

The Blue Guitar

Electar Tube 30: Conversion to Blues Express

Introduction

Musicyo.com has been selling these 10" combo amps for \$129 and they make a great platform for experimenting with EL84 amp designs. I had ordered one with the idea of rewiring it as a Matchless Spitfire clone but with all of the interest in the Trainwreck Express amps built by Ken Fischer I decided instead to try building something along those lines.

The Electar Tube 30 uses two 12AX7 tubes and two cathode-biased EL84's so I figured that I would limit myself to that tube configuration. With the Express preamp having 3 gain stages, that left only one stage for the driver/PI so I used a cathodyne (AKA split load) phase inverter instead of the long-tailed pair used in the "real" Express amps. (If I was to build another Express-based amp on an Electar Tube 30 chassis I would probably add in the 5th tube socket so that I would have the extra stage required for a long-tailed pair; that would require that the design presented in this article be revoiced.)

This project was both fun and educational, and I learned a lot about EL84 power amp designs, cathodyne drivers, and the basic Trainwreck Express preamp. [Note: although originally called the Express "Lite", this amp has since been dubbed the **BLUES EXPRESS**.]

Background

There have been two different versions of the Express design floating around the Internet and they can be downloaded at the end of this article (wreckxpr.pdf). **VERSION A1** uses a 500pF treble cap, a 250k treble pot and a .002uF/150k RC network between the 2nd and 3rd stages. **VERSION A2** uses a 50pF treble cap, a 1M treble pot and a .001uF/56k RC network between those stages. I experimented with both and decided to use **VERSION A2** because its lighter/brighter tone seemed to be more appropriate with the small 10" E30 cabinet. The resulting sound is a killer blues amp; at the lower gain settings the sound really sparkles and when you crank it up you can get the gnarly sound of a vintage AC30. I suspect that you would want to use a long-tailed pair PI if you were to build an amp based on the **VERSION A1** drawings, which sounds more like a Plexi.

When I first wired up the **VERSION A2** preamp to a cathodyne PI without NFB, the results were very wild and out of control. It wasn't until I tried wiring up the EL84's as quasi-triodes that I was really knocked out by the sounds. Unfortunately it was pointed

out to me that I was running the EL84's way too hot (16 watts idle for a tube that is rated at 12 watts); wiring up the EL84's as triodes evidently increased the current roughly 25%. Increasing the value of the cathode resistor from 130 ohms to first 150 and then 180 ohms lowered the bias current a bit, but the sound and response was just not the same. So I removed the pentode/triode switch and wired up the EL84's strictly as pentodes.

Incidentally, the stock Electar 30 PT will produce a B+ of 392vdc through a full wave bridge rectifier; many people recommend running EL84's with a B+ of 338vdc to 356vdc. To bring the voltages down to these levels I wired up five 10v/5watt zener diodes between the negative terminal of the FWB and chassis ground. As I liked both of these voltages, I wired up a front panel switch to toggle between 356vdc (3 zeners) and 338vdc (all 5 zeners). BTW this switch is absolutely silent with no pops or clicks when you toggle it back and forth. And because it is dealing with low voltages close to ground potential you don't have the problems of running high voltages to a top-panel switch.

After dispensing with the quasi-triode mode, I still had my amp wired up for cathode bias using the 130 ohm 5 watt resistor. At the recommendation of a friend who had built a similar amp (my inspiration for this project) I decided to add in a fixed bias mode and wired up a bias supply using the unused 20v windings from the PT. In fixed bias mode the amp was initially much too harsh so I went through the preamp and added several fine-tuning tweaks to smooth out the sound. Adding a 100 grid stopper on the 2nd stage and bypassing the 2nd and 3rd stage plate resistors with 250pF mica caps did much to smooth out the sound and stabilize the circuit a bit. But the "icing on the cake", so to speak, is the **INPUT TRIM** control that I added ahead of the first stage.

Backtracking a bit, I had planned on using the 5th control as a **MASTER VOLUME**. But having been dissatisfied with the results of two different MV circuits in this amp, I decided to forget about using a MV here. (Most of my amp projects do use MV's, but with this particular design, the distortion and saturation from the output stage is such an integral part of the cranked sound that a MV does not do it justice.) So I had space for an extra pot right next to the input jack and decided to wire it up as a variable grid load for the first stage (with just two short leads to the input jack). After first trying a 2M linear pot I ended up using a 1M audio pot with a 22k resistor in the ccw leg to ground. So with the **INPUT TRIM** pot set fully clockwise the grid load for the first stage is 1022K; with the control set fully counter-clockwise the grid load is 22k.

I rarely plug my guitar into the #2 low gain jack of any of my stock amps— the sound is too dull and muted for my tastes! So I was very surprised to find myself setting the **INPUT TRIM** control to **3** or **4** practically all of the time; that works out very close to the 68k grid load of the low gain jack on a BF/SF amp. What is interesting is that this control does not affect the overall gain as much as it affects the overall high frequency content (at least unless you turn it much below **2**). Turning the control from **3** to **10** does

not make the amp much louder, but it does make the tone much brighter and harsher. It has proved to be very handy in fine-tuning the sound from different guitars and pickups; if the sound is a bit muddy, then raise the control from **4** to **5**. If the sound is a bit too bright then lower it from **4** to **3**. I consider this control to be a very lucky "accident" since I had never planned on including such a control; the only reason I tried it at all was because I had space for an extra control and the MV designs I had tried did not work very well. FWIW several people who had built Express clones mentioned that their amps were too bright or harsh. Adding in such an **INPUT TRIM** control (or at least lowering the grid load resistance on the input jack) might be a better way to smooth out the sound from such a clone rather than doing something more drastic like bypassing preamp plate resistors with large caps or dumping high frequencies to ground through a large cap.

One final note before I move on to the details of my Blues Express amp: it was suggested to me that EL84's are "happiest" if you keep the ac signal on their grids below 17vac. The rule of thumb mentioned was to try to keep the ac voltages on the grids at approximately 125% of the typical bias voltage (~12vdc for an EL84) which works out to roughly 15vac. I have passed this tip on to several amp builders who have noticed a definite threshold around 17vac. With my own amp, I found that the most transparent way to reduce the ac voltage on the grids was to replace the 220k bias/grid load resistors with 150k.

As drawn in the latest schematic, this amp works very well in both the cathode-biased and fixed-bias mode, and with the B+ set to 356vdc or 338vdc. One change that you are encouraged to make is to tap the bias supply off the Hi-vac secondary from the PT rather than use the separate 20v-0-20v windings; as you switch from 338vdc to 356vdc, the change in idle bias current would not be as drastic (with my amp it jumps from 26mA to 30mA). Although the fixed-bias mode was very harsh at first, after smoothing out the sound from the preamp, it is a definite "keeper"; the sound and response is much more dynamic compared to the cathode-biased mode and you can also get much more chime and clarity with the clean settings.

Details

Gutting the stock Electar Tube 30 can be a lot of fun! Just a few notes... The PT has 3 secondary windings; the red pair of wires is the high voltage, the yellow pair is the filament windings and the blue and black wires are the center tapped low voltage windings which run the ss circuitry. The OT primary has two red wires with a black wire as the center tap; the OT secondary leads are both brown. Since the Blues Express does not use NFB the polarity of the OT wires is not critical. [Note: my second E30 (built in 1998 instead of 1997) uses red and white leads for the OT secondary connection to the plates.]

The stock E30 chassis has the OT mounted on the opposite side from the PT, with very long leads going across the outside of the chassis inside a thick plastic tubing. I moved the OT from its original location and mounted it roughly halfway between the PT and the closer EL34 tube socket, but towards the baffle board edge of the chassis. I had some concerns about the OT mounted close to the PT but before screwing it down I tried moving it around while observing the noise level. My conclusion was that the long leads themselves contributed more to the noise level than anything else. Incidentally, with the OT moved from its original location, you can then add in a third preamp tube right where the OT had been. (That is not necessary for this project unless you decide to use a long-tailed pair for the PI).

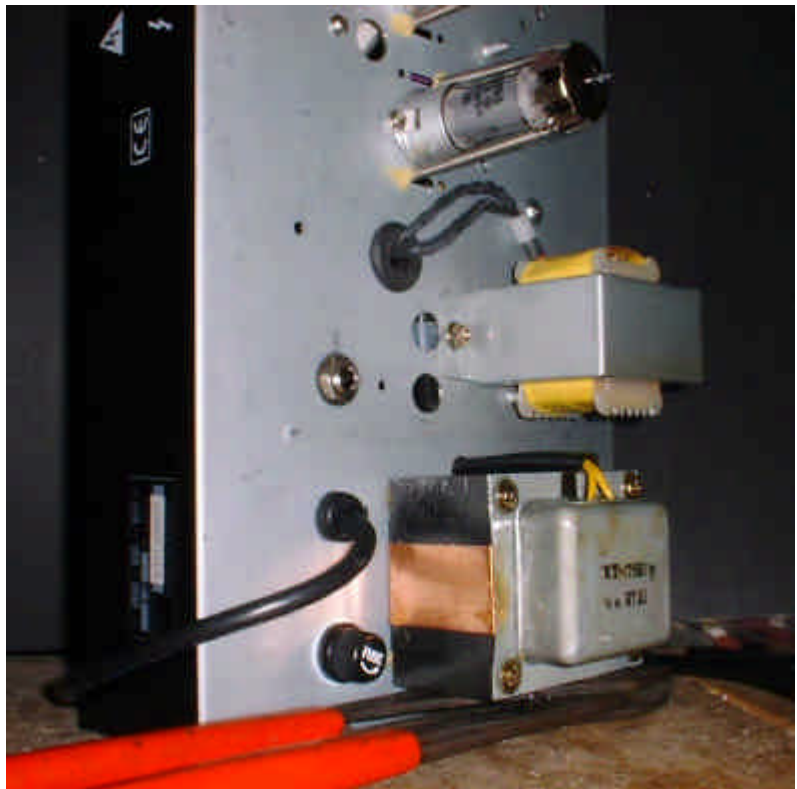


Figure 1. Relocated Output Transformer

The stock tube sockets are mounted on the main pcb so you will need to add chassis mount sockets. The two 12AX7's include the mounting base and shield which can be used to mount a ceramic or phenolic tube socket. For the EL84's I decided to keep the spring-type tube retainers and added in two ceramic sockets with mounting bases. Due to the high heat generated by the EL84's I'd recommend using a good quality ceramic socket for them.

Once the new tube sockets are mounted you can then design and fabricate the board for your amp circuit. I used a vulcanized fibreboard similar to what Fender used for their eyelet boards only it is grey in color. This material can be cut with tin snips; make two boards the same size; the second one will be used as an insulator. After drawing out the location of all of the eyelets I then drilled out all of the holes with a cordless drill and an 1/8" drill bit; you might try using a 7/64" drill bit so the eyelets will not keep falling off when you get ready to set them. I used an unpowered 8" drill press with a cross-vice and the staking kit from Mouser to set the eyelets. Incidentally, this staking kit seems to be missing a small stud to keep the eyelets in place as you set them; I found a drill bit that fit tightly inside the bushing from the kit and cut it to the proper length. With this setup you pull down on the drill press handle very slowly; if you pull

the handle too fast the eyelets will not set as well. It has been suggested that you use a hand punch instead of a drill to make the holes for the eyelets.

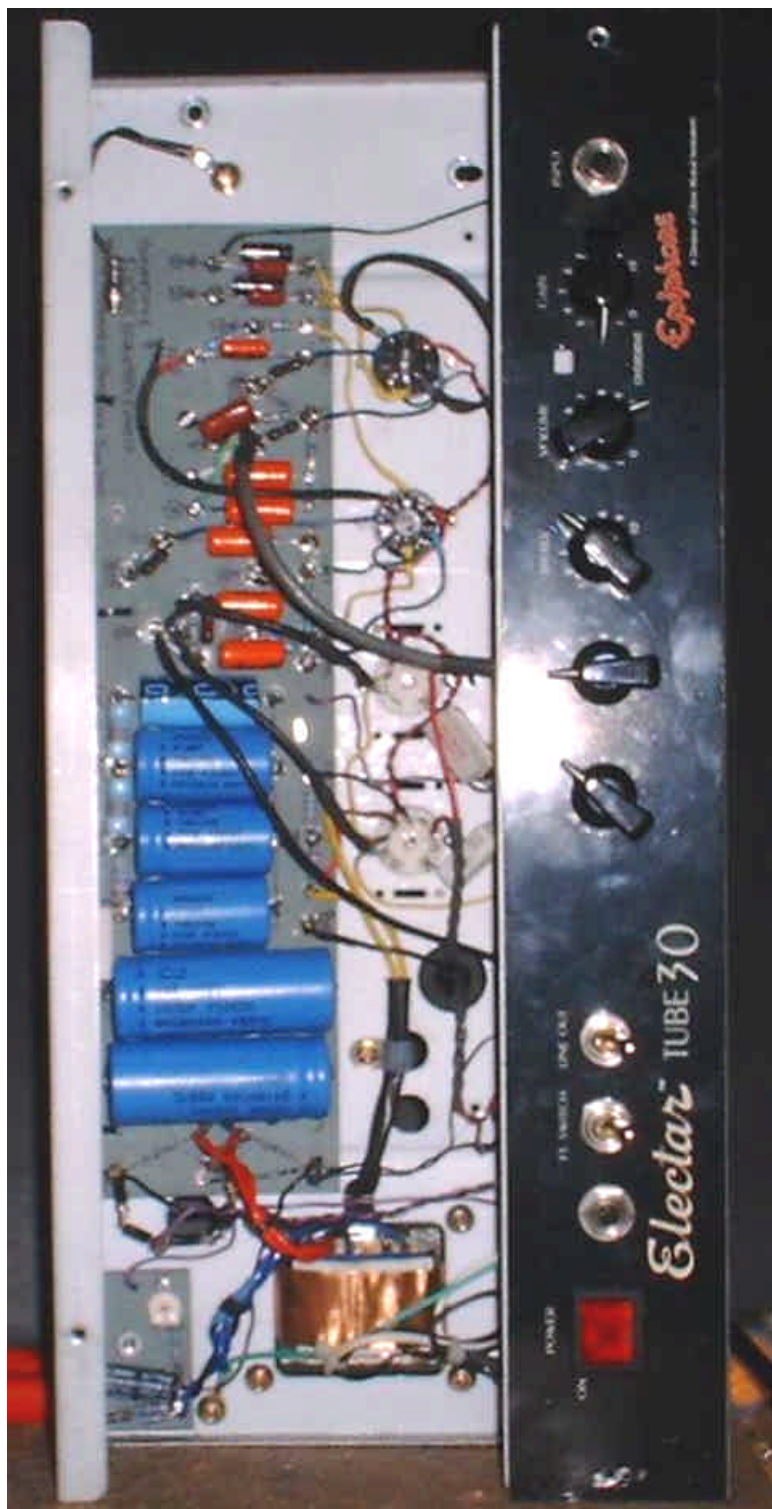


Figure 2: The amp chassis as of July 29, 2000

Here is a summary of the changes done in each of the major revisions of this project:

Version A5a

At this point the preamp was essentially identical to the Version A2 Express. Wiring the EL84's as quasi-triodes smoothed out the sound of the amp (which would have otherwise been much too rough.)

Version A5b

This version included most of the major changes from the original design, like the revised power supply, the input trim control, the 100k grid stopper on the 2nd stage, the 250pF mica caps across the 2nd and 3rd stage plate resistors, and the fixed/cathode bias switch. I also used the 100pF mica cap across the outputs from the PI, right before the coupling caps. One change that I abandoned later was the 1M resistor to ground and 100k grid stopper on the input to the PI. (I had added this to reduce the signal level which was creating ugly distortion in the EL84's.)

Version A5c

After removing the 1M resistor to ground and 100k PI grid stopper, I was looking for alternate methods of reducing the signal level to the EL84 grids. The crossline 150k/1200pF RC network in the output section was suggested by someone who had seen such a circuit in one of the more famous boutique amps. The RC network did reduce the signal level going to the EL84 grids, and also smoothed out the frequency response. While it sounded pretty good with single coil pickups, the overall effect was a bit muddy for humbuckers (which would still overload the EL84's).

I also revised the input trim control by adding a 22k resistor in series with the ground connection so that it can be turned all of the way down with muting the guitar signal.

Version A5d

I removed the 150k/1200pF RC network and replaced the 220k grid load resistors for the EL84's with 150k resistors. I also added back in the 100pF mica cap across the outputs from the PI (which had been removed in **VERSION A5C**). At this point the amp sounded really good with single coil pickups, but the EL84's would be slammed pretty hard if I plugged in a guitar with humbuckers.

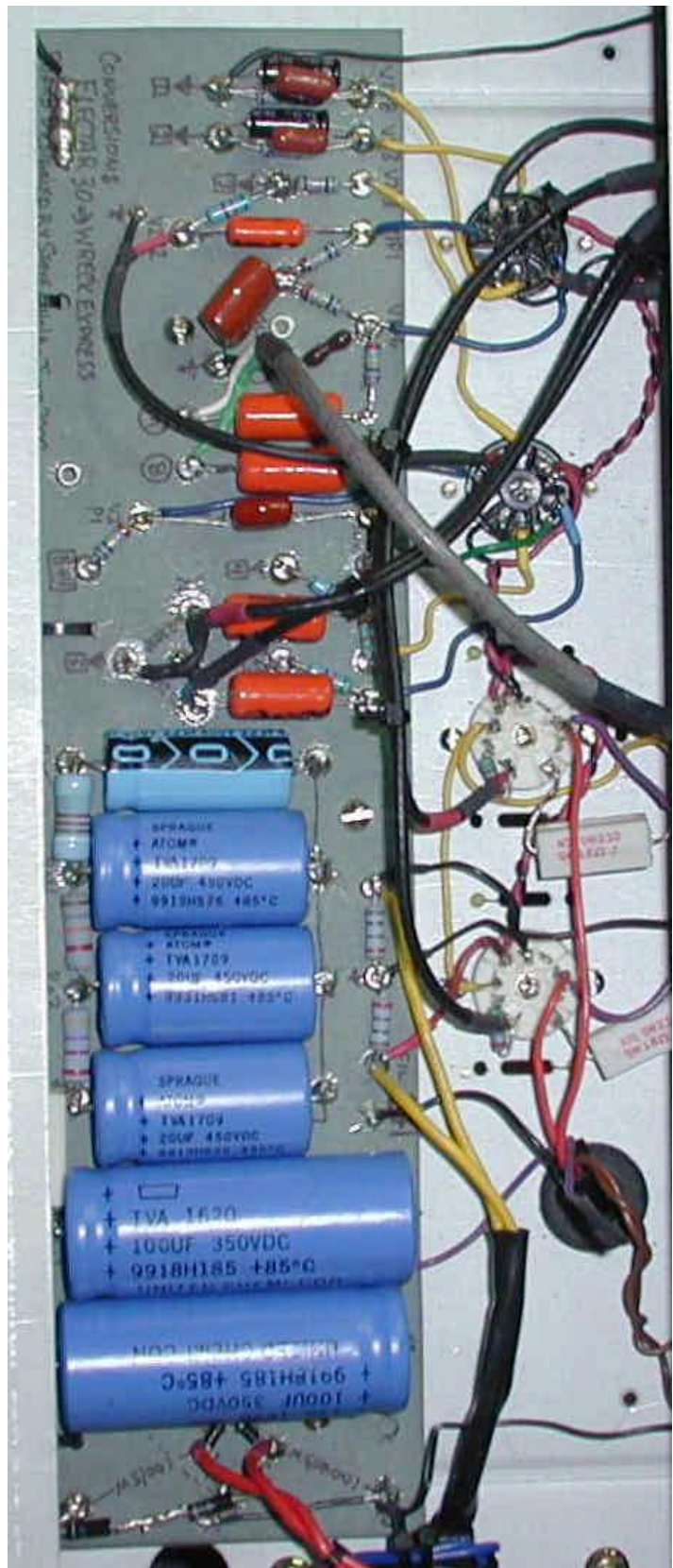


Figure 3: Earlier design with grid-load MV

Version A5e/f/g

I was measuring peaks of 30vac on the grids of the EL84's when using humbuckers, so I decided to get radical and try a zener limiting circuit. Although "diode clipping" has been used as a quick and cheap way to produce distortion in a preamp circuit, my idea was to have it limit the signal going to the EL84 grids as transparently as possible. After trying a few different zeners and resistors, I ended up using 17v 1 watt zeners back-to-back, forward and reverse, with a 100k resistor between each pair. I also experimented with adding caps across the 100k resistor and settled on 100pF mica caps because they added a nice LPF effect to the zener limiter. It sounds fairly natural with the peaks being muted a bit and the sound brightening up right after the initial attack. **VERSION A5E** shows the zeners hard-wired in, while **VERSION A5F** uses a center-off DPDT toggle switch to select between no zeners, zeners with the caps, and zeners without the caps. (**VERSION A5G** adds two 27 resistors to make the effect more subtle.)



Figure 4: The top of the eyelet board as of June 10, 2000 (Revision 2)

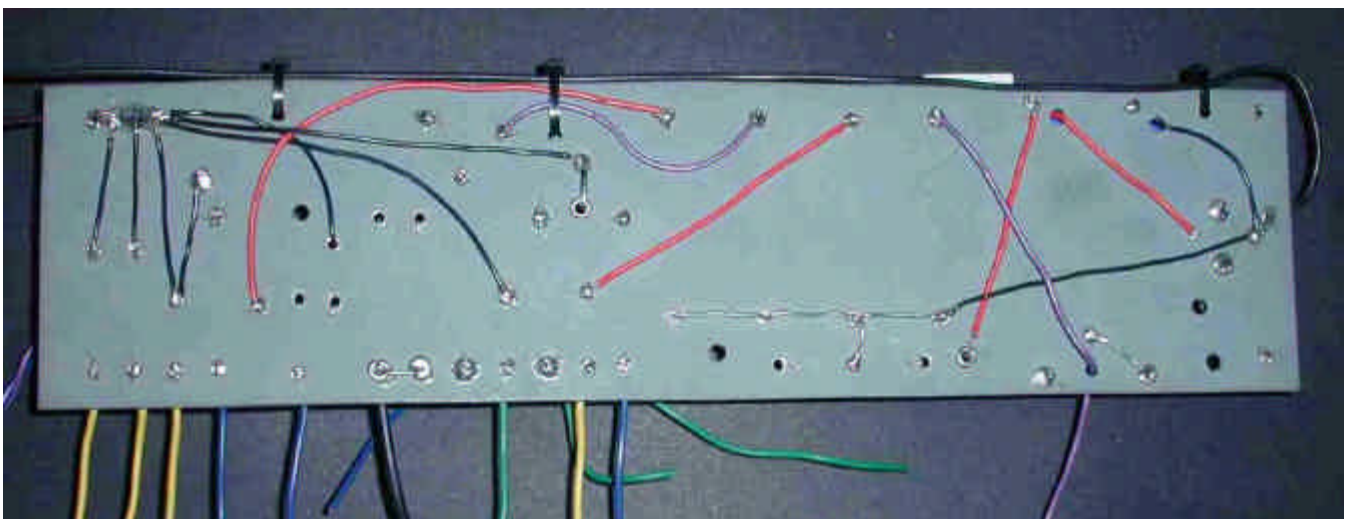


Figure 5: The bottom of the eyelet board as of June 10, 2000 (Revision 2)

Final notes

This amp project has been a lot of fun. Although the preamp is based on designs from Ken Fischer, I'm sure that it sounds nothing like a real Trainwreck. But it does have a clear, chimey sound at low gain settings and a nice gnarly grind when you crank it up. Working with EL84's can be very touchy since too high of a signal on their grids can make them crap out, especially when the output section doesn't use negative feedback.

In dealing with the problems mentioned in this article, I came up with some solutions that may be applicable in other amps. The Input Trim control, which sets the grid load resistance of the guitar signal from 22k to 1022k, acts much like a presence control in adjusting the high frequency content of the overall sound. (I do not believe that it would be as effective on a lower gain circuit such as a BF/SF Fender amp.)

As for the zener limiter circuit used in the final version of this amp, I'd like to thank all of the techs over at [AMPAGE](#) for their contributions to the design.

Good luck!

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

Trainwreck Express and Blues Express files:

Trainwreck Express schematics

<http://www.blueguitar.org/wreckxpr.pdf>

Blues Express schematics

<http://www.blueguitar.org/blxprsch.pdf>

Blues Express pictures and drawings

<http://www.blueguitar.org/e30xprss.zip>

Blues Express sound samples

<http://www.blueguitar.org/bluesxpr.mp3>

Spec sheets on vulcanized fibreboard

<http://www.blueguitar.org/fishpapr.zip>