

# ***The Blue Guitar***

## **Hot Rod Tweed Conversion for SF Bassman Head**

### **Introduction**

John McIntyre's Bluesmaker mod for a BF Bassman head from the February 1993 issue of *Guitar Player* has been one of the more popular projects for DIY guitar amp rebuilders. I decided to come up with a 1999 version of his basic idea, with detailed instructions, drawings and pictures to make it easy for a beginner to turn an old Bassman head into a hotrodded version of the 5F6A Fender Tweed Bassman. While the Bluesmaker sought to recreate the Marshall tones of the British Blues bands from the mid-sixties, I was seeking to recreate many of the more authentic blues tones ranging from the 50's through the present.

Rather than try to reinvent the wheel, I have borrowed freely from Dennis Kager's Pignose G40V amp design (which itself was not unlike his earlier Sundown amps). The G40V is very similar to the tweed bassman and early Marshall amps, but with an added gain stage before the dc-coupled pair (w/ cathode follower) and a Pre-PI master volume control added after the tone stack. While many guitarists do not like the sonic directions Marshall took when they started adding master volume controls to their amps, the Pignose G40V amp kept the design very simple, retaining the traditional tweed bassman sounds at the higher settings of the master volume while adding some nice sounding overdrive as you backed off the MV control and increased the pre-gain control. While the purists out there may discredit the addition of a master volume and added gain stage to a classic amp design, the basic reality is that many of us do not have the freedom to crank our amps wide open and really need to be able to get some decent sounds at lower playing volumes. The Pignose G40V amp gets some nice sounds throughout a wide range of gain levels and playing volumes.

In transplanting the G40V basic design into a SF bassman head many modifications were required due to the larger transformers and higher B+ voltages. At various times I also added several optional switches which optimize the sounds for electric blues, blues rock or hard rock. Once you have built the basic design, much of the fine-tuning can be done by replacing a few components on the eyelet circuit board. At this point I would like to credit some of the people who helped out on this design in one way or another. Bruce Collins of Mission Amps has always been very helpful and he made many suggestions which were incorporated throughout the circuit. Many thanks also go to RJ Wilcox who took the basic untested design I drew up on paper and turned it into a fine sounding amp by carefully fine-tuning the tone and gain structures. And all of

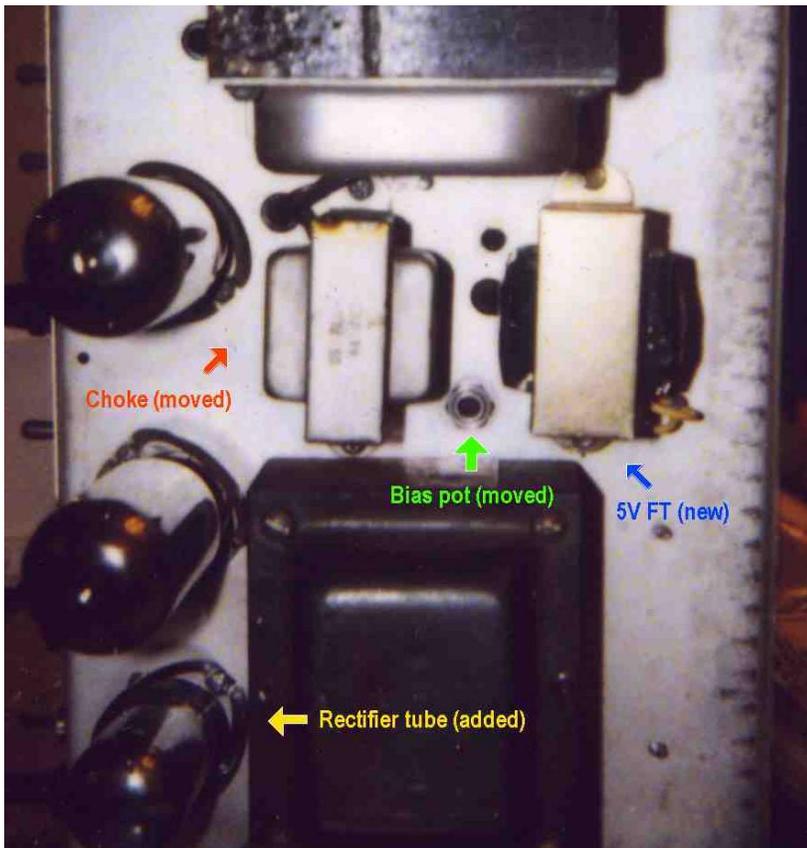
the experts over at the AMPAGE BBS have been great in educating us DIY-ers in the finer points of guitar amp design.

## The Details

Before beginning this project you need to decide whether you might want to undo the mod later and restore the amp to its previous state. If that is the case, you should remove the eyelet board and front panel pots, and start off fresh with a new eyelet board and new pots. You may also want to remove all of the wires from the tube sockets and label them with the tube and pin number for future reassembly.

However, my amp was no vintage treasure so I decided to use the existing eyelet board and proceeded to strip out all of the parts. You can take your own chances trying to reuse the old resistors and capacitors; after all of these years their values may have drifted and the caps themselves might not have ever sounded that good. (I prefer to use the Type 418P 600V Sprague Orange Drop caps available from Torres Engineering, but some people use the Type 715P Orange Drop caps more readily available from many supply houses. Other people have reported good results from the Mallory 150 caps.)

As for the power supply, I would recommend that you change any of the original filter caps.



power supply resistors have been replaced. Depending on the actual voltages from your power transformer you may need to revise these values a bit, but for starters 12k/10k/10k seem to work pretty good.

With the eyelet board removed from the chassis you can now drill and punch out the holes for the optional rectifier tube socket and an optional ss/tube rectifier toggle switch. I prefer the sound and response from the 5AR4 tube rectifier so much that I rarely use the switch in the SS mode, but the added versatility of having both options could prove to be handy. I used a Uni-Bit to drill out the hole for the full-sized toggle

**Figure 1: Components on chassis**

switch and a Greenlee nominal 3/4" conduit punch to make the 1 1/4" hole for the tube socket. You may also want to drill a few holes on the back panel at this time in case you decide to add in other option switches later. (I also drilled 3 holes for an optional tube-buffered FX loop that I plan to add in later and covered the holes with gray duct tape for the time being.)

If you decide to add the rectifier tube, you will need to get a 5 volt 3 amp filament transformer (FT). 2 amps is sufficient for a 5AR4 rectifier tube but I chose a 3 amp FT so that I could also use a 5U4 later if desired. To mount the FT on the chassis I had to relocate the stock choke and bias pot (see Figure 1 above). I had been concerned that rotating the axis of the choke might add hum or noise to the amp but I have noticed no problems.

In wiring up the eyelet board, pots and tube sockets, I adhered to a fairly strict star-grounding technique. I connected all of the grounds to a jumpered 5 lug terminal strip, mounted with a screw and nut in the same hole that secured the power supply board to the chassis. At least on my chassis with the stock eyelet board, this position worked perfectly because the terminal strip was right up to the eyelet board so that it

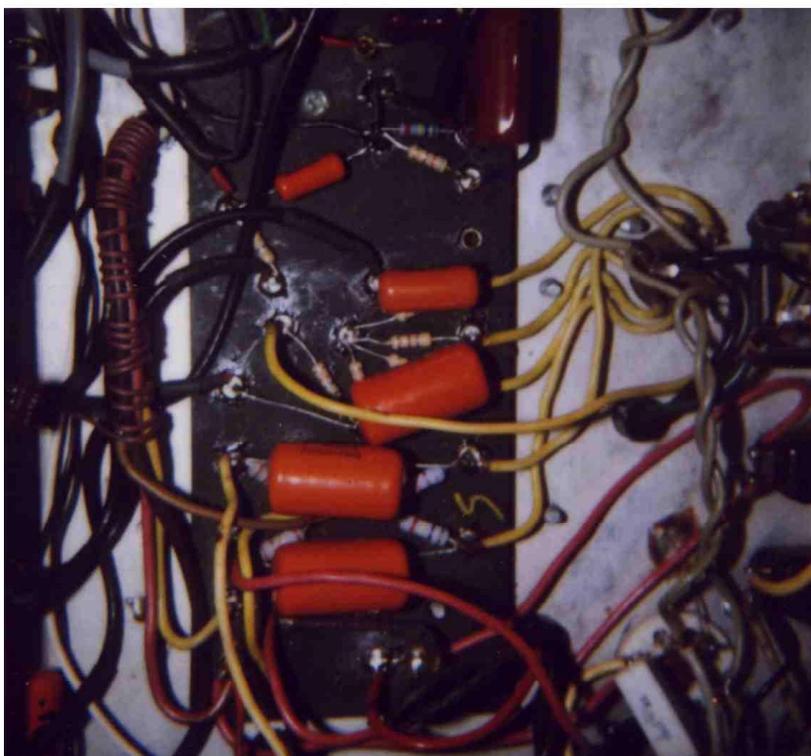
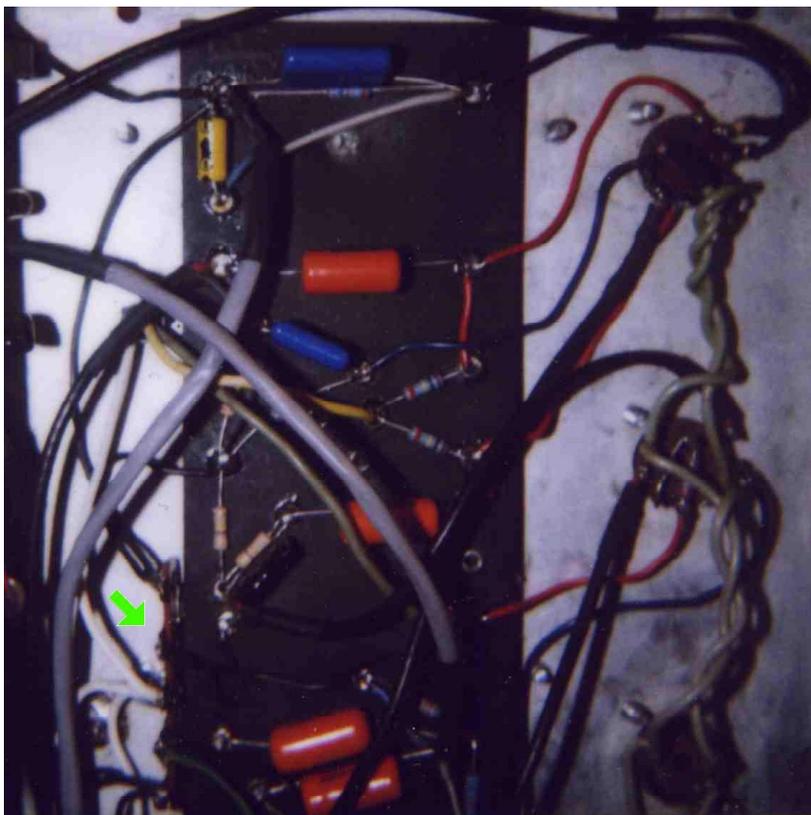


Figure 2: Eyelet board

would not rotate. (The terminal strip is indicated by the green arrow on Figure 2 to the right.)

One trick for a relatively hum-free amp design is to run the PT CT directly to the negative return from the large initial filter cap(s) in the power supply. In the case of my SF Bassman head, this was the negative return from the two 100uF/350vdc caps wired up in series. The negative return from those two caps has all of the garbage filtered out from the very raw dc voltage from the full wave rectifier (tube or ss) and by running it directly to the center tap of the power transformer, that garbage is presumably cancelled out en route to the two HiV leads. In any case, regardless of the actual scientific reason it does seem to work and should be used in any amp design which would normally ground the PT CT to one of the transformer mounting bolts.

Another trick which helps reduce the hum and noise picked up by the initial preamp gain stage is to isolate the input jacks from the chassis and use shielded cable to run the signal to the 33k grid stopper resistor mounted on pin #2 of the V1 tube socket. I ran a ground wire from the input jack shields to the same point on the eyelet board where the cathode resistor (Rk) and cathode resistor bypass capacitor (Ck) were terminated and then ran a lead to the star-ground terminal board. I used a similar tactic for V1B, with the 470k grid stopper mounted directly to pin #7 and the associated signal returns for that stage terminating in what is designated as ground point #2 on the layout drawing. (Note: it has been mentioned that using a two-lug terminal strip right next to the tube socket allows you to replace the resistors as needed to adjust the gain and response, and also offers a convenient ground for the shielded cable.) Ground point #3 was used for V2 (the dc-coupled pair w/ cathode follower) and the signal return from the tone stack. Ground point #4 was used for the bias supply and bias pot and ground point #5 was used for the PT CT/initial filter cap. (Note: all 5 ground points run to the 5 lug terminal strip, with all 5 lugs jumpered together and a single lead run to the chassis.) By following this grounding technique the amp has been remarkably quiet.

## **Tracing the Audio Signal**

We will now trace the audio signal through the circuit. Starting with the input from the guitar, the jacks are wired up in a Hi/Lo arrangement, with the 33k grid stopper resistor mounted directly on the tube socket pin to reduce hum and noise. The circuitry at the two jacks is courtesy of Bruce Collins and allows for separate high gain and low gain inputs by selecting different values of the grid load resistor. I added in a further refinement here. Here's the background: I hardly ever use the low gain inputs on any of my amps since they seem to load down a guitar signal a lot. So that jack is usually just wasting space on my amps. Then again there is another complaint I have: if I have the amp controls set perfectly for my strat and then plug in my LP, I have start all over and adjust everything to get the same playing volume level and response. Solution: why not

design the #2 jack so that with a typical vintage-style LP plugged in you get the same volume and response as a vintage-style strat plugged into the #1 jack? The value I ended up using for my own guitars is a 120k resistor mounted between the hot and switch terminals of the #2 jack instead of the 68k resistor on the original design from Bruce. However, you may wish to experiment to see what value works best for your own guitars (you probably don't want to go much lower than 100k for a vintage style PAF). Incidentally, the #1 jack has a 1M grid load resistance, which is the same as on the traditional Fender input circuit. You may also try different values instead of the 33k resistor on the grid pin of the tube socket; Mike Soldano uses a 56k resistor on his Atomic 16 amp and H. Alexander Dumble uses a 22k resistor on many of his amps.

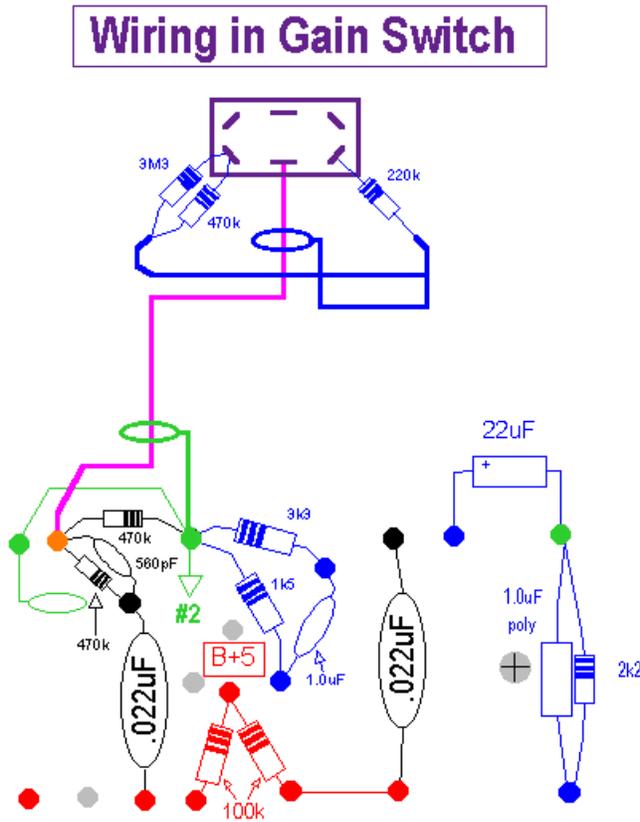
Proceeding to the first stage, there is a 100k plate resistor ( $R_p$ ) and a 1k8 cathode resistor ( $R_k$ ). The stock bassman "Bright" switch is used to add a 5uF/50v electrolytic cap in parallel to the 1.0uF/100v poly cap mounted on the eyelet board as the cathode resistor bypass cap ( $C_k$ ). To reduce switching noises, a 100k resistor is mounted across the switching terminals which bleeds off any charge which might build up on the 5uF cap. The  $C_k$  cap in conjunction with the  $R_k$  resistor creates a high-pass filter, the tuning of which is determined by their values. With the 5uF  $C_k$  cap added, the frequency of the high-pass filter is very low which allows most of the guitar frequencies to pass through. With only the 1.0uF cap on the board as  $C_k$ , the shelving frequency is around 1khz for a more midrangy sound. A 0.68uF cap could be used instead of the 1.0uF cap for an even higher shelving frequency for the high-pass filter; similarly a 2.2uF cap could be used for a lower shelving frequency. (Note: adding a small poly cap in parallel with a typical e-cap is supposed to smooth out the response of the e-cap so I use that trick in most of my amps.)

The audio signal then passes through a 0.022uF coupling capacitor and a 1M series resistor enroute to the modified 1MA Pre-Gain (or Drive) control. To keep noises picked up by the shielded cable to a minimum, I have the 1M series resistor mounted on the cw ("hot") terminal of the volume pot. The audio taper of the 1M pot has been modified to allow for a wider range of medium gain sounds by adding a 1M resistor from the wiper to the ccw ("ground") terminal. Before adding in the 1M resistor the medium range "blues" tones were limited to the settings between 2 and 4, with anything higher than that falling under the category of heavy distortion. Since there is little subtlety in the heavily distorted tones, roughly half of the range of the pot was wasted before adding in the 1M resistor to create what I call the "super audio" taper, with the medium gain blues tones spread out between 2 and 7 on the control. The 1M resistor also reduces the net resistance of the Pre-Gain pot to 500k (which is the value used by Dennis Kager in the Pignose G40V). This pot also has a 22pF bright cap mounted between the cw terminal and the wiper, which results in more high frequencies for the lower gain settings (Clean and Blues). There is a 100k series resistor after the wiper of the Pre-Gain control, mounted right on pin #7 of V1 to keep noises down.

[Note: Adding the 1M resistor from the wiper to the CCW terminal of the pot does change the impedance seen by the preceding change as the control is adjusted. In reworking the circuit recently I replaced the modified 1M pot with a standard 500k audio taper pot with a 39pF silver mica bright cap. 03-24-00]

We are now up to the second stage which uses a 100k plate resistor and a 1.5k cathode resistor. On the Pignose G40V, a 10k cathode resistor was used, bypassed with a 0.047uF poly cap (which acted much like a Bright switch on a BF Fender amp). Dennis Kager presumably was following one theory of modern guitar amp design by boosting the high frequencies of the signal going through the high-gain preamp stages, and then cutting them back to a more usable level by inserting a 0.001uF cap to ground right after the tone stack. One advantage of that design is a reduction of high frequency noise created in the preamp (not unlike dBX noise reduction for analog tape). However, I felt that the 0.047uF cap resulted in a "glassy" sound for the lower gain sounds so I

replaced that Ck cap with a 1.0uF poly cap. When I did that the gain and distortion of the preamp was boosted to an unacceptable level so I then added a 3.3k resistor to the normally grounded end of the 1.0uF Ck cap to reduce the Ck gain from ~6dB to ~3dB. With the signal going through the preamp lacking the excessive highs produced by the original 0.047uF Ck cap, I lowered the value of the cap to ground after the tone stack from .001uF to 750pF. (BTW, RJ had used a 390pF cap instead, but it should be noted that his main guitar is a LP while mine is a strat.)



**Figure 3: Wiring up the gain switch**

After leaving the second stage and passing through another 0.022uF coupling cap the audio signal now goes through an RC contour network of a 470k resistor in parallel with a 560pF mica cap, which boosts the high frequencies a bit. We now reach one of the more critical components of the preamp circuit which is the grid load resistor for the third stage. This resistor also acts a voltage divider in conjunction with the 470k resistor of the RC contour network to reduce the level of the signal going into the third stage. I had originally tried the G40V value of 470k here, producing a very distorted sound at the higher settings of the Pre-

Gain controls, which I dubbed the "Crunch Monster" version of this amp design. I then tried using a 220k resistor instead, which produced lower gain sounds more appropriate for the blues, and I called that version the "Blues Master" variation. Even with that value I was not getting a very wide range of clean sounds so I tried reducing the value of that resistor even further to 150k, which helped a lot. I liked all three values so I decided to wire up a center-off DPDT switch to select between those 3 values for the grid load resistor. I mounted the 470k resistor ("Crunch") on the eyelet board and then added on the switch (in parallel) a 470k and a 3.3M resistor (also in parallel) for a net value of approximately 220k for the "Blues" setting. For the "Clean" setting I added a 220k resistor in parallel with the 470k resistor on the eyelet board for a net value of approximately 150k. The drawing to the left, Figure 3, shows how to wire the switch up.

[Note: in a recent reworking of this amp I removed all of the crap between V1B and V2A and soldered in two 500k trimmer pots as variable resistors. The first trimmer was wired in series after the V1B coupling cap and the second was wired to ground before the grid to V2A. The series trimmer adjusts the high frequency content of the signal in conjunction with the coupling cap for V1B, while the trimmer to ground basically establishes the overall level of the signal going into the V2A grid, with a smaller effect on the low frequency content of the signal. Using an EI 12AX7 for V1 and a Sovtek 12AX7WB for V2, the values I settled on were 130k as the series resistor and 120k as the grid load resistor. I also replaced the 0.022uF coupling cap with a 0.01uF cap for a clearer sound. One observation here is that by simplifying the circuitry between V1B and V2A the filtering effect is stronger for louder overdriven signals, but fairly transparent for cleaner signals with a lower voltage. In removing the 560pF cap and 470k series resistor from the earlier designs, the signal from the tone stack was no longer overly bright so I was able to remove the 500-750pF cap to ground from the wiper of the treble pot. 03-25-00]

The audio signal has now reached V2, which is the DC-coupled pair [with cathode follower]. I have used the traditional 5F6A values here with an 820 ohm Rk resistor and a 100k plate resistor on the first half, and a 100k Rk resistor and no plate resistor on the second half (which is the cathode follower). Take a look at the V2 tube socket in the layout drawing for wiring up a dc-coupled pair using a single resistor.

As the signal passes from the cathode of V2B, it is first optionally run through a 3.3uF/250v poly cap enroute to the tone stack. Peavey uses this trick on their Classic 30 and 50 amps to reduce the raw dc voltage going to the tone caps, but with the 0.047uF value that they use there is some roll-off of the lower frequencies (which may be desirable in some cases). While I used a 3.3uF cap for a very flat frequency response you could try a smaller value, such as 2.2uF or 1.0uF or even 0.1uF, but be sure that the cap is rated for at least 200 volts because there is over 160vdc at the cathode of V2B.



750pF although you could also try the 390pF value recommended by RJ. [Note: as noted above I removed this cap altogether when I revised the interstage circuitry between V1B and V2A. 03-25-00] Other "tweaks" to the basic Pignose circuit involve the Master Volume control. The Pignose then runs the signal through through a 510k series resistor enroute to the 500kA mv pot. I used a 470k resistor in series with a 1MA pot, but added in a "Half-Power" switch which shunts half of the signal going to the MV pot to ground through a 470k resistor (see Figure 4, above). This switch affects the tone as well as the strength of the signal going to the MV control; the 750pF cap to ground seems to have a more pronounced effect on the tone in the half power mode. While not as critical as the gain switch described earlier the half-power switch does give you more options from this amp design. One addition to the G40V circuit is the 100k resistor between the wiper of the MV and the 0.022uF coupling cap going into the PI; this resistor is recommend in Kevin O'Connor's books to allow for better bass response at the lower settings.

In the output section, RJ recommended the sound and response of a 56k resistor in the negative feedback loop and I've been happy with that value. The Presence control uses a 25kB pot bypassed with a 4.7k resistor to ground, and uses the standard 0.1uF cap. I also replaced the 0.022uF coupling caps going to the output tubes with 0.033uF Type 418P's and added a 47pF cap between the outputs of those caps to smooth out the signal a bit. For slightly more bass response you could use 0.047uF caps; for slightly less you could use 0.022uF caps.

### **Other notes:**

After this article was originally written I added in the "Smooth" switch on the second stage to introduce a local feedback loop between the plate and the grid. There is a 0.047uF/600v cap connected to the plate and that is routed to the grid through a 22M or 32M resistor. The third position on the center-off SPDT full-sized toggle switch bypasses this loop altogether for the stock sound. I mounted the switch near the tube socket so that the cap and 22M resistor run directly from the socket pins to the switch. The response of the local feedback loop is interesting because the rather large sized cap creates an RC timing circuit with the 22M or 32M resistor; until the cap charges up the filter effect is reduced so you get the sharp sound of the initial pick attack but the sound is smoothed out as you sustain a note. At least that has been my impression of the circuit, which I have added to many of my amps. Along with the "Smooth" switch I added a 270pF cap between the plate and cathode of the third stage to smooth out the sound a little more. (Note: both of these changes are indicated on the schematic but not the layout drawing.)

## **In Conclusion**

This amp project has been a lot of fun and the results have been some really nice blues guitar sounds. The amp design does not include modern features like channel switching but by different settings of the switches and controls you can get a lot of different tones ranging from Clean to Dirty Blues to Downright Crunchy.

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(Revised 12/31/01)

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### **Other Hot Rod Tweed (and related) files:**

**Schematic: Hot Rod Tweed [current design]**

[http://www.blueguitar.org/hrt\\_sch1.pdf](http://www.blueguitar.org/hrt_sch1.pdf)

**Layout Drawings: Hot Rod Tweed [current design]**

[http://www.blueguitar.org/hrt\\_lay1.pdf](http://www.blueguitar.org/hrt_lay1.pdf)

**Schematic: Hot Rod Tweed [earlier design]**

[http://www.blueguitar.org/hrt\\_bm\\_s.pdf](http://www.blueguitar.org/hrt_bm_s.pdf)

**Layout Drawings: Hot Rod Tweed [earlier design]**

[http://www.blueguitar.org/hrt\\_bm\\_1.pdf](http://www.blueguitar.org/hrt_bm_1.pdf)

[http://www.blueguitar.org/hrt\\_bml2.pdf](http://www.blueguitar.org/hrt_bml2.pdf)

**Schematic: Pignose G40V:**

[http://www.blueguitar.org/g40\\_full.gif](http://www.blueguitar.org/g40_full.gif)

**Schematic: Soldano Atomic 16:**

<http://www.blueguitar.org/atom16.gif>

**Schematics: ProManiac project:**

[http://www.blueguitar.org/pro\\_man1.pdf](http://www.blueguitar.org/pro_man1.pdf)

[http://www.blueguitar.org/pro\\_man2.pdf](http://www.blueguitar.org/pro_man2.pdf)

[http://www.blueguitar.org/pro\\_man9.pdf](http://www.blueguitar.org/pro_man9.pdf)