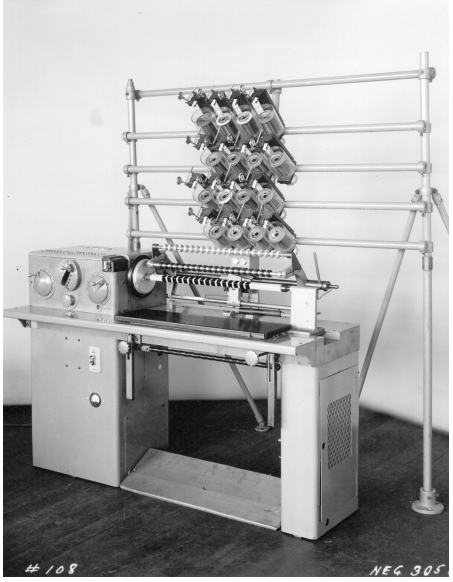
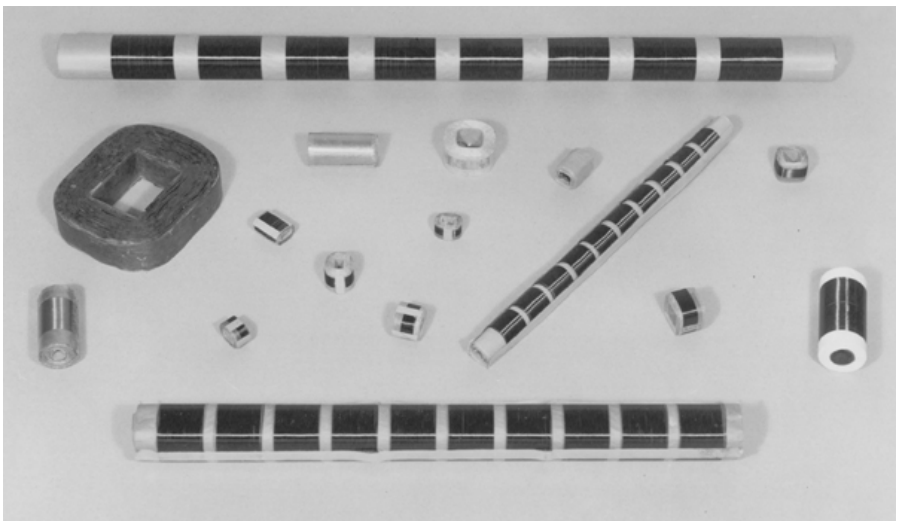
The cost of rewinding layer wound transformers.

Layer wound transformers are and have been used in millions of pieces of electronics. In manufacturing they are not only economical to make, they also have technical advantages as well. Layer wound transformers are commonly used as input and output transformers, power transformers, chokes and more. The greatest manufacturing advantage associated with layer wound coils is that multiple coils can be wound at the same time and every coil wound at that session will be exactly the same.

Winding multiple coils at the same time is done by using what is commonly referred to as a stick winder. The winding machine below was manufactured by the Leesona Winding Company. Leesona still manufactures machines for the textile industry however the Coil Winding division was sold years ago and has passed through several owners. It is now under the stewardship of Vintage Windings.





Stick winding was/is a very economical way of winding multiple coils that are identical. This method of production not only allows many coils to be wound simultaneously but the performance of the finished product is superior to that of the comparable bobbin wound coil. Layer wound coils have less capacitive losses than bobbin wound coils for a variety of reasons too numerous to detail here. While stick winding produces layer wound coils very cost effectively, winding layer wound coils one off is very time consuming and therefore not inexpensive.

Here is a run-down of the re-winding process. There are variations of course but this is the general order of a typical rewind and the work involved for a faithful recreation of the original transformer:

1) Assessment, measurement of working windings, research schematic. Begin the scanning process. Scans are made from beginning to the end of the reverse engineering stage. Details that are not always noticed or apparent during dis-assembly can often be determined by referencing the scans. A dissection journal is also started to catalog the unwinding.

2) Removing the coil from the case if there is one. This can be very easy or a nightmare depending on the number of shields, how it was potted, and with what type of compound. If heat is used to loosen potting compound it must be used very carefully so the anneal of the laminations is not altered.

3) Once the transformer is out of the case any access potting compound is very carefully removed from the coil and laminations.

4) The laminations are then removed from the coil. This step will make or break the whole rewinding. If the laminations are damaged by being bent as they are removed the original anneal of the laminations will be ruined and they will not perform in the transformer to spec. This is especially important with miniature small signal transformers. The laminations tend to be high Nickel content very soft metal and removing the first several without bending them can be more than challenging.

5) The laminations are solvent washed and placed in a ultrasonic cleaner.

6) The coil is then placed in an un-winding machine and the outer layers of wrappings _very_ carefully removed. If the transformer has not been previously reverse engineered it is critical at this point that all connections remain as intact as possible. As the wrappings are removed and the various taps, tie points and their associated leadout wires are revealed, each is carefully labelled and all connections noted in the journal.

7) The leadout wires are cut from the magnet wires making sure to tag and label the magnet wires at the coil so all connections will match the original.

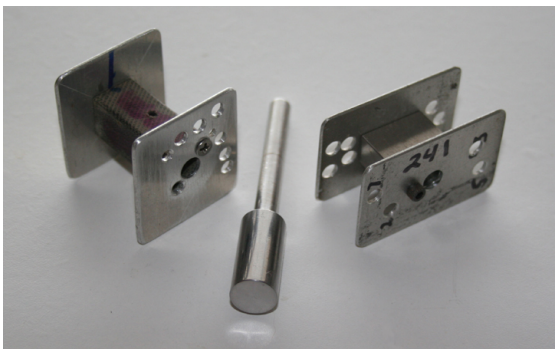
8) Once that work is done the coil can finally be unwound. This process can be very easy or a complete nightmare depending on the coil size, type of potting compound, wire size and other variables. Generally the smaller the coil, the harder it is to unwind. Small wire in a coil that has been potted breaks often which makes turn counts much more difficult to keep track of. AKG T-14's use AWG 48-49 on the hi side and they are potted with varnish. AWG 48 wire breaks if you look at it too long. The T-14 was the most challenging transformer that I have reverse engineered.

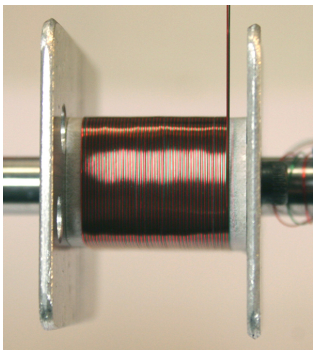
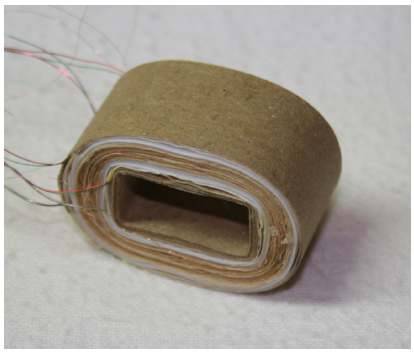
9) During the unwinding process the type and size of all of the wire used is noted and every turn of each winding is meticulously counted and logged as are details like wind rotation etc. All insulation materials are noted and any details of the manufacturers winding protocol are written down as well.

10) Any wire size or type that isn't stocked is ordered as are any other materials not on hand. Vintage Windings stocks most types of interlayer insulations that one would find in any vintage transformer. We use original materials (new) whenever possible and only use alternatives when the original material was the cause of the failure. Vintage Windings only uses new wire as NOS wire has old coatings which are most likely dried and not up to original specifications.

11) The coil is now down to the coilform. If the coilform is reusable (rarely) it is set aside. If it is not reusable a new one is made using similar material. If the coil used a bobbin a determination is made to reuse the bobbin or create an new one. Bobbins are almost impossible to find for sale one at a time. Finding the right size can also be useless. Most time new bobbins are made using a 3D printer which requires drawing in cad and creating a G-code for the printer. 3D Printers do not have the resolution required for very small bobbins like one would find in a high end German tube microphone. They must be either cast or made from polystyrene stock. Both operations are very time consuming.

12) At this point the unwinding process is reversed and a winding protocol is established. The winding protocol contains all of the details needed to design a Break-Away Bobbin (paf) and create a program for the winding machine.



13) Mill a Break-Away Bobbin. The photos above show some of our Break-Away Bobbins. These are needed to wind a layer wound coil that is exactly like the original. Each Break-Away Bobbin is made to be used with a specific coil. The Break Away Bobbin consists of a spindle block which is held to the spindle with a set screw, and removable sides. The sides have holes in them that correspond to the leadouts of the windings. As a winding is started or finished the magnet wire is taped on the coil and some extra wire is passed through the assigned hole in the milled bobbin side. These wires are taped to the spindle while winding the rest of the coil.

14) Create a program for each winding and load them all into the winding machine.

15) Insulation materials for in between layers doesn't come in convenient strips. Glassine, Kraft winding paper, CA and most other types of insulations come in sheet form. That is how they are used on a stick winder. A sheet that spreads the whole length of the arbour is placed over the coils, the machine spins a turn or two and the sheet is cut. When using a Break Away Bobbin the insulation sheets have to be cut into strips that perfectly fit between the bobbin sides. This is done before winding starts.

16) Finally, after all of the prep work the actual winding can begin. This part can take a half hour or a half a day depending on the coil size, number of windings, type of winds, wire size(s), number of interleaves, number of interior tie points, the number of taps, type of insulation. and other factors that are unit specific.

17) After all of windings are completed a protective wrapping is placed over the last winding and the spindle is removed from the machine. The tape is removed from the leadout wires. The bobbin sides are then carefully removed from the block allowing the leadout wires to slowly slide through the side holes. The coil is then slid off the bobbin block and goes to finishing.

18) Appropriate stranded wire is chosen to connect with the magnet wires and the interior and exterior winding connections are soldered and taped. Final wrappings are done.

19) The cleaned laminations are replaced in the coil and the whole assembly is placed in a vacuum oven under low heat to evaporate any remaining moisture. The coil is then vacuum potted using a similar material to what was used originally (unless the original

was unpotted of course). We DO NOT use the old toxic black goo.

20) The original case is cleaned. If there are dents they are removed and the case repainted as close to original as possible.

21) The transformer is potted back into the case

22) Time to test and ship. Wow that was a lot of work for one transformer!

So there you have it. A transformer that costs $45.00 US to mass produce on a stick winder will cost between $250.00 US and $500.00 US to rewind one off. Unfortunately there are no steps that can be eliminated to save money. Often it is less expensive to find a piece of gear with the same transformer, purchase that and swipe the transformer out than it is to rewind an original. In some cases there simply isn't an alternative a rewind is the only way to go especially on a rare valuable piece. cp