CONVERTING AN EXISTING AMP CHASSIS FOR GUITAR USE

A work-in-progress to be added to later by Niels “Petco” Nielsen

The fastest way to get started goofing with amps is to convert an existing amp to guitar. This way you don't have to wire a chassis from scratch, which saves money and time. Much of the hard work has already been done- all you have to do is remove what's unnecessary and replace a few key parts. But what type of amp? And what conversion will it need? Here are some basic guidelines.

SELECTING A PROJECT- what to avoid, what to look for

What to pay? Anything that costs more than $20 is too expensive to be worthwhile. (Roberts-Akai stereo decks can be bought for $10 to $20, powered satellite speakers for the same, and big honking old parlor organs from the 1950’s can be had for nothing.) More money than this and you are better off building from scratch: remember that the thing you want to convert might not work at all even before you start converting it, and you might have to throw the whole thing into the trash or shell out $20 for a set of fresh tubes for it.

Some amps are easier to convert than others, but some are actually dangerous to use regardless of how easy they might be to convert and should be avoided unless you really know what you are doing. Let’s discuss these first.

You will encounter ***cheap, little tube amps that have NO power transformer.*** They use special tubes (with high voltage heater filaments) in series like an old christmas tree light string, so this type of amp needs no 6.3VAC supply for them. These tubes have names like 50C5 and 35W4, the first two numbers are the voltage drop across the filament. You string these tubes together until the voltage drops all add up to 120V and then you run the wall current straight into the tube string. If one filament burns out, all the other filaments go out.

They also have a high-voltage supply called a "voltage doubler" or "transformerless" supply which cleverly uses diodes and capacitors to take the 120VAC line and pump its filter caps up to 240V with it- without the use of a power transformer to step up the voltage. By eliminating the power transformer in this way, this makes for a very cheap circuit, BUT without a power transformer it GREATLY increases the risk of **lethal electrical shock** both when you are operating the amp AND when you are working on it.

Without going into too much detail, a transformerless power supply circuit will connect the hot side of the 120VAC power line to the chassis ground depending on which way you have stuck the power plug into the wall. This forces the amp designer to try and shield the user from electrocution by double-insulating the chassis and/or the power supply circuit- measures that do not always work. **THIS CIRCUIT CAN KILL YOU;** Underwriter's Labs will no longer approve them and nobody uses them any more. But if you absolutely MUST dork around with one, they can be made safe by wiring in something called an ISOLATION TRANSFORMER. This is a very simple job but requires the part, which is a power transformer with a 120VAC primary AND a 120VAC secondary (in transformer talk, it has a “1:1 turns ratio”). Unless you have a cheap source, these cost more than the amp is worth.

How about a tube stereo? Don't bother trying to convert a tube stereo amp. To begin with, guitar amps don’t need stereo, and it is not straightforward to bridge the outputs to drive a single speaker. Most of these units are valuable in their own right on ebay- you will be astounded at what people will pay for one of these, even from obscure brands. If you want to go stereo, do no

buy an “integrated” tube stereo receiver that has a built-in FM tuner (you do not want the hassle of decommissioning the tuner circuits) and in any case, plan to drive separate speakers with each output amp. If you can get it cheap enough, my advice would be to buy it for resale and use the money to buy something more suitable, as described below.

Mono tube (hi-fi) amps (from the 1950's) are easy to convert but tube audiophiles might still burn your house down if they find out that you've "ruined" one of their treasures. The best examples are the ones that use common tubes like the 12AX7, 12AT7, 6V6 and 6BQ5. Don't bother converting a tube mono hi-fi amp if it uses "all-digit" tubes like the 6973, 7199, and so on. These are special hi-fi tubes whose capabilities are wasted on guitar. Amps that use these tubes are treasured by the audio nuts, and re-tubing one with fresh tubes for guitar will be REALLY expensive (I mean like $50 or more per tube!) and hence defeat the purpose. Resell them on ebay and move on. The only exceptions are for these specific tube types: 7025 (this is really a 12AX7) and 5881 (this is really a 6L6GC).

Floor-model (“console”) hi-fi tuner/record player combinations can be converted, but the only ones worth working on are those in which the amp chassis is a separate, self-contained unit that can be pulled out by itself, leaving the tuner section to go into the trash. More on record player conversions below.

Tape recorders with tube guts make good conversions IF they have output amps for driving internal speakers. Old reel-to-reel recorders with tubes in them are generally worthless junk, and nobody will threaten your life if you come at one with a soldering iron in your hand. But beware! There is a lot of superfluous "stuff" in a tube-powered tape recorder that you have to remove before you can get down to the essentials and this can be a lot of very tedious work. The easiest conversions are the Roberts/Akai stereo units, as discussed earlier. They have almost all the electronics bundled into easily-removable modular chassis units separate from most of the motor drives and control levers, which makes your job simpler. Furthermore, one deck provides TWO amps! Note however that these came in both tube and transistor form, and that only the tube units are worth buying. How to tell? Plug the thing into the wall and listen to the built-in speakers. The transistor units come on immediately and the tube guys have to warm up first. Also, there will be a ventilation grille in the cabinet somewhere through which the tubes can be observed glowing; it is this grille that you would remove to service the tubes. No removable grille and no glow means transistors: do not buy!

Tube record players are very easy to convert. However, many of them contain very small amps which use the infamous "transformerless" power supply circuit. Stay away from anything that does not have a power transformer, if you value your life. As noted earlier, these units use tube types with two leading digits, like the 35W4, 50C5 and so on, so if you can read the tube types you do not have to pull open the chassis to determine whether or not to buy. The best tube record players for conversion are the "Newcomb" and "Rheem-Califone" elementary-school-auditorium units covered with gray vinyl that had a 12" loudspeaker mounted in the lid which could be separated from the turntable for use when Mrs. Hausauer’s 3rd grade class was forced to learn Traditional American Folk Dances in the cafetorium. They also made a smaller version of this which used a small oval speaker mounted in the same housing as the turntable and had about half the power output of their bigger brothers. Beware! As with the Roberts/Akai tape recorders, some of these models came in both tube and transistor versions. The transistor-equipped ones are worthless except to mentally-defective rich guys on ebay. They are NO GOOD for guitar. The preamp circuit of a record player amp will need modification to properly process a guitar signal and this is described below.

Tube PA amps: YESSS! FABULOUS guitar amps can be made with very little effort out of tube PA amplifiers from Bogen, Knight, Fanon-Masco, Chicago/Webcor, Stromberg-Carlson, RCA and others. Look for the ones that use pairs of 6V6 and 6BQ5 tubes in the output. You will also see single 6L6GC circuits that are WAY COOOL from Bogen, they make absolute KILLER

guitar or blues harmonica amps with almost no effort. Some of these have two 6L6GC or two 5881 output tubes and are very powerful and dangerously loud, but fairly scarce.

Also very valuable are ***small tube amps built into remote speaker cabinets*** that plug into tape recorders or record players, so people out next to the swimming pool can hear your records and tapes too. Look for these self-powered "satellite speakers" from Voice of Music ("VM"), Sears Silvertone, Ampex, Webcor and others. They are the easiest of all to convert, and in addition you get a cheap little loudspeaker included in the deal.

Old electric organs from Baldwin, Wurlitzer, Guldbransen, Conn, Kinsman and other makers are well worth considering because they are frequently given away for free and contain lots of useful things that can be mined out of them (besides the amp chassis): nicely-veneered lumber, alnico-magnet loudspeakers and baffle boards in 12" and 10" sizes, cool old grille cloth, power switches, reverb tanks, knobs, pilot lights, nuts, bolts, T-nuts, screws, raw wire, terminal strips, and so on. Some of these organs also contain Leslie-style rotating speakers which are totally cool to play guitar through and which can be sliced out of the organ console with an electric jig saw for conversion into a stand-alone. However, do NOT scrap out a HAMMOND organ!!! They are worth big bucks to collectors and musicians.

The only drawback to scrapping out an organ is the quantity of trash that you will generate in the process, but the big advantage is that this way you can get very hip loudspeakers for free that would otherwise cost anywhere from $20 to $40 each. This makes the effort worthwhile even if the amp chassis you get is not well-suited for guitar conversion because of its complexity or design (more on this later).

CONVERSION DETAILS

The job of doing a conversion successfully relies on three things. First, you have to start with something that works properly before you start the conversion. If not, you have no guarantee that it will function after your conversion is completed. Second, you have things to remove from the circuit. Third, you have things you'll need to add, after getting rid of the things you have to get rid of. I'll detail each of these below.

We start by determining whether or not the amp-to-be-converted is in working order, a process which always starts with a tube test. If the tubes are shot, replace them; but if at all possible use some functional but free tubes from your stash so you do not have to shell out $20 for a brace of new tubes only to discover afterwards that the power transformer is burnt out. If you have to actually go out and buy them, you will quickly appreciate why we aren't converting an amp that uses two 6973's and a 7199.

Next we connect a speaker load to the output of the amp chassis and carefully power it up. This may involve splicing a temporary power cord to the primary of the power transformer. If the amp does not have a fuse, wire one up with the temporary power cord and put a 2 amp slo-blo fuse in it. If the fuse blows when you plug in the amp, you no longer have a conversion project, you have a repair project. Stop now and refer to our repair literature instead.

If the fuse does not blow, let the amp warm up and check for hiss and hum coming out of the speaker. If it starts to produce static when it's warm, the amp is probably functional and you are indeed working on a conversion and not a repair.

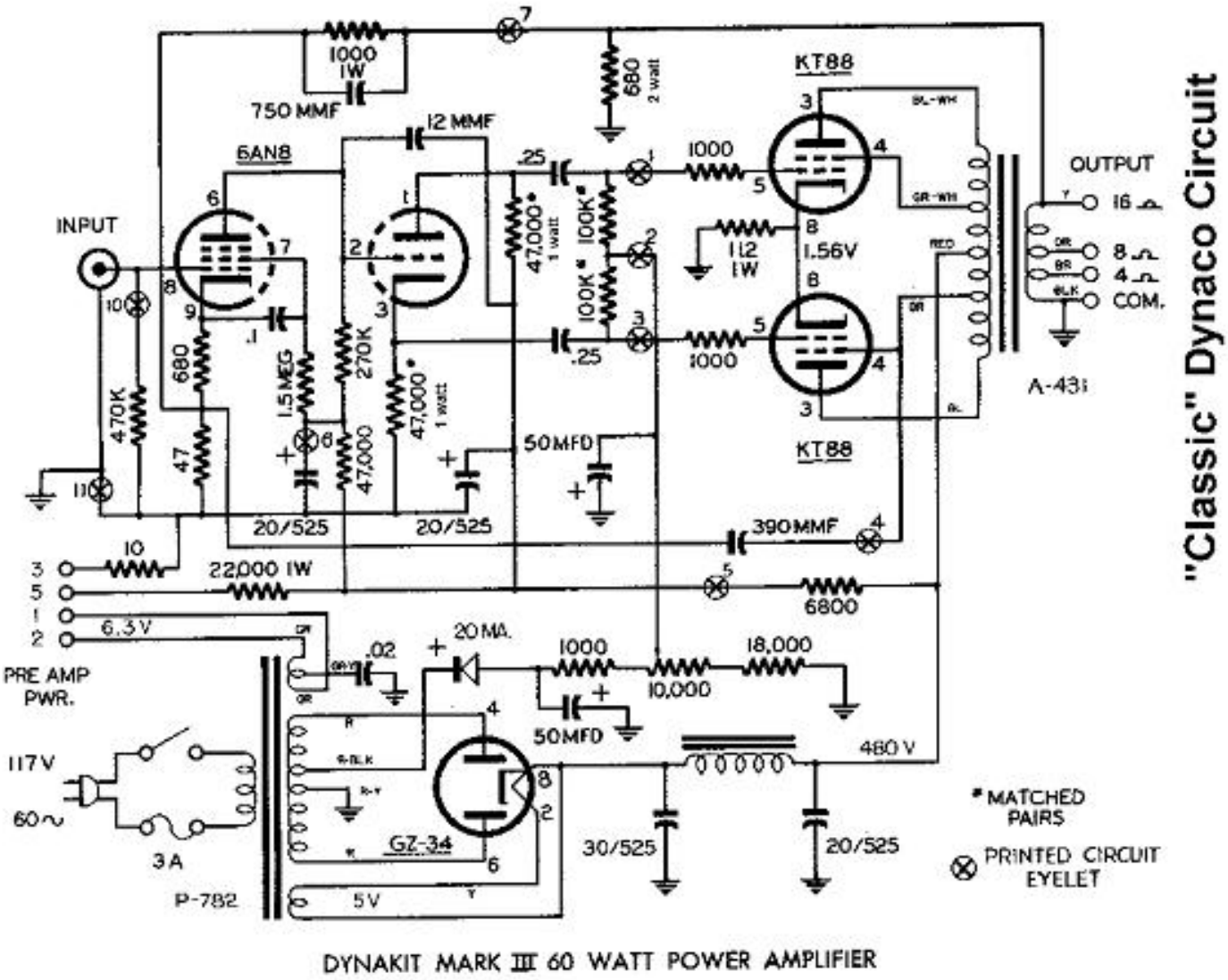
Now shut the amp off and identify the signal input point for the chassis. This will most likely be an RCA phono pin socket. Get you a phono cable with the plug cut off one end and the shielded wire unbraided so the center conductor is out in the open and plug it into the chassis. Turn the amp on, let it warm up and gingerly tap the center conductor with your finger tip. If the amp really is working, you should get a loud **BRRRRRRONK** out of the speaker each time you tap your finger on the center conductor. If you get either a weak brrrrronk or nothing at all, it either means the amp

is not working (and is now a repair job) or the input requires a line-level signal to drive it (which means you'll have to build a preamp for it to boost up the signal level). You can determine if this is the case by connecting the chassis input to the tape deck output of a stereo receiver, which will then present a preamped, line-level output signal to the amp chassis. If your favorite oldies station now comes out of the speaker connected to the amp chassis, you have proven that the amp chassis works but requires a 12AX7 preamp to kick it. More on this later.

(One quick thing to remember here: *Both the 6V6 and the 6BQ5 output tube will normally become far too hot to touch with your bare fingers when they are properly biased and fully warmed up. An amp with weak output and a 6V6 or 6BQ5 that is cool enough to NOT burn your fingers on probably has a bias fault- which is easy to fix.* More on this in the Amp Repair Document.)

THINGS TO GET RID OF…

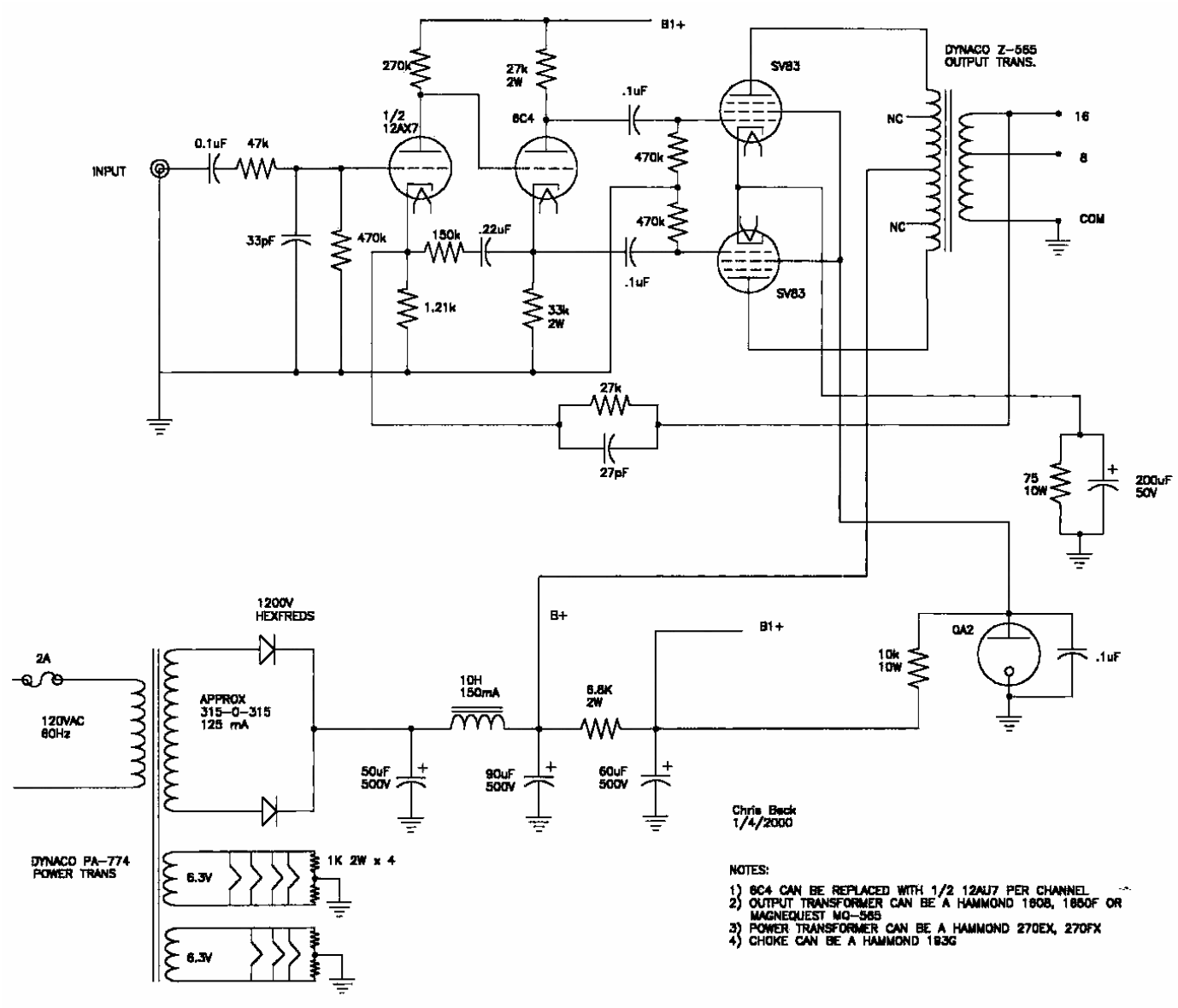
Identification and removal of feedback circuits. Organ and hi-fi amps almost always have a feedback circuit that is used to cancel unwanted distortion. For example, below I have reproduced a schematic for a hi-fi power amp that has a feedback loop running from the 16 ohm tap of the output transformer secondary to the cathode circuit (pin #9) of the 6AN8 preamp tube. Clip it out at both ends and throw it straight into the trash. We are not after hi-fi here- we WANT the distortion!



DYNAKIT MARK III 60 WATT POWER AMPLIFIER

While we are at it, note that there are two extra primary taps in the output transformer that serve the screen grids (pin #4) of the output tubes. This is called an “ULTRALINEAR” circuit and is common in hi-fi power amps. For guitar, though, we do not want to use this type of circuit. Rewiring to eliminate the ultralinear taps can be done but is an advanced topic I will not spend time on here.

Voltage regulators are commonly used to reduce distortion in electric organ amps, especially the big ones used in churches, and in fancy hi-fi amps. These consist of special tubes with names like OA2, or possibly a 6L6GC that is sitting all by itself in the power supply section of the amp instead of the output section. Here is a typical schematic of an amp with an 0A2 in the power supply section (lower right corner) to show you what it looks like:



A hi-fi amp chassis that is “serious” enough to have an OA2 in it will generally represent an amp that is valuable in its own right (besides being an overly-complex conversion task that is a poor choice for a beginner) so unless you got it for nothing and are hell-bent on converting it, sell it on ebay and buy something else. An 0A2 in a worthless old organ chassis can be defeated simply by pulling the tube out of its socket and throwing it away.

Finding and defeating the “RIAA phono equalization” circuits. In the “phono input” preamp circuit of every hi-fi amp and record player amp, you will find an EQ network wired in which forces flat frequency response out of a vinyl record. This network does its job by cutting the treble response and greatly boosting the bass, which vinyl pressings require but which produces really lousy tone if you run your guitar straight into the phono cartridge input. Removing the phono EQ network requires clipping out the whole tone and volume control circuits from the preamp section, which is a good idea in any case since the treble and bass cut-and-boost frequencies that a hi-fi amp uses are not the best ones for guitar. The good news is that the simple, two-knob tone and volume circuit from a tweed Fender Deluxe has great tone, is easy to build, and can be dropped right into the spot where you tore out the old tone and volume circuit.

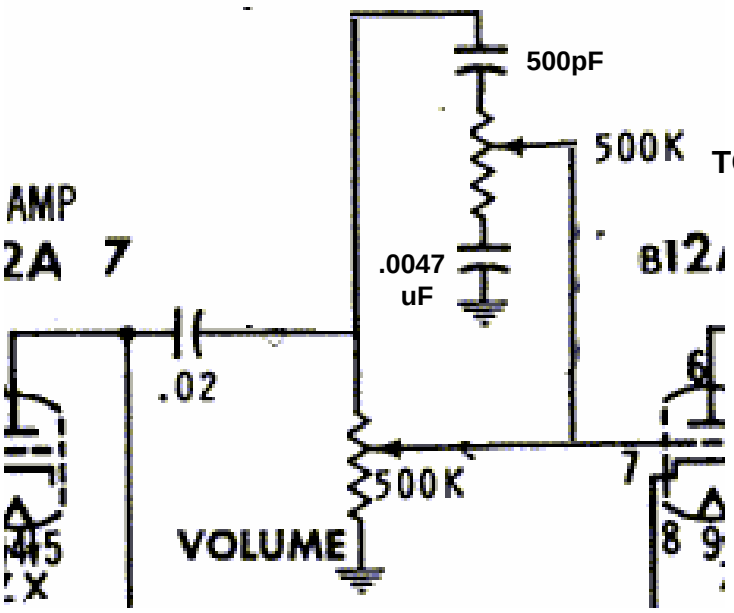
Juicy coupling capacitors and what to replace them with. Throughout the circuit, you will find the plate of one tube connected to the grid of the next tube downstream in the signal path through a “coupling capacitor” of value anywhere from 0.01uF to 0.1uF. Old amps used tubular capacitors containing rolled-up metal foil sheets separated by oil or wax-impregnated paper insulation. They go bad by leaking the wax or oil (“juice”) out and/or by developing tiny short-circuits inside which allow DC current to leak through the capacitor. Please note that these are good only for about 20 years of use and then they croak and must be replaced! The good news is that the new types available today do not wear out like this and hence almost never go bad.

Even if the coupling capacitor is only the slightest bit bad (i.e., it leaks even a tiny amount of the plate voltage of one tube onto the input grid of the next one) the amp will seriously malfunction, so on principle **you should always clip these out and replace them with brand new 400 volt-rated capacitors** (either Orange Drops or ceramic disc capacitors). Note that for rock and roll guitar use, it is perfectly OK to replace a 0.1uF coupling capacitor with a much more compact and less-expensive 0.05uF or even a 0.02uF capacitor since all this will do is roll off the bass response very slightly. But you MUST use capacitors rated for at least 400 volt service in any case. **Do NOT splice in a replacement coupling cap unless you are CERTAIN that it has a minimum 400 volt rating.**

THINGS YOU HAVE TO ADD…

Fuse holders. **NO GUITAR AMP SHOULD EVER BE OPERATED WITHOUT A FUSE OF THE RIGHT VALUE IN ITS POWER SUPPLY.** This is particularly important if your chassis uses a tube rectifier like a 5AR4, 5U4, 6X4 or 5Y3, because rectifier tubes can fail by short-circuiting the high voltage AC from the power transformer straight to the filter capacitors. This fries the filter caps immediately, which then get hot enough to either explode or spray their chemical guts out all over the insides of the chassis, and causes the transformer itself to get hot enough to melt the insulation right off its windings and CATCH FIRE.

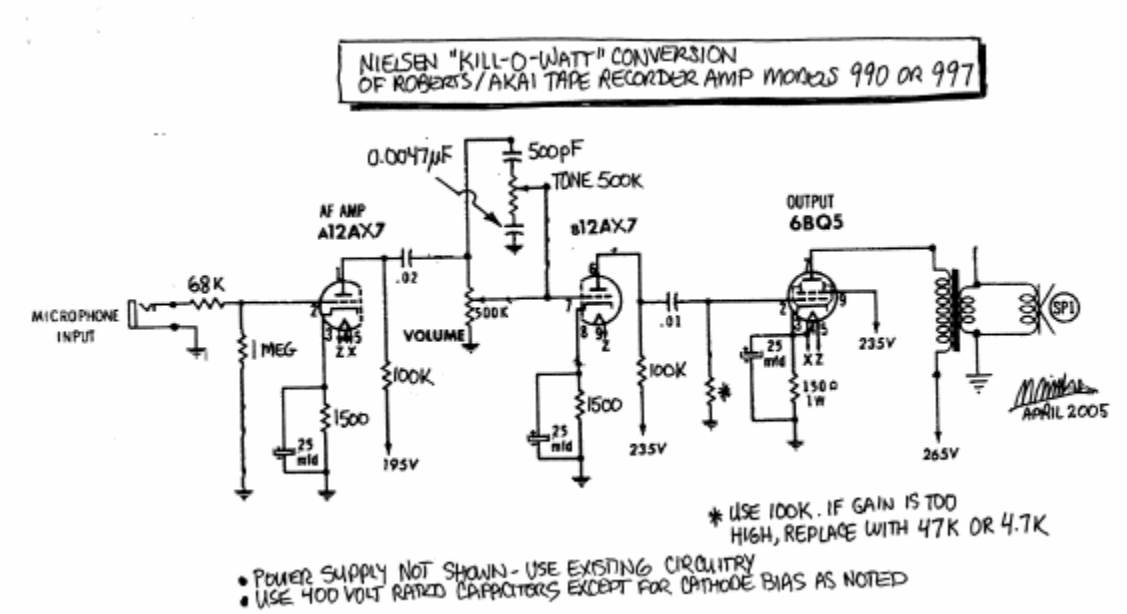
Adding tone and volume controls. The tweed Fender Deluxe tone and volume circuit works really well and is extremely simple to build. Below I have sketched it out, inserted between the first and second stage tube sections of a typical tube preamp where the existing tone control and volume knob have been clipped out. The output of the first tube stage is picked off its plate using the 0.02 uF coupling capacitor which leads to the "top" of the volume control pot. Also connected to the top of the volume pot is a line going to the tone circuit. When the tone knob is turned up, the pot wiper points to the 500pF capacitor. This capacitor leapfrogs all the high frequencies over the top of the volume control and sends them straight into the input grid of the next tube. This yields lots of treble. When the tone knob is turned all the way down, the wiper instead points to the much larger 0.047uF capacitor which short-circuits all the high frequencies present on the input grid of the second tube straight to ground. This makes the tone really bassy.



I have experimented around with lots of tone control setups and found this one to be the easiest to understand and build, and tone-wise it totally rocks (how much better can you get than a tweed Fender Deluxe, anyway?). It is virtually identical to that used in the Gibsonette amp. You can customize it by playing around with the values of the two capacitors. Replacing the 0.0047uF cap with a bigger one will make the output bassier when you turn the tone knob down. Putting in a treble cap smaller than 500pF will make the output sharper but weaker when the tone knob is turned up. Remember that to get the tone responses to change requires a change in the size of these caps by a factor of 5X to 10X, so be bold!

EXAMPLE: The Roberts/Akai Model 990/997 conversion

As noted earlier, a sweet setup is the Roberts/Akai stereo reel-to-reel tube tape recorder with built-in speakers. Two complete guitar amps can be built out of one of these because it contains two separate amp chassis. The schematics for each are quite complex since they contain all sorts of stuff that we have no use for, like the record bias oscillators, the record driver amps and so on. In fact, once all the extraneous garbage is removed and the right stuff added, the actual schematic is very simple, and is reproduced for your reference below.



The cathode bias capacitors are all rated for 25 to 35 volts. Don't re-use the originals- they go bad with age and are a bad bet. Buy some new miniature tantalum capacitors and drop them in instead. Remember the polarity: negative to ground, positive to the tube.

The resistor marked with the asterisk is there for two reasons. First, it prevents the input grid voltage from "floating" arbitrarily (which would de-bias the tube) and second, it limits the size of the signal that the 6BQ5 tube can see. Both things are essential, so don't think you will be getting more gain out of the amp by removing it- this circuit as drawn has gobs of gain. In fact, depending on how hot the 12AX7 is running, you might have to reduce the size of this resistor to as low as 4.7k to keep the 6BQ5 from being horribly overdriven.

The power supply is not shown, but all you need to do to it is wire up a three-wire (grounded) power plug, an on-off switch, and a fuse holder with a 1amp slo-blo fuse in it. I also prefer discarding the 6X4 tube rectifier and replacing it with a silicon diode bridge, but there are some tone nazis out there who claim they get "better" tone (whatever THAT means!?!) with tube rectification. Regardless of what you decide, don't forget that fuse!

After you have pulled out all the switches and signal jacks out of the front panel of the Akai chassis, you will have plenty of holes available in which to mount the input jack. Which to use? Easy. **Use the hole that will put the input jack closest to the 12AX7 socket,** and use a jack that shorts the input to ground when nothing is plugged into it.

If you want to wire up an output jack for the speaker to plug into, mount it as far away as possible from the 12AX7 and the volume and tone controls, and use another jack that shorts the output to ground when the speaker is unplugged.

Per the schematic, one of the wires from the secondary of the output transformer will go to ground, and the other one goes to the speaker output. It is recommended however that you do not simply tie one wire to ground right next to the transformer and similarly ground the return side of the output jack, but instead run the transformer ground wire all the way over to the output jack ground lug and make the ground connection there. This keeps all the ground return current in the speaker circuit from having to propagate itself through the chassis, which can trigger internal feedback problems especially in a high-gain circuit that is crammed into a small chassis.

***Re-forming derelict filter capacitors*.** The heat and noise tests to determine “goodness”

Power switches

3-conductor power cords
Cheap amps, and all amps built before the 1980’s, had only two-prong power plugs and no means of either reversing the polarity of the power line or of shunting conducted interference to ground. Your conversion project will most likely have only a two-prong plug. To minimize noise and maximize safety, what should the amp builder do? **By far the best thing is to use a 3-prong cord in which you tie the green (ground) line to the chassis-** and then always plug it into a three-prong outlet. You are not saving any money by sticking with the original two-conductor power cord if you then kill yourself because the chassis was not tied to ground. Most of the power cords I have seen on old amp chassis are old enough to have rotten insulation on them, which means you must replace the power cord anyway. Just do it, and use a 3-conductor cord.

“Ground reverse” caps
For many years, Fender amps have used a “ground reverse switch” which actually does not reverse the plug polarity but instead ties your choice of either one or the other of the AC input lines to ground through a small capacitor. This presumably dumps all the noise, buzz and static that the hot side of the AC line picks up and would otherwise feed straight into your precious amp project. Instead of using one capacitor and a selector switch, I use two capacitors (because the second cap is cheaper than a switch) and I wire them both in permanently.

Power input sockets
If you have a scrap computer power supply in your junk box, you can scrounge a handy AC power input socket from it that a standard computer power cord then plugs into. Many of these power supply sockets have built-in noise filters in them; if you use one of these, then you do not have to bother adding the noise dump caps described above. The only downside to this is the socket requires a rectangular mounting hole punched into the chassis. I have a hand-operated sheet metal nibbler tool that I use to open round holes into square ones; it is a tedious thing to use but the plug-and-socket installation is worth it.

Pilot lights

Upping plate voltages for more power
To get as much gain as Fender does out of a 12AX7, you have to feed it the same plate voltage. If your chassis does not furnish as much voltage as a Fender would, AND if it uses a tube rectifier, you can increase the plate voltages throughout the chassis by about 50 volts by replacing the tube rectifier with a pair of diodes. The schematic below shows you how. Use 1 to 2 amp, 500 to 1000PIV silicon diodes (values in these ranges are noncritical). Be aware, though, that the filter capacitors must be rated to handle the extra volts. If you pump up the power supply to 400 volts and the caps are rated for 350, they will blow! Replace them with 400 or 450 volt units.

Filter capacitor details
How much capacity is enough? A Fender Deluxe uses one 16uF, 450V capacitor for filtering each stage of the supply. 20 to 40uF per stage is plenty. More than this is overkill. A multi-segment can capacitor (a big aluminum tube with three or four separate filter capacitors rolled up inside) is easy to install but they commonly have different voltage and capacity ratings for each of the segments inside. Which to use? Use the highest voltage-rating segment for the first stage filter (connected straight to the rectifier output), the second-highest for the next stage, and so on.

Altering circuits for more gain- 12AX7substitutions, 100K plate resistors, biasing hints

Master gain controls/clipping circuits