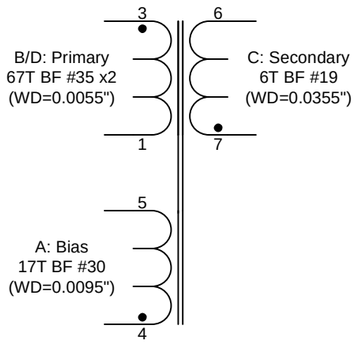
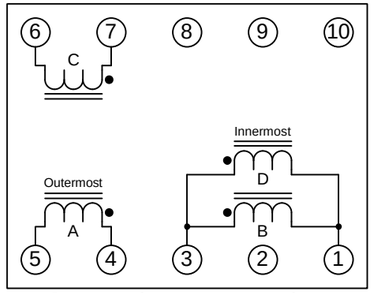
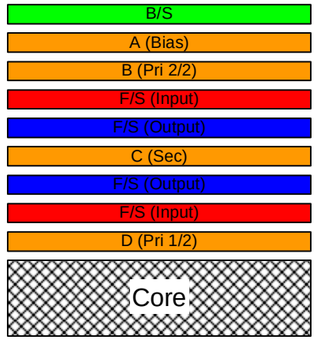
GPC41-5 TRANSFORMER REWIND 1/6

Original





Connection, Bottom View

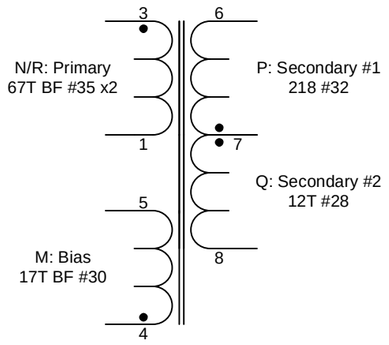


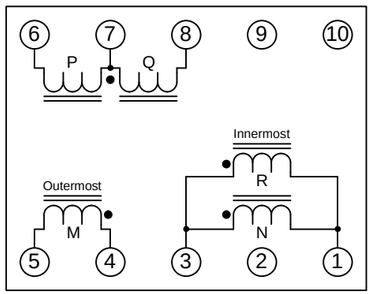
Winding Stackup

<u>Secondary current density</u>
Two conductors in parallel of #19 AWG:
1288CM x 2 = 2576 CM
2576 CM / 6A = 429 CM/Amp

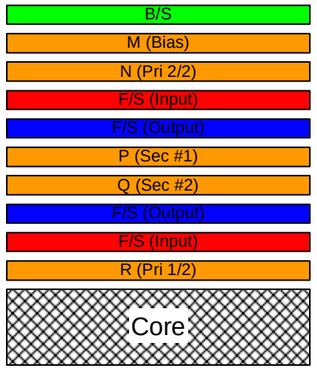
<u>Secondary turns ratio</u>
6 turns for 5V (Average) output voltage:
6T / 5V = 1.2 T/V

Re-wound





Connection, Bottom View



Winding Stackup

Secondary number 2 ("Q") turns was simply chosen as 2x the turns from the original 5V winding to provide overhead for 5V regulator.

<u>Secondary "P" current density</u>
36W / 180V = 200mA
0.200A x (429CM/A) = 86CM
#31 AWG = 89.3CM
#32 AWG = 79.5CM
>>Use #32 (Close enough!)

<u>Secondary turns ratio</u>
1.2 T/V x 180V = 216T

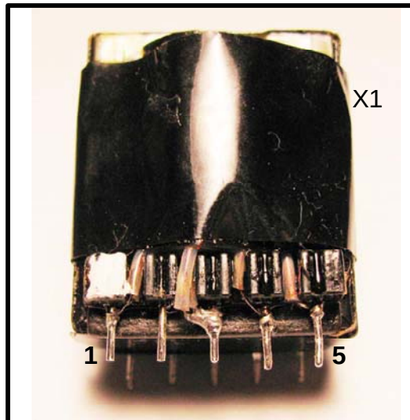
<u>Winding layers</u>
0.500" winding width (Original)
#32 = 0.009" dia (Insulated wire)
0.500" / 0.009" = 55.5 Turns/Layer
216T / (55.5T/L) = 3.89 Layers
216T / 4L = 54 Turns/Layer
(Even layer count allows entry/exit to be from same edge)

Note: The pictures that follow show winding Q on top of winding P. On further reflection after winding the transformer in the pictures... Because the ground connection is at the bottom of the winding P (Main output), it would be better to put Q under P. This will lower the amount of coupling from the high voltage winding to the low voltage winding. The order has been adjusted to reflect desired stack-up.

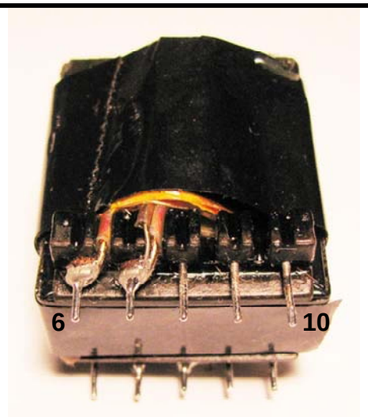
<u>Glossary of terms and abbreviations</u>

T	Turns
L	Layers
BF	Bi-filar, 2 wires in parallel
WD	Wire diameter, bare wire
CM	Circular Mils
V	Volts
A	Amps
F/S	Faraday (Voltage) shield
B/S	Gauss fringing field shield
Pri	Primary
Sec	Secondary
Kapton	1 mil thick adhesive backed Kapton polyimide tape, appox. 3 mil total thickness.

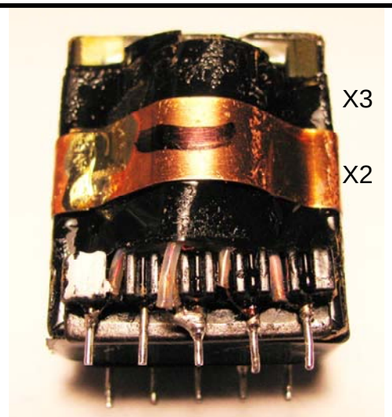
GPC41-5 TRANSFORMER REWIND 2/6



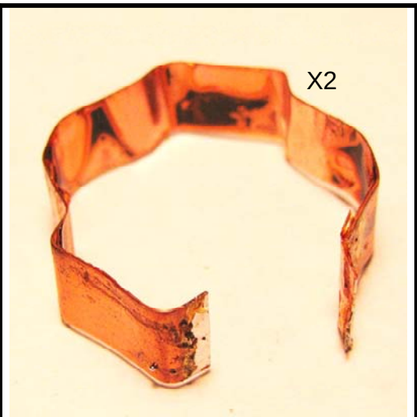
The transformer before modification, Input side connections (1-5) shown. Pin 1 has been marked with a white dot.



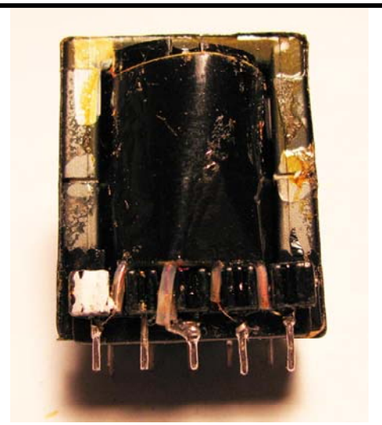
Transformer before modification, Output side connections (6-10) shown.



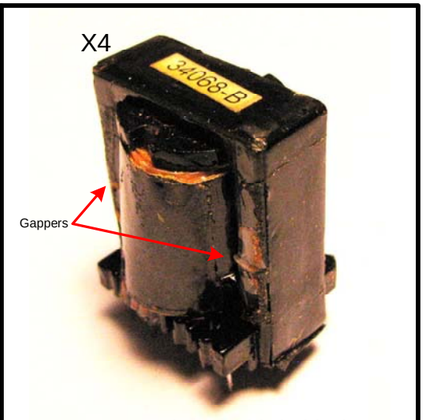
Outer black tape wrap removed showing core gap gauss field shield (Copper strap).



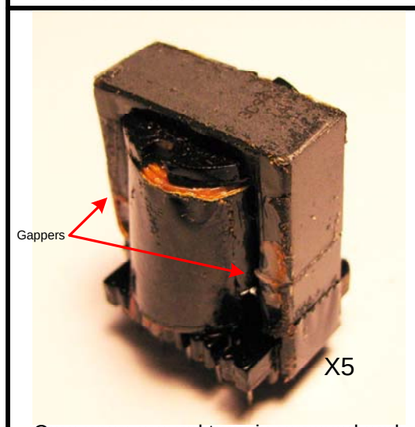
Core gap gauss field shield removed by desoldering at overlap.



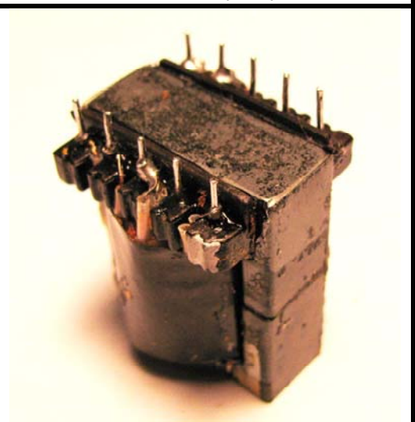
Next layer of black tape removed, this isolates the core gap shield from the core.



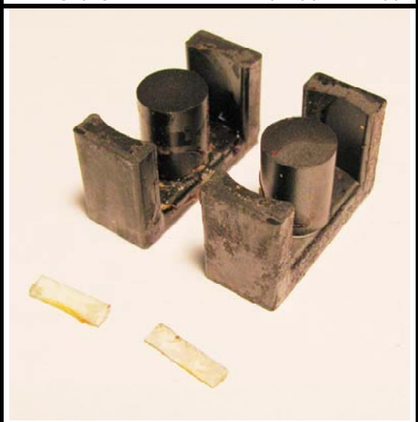
Core wrap-around tape; this holds the core halves together during varnishing. Notice core gapping inserts at arrows.



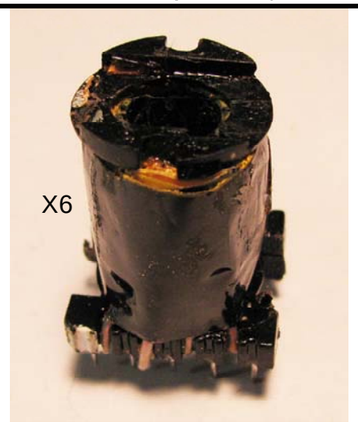
Core wrap-around tape is removed and core bottom tape exposed. Again, notice the core gapping inserts at the arrows.



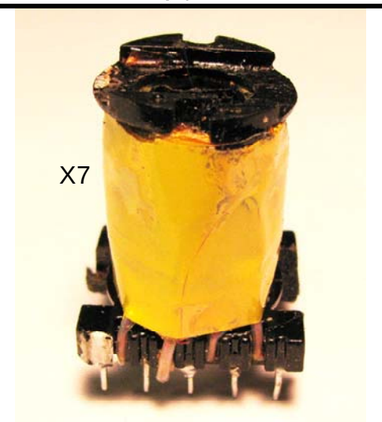
Core bottom tape removed, now the cores can be heated and pulled off the bobbin.



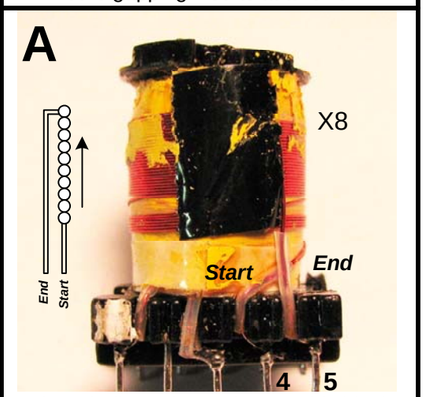
Cores have been removed, save the gapping inserts to put back later!



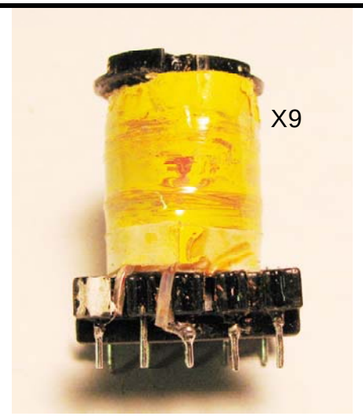
Transformer is now ready to be unwound, start by removing winding cover tape.



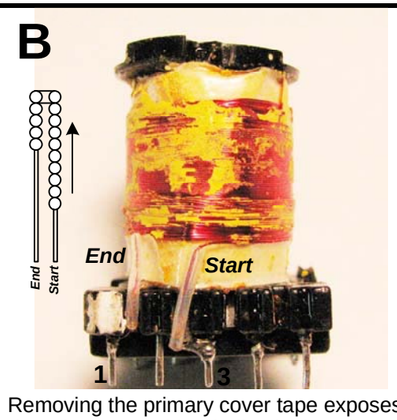
Primary side high voltage tape, remove this to expose the "Bias" winding A.



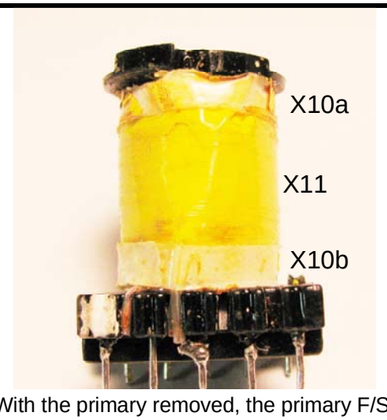
Bias winding A is one layer. This black tape holds the "End" of the winding in place while it's routed to the bobbin. This winding will be put back later with fresh wire.



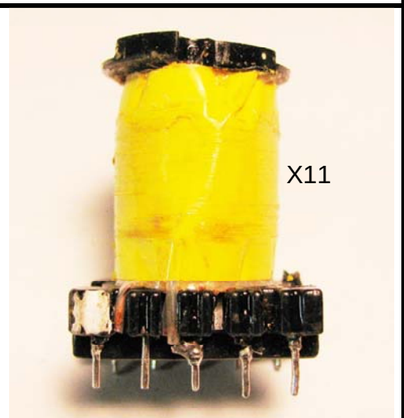
With winding A removed, the primary cover tape is exposed.



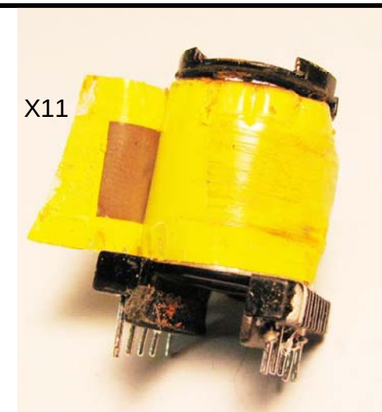
Removing the primary cover tape exposes the primary B. This winding is done in 1.5 layers and will be put back later with fresh wire.



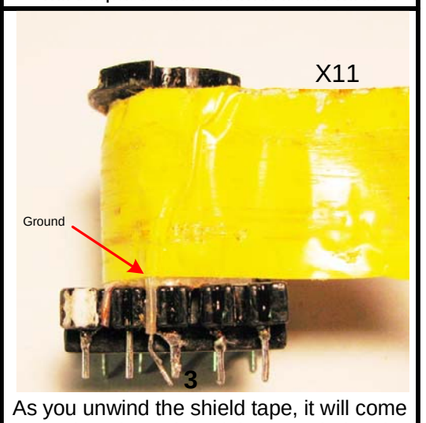
With the primary removed, the primary F/S covertape is exposed as well as the edge bumper tape which keeps the windings flat. Notice that primary D remains on 1 and 3.



Remove the edge bumpers to expose the primary F/S which has copper tape stuck to its underside.

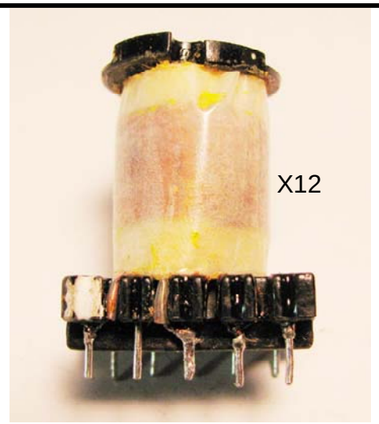


Remove the primary F/S.

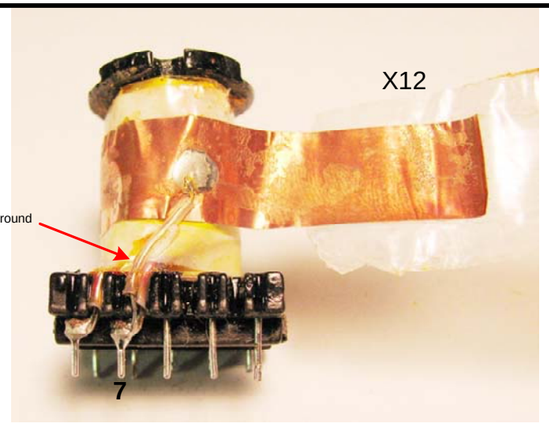


As you unwind the shield tape, it will come around to pin 3 where it is grounded to the primary side of the transformer. Carefully unsolder the wire from the bobbin.

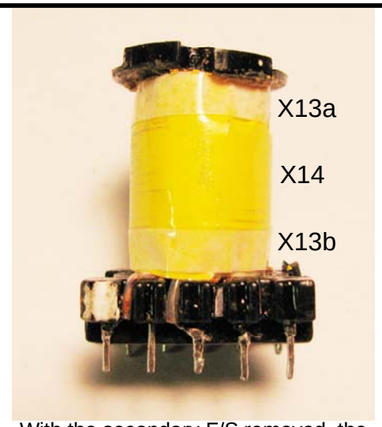
GPC41-5 TRANSFORMER REWIND 3/6



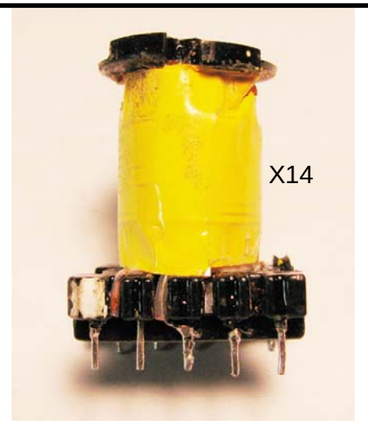
Removing the primary F/S exposes the secondary F/S.



Unwind the secondary F/S until you get to pin 7 where it is connected to the output ground. Unsolder the wire from the pin before unwrapping the shield completely.

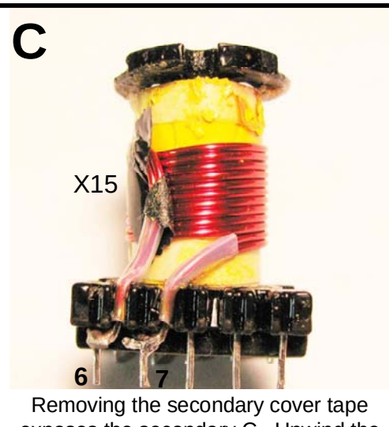


With the secondary F/S removed, the secondary cover tape is exposed as well as the F/S leveling bumper tapes.

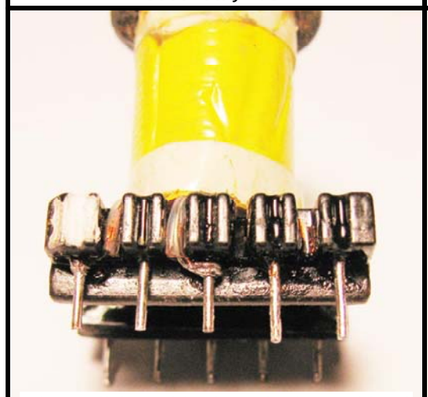


Remove the bumper tapes and the secondary cover tape.

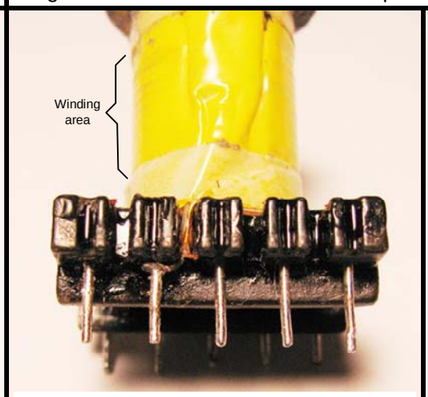
C



Removing the secondary cover tape exposes the secondary C. Unwind the secondary after unsoldering the wires from the bobbin and recycle the copper!

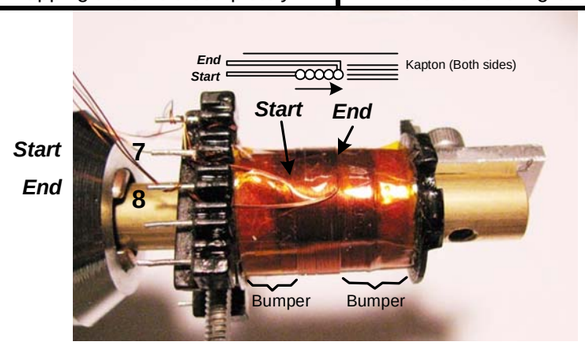


Clean off the solder from the input side of the bobbin, getting the pins ready for the primary and bias windings to be replaced, now named N and M respectively.



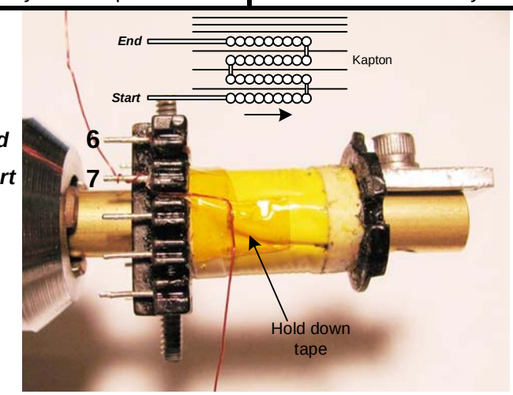
Clean off the solder from the output side of the bobbin, getting the pins ready for the new secondaries Q and P. The secondary bumper tapes define the winding area.

Q



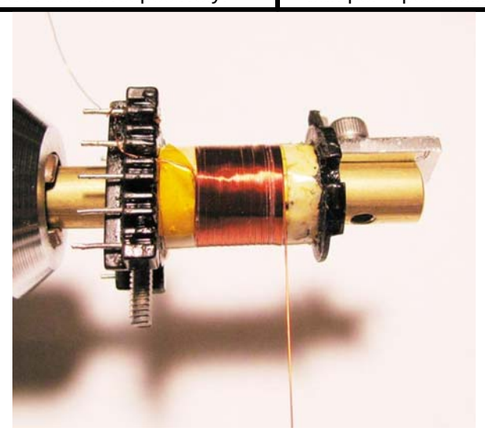
Starting at pin 7, wind Q with 12 turns of #28 AWG centered in the winding area ending at pin 8. Wind leveling bumpers to the right and left of the the winding with 4 turns of Kapton and cover the entire winding and bumpers with 1.25 turns of Kapton. ***Note that the P/Q winding pictures are out of order from this sample since it was decided after the fact that Q should be wound first to lower the coupling to the high voltage winding P.***

P



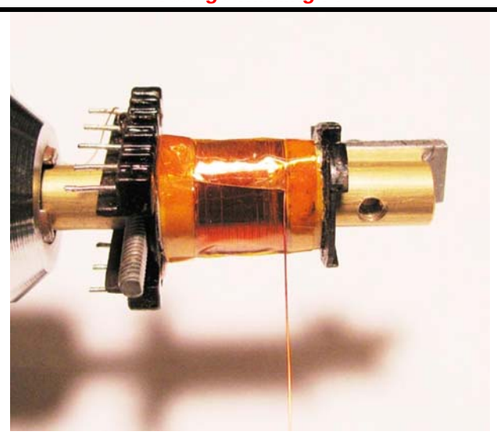
Starting at pin 7, wind P as 4 layers of #32 AWG using the white leveling bumpers as a guide. A small square of Kapton holds the wire in place as the winding is started. Between each layer put 1.25 turns of Kapton and then the whole winding is covered by 3 layers of Kapton to insulate it from, and lower the coupling capacitance to, the Sec F/S.

P



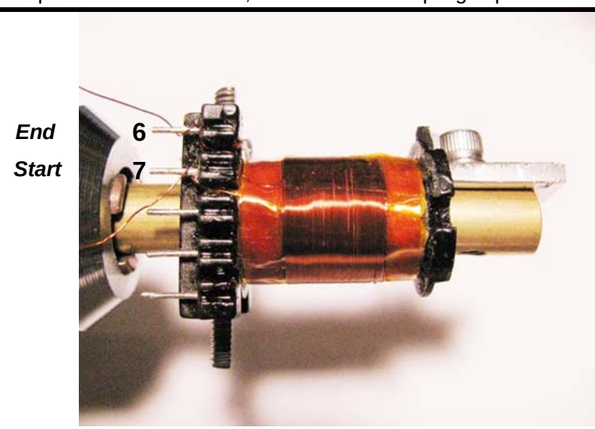
This is the first 54 turns of secondary winding P.

P



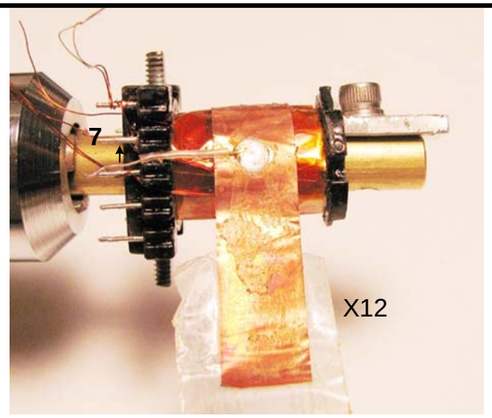
Cover the winding with 1.25 turns of Kapton to insulate it from the next winding. Do this between each of the following winding layers.

P

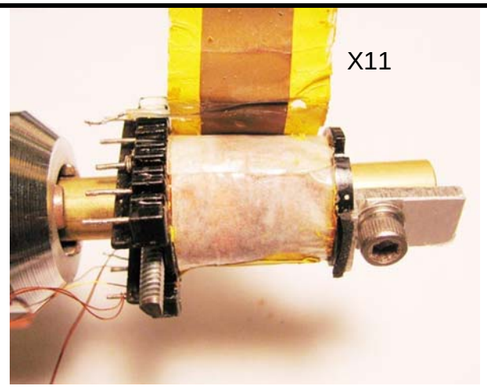


Repeat the process until all 4 layers of 54 turns each are wound for a total of 216 turns ending at pin 6. Cover the entire winding with 3 layers of Kapton.

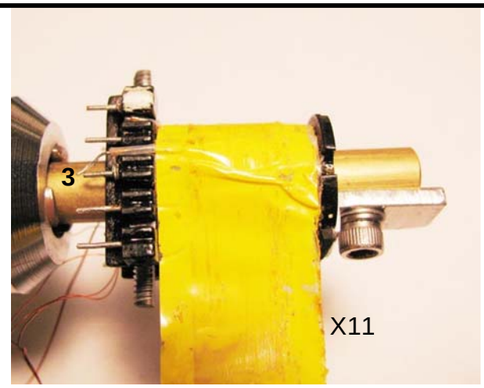
GPC41-5 TRANSFORMER REWIND 4/6



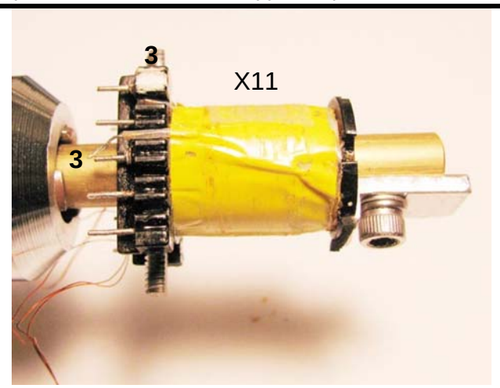
I threw away X13, X14 and X15 and go right to X12 (The secondary F/S) putting it back in place with its wire connected to pin 7, the output ground. Be sure there are no cuts or openings in the tape that would allow the copper strip to touch itself on adjacent layers.



X11 is put back over X12 lined up so its wire can be reconnected to pin 3, the input ground.

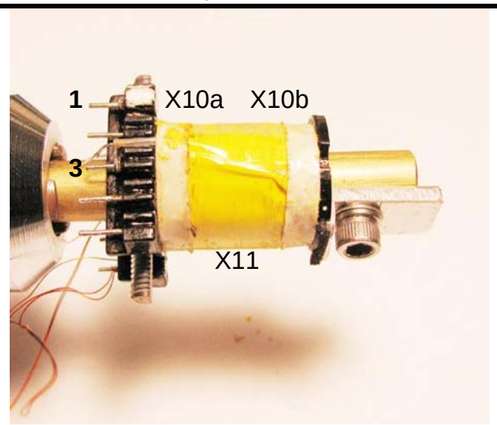


Continue wrapping X11 ensuring its wire lands on pin 3.



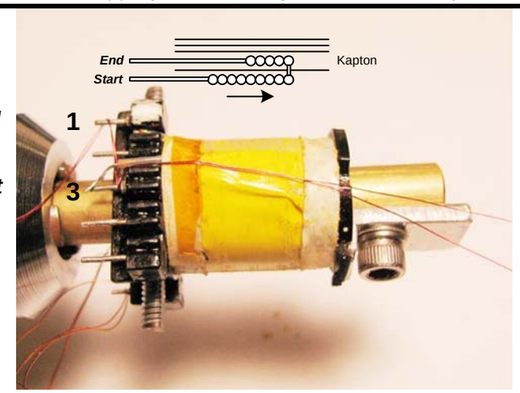
X11 is completely replaced.

Make sure, just as with X12, that there were no cuts or openings in the tape that could allow the copper strip to touch itself on adjacent layers. Called a "Shorted turn", it will make the primary side controller go into permanent current limit.



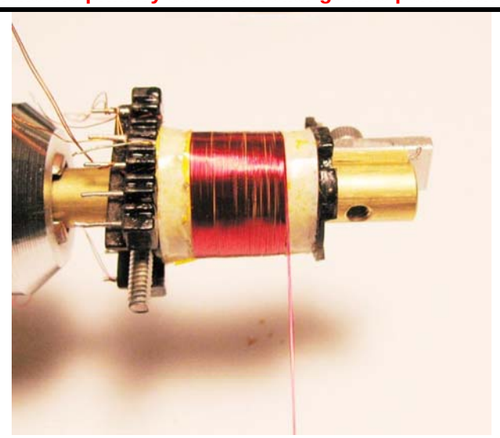
Replace the leveling bumpers, these will define the winding area for the primary.

N



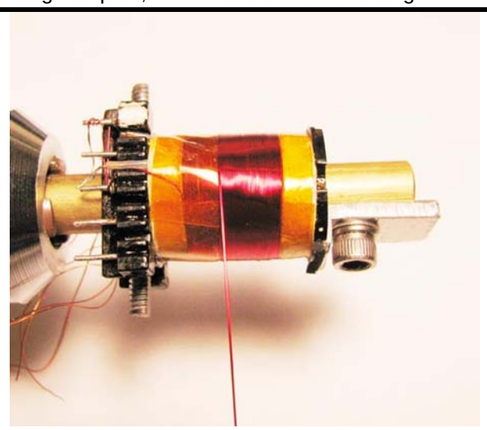
Starting at pin 3, wind 67 turns bi-filar of #35 AWG ("bi-filar" means two wires side-by-side) . The first layer will take about 40 turns and make sure to keep the winding flat without any cross-overs! The first layer will be covered with 1.25 turns of Kapton and the whole winding covered with 3 layers of Kapton.

N



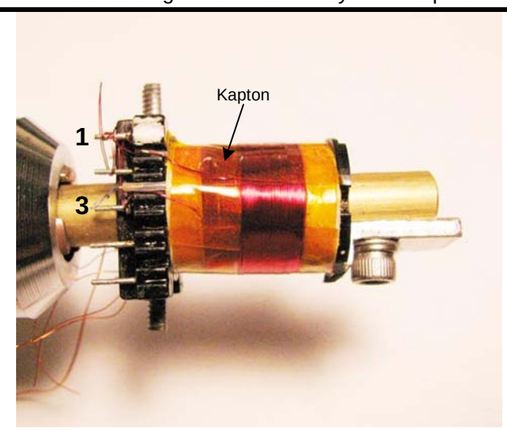
This is the first layer of approximately 40 turns for the primary winding, cover with 1.25 turns of Kapton.

N



Continue winding the remaining 27 turns over the first layer.

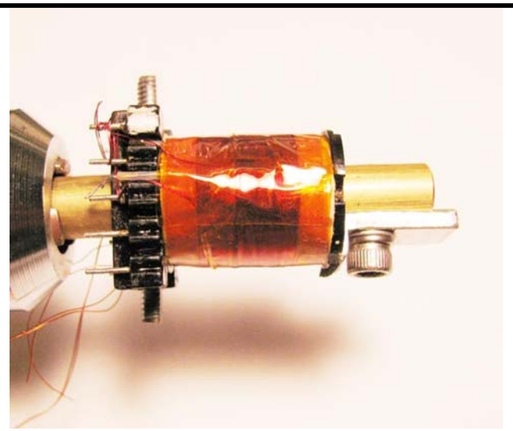
N



Use a small square of Kapton to hold the end of the winding in place and route to pin 1.

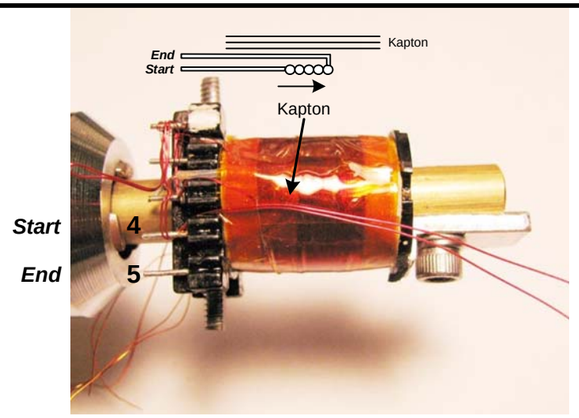
GPC41-5 TRANSFORMER REWIND 5/6

N



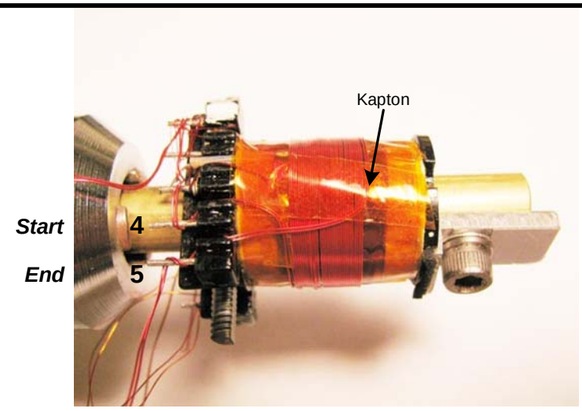
Cover the primary winding with 3 layers of Kapton.

M



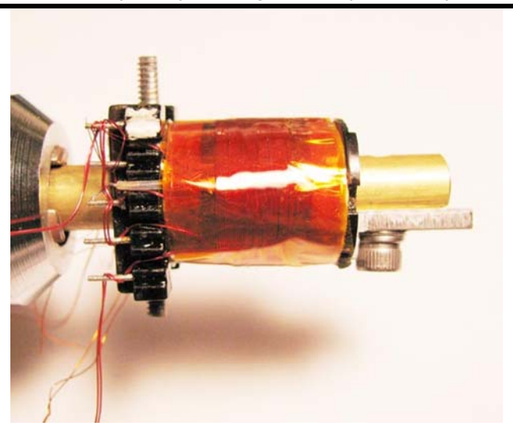
Starting at pin 4, wind 17 turns bi-filar of #30 AWG. This winding should be centered over the primary winding beneath it. As with the other windings use a small square of Kapton to hold the wire in position.

M

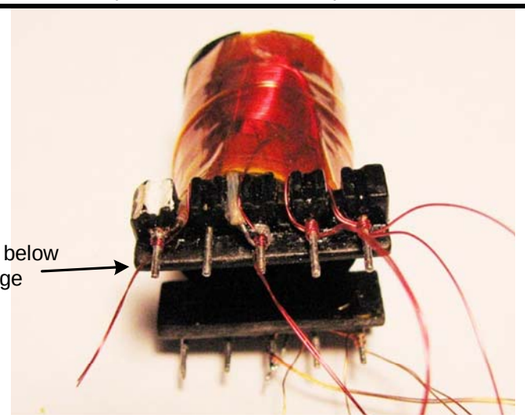


Finish the winding by securing with Kapton and route to pin 5.

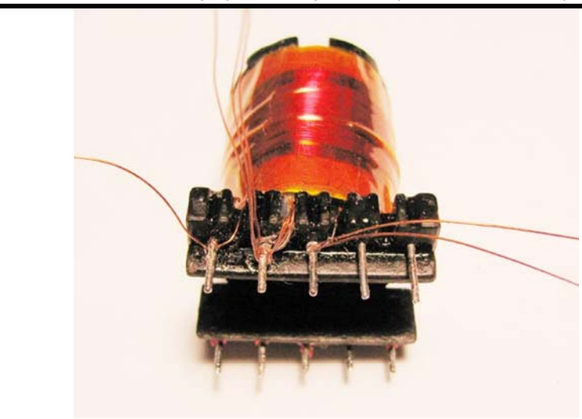
M



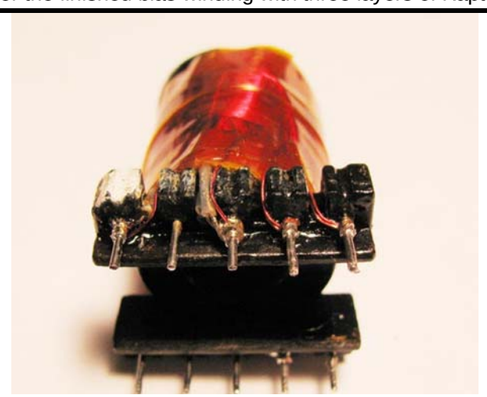
Cover the finished bias winding with three layers of Kapton.



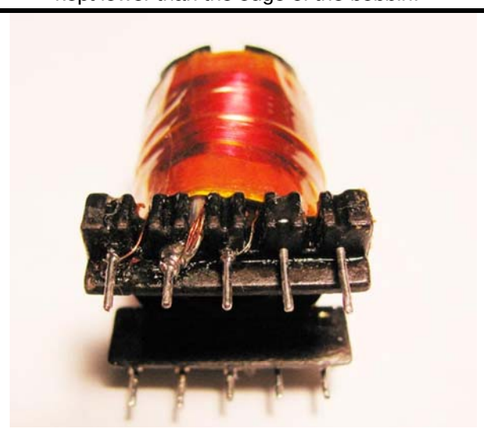
Now it's time to connect the wires to the bobbin pins. This is the input side connections, route the wires to the correct pins, wrapping them around the pins twice. Wire should be kept lower than the edge of the bobbin.



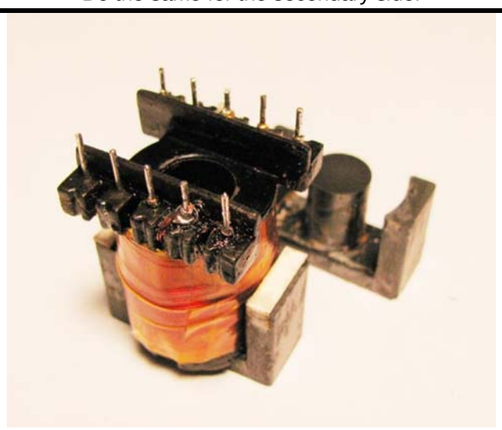
Do the same for the secondary side.



Trim off the excess wire on the input side and solder the wires to the pins. Polynylon insulated wire (Brightly colored) can be stripped and soldered at the same step with an iron set above 450C. Polythermalese or Formvar wire (Brown or dark brown) must be mechanically stripped before wrapping on the pins.

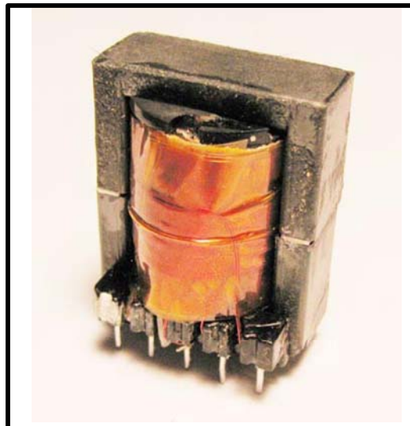


Do the same for the output side of the transformer.

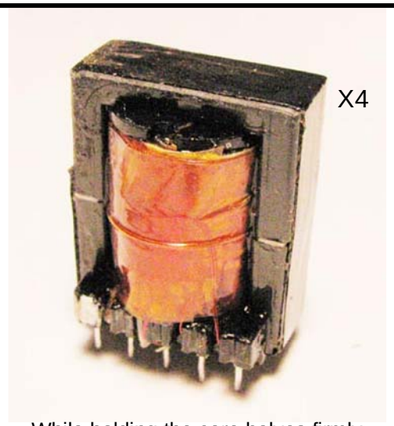


Assemble the core set to the bobbin, replacing the two white gapping spacers on the outer legs of the core. I chose to not put the X5 tape pieces back onto the core.

GPC41-5 TRANSFORMER REWIND 6/6

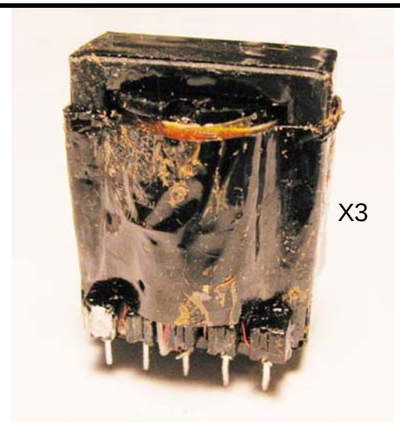


Put the top half of the core into the bobbin.



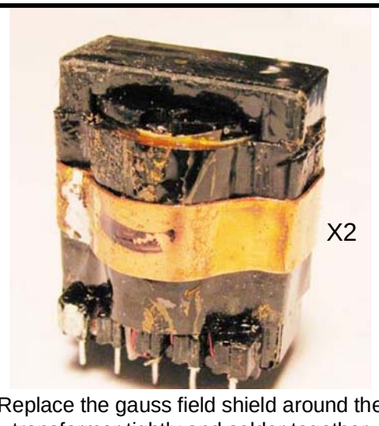
While holding the core halves firmly together, wrap the core tape around the cores to hold them in place.

X4



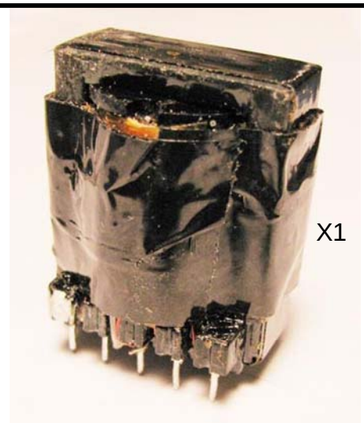
Wrap the shield to core insulator tape around the transformer.

X3



Replace the gauss field shield around the transformer tightly and solder together being careful to not melt through the tape underneath.

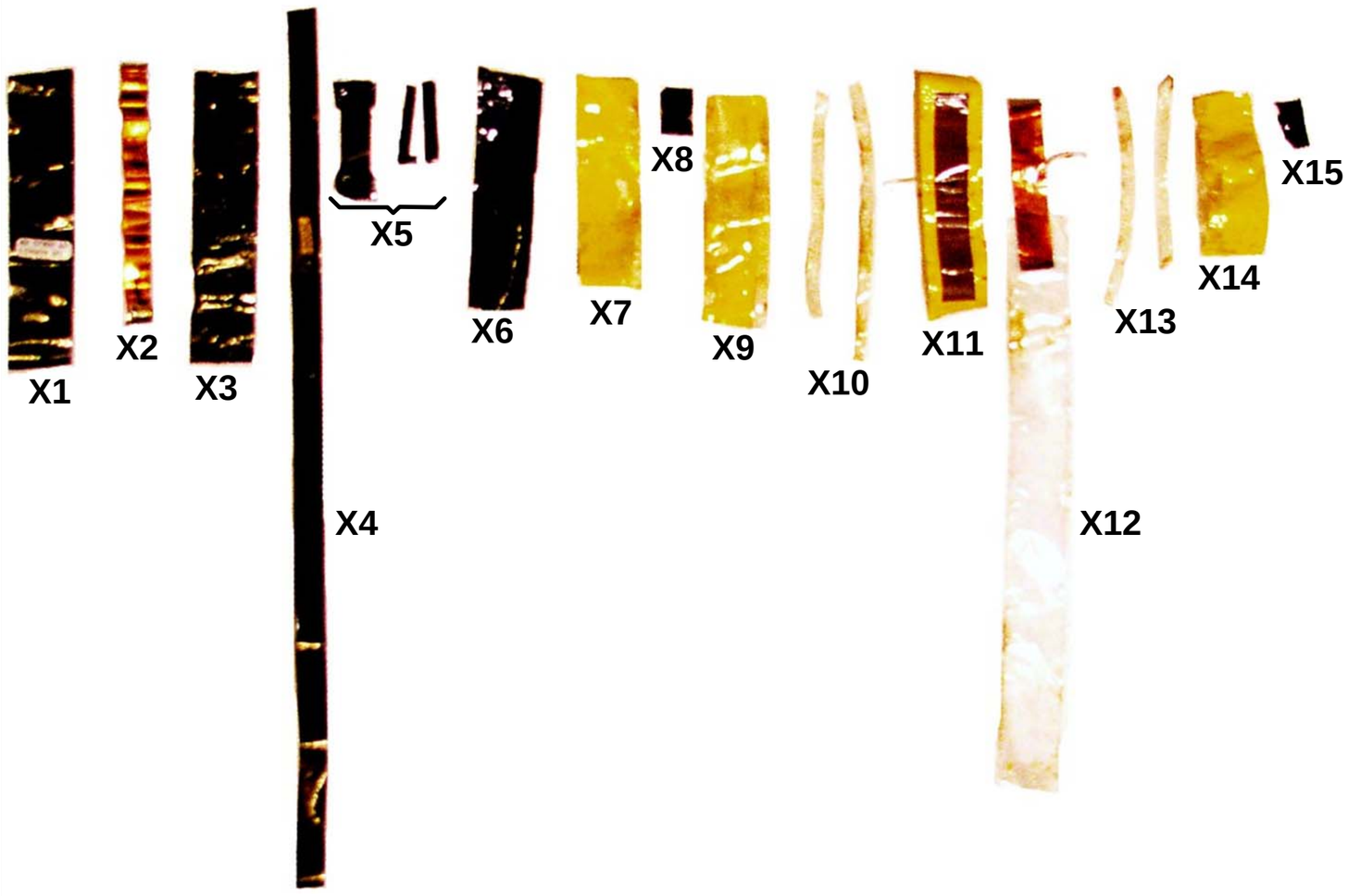
X2



Wrap the transformer with the outer insulation tape.

X1

Apply varnish or other coating to glue the assembly together. Extra varnish in the center leg space will help keep the cores held tightly together.



Wrapping nichrome wire around the cores and slowly heating them with a DC current will soften the varnish and allow them to be pulled of the bobbin. Test the varnish softness with a sharp object and slip off the heating coil when ready. Avoid quick heating as the temperature differential across the cores will cause cracking. Be patient as the thermal conductivity of ferrite is very low.

When pulling the transformer windings apart, put up the pieces in the order they were removed to allow them to be reused. Take a picture or sketch the layup of windings that need to be replaced and use fresh wire. Note the pin numbers and connections of the windings and shields, paying particular attention to the direction or "Phasing" of the windings. Phasing is CRITICAL.

When measuring the wire diameters, carefully burn off the insulation before measuring it. Heavy insulation on fine wire can be a large percentage of the insulated diameter. A wire table can be used to determine the gauge: http://www.tayloredge.com/reference/Tables/wire.pdf