

Tannoy 315 HPD Loudspeaker Project



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Background:

I have been interested in Tannoy loudspeakers for a few years now and have owned both vintage and modern versions (Tannoy Mansfields and Tannoy Turnberry Prestige). They have an indefinable draw which for me is how they convey scale and also the strength of the stereo imaging, both are effortless and somehow more natural than many other speakers seem to manage.

I prefer the older versions though, particularly the HPD models which have greater clarity through the all important midrange than the Prestige series, and seem less prone to crossover distortion and "honk". I parted company with my Turnberrys because I could not bear to listen with them to opera any more, so sensitive was I to that upper mid/lower treble distortion.

Luckily for me I found some used Mansfields of 1974 vintage, perhaps one of the last pairs built in London before the move to Coatbridge in Scotland of the Tannoy factory. The Mansfields used 12 inch HPDs and they were in need of complete restoration. I had the drivers re-coned and new voice coils, suspension and foam surrounds fitted, but decided against keeping the cabinets as like many similar vintage Tannoys, they were not the best quality, prone to resonance and insufficient in volume to get the very best from the 12 inch HPDs, although they weren't that bad either and a definite improvement on earlier Lancasters. A new speaker project was born which would ultimately conclude with the birth of the "Reference Fidelio" Loudspeaker which has now become a commercial venture such was the success of the design.

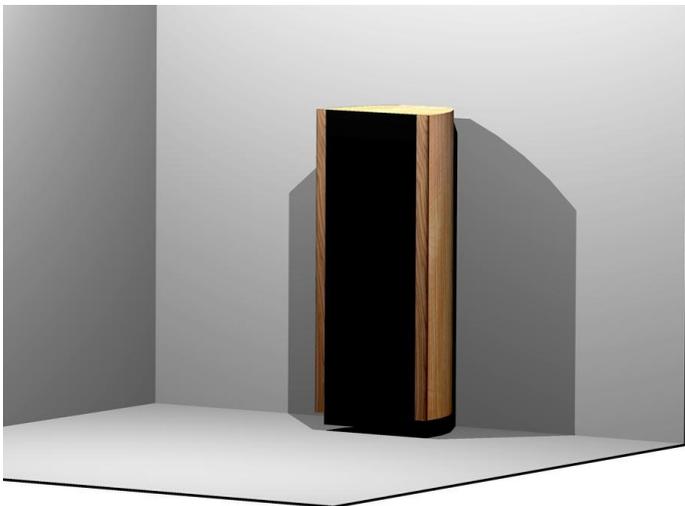
Design

Having researched information on Tannoy cabinet matching, I was aware that Alex Garner (of Tannoy) had historically recommended that the best reflex cabinet size for 12 inch MG drivers was 150 litres, so this was a good starting point (albeit not the final volume). I had settled on reflex cabinets as they are easier to get right than more complex designs although I was also aware that DC drivers do not model as well as other designs, so that some fine tuning would likely be in order.

I decided right from the outset that cabinet distortions had to be very low, loudspeaker efficiency as high as possible whilst balancing that with the best bass response possible for the HPDs. There are several schools of thought nowadays on cabinet design. Some companies believe that no damping is a good thing because allowing energy to be dissipated in the cabinet as long as the resultant resonance is either very high or very low in frequency terms will result in a clear midrange plus the cabinet itself adds to the tonal character of the loudspeaker. I do not altogether agree with this as a definitive design philosophy because it encourages cabinet colourations and no-matter how it's

squared, it can lead to cone phase distortion as out of phase information is reflected back through the cone muddying the sound.

I settled on a well damped very rigid cabinet design and decided on curved side panels to help with structural stiffness and to help prevent internal standing waves. A CAD mock-up was produced:



After several weeks of maths working out critical dimensions and some modelling undertaken using WinISD, the ideal volume for the HPD seemed to be between 160 and 170 litres. Gross volume of the design was 178 litres. To generate a very smooth bass response free of bass lift which might coincide with room reinforcement, EBS tuning was selected (extended bass response) and this meant the use of two 100mm diameter ports, 225mm in length tuning the cabinets to around 31Hz ($F_6 = 28\text{Hz}$). That allowed for in-room reinforcement and baffle step losses to cancel each other out below 200 Hz which in theory suggested a fairly flat response. So far so good!

Construction was based upon the use of 24mm Birch Ply for all panels, and a lamination of 24mm Birch ply and 6mm MDF for the front baffle. All panels were to be surface damped to ensure a reduction of panel resonance time and bracing was to be employed to stiffen the panels up to take individual panel resonance above midrange frequencies where it could do no harm. I was very careful in calculating the dimensions to ensure that bracing broke the panels into different sizes such

that no one panel could amplify sympathetically resonances in a neighbouring panel. It's also worth noting that not one single dimension, either internally nor externally is divisible by any other to reduce any risks of standing wave formation. There was also to be a sloping internal base to ensure that it was not parallel with the top panel.

Construction:

Construction started!



One of the side panels being laminated from multiple ply layers in a DIY vacuum former using high grade PVA glue. The glue was selected to be "lossy" so that it never sets hard but remains slightly flexible. Another way to win the battle against unwanted resonance!



Ports before spraying black and extending with some uPVC pipe couplers (flared at the ends using a heat gun and former). I glued some wool felt to these again in my obsessive target of controlling internal reflections, possibly overkill though.



Side panels Glued to base and top panels. At this stage, the veneer had already been applied to the side panels in the vacuum former as that was the best way to achieve a bubble free veneer!



Veneer selected had to be light enough to work in modern surroundings as darker woods could have made the cabinets dominate too much. I selected a Ripple Sycamore.



Next stage was the internal bracing and sloped internal base. Each brace had to be individually cut and shaped to ensure a millimetre perfect fit so this was very time consuming. Part of the issue is that the formers used for the side panels were hand-made and had minor inconsistencies, so if done again, CNC cut formers would be used.



Rear panel fitted. Note the cut-out at the base. This is where I wanted to fit removable crossover panels. I didn't want external crossovers in boxes because of the unwanted extra boxes and wiring.



Internal padding out: Internal surface were first sealed then 2mm of bitumen sheeting applied to all surfaces. Next, 40mm foam (acoustic coeff: 0.7) was glued in place. On the middle chamber section I also glued in 12mm dense wool felt beneath the foam as this was the largest un-braced panel section, so the additional wool helps with both panel damping and to help absorb rear energy from the driver. Over the foam, but just in the middle section, I applied 35mm of 75% long lambswool/25% polyester wadding. I later removed the wadding from the sides, top and bottom because it proved to over damp the cabinet, so I only left the wadding to the rear directly behind the cabinet.



One of the front baffles following veneering. Here, the veneers had to be carefully book-matched. I had Neodymium magnets bonded into the baffle beneath the veneer. I thought that this would be a sneaky way to secure the speaker grilles!

Holes had yet to be cut for the driver and ports.



Baffle glued into position and baffle edge strips (oiled American Black Walnut) added. The grille will fit neatly in between the edge strips which have rounded edges on the corners of the baffle to improve baffle performance. The top of the cabs has now been veneered and a 50mm curved plinth added to the base.



Finished speakers! I added the classic “lightning strike” Tannoy badges to the grilles in recognition of the legendary drive units used in this build. Some more pictures:



At this stage I had fitted commercially available fixed value inductor crossovers from a supplier recommended by a fellow Tannoy enthusiast. However, the speakers didn't sound right. They were too "toppy" having way too much HF detail and lacked midrange. Initially I feared the worst and started ploughing through the 25 pages of calculations drawn up for the speaker design, but all seemed fine. I then suspected the new crossovers so whipped them out and had a look. Out came the multi-meter and sure enough, two of the 3 inductors were the wrong value as was one of the resistors.

The mistakes seem to be very common and are the result of misunderstanding Tannoy's circuit diagram for the 315 crossovers. What Tannoy set as the "flat" setting on the autoformer is in fact electrically raised (the Yellow tap) and whilst the inductance of the yellow tap is roughly 4mH, it is has raised voltage and hence raised treble energy. You cannot simply replace this with a fixed 4mH inductor and expect the crossover to behave like it would if the same setting were used on the autoformer because no voltage gain is present. It's for this reason that many people mistakenly blame HPD's as being overly bright when in fact it's the crossover values selected that are often wrong. The HPD uses an identical tweeter assembly to the Monitor Gold and other DC units of the day so any HF lift has to be due crossover design issues and the selection of inappropriate values.

The correct value to use for the HF inductor corresponds with the Green tap which measured an average of 2.9mH on my old crossovers at 0.6Ohms DC resistance. The Green tap is also electrically connected back to the Orange tap which has an inductance of 6mH so the inductance ratio is roughly 2.0. This means that reflected impedance ratio equivalent must also be 2.0 therefore the fixed value resistor shown as 50 Ohms on the autoformer circuit must become 25 Ohms for a fixed inductor circuit.

All other values should be as Tannoy intended. They knew what they were doing better than meddling DIY enthusiasts (tongue firmly in cheek!) so I figured on leaving the rest of the circuit as they designed it. The result is shown below:



Capacitors are (all bar one) Clarity Cap ESAs. Inductors are from Janzten, the LF and notch filter inductors are air-cored although that's probably overkill. I was careful to ensure electrical compatibility with the originals, so the DC resistance measures EXACTLY as per the Tannoy originals. I had to add a resistor to the notch filter inductor (in series) to achieve the 2.6Ohms required. PCBs are custom built and fit the space for my removable panels at the rear of the speakers.

Final touches include the very flash Furutech Torque-Guard FT 809G binding posts:



Sound Quality

Did they sound as good they looked? Well not at first due to the crossovers, but with the new DIY crossovers in place, WOW! It's hard to believe that what I was listening to was a 40 year old Tannoy HPD driver doing all the work. Bass wasn't just beautifully balanced in-room but using a frequency test recording, they delivered clean bass all the way down to between 28 and 30Hz before starting to roll off steeply, exactly as predicted. EBS tuning seems to work well with these units and I would happily recommend anyone doing a similar project to try low tuning between 30 and 32Hz.

Mid-range was much improved from the Mansfield cabinets. Again, these new crossovers gave a fullness and richness to the mids that invited extended listening. The clarity was superb even at very

very high SPLs, which I guess is a testament to the design philosophy used for the cabinets. HF detail is exceptionally good without ever getting sharp or overly bright, so all the boxes seem to be ticked.

Addition Gains

What I hadn't bargained for was the change to stereo imaging. This can be thought of as the output of several factors: the recording itself (ie how it has been mastered), the replay systems (channel separation performance) and the loudspeaker and crossover design. It's the latter two points here that were game-changers. The rounded baffle edges, the setting out of the drive unit and the crossover design all combine to give a wider-than-life image which seems to extend well beyond the speakers. I tried moving the speakers 2m apart, much closer than normal, but the image seemed to stay rock solid over a 4m space! Front to back was typically Tannoy, a little recessed but seems to extend further back than before. Pin-pointing of musicians and instruments in the mix (providing the information is on the recording) is also excellent. These seem to image as well as the very best stand mounters I've heard, which I find extraordinary given their size.

The Outcome

I have been so delighted with the outcome of this project that I have now started to offer to build these for other people as they deserve to be shared! They are available as cabinets only, cabinets and crossovers or as a completed speaker package. I have also deemed them worthy of one of my "Reference" tags (from my Reference Fidelity Components products) and they are now part of my product line up and are known as "Reference Fidelio" loudspeakers. (If you want to read more about them, you are welcome to visit my website). They cannot be cheaply produced since about 200 hours is invested in each pair not to mention top quality timbers, veneers and components but I can vouch for their extraordinary performance which I believe does elevate them into modern "high-end" loudspeaker territory.