Vacuum Tube Booster Amp for the TMCC/Legacy track signal

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My unit is based upon Jim's Lefevre design, but adds:

- Variable tuning
- Variable drive level
- Output level monitoring

Replaced the 6X4 vacuum tube with silicon diodes.
The 6AQ5 is a beam power tube similar to a 6V6, but with a 7-pin miniature base.

The B+ voltage in the booster circuit is low compared to the max rating of the tube. The extra voltage due to lower drop across the silicon diodes is not very significant.

Some folks like rectifier tubes because they delay the B+ on the tubes somewhat so that their filaments can warm up before the B+ hits, allowing the tube to wake up in the properly biased state.

I started out designing a solid state amp, but quite frankly I got lazy. I thought that Jim's circuit would allow me to determine just what problems I need to address.

Last night I did some testing. I only have 3 TMCC engines - a converted PW F3, a modern F3, and a converted scale brass GG-1. I have two troublesome areas on the layout for TMCC signals. One is a PW bascule bridge that stalls the GG-1, especially if the engine is moving very slowly. When the engine is fully inside the bridge, the signal drops out. (Yeah, I know - add a earth-ground reference wire....)

With my adjustable output control I am able to vary the drive from an indicated value of 0 to 8. My F3s would run out in the open space with a value as low as .1, but when the GG-1 was stuck in the bridge, not even an 8 would get it out. I have more to learn here!

An op amp driving discrete medium-size transistors was my first idea. Running on +/- 15V rails, I should get about 30V peak-to-peak output. Compared to the Base's output of 5V P-P, that would boost the signal by about 15 dB, which should be a healthy boost.

I did some more testing with the Booster.

First, I decided to work on the GG-1. I had a coupler "tack" that was dragging and shorting out on the center rail joint where the bascule bridge meets the fixed track. This caused the engine to stall and trip the circuit breaker.

While I was fixing that, I decided to swap the Railsounds power supply board that didn't have a shield can for one that did. Mike Reagan had said that this was a way to reduce the "noise" from the switching power supply that can desensitize the R2LC receiver.

While I was at it, I installed a length of insulated piano wire inside the bascule bridge running from one end to the other down the center on the underside of the top metalwork. I had a long wire attached to this, but I never connected the wire to earth ground. This rod could probably still act as a ground signal radiator, which means I may have contaminated my experiment by changing too many variables at once.

When I returned the GG-1 to the layout, It did indeed have much better reception. The bascule bridge still was the worst spot on the layout, but now I could raise the booster's drive level a small amount above minimum and get flawless performance.

My other test zone had been where the GG-1 passed under some overhead layout wiring. With the shielded board there were no problems at very low signal levels.

I am talking about signal levels that read a couple tenths of a volt on my meter, compared to the full booster output of over 6 volts. It is really interesting to be able to dial the track signal strength up and down!

I have received samples of some higher-frequency medium power transistors (Ft=30 MHz) and I have a high-frequency Op-Amp capable of 50 mA at one MHz on the way. Running a bipolar 15V supply should give me about as much voltage as the tube booster, but I think it may be more sensitive to output loading, although the Op-Amp is supposed to be able to drive capacitive loads without problems. Film at 11.....

My last modification to the amplifier was adding a 0.1uF/600V capacitor in series at the output. I wanted some protection for the output coil just in case somebody has a stray voltage between earth ground and the outer rail.

I also changed the knob on the output tuning capacitor for one that has the locking screw deeply embedded into the knob. My first knob had the screw almost flush with the outer surface. Guess what - the shaft of the tuning capacitor is at high voltage, and that means the screw is also at high voltage! Simultaneously touching the knob's screw and ground is an invigorating experience!

I visited the NJ Highrailers last Friday night. We tried hooking up my track signal booster. The open circuit voltage of the booster is 21 volts on the built-in signal strength meter. With the large layout connected, the output dropped to 1 volt! There was not a significant improvement on the troublesome loop that we used for testing.

If I had used my brain, I would have made the signal strength meter available to also read external voltages so that I could compare the amount of drive directly from the Legacy Base to the layout with the booster's output. Doh!!!

When I get a chance, I am going to load the output down with capacitance to see how much capacitance it takes to drop the output to 1 volt. I am also going to determine the output impedance of the amplifier.

The good news is that I had a great time visiting the Highrailers' layout and also spending a day with Bob Taylor.

When I planned the trip, I completely forgot about the Memorial Day weekend. I probably would have chosen another time.

I will write a more complete report after I have researched the output impedance problem.

I am beginning to suspect that we have something to learn about how and where we run earth-ground wires. Bundling them with the track power wires may create excessive capacitance and may contribute heavily to the signal drop.

I am also wondering about the idea of using coax to run the track signal around. I don't think coax does much in the way of looking like its characteristic impedance when it is only 1% of a wavelength long. I need to learn about that. Maybe it just looks like 20 pF per foot of extra capacitance.

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