MIG-L Tube Preamp for Leslie Organ Speakers

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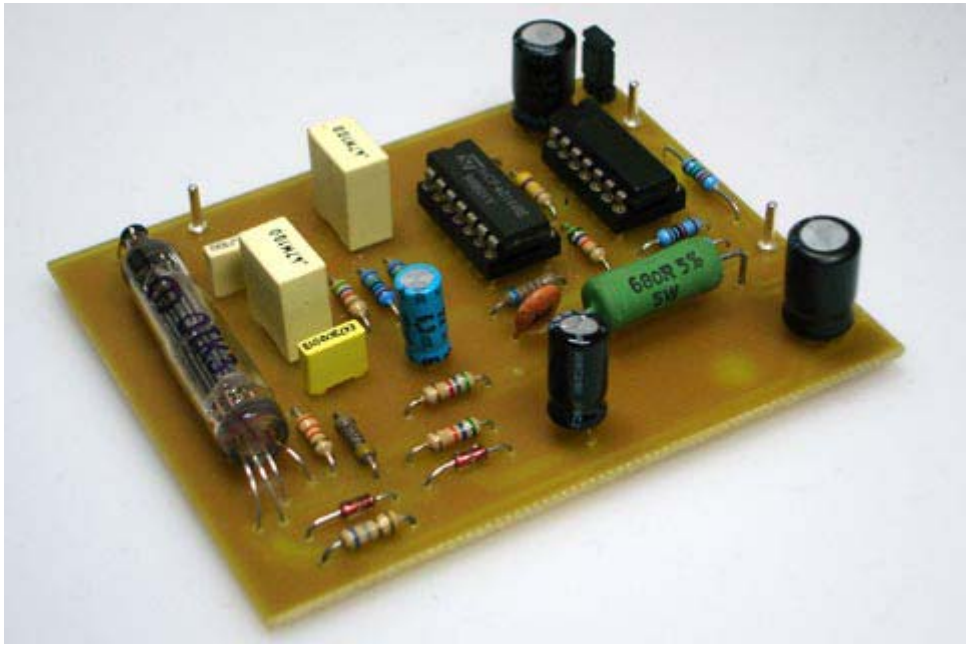
Want that sweet tube sound for your transistorized organ speaker? Install a real tube amplifier in your solid-state Leslie!



The MIG-L Leslie Tube Overdrive works with a real miniature tube. The MIG-LR even has a remote control input for switching between tube limiter and bypass mode.

But wait... don't those tubes require a letal high anode voltage and a big transformer for heating? True for most, but not for mine. I found some miniature tubes that work perfectly with the Leslie's 28V power supply, and they need only a few milliamps for heating.

Let the Russians do the work!

Remember russian pilot Victor Belenko who defected to Japan in his **MIG-25 Foxbat fighter** back in 1976? U.S. military officials were stunned when they examined what they thought was the most advanced fighter jet in the world. The Russians, it turned out, were still using **old-fashioned vacuum tubes** instead of state-of-the-art transistors and computer chips. For all their vaunted military reputation, the Soviets seemed incredibly backward. Eventually though, it dawned on the Americans that the Soviets had figured out the old tubes would be less vulnerable to the electro-magnetic pulse of a nuclear blast than some newer components. The MIG-25 fighter was equipped with thousands of miniature vacuum tubes, and most of them are still available, since the russians literally made millions of them for military stock. Since they are military grade quality, chances are good that they outlive your Leslie.

What makes the "Tube Leslie Sound"?

The **122** is "the" Leslie to have. Equipped with big 6550 tubes, a mysthic glowing stabilizer and lots of iron, it adds the characteristic growl and distortion to your organ. Since 122 and 147 Leslies are pretty expensive nowadays, Hammond players wonder if they could achive the same sound from their solid-state Leslies (700, 800 and 900 series, in particular).

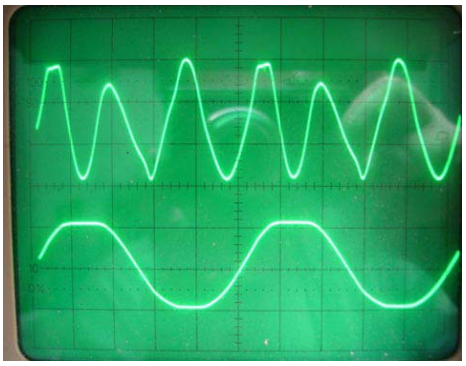
Before thinking about certain modifications of a transistorized Leslie, let's talk about some issues that contribute to the Leslie's sound. First, the **speakers, rotors and the cabinet** do most of the work. Also, the **Jensen V-21 treble driver** has a heavy rolloff from about 8 kHz up, so it smoothens distortion coming from the amp. I also think that the narrow louvers in the wooden cabinet contribute to the sound. In fact, the stage Leslies sound more bright than their wooden counterparts. So, if you own a genuine 770, you're on the right way.

The Tube Deal

Without driving it into distortion, differences between tube and transistor amplifiers are **subtile** - the audience won't hear it, if you don't tell. The 122 amp has some distortion in the **3% range** when putting out around 10 Watts and an **almost flat frequency response** from 30 Hz to 10 kHz (there is a slight rolloff for frequencies from 8 kHz up). However, there are differences in their output damping: Transistor amps do have very low **internal impedances** in the **Milliohms** range, so they control speakers very exactly. Tube amps may have internal impedances in the **2 Ohms range**, especially when overdriven (loss of negative feedback), so speakers connected to them tend to live their "own lifes". This emphasises the speaker's/driver's characteristics. BTW: We are NOT talking about speaker impedances here!

Emulating the relatively high internal impedance of a tube amplifier is pretty easy: Just put a 1.8 Ohm/11 Watt resistor (for 8 Ohm drivers) in one of the Jensen's speaker leads and a 1 Ohm/11 Watt resistor in one of the woofer's leads. That marginally cuts off the amp's power, but it makes the speaker act like connected to a tube amp. As the audiophools would say: "You will definitely hear a difference", not only from the lowered power output (loss is in the 5 Watt range). **Give it a try**, it won't cost you a fortune.

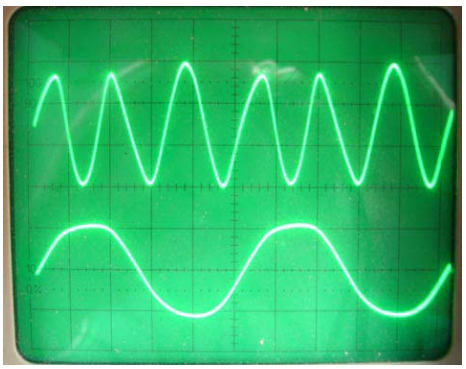
When it comes to an **overdrive condition**, differences are **way more big**. Solid state amps just cut anything above their margins, so a sine wave becomes a sharp clipped trapezoid shape. That sounds harsh and very unpleasant, because it adds lots of higher odd harmonics (those **kill your treble driver fast**). Overdriven **tube power amps** also clip signal shapes, but with a decent **rounded behavior** (see picture below), so higher odd harmonics are present at a way much lower level. To achive the distorted tube Leslie sound, you have to add a limiter that imitates the push-pull power stage exactly.



An overdriven Leslie 122 amp (this one equipped with new Electro-Harmonix 6550) produces a smooth round clipping above the amp's power margins (lower curve). The upper curve (done by a distortion analyzer) shows the distortion product. As you can see, most of the "overdrive condition" distortion is "k3" (three times the frequency of the 1 kHz test signal).

The Solution: MIG-L

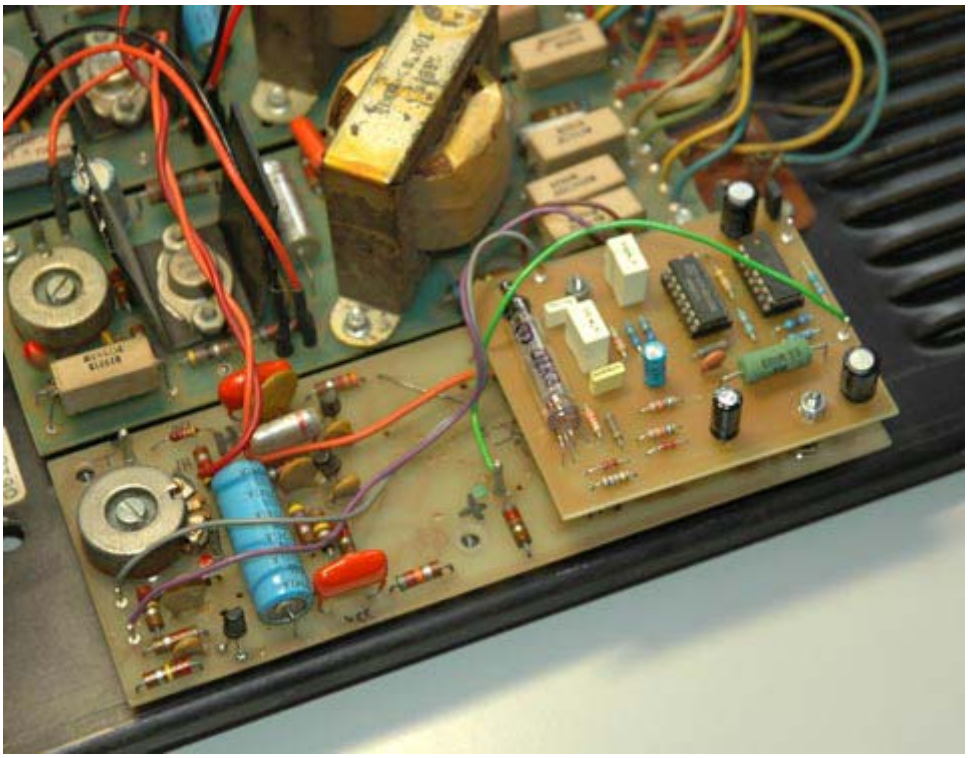
I've made up a little gadget that "tubifies" your transistorized Leslie. It works well in solid-state Leslies with an active crossover board as seen in the picture below. First, by putting a real miniature tube (russian 1SH18b) in the signal path that adds those (triode-like) pleasant soundig **even harmonics** (k2, k4), second, by adding an **overdrive stage** that works with integrated field effect transistors (FETs) instead of silicon diodes (as seen in many guitar stomp boxes) to add the **odd harmonics** (k3, k5) produced by saturated 6550s. FETs act much more like tubes than transistors, since they use the electrical "valve" principle.



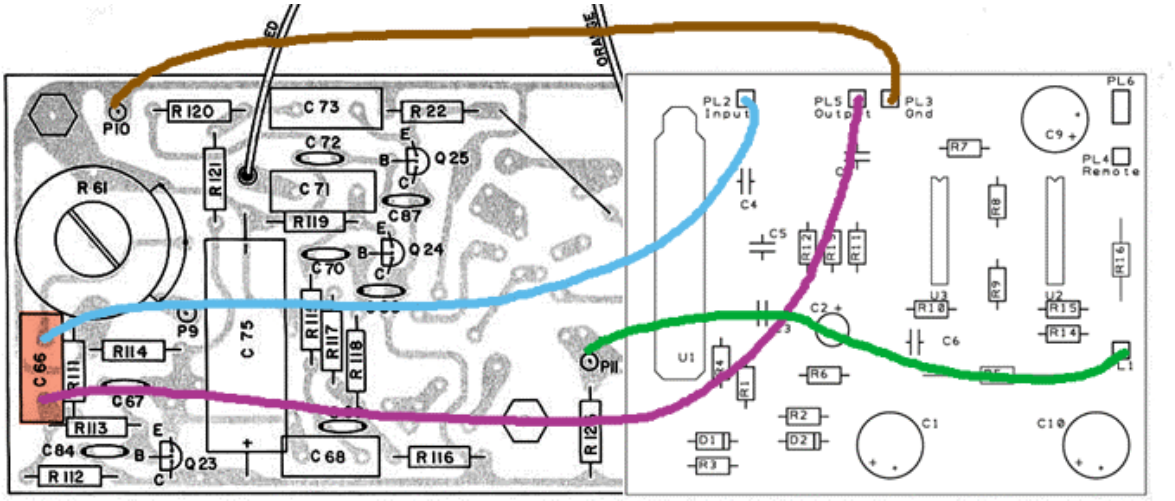
The MIG-L resembles the sound of an overdriven Leslie 122 amp perfectly. It produces a smooth clipping (lower curve) which is a little more rounded than the 122 amp's cut to emulate somewhat "used" tubes. As you can see, even the distortion product (upper curve) comes very close to the original. You can even modify the MIG-L to get a "new tubes" sound with a clipping exactly as pictured above, if you prefer.

Installation

The MIG-L has to be inserted in the Leslies's signal path right behind the input gain pot. It gets a +28V supply (green wire/plug) and ground (black wire/plug) from the **active crossover circuit board**. Remove lower backplane of your Leslie and note position of plugs. Remove plugs from power supply and speakers. Locate the active crossover board, it's the uppermost board above the two power amps. Remove four screws from active crossover board. Desolder capacitor C66 (next to Volume Control) and insert two wires instead (see picture below). These lead to MIG-L input and output pins, respectively. The grey wire next to the **Volume Control** pot leads to **MIG-L input**, the violet wire comes from **MIG-L output** pin and send the signal to the crossover. The green wire is +30V supply, solder to connector marked with green dot. Don't forget the ground pin (brown wire, barely visible) lead to Leslie ground (connector marked with black dot).



This is a MIG-LR affixed to a Leslie 760 amplifier panel. To the left you can see the Gain and Volume potentiometers. I have drilled them and glued a long M4 screw as an axle into the hole for easier access. The MIG-L board measures 80 x 65 mm; screw holes fit well above the crossover board so it can be mounted on top with two 6-32 UNC 1" screws and two 15 mm plastic spacers. Be careful not to short-circuit the MIG-L power plane with the screw/bolt.



Wiring is very easy (only four wires), but some soldering necessary. C66 (marked red) has to be removed before inserting and soldering of input/output wires into circuit board holes. Be careful not to short-circuit the MIG-L power plane with the screw/bolt.

(Sorry for the b/w reproduction; see www.keyboardpartner.de/hammond/pics/MIG-L-crossover.png for a color presentation.)

Adjustment

The **proper adjustment** is very important for a real tube Leslie sound. Clipping should solely occur in the MIG-L, and **by no way** in the transistor amps. As the most solid state Leslies come with a master **Volume Control** input potentiometer and two **Bass/Treble Gain** pots (for horn and rotor amps), it is possible to play an overdriven Leslie at very decent volume levels. When installed, lower leslie volume by decreasing the **Bass/Treble Gain** volume, then increase **Master Volume Control** until the MIG-L overdrive gives you a nice growl when organ volume pedal is floored. Then increase both bass/treble **Gain** volumes until loudness is as desired. If you own an oszilloscope, you may check when clipping occurs in the transistor amps and mark that setting as a maximum on the **Gain** pots.

As you can see in the picture above, I drilled the potentiometers and installed a long M4 screw as an axle to fit a 4mm knob on the outside. This makes adjustments very easy -- no fiddling with a screwdriver!

The MIG-L and LR are intended for use in a genuine Leslie speaker with transistor amplification; they need about **1 Vrms input** for full distortion. This is true for Leslies controlled by a **Combo Preamp** or an organ high-level output.

If you need more gain for some reason (organ volume too low), you may replace R2 (originally 56kOhm) on the MIG-L(R) board by 100kOhm. For even more volume, you may swap R1 and R2 values, so R1 becomes 56kOhm and R2 becomes 330kOhm. If output volume of MIG-L(R) is too high (true for non-Leslie or Leslie clone use), you may swap R9 and R10 values so the output voltage becomes attenuated before entering your amp.

“The” Sound

Organ players often want to reproduce the “Jimmy Smith” sound. This sound is a result of playing techniques, typical drawbar registrations and an decent overdrive that just kicks the percussion to distortion. Do not forget the mikrophone and studio issues; a miked leslie will sound very different dependant on the mikrophone position. Some people even forget that the typical “growl” will need certain left-hand and bass pedal work.

Try a 88820000 setting on right, percussion 2nd short, soft, vibrato off and raise the volume until the MIG-L begins to distort on the percussion decay. There should not be much distortion on decayed notes to achive the JS sound. Try 88882000 setting on right, percussion 3nd long, soft, vibrato C3 or V2, leslie slow. Distortion should occur on the percussion. Distortion and growl may be emphasised by holding a left-hand chord and a bass note on pedals.

Calamity Clones

If you have a Leslie clone, it will need some work to achive the smooth sound of a Jensen V-21 driver with it's phenolic diaphragm and characteristic frequency response. Leslie clones often use high-range drivers (tweeters) and a **1500 Hz crossover network**, while the Jensen works from about 700 Hz up (official crossover point at **800 Hz**). Typical tweeter drivers used by brands like Elka, Solton, Allsound, Echolette, Dynacord sound shrill and aggressive compared to the V-21, so think about replacing the crossover network and the tweeter by a mid-range PA horn driver like the **Monacor KU-516** when you own a non-Leslie Leslie. For two of my Leslie clones, I used old military surplus midrange PA drivers from a command

truck speaker. They are loud as hell and need hefty attenuation to match up with the woofer, but they come very close to the V-21's frequency response.Non-Leslie Use

In the **MIG-LRL** version for Leslie clones the amplification yields full distortion at **100 mVrms input**, so it can be used with line-input amplifiers often used on Leslie clones. You will need a +24 to +35V @ 50mA supply for the MIG-LRL. This voltage may be derived from the positive power amp supply rail. If power amp voltage exceeds 35V on idle, you will need a power resistor of 100…270 Ohms/4 Watts in the supply wire to achive a +30V supply for the MIG-LR (recommended voltage). The MIG-LR uses about 50mA, mostly for the tube heater, so you need about 270 Ohms for a +45V supply (Ohm's law).

Remote switching (MIG-LR only)

The MIG-LR version has a remote control input for switching between tube limiter and bypass mode (pin in upper right corner, see picture). Normally, a jumper is installed to switch **on** the overdrive effect. If you pull the jumper, you are in bypass mode (effect off). You have to connect the **remote input pin PL4** to ground now (via a footswitch, for example) when you want the overdrive to be on. To use this feature, pull the **jumper** installed, and connect a latching footswitch (like **Boss FS-5L**) to the remote pin (plug tip to pin, plug shield to ground). The pedal toggles between distortion and bypass mode.

Modifications

Changes to MIG-LRL version with 100 mVrms input/outpul volume setting:
R1 = 1k94
R2 = 220k
R9 = 47k
R10 = 3k9

Changes to MIG-L version without bypass remote input:
U3 omitted, replaced by jumper wire from pin 1 to 2. R11…R15 omitted.

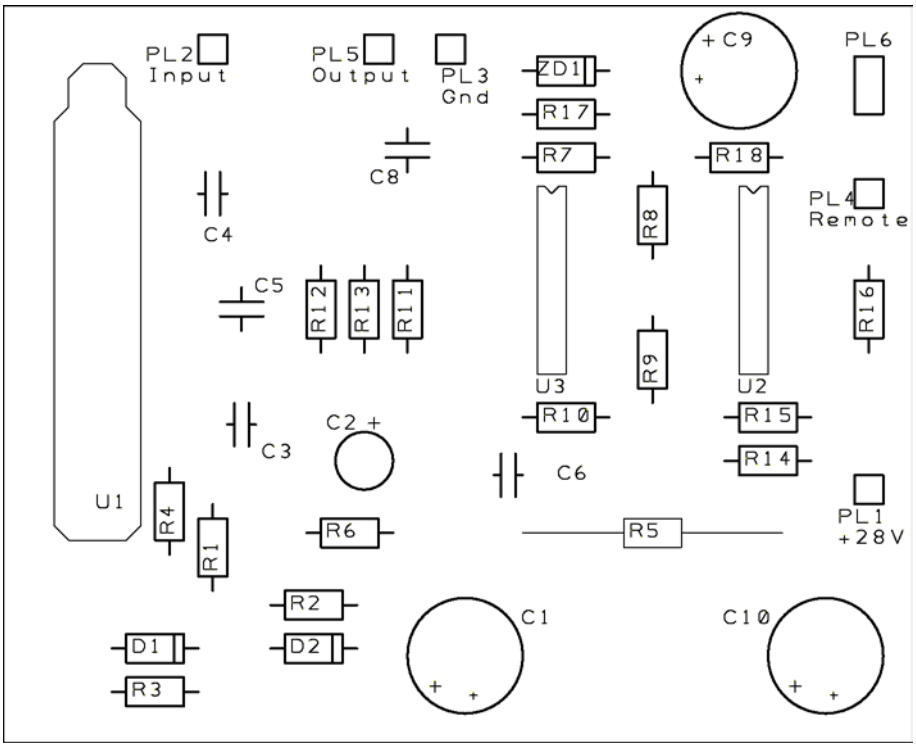
To achive a smoother "worn tubes" overdrive effect, remove Zener ZD1 5.1V and replace ba a 8.2V type. This modification gives a higher output level, so also change R9 to 27kOhms.

Some parts are selected to give the intended overdrive effect, especially the CMOS overdrive stage. Using other manufacturer ICs will give poor results.

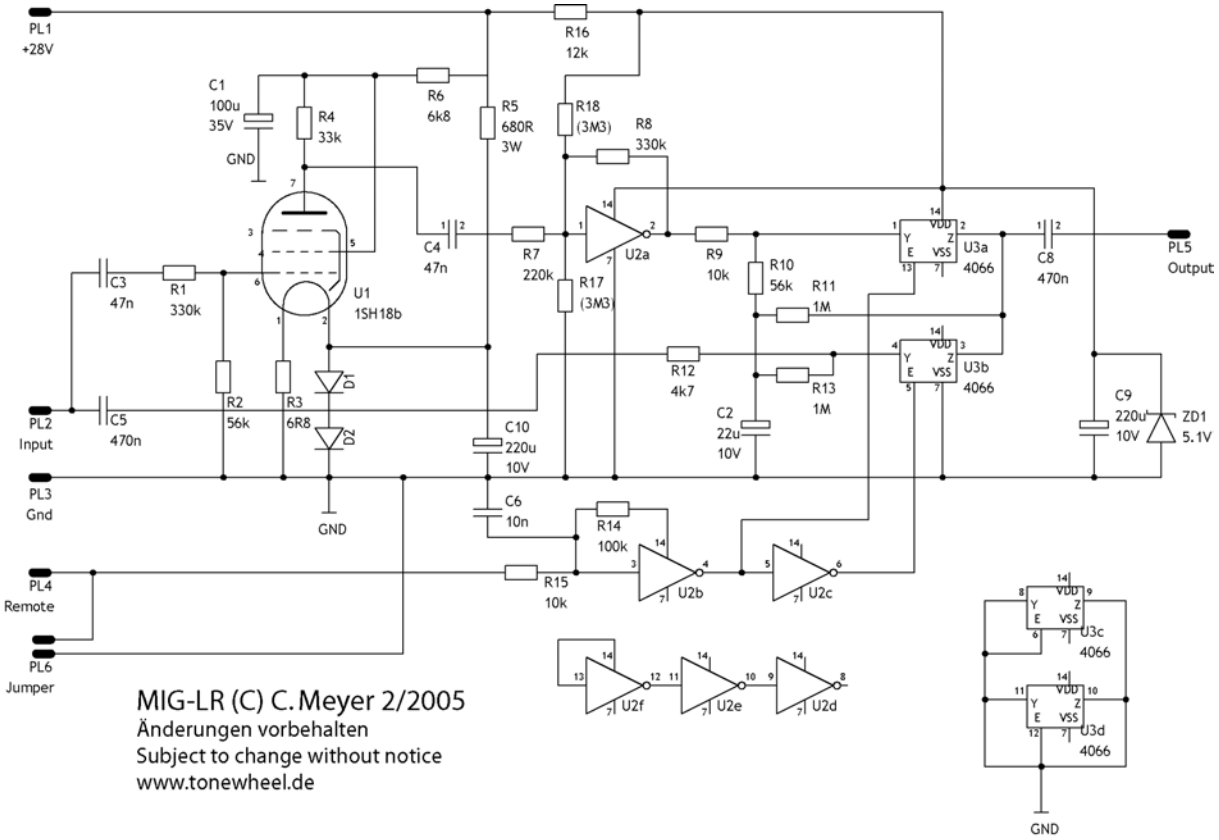
For support and complete modifying instructions, visit our webpage
www.tonewheel.de/hammond/

Important

Under rough use (vibrations due to transport or high volume levels) you should secure the tube with a thick bead of silicone sealant to the MIG-L circuit board. This also minimizes microphonic effects.



Board layout of MIG-L printed circuit board



Schematic Diagram of MIG-LR