Rebuilding Vintage Transformers

One of the most important things you can do to extend the life and performance of vintage tube audio gear is to rebuild the unit's transformers. I am talking primarily about "unpotted" transformers. The type where you can see the EI laminations and usually have "bell ends" to cover the winding and lead wires.

This type of transformer has a limited life cycle. On many vintage amplifiers the transformers were potted. The wound transformer core was inserted into a can or enclosure and the can was filled with a non-conductive wax or petroleum based "tar".

"Unpotted" transformers have a limited life due to the fact that the laminations and windings are exposed to chemical and moisture in the atmosphere. They are also prone to condensation. Push-pull output and power transformers can run hot. Most of the ones found in vintage tube equipment do.This is because manufacturers wanted to save money and used a core size that lets the transformer get quite hot.

When you shut down a hot transformer condensation takes place and the resulting water droplets forms in the transformers windings, on the inside of the bell ends and at the lead wire/magnet wire solder joints.

Unpotted transformers can also get noisy. The iron laminations in the EI core start to vibrate. This is because the "varnish" the transformer was usually dipped in has broken down due to the many cycles of expansion and contraction that takes place as the transformers have been turned on and off

There is a pervasive belief that hot transformers sound better. This must have started because audio enthusiasts believe there must have been a sonic reason why manufacturers ran them so hot. Just remember that increased temperature means increased resistance or less conductance, unless you are talking about a tube's heater or filament supply. Vintage designs that were built for reliability had potted transformers. The best of them ran at room temperature.

So how to make sure your vintage iron is going to last, simply rebuild the transformers. With a minimal degree of mechanical ability and the ability to make a good solder joint, you can do it. It takes time and, as you will soon see, a large dose of WAF (wife or partner acceptance factor), will be required. We are talking about violating the sanctity of the kitchen here.

Simple Steps to Renovated Iron:

Remove the transformers from the unit

Clearly identify the wire leads and connection points for re-installing the transformers. Draw a copy of the layout. Mark down the lead wire colors and attachment points. Don't rely on memory.

Unsolder all the connections. Use a 50Watt soldering iron. 25 Watt irons take to long to heat the solder joint. All you are going to do is melt the lead wire insulation. Use 3/16" wide "Solder Wick". If you have a nice de-soldering iron, use that…as long as it is a minimum of 35 Watts.

Draw a sketch showing the transformers' proper orientation on the chassis. What color lead wires feed through what chassis hole and transformer bell ends.

Once you have the wire leads free, unbolt the transformer and carefully feed the lead wires through the chassis holes as you pull the transformer away from the chassis.

Remove the "bell ends" or end covers.

Make sure (if your transformers have wire exiting from both bell ends) that you have a drawing identifying the wire lead colors from each cover.

Remove the Machine screws that attach the bell ends to the lamination core. Position the transformer so the longest side of the lamination is resting on your work surface. This prevents the laminations from shifting.

Remove the screws holding the bell ends on the core. If they seem tight, spray them with Liquid Wrench. The better transformers used plated brass screws, you don't want to damage them. By the way you can use a magnet to make sure the screws are not steel. If they are you will get better performance from the transformer by replacing them with brass or stainless steel.

If the laminations seem loose and you are worried about them shifting, reinstall the screws to hold them in position.

Position the transformer core so that the section where the lead wires enter the winding are up. There will be a layer of Kraft paper or tape covering the lead wire/magnet wire connection. Use a sharp razor knife and slit the paper or tape covering the connections. Peel the paper/tape away until the connections are exposed.

Don't be surprised to find the connections covered with lumps of green corrosion. Use a toothbrush and some contact cleaner or denatured alcohol to clean the connections. If your lead wires look good and you want to use them. Use a soldering iron and re-solder the connections. Use a solder with a very reactive rosin core flux. This will help flush any corrosion out of the solder joint.

If you want to replace the lead wires, unsolder the connections (one at a time) and solder on new lead wires. I feel the quality of the lead wire has a great impact on sound performance. For that reason, I use solid core wire for leads. I find it best to use wire with a white insulation. That way I can use colored felt markers to mark each lead with the same color code as the lead wire it replaces. I also use clear fingernail polish to coat the solder joints. This will help minimize future corrosion.

The next step in rebuilding your transformer is to purge out any chemicals or moisture in winding or laminations. This is where you need an electric oven. Don't use your kitchen oven without planning to clean it afterwards. You will be amazed at what's going to come out of the cores.

You can't use a gas oven, because you can't control the temperature. The setting you use on the electric oven is the lowest setting that will turn it on. This is usually about 120 degrees Fahrenheit. Set the operating control on bake and turn the temperature control until the red light comes on.

Position the transformer core on a shelf centered in the oven. Have the lead wires pointing up and make sure they do not come in contact with the shelf, transformer laminations or the sides of the oven. Close the door and let them cook.

After about 30 to 40 minutes open the oven door. You will see a fog of moisture come out and you noise will detect a very disagreeable odor. This process is not recommended when “she who must be obeyed” is at home. Have some Air Freshener handy. In fact if you plan to do this often, find a small portable electric oven you can put in your workroom. They usually turn up at garage sales and thrift stores. You won’t have to clean that one.

Bake the transformer for at least 3 to 4 hours. Just keep that temperature down. Turn off the oven and leave the transformers sit overnight with the door closed. It takes a while for all that iron to cool off and you might as well let it cool down gradually.

Finally you need to dip the transformers to fill any voids in the laminations and winding. This will improve the insulation between windings and reduce mechanical noise.

You need a five gallon plastic bucket preferable with a cover. You can always make one by using a piece of plywood. Prepare the bucket by installing a cross bar about 1” below the rim. This will be used to hang you transformer cores in your “magic dipping liquid”. Use a metal rod or wooden dowel and drill the two appropriately sized hole 180 degrees apart to provide a tight fit for your crossbar.

You can use shellac, spar varnish or polyethelene varnish as a dipping liquid. You need to prepare enough so that it will cover the cores when they are suspended or hung form the crossbar. Use the recommended thinner and thin it until it has the same consistency as water. Too thick and it won’t get in all the cracks and crevices. I use “orange” shellac. Don’t use paint or any coloring agents. How do you know it’s non-conductive or non-corrosive?

After you have your dip tank prepared. Cut and bend a coat hanger to make a hanger for your transformer. Make sure it won’t slip off your crossbar and it holds the transformer securely. I slide the coat hanger in the corner holes of the laminations so that the wire leads are up. I bend the coat hanger to form a “U” with the core trapped inside it. I bend the two coat hanger wires together to form a hook on top. I also tie the lead wires to the support to keep the ends out of the dipping liquid.

I slide the transformer with the wire support into the oven to warm it up. You want the core and wire cool enough to handle but warm enough to help draw the liquid into all the nooks and crannies.

Once you have the transformers warm, dip them (one at a time) into your “magic dip”. Tilt the cores to help any air bubbles escape. Don’t stir the liquid with the cores because you will trap air bubbles in the liquid. Just slowly tilt and rotate the core. Once you have one done hang it on the crossbar and do any other cores you are working on. In most cases you can only do two at a time. Once your transformers are hanging on the crossbar put the cover on the bucket

Leave the cores in the dipping compound overnight. When you remove the cores from the liquid you will need a place where they can be hung to drain and dry. I use another bucket with a crossbar. When you remove the transformers form the liquid tilt and rotate them to help all the liquid drain back into you dip bucket. Hang them up to drain and dry. It should take about

24 hours, maybe a little longer with polyethelene varnish.

The final step in preparing the transformer core, is to bake it at the same low temperature you used before for about 4 hours. This will harden and cure the “magic dip”. I leave the oven door open for the first hour. This will allow any remaining vapors to dissipate.

Painting the Bell Ends or the laminations

The last step prior to assembling and reinstalling your transformers is to paint or refinish your bell ends and if you want the exposed laminations.

I suggest you use a good grade of enamel and bake the units to set and harden the finish. One thing to remember is to not paint the bell end surfaces that contact the face of the laminations. You want good contact both mechanically and electronically between the bell ends and the laminations. So just paint the outside of the bell ends. After you reassemble the transformer you can hand paint the outside exposed face of the laminations.

The colors and gloss are up to your own imagination. Restorations are up to the imagination of the original manufacturer. I will add that the prettiest unpotted transformers I have ever seen were done by Altec. They used a glossy dark “Hammertone” gray and painted the laminations a flat light gray.

One thing to keep in mind. If you are restoring gapped transformers. Chokes and single ended audio transformers were gapped. You need to paint the exposed laminations with a couple coats of “ varnish or shellac before you disassemble the transformer. If it looks like the lamination core has shifted. Run some DC voltage through the primary of an audio transformer or the choke wires. Loosen the clamping screws make sure the I section is tight and retighten the screws. Then paint the core.

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