HAMMOND Tone Cabinet 12-77.

Forewords.

While I like the X-66 console, I'm not that enthousiastic with the TC 12-77 concept. Having worked during 17 years in Hi-Fi business with Marantz, I have acquired a certain expetise in both amplifiers and speakers design.
Seen from the outside, this tone-cabinet is rather bulky, heavy, imposing and nice. However, to my opinion, the inside is much less impressive.

In the 60's, it was easier to design a good power amplifier with tubes than with transistors. During that period, only Ge(1) transistors were available at affordable cost. Those Ge devices had limited specifications in terms of power, voltage, junction temperature … and were not as reliable as today's Si(2) power transistors.
Because of those restricted specs, the designer was forced to reduce the DC power supply to about +/- 30Vdc entailing so a limited power output.

The speakers used in the upper part of TC 12-77 are really low-cost ones. Just have a look to the magnets of the 8" transducers, thickness of the basket and fixation screws. Moreover, the horns of Tibia 'A' and Tibia 'B' are installed vertically ! Every engineer involved with speakers design should know that horn tweeters have to be mounted horizontally for better "high-tones" dispersion diagram. Those are fundamentals of acoustics. Also Tibia 'A' & 'B' speakers are installed on the back side of the front speakers with almost no opening for the sound pressure to get out and the cross-over is composed on one single capacitor of 3 µF. Really surprising. Intermodulation distortion (IMD) between speakers should be also terrible.

Other inadequacies are on the amplifier chassis itself. The adjustable gain controls should be positioned on the control panel and there are more.

TC 12-77 was probably the last attempt of Hammond Co to compete against Leslie Co but, to my opinion, they failed and have taken a good decision to stop designing tone cabinets such as TC 12-77 (or 10 Series) that are not at all in line with the X-66 console.
Of course, this is a pure personal opinion.

(1): Ge = Germanium semi-conductor
(2): Si = Silicon semi-conductor

Power Supply A0-73-1.

This DC power supply is rather basic design. Not to much to talk about.
The four filter capacitors (C101 ~ C104) did show some sign of aging and have been replaced by new ones (2x 16.000 µF & 2x 10.000 µF).
It is quite important that symetrical output voltages measured are as close as possible. If not, the DC balance at the output of the power amplifiers will not be close to 'zero' Vdc. This should be avoided. In my case, it was not possible to obtain correct +24Vdc/-24Vdc values.

So, the four diodes D105~D108 have been exchanged by new BY550.400 diodes and the exact voltages were so restored afterwards.
The voltages at secondary sides (with 234 Vac input) are as follows:

- 2x 24.7 Vac
- 2x 19.1 Vac

Power Amplifier AO–75-0

In this TC 12-33, the five amplifiers were totally "dead", believe it or not so I decided to rebuild them. The four treble amps are identical, the bass amp is more powerful but based on same design.
For several reasons such as reliability, b-c voltages, availability, etc.. the Ge power transistors were thrown away and replaced by current Si transistors.
However, this change of technology implies some modifications in the bias voltages (e-b voltages) and other unexpected phenomenons (oscillations) were noticed but resolved later on due to superior performances of Si semi-conductors.
Here again, all the elco's were systematically thrown away and replaced by new ones. (Panasonic cap's – 105℃ i.s.o. 85 ℃ are pr eferred).

As a general rule, if the power amp is blown, it's always a good decision to also replace the driver and even the pre-driver devices at the same time.
This is just an advice.

Treble amplifiers (Tibia 'A' & 'B', Bright, Reverb).

The former Ge power transistors 2N1541 were replaced by MJ2955 (refer to datasheet for more details). Since TO-3 cases are identical, it's easier for re-installation on heatsinks. To get the proper e-b voltage, the resistors R422~R425 must be replaced. Refer to schematic here under. Special attention to be taken on those resistor bridges. Try to select values of resistors as close as possible from each other. Ideally, 1% resistors would be needed. If not, the DC balance at the output will never be close to 'zero' volt. This should be avoided.
The other way is to install in paralell additional resistors (the Ohm's law again..) to get the correct 0 Vdc output.
Those resistors R422~R425 have to be installed with ceramic spacers for better ventilation and avoiding PCB overheating.

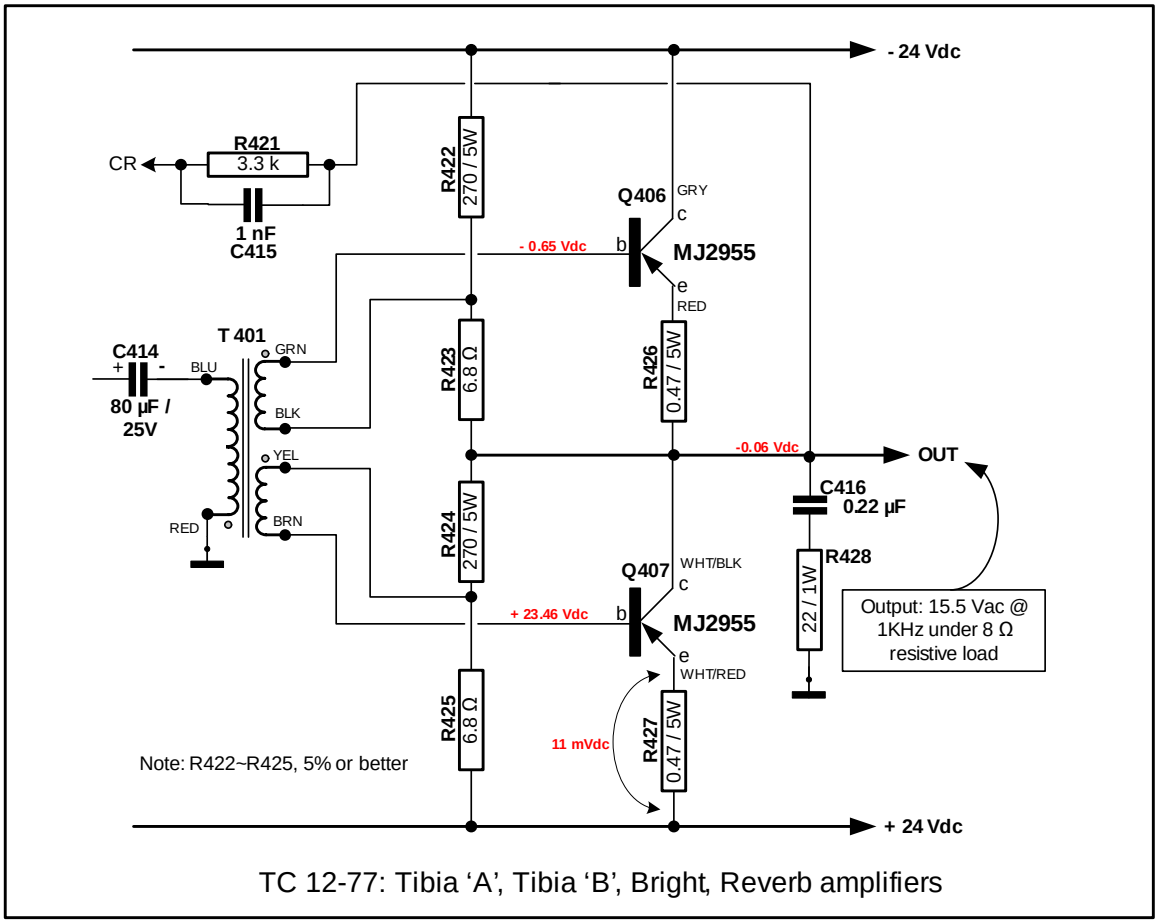
The resistors R426 and R427 were also replaced.
Since PCB's have to dismounted anyhow, carefully check the solders of connecting pins (where all wires are connected). I have found a lot of opened PCB traces, poor soldering, etc.. at that level.
It's also advisable to verify the transformers T401. The primary side should measure 11 Ω and each secondary shoul be in the range of 2.3 Ω, just to be sure.

Measurements on Treble amp's.
After 'rebuilt', the following output levels were measured:

- Tibia 'A' amplifier: 15.7V @ 2 KHz on 8 Ω load, i.e. **30.8 Wrms**
- Tibia 'B' amplifier: 15.9V @ 2 KHz on 8 Ω load, i.e. **31.6 Wrms**
- Bright amplifier: 15.8V @ 2 KHz on 8 Ω load, i.e. **31.2 Wrms**
- Reverb amplifier: 16.0V @ 2 KHz on 8 Ω load, i.e. **32.0 Wrms**

Of course, more tests than the above ones were conducted to check other performances.

Schematic of final stage Treble amp with Si transistors.



TC 12-77: Tibia 'A', Tibia 'B', Bright, Reverb amplifiers

Bass amplifier.

Similarly to Treble amp's, the output devices of the Bass amp were replaced by Si transistors. Here again, the resistors brigdes were replaced with calculated values to correctly bias the Si power transistors. The former 2N458A have been exchanged with MJ15016 type (see datasheet for details).
However, the performances of those devices are far superior than the previous Ge transistors. This was noticed specially in the high-ends generating so abnormal oscillations far above 20 KHz. To overcome this phenomenon, three additional cap's were added (C316, C317 & C318). Refer to schematic diagram. By doing so, those oscillations were totally cancelled out and did not affect at all the bandwidth of this amp.

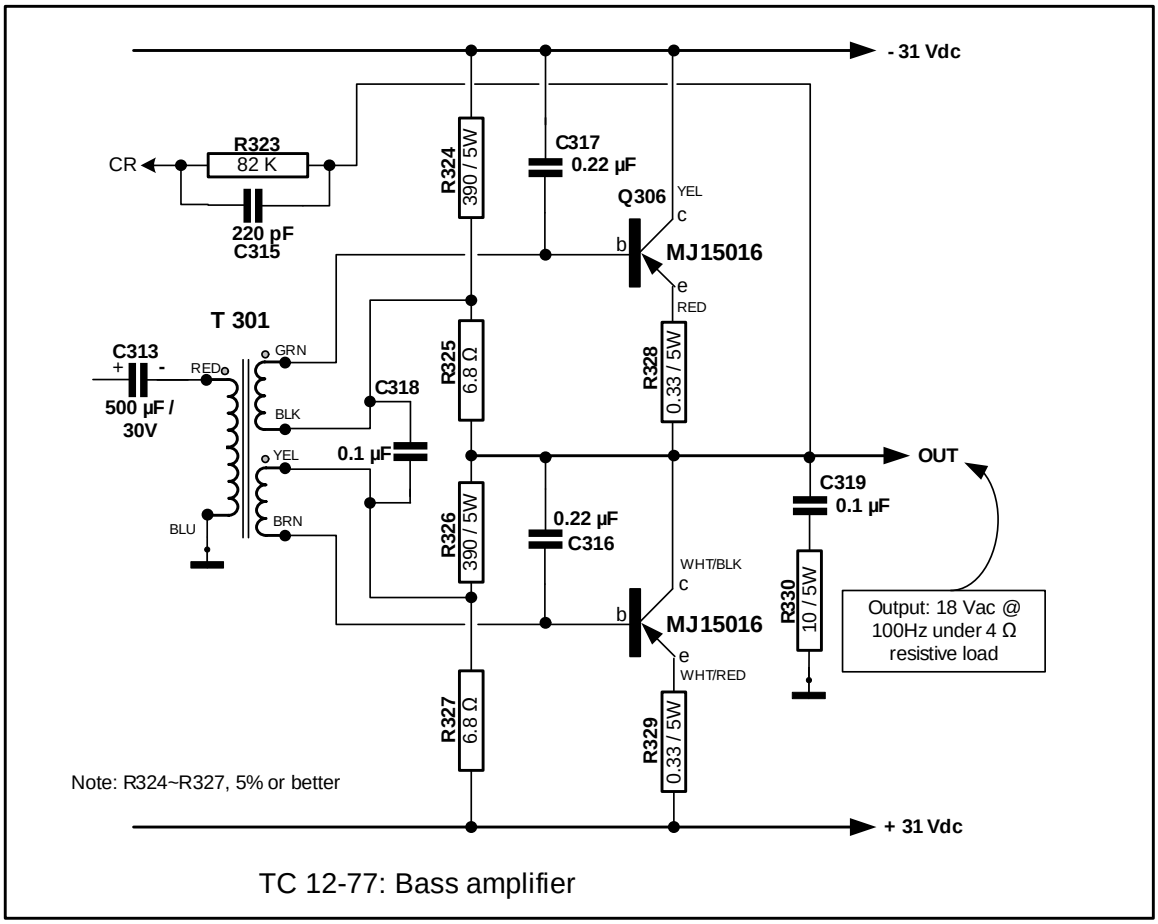
To be noted that one RC cell (C319 & R330) was also added at the output of the final stage. Here again, it is important to select resistors R324~R327 in order to grant a 0 Vdc at the output.

In this Bass amp, the pre-driver and driver transistors were found shorted and were replaced by 2N2904A for Q304 (i.s.o. 2N1375) and by MJ2955 for Q305 (i.s.o. 2N1541).

It's a good advice to also control the DC resistance of the transformer T301. The primary side should be in the range of 7.6 Ω and both secondaries at 2.0 Ω.

Initially, Q305 was shorted. This short-circuit entails the blowing up of resistor R321 (50 Ω, 10W) that was also replaced. A new resistor was re-installed on ceramic spacer as well.

Schematic of final stage Bass amp with Si transistors.



TC 12-77: Bass amplifier

Measurements on Bass amp.
After 'rebuilt', the following output levels were measured:

- Bass amplifier: 18.0V @ 100 Hz on 4 Ω load, i.e. **81 Wrms**

Of course, more tests than the above ones were conducted to check other performances, no problem so far.

Note: it is always a good engineering practice to add one film capacitor (1) in paralell on elco's of high capacitance which is the case here. So, four capacitors of 100 nF/100V were installed on +31V/-31V & +24V/-24V on the amp's chassis itself, nearby the output devices. Not absolutely needed but just to feel better so….

(1) one hundredth of the elco value

Cabinet TC 12-77.

When opening the rear panel of the cabinet, the fiber glass mattress was fallen down inside and had to be repositioned correctly (hot glued) and stapled. Also the front, rear and top panels were covered with felt material in order to reduce internal acoustical reflections.

For information, all my Leslie's are upholstered so providing a more smooth, " velvet sound " due to this damping material. Much more pleasant sound is getting out reducing the listening fatigue tremendeously. This way of doing was recognized by many of my friends organists.

15" Woofer.
The 15" woofer in the cabinet was probably not the original one. When pushing by hand the diaphragm, the bottom cloth was touching the suspension creating some 'sticky' noise. To eliminate this boring noise, a 15" wooden ring of 10 mm thickness has been cut to provide sufficient distance between the membrane and this clothing material.

Crossover network.
Indeed, it is not a real crossover. Only capacitors C417 & C517 are used to feed the horn speakers Tibia 'A' & 'B' channels. Those two non-polarized cap's were replaced as well since capacitance values were found out of tolerances.

Additional comments.

Power supply (recommendation only).
TC 12-77 is powered through the 7-pins cable connected to the X-66 console.

This way of powering while being convenient is questionable for two major reasons:

- European Safety Regulation: such 7-pins connectors with single insulation AC mains cables carrying 230 Vac nearby audio leads is not meeting the European safety regulations. Normally, a separate 3-pins receptacle has to be installed on the connecting panel and earthed according Class I standard. Switching ON/OFF can be done either via built-in power switch of the AC Mains socket or more simply by using wireless command currently found in any electric-shops.
- Audio cables connecting the X-66 console to TC 12-77 are not correctly shielded. Hum and noise is so generated. The longest cable, the worst.

Throw away those obsolete cables and replace them with professional audio cables. At least a -3dB Hum a Noise improvement will be granted . Problem is to find 7-pins male/female connectors to avoid cannibalization of outlet panel of X-66 console.