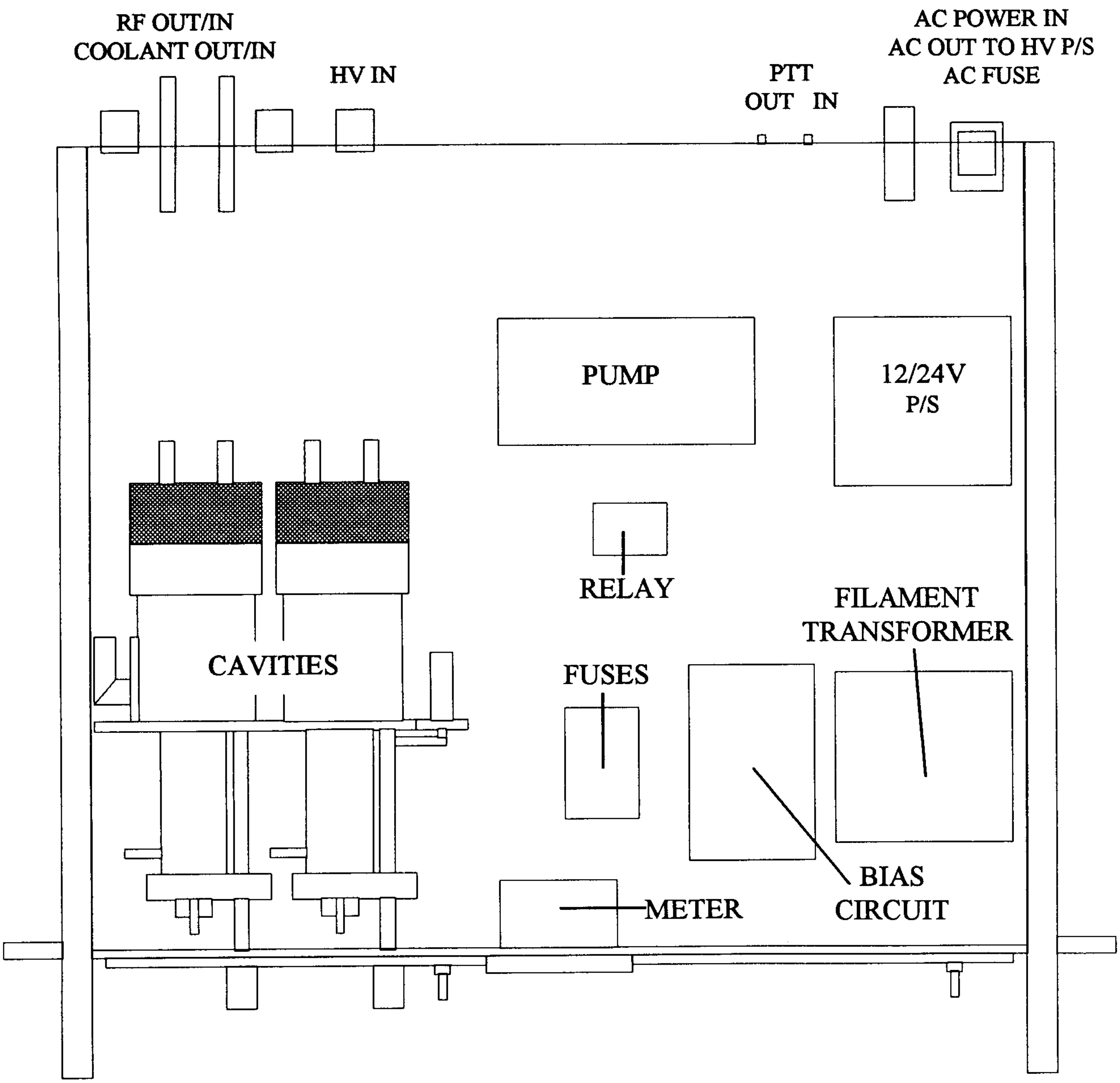
COOLANT BULKHEAD
FEEDTHROUGH



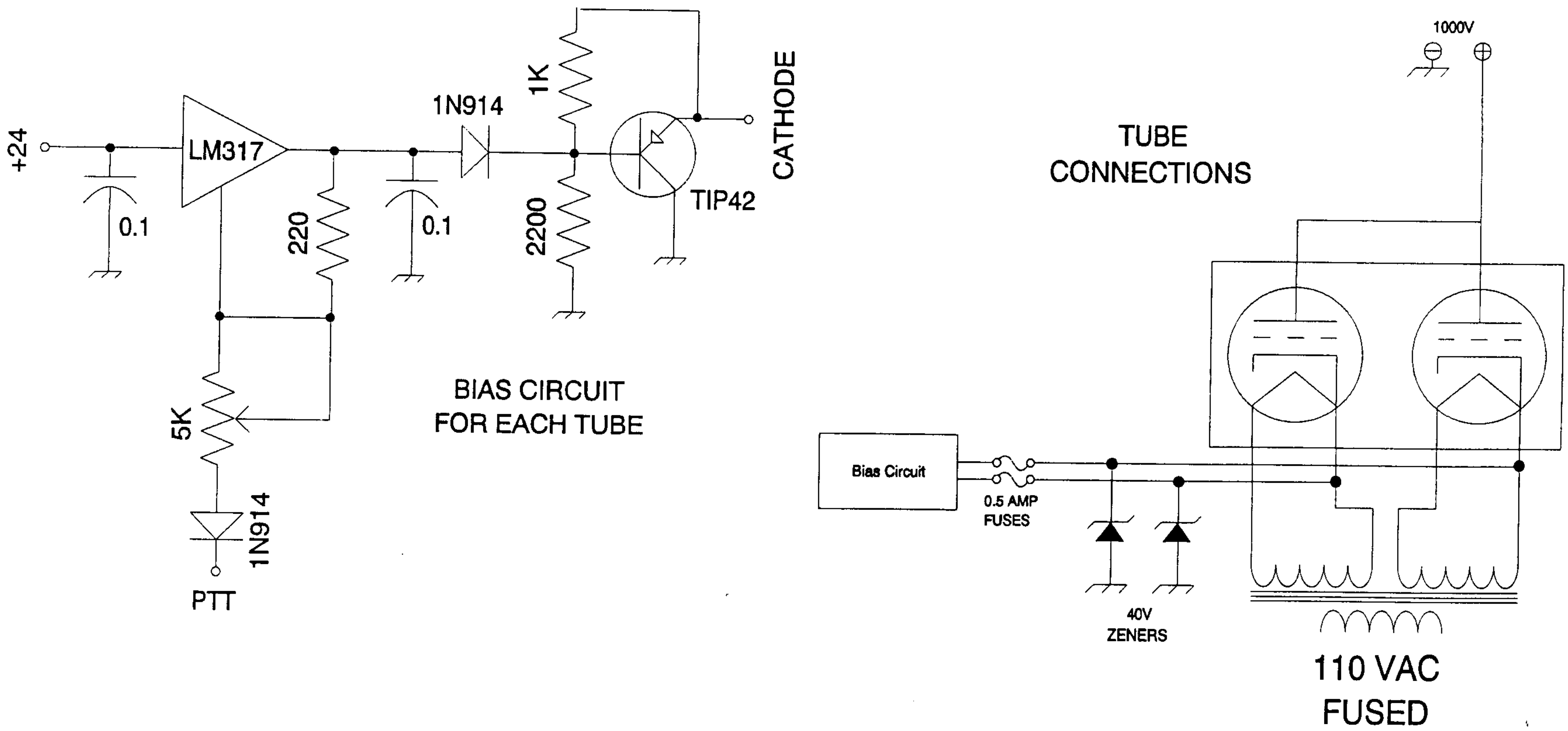
The TACAN cavities provide a BNC connector on the output. The input is a screw lug originally connected to the output of a multiplier cavity. A flange style BNC jack can be soldered in very easily as an input connector.

The cavities originally had 2C39 tubes. Of course, I substituted 7289s. I had been using the cavities for EME amp previously, but with somewhat cruder implementation. Using cathode resistor bias and excessive high voltage, I managed to develop 150 watts or so with the sacrifice of a few tubes. Not much for two tubes you say? Here is the truth: These cavities are in *series*. Under the new construction, I am getting 250 watts out. With two tubes in series, very little drive is required, only about a watt. It's eerie to drive the amp with my 1 watt handheld and see 250 watts out (no I don't use it on FM)!

Future possibilities include improved metering, a power-on timer and a radiator. If the cathode fuses turn out to be a problem, I can mount the fuseholders on the front panel. Digital metering would be nice, especially if meter switch positions for high voltage and RF output power were included. If the gallon coolant reservoir overheats, some sort of heat transfer/fan system might be called for.



Chassis Layout



AMPLIFIER CIRCUIT

N4MW DEC 93