

7W Power Amp with Cathode NFB

This push-pull 6V6-based amp design delivers powerful sound, while successfully dealing with the issue of negative feedback.

As far as a tube power amplifier is concerned—at least here in Japan—NFB (negative feedback) has long been a topic for argument among amateur amp builders. Some insist that NFB improves THD, while others maintain that NFB kills the liveliness of reproduced sound. I can hardly judge. However, with low THD and a good damping factor non-NFB amps often sound cool and vivid.

To determine the effect of NFB, I first built an experimental amp using triode tube 6CK4. I placed the selector on a beta circuit to produce three different NFB operations—non-NFB, 6dB NFB, and 18dB NFB. I must confess that my poor circuit design produces a harsh sound at non-NFB operation, while 18dB NFB sounds somewhat static. Unfavorable sound of the non-NFB seems to me due to the poor linearity of 6CK4. So, I am convinced that the comments made by most amateur amp

builders are almost correct.

Also, I realize that a designer must make the amp with low THD level without NFB, which should not be used as a trick to improve the measured performance. Should the non-NFB amp

realize low THD and a good DF, the designer would be praised. If you try to design a non-NFB amp, you must carefully select a good power tube with favorable linearity. In my opinion, the benefit of NFB is to stabilize the amp

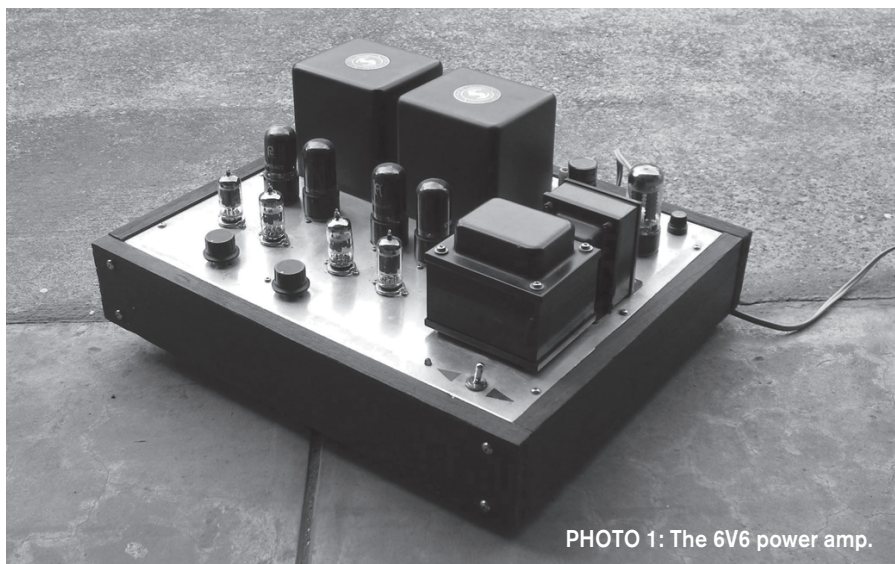


PHOTO 1: The 6V6 power amp.

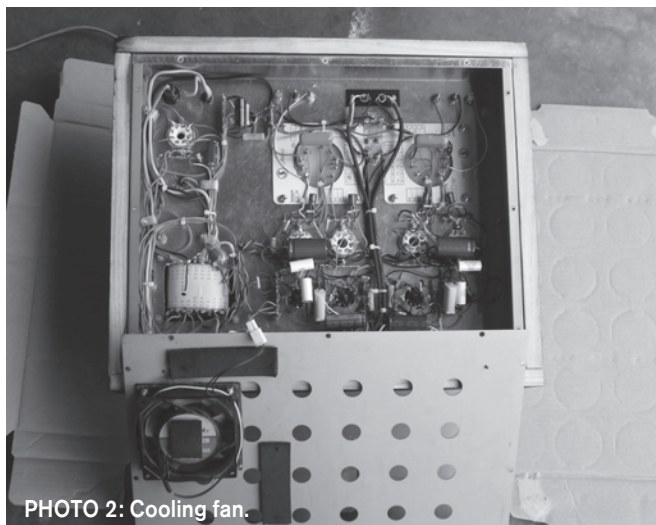


PHOTO 2: Cooling fan.

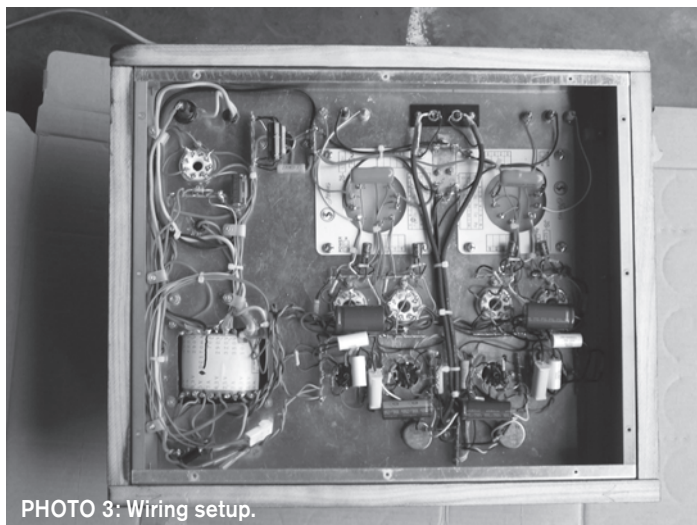


PHOTO 3: Wiring setup.

and keep the performance longer even though the tubes become aged. In this regard, I think this is why commercial amp manufacturers adopt the NFB technique.

6V6 is a good choice if you do not need big power because many amateur amp builders claim it is a nice tube with a tractable character. Also, 6V6 is popular in many brands. The only problem is its high internal impedance.

As a matter of fact, when I first built this amp without cathode NFB, measurement revealed the poor result. The output impedance measured 9.8Ω, which is higher than the 8Ω usual speaker impedance. I am therefore determined to include cathode feedback (CNFB), which dramatically reduces the output impedance to 6.4Ω. How CNFB is valid for the output impedance depends on the tube character. 6V6 seems to react well to it.

CIRCUIT TOPOLOGY

The circuit diagram (Fig. 1) is nothing remarkable. Basically, it is a totem pole first stage with a long-tailed pair that drives a pair of 6V6s. A textbook explains that the totem pole guarantees low THD, wide frequency range, low output impedance, and so on. But to me, the totem pole has another charm. Because the cathode voltage level of the upper tube or the plate voltage level of the lower tube is almost half of the B+

given to the tube, this defines the voltage level of the next stage grid when the first stage and the driver stage are directly coupled and make it easy to calculate the long-tailed pair performance. Heater bias is provided so the cathode-heater voltage stays within the limit.

I believe readers are familiar with the long-tailed pair, so I need not describe it further. A 33k resistor between the first stage grid and input prevents oscillation in the event a nervous preamp such as antique AG1511 is used to drive this power amp. You must solder the resistor quite close to the grid pin; otherwise, the high frequency will be spoiled.

The Taiwan-made output transformer has a wonderful wide frequency range. This OPT can take the power up to 30W, which may be too much for this 7W amp; however, the larger OPT guarantees deep bass. The power transformer is apparently weak in terms of electric current.

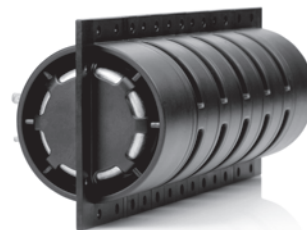
My experience indicates that you can retrieve more DC current with a choke coil and a tube rectifier than the transformer catalog states, but then, it dissipates more heat. Therefore, I installed a cooling fan just under the transformer. The result is beautiful.

WIRING

There are various ways to wire a tube amp. If you compare a classic Western Electric amp with a famous QUAD

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PARTS LIST

Tube

12AT7 (2)	RCA
12AU7 (2)	Philips ECG
6V6 (4)	Russian made, brand unknown
5AR4	Sovtek

Transformer

OPT (2)	James 6238h
Power	Noguchi PMS170M
Choke coil	Noguchi PMC1520H

Cooling fan

AC115V 130mA

Volume

50kΩ B (2)

Capacitor

10μ 450V	
22μ 350V	
100μ 100V (4)	
100μ 250V (2)	
100μ 350V (2)	
0.2μ 400V (4)	film
0.47μ 400V (4)	film

Resistor

220Ω ½W (4)
2k ½W (2)
2.2k ½W (4)
33k ½W (6)
100k ½W (2)
330k ½W (4)
560k ½W (2)
560Ω 2W (4)
5.6k 2W (2)
27k 2W (2)
27k 5W (3)
100k 5W

Chassis

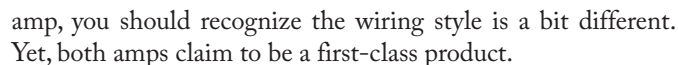
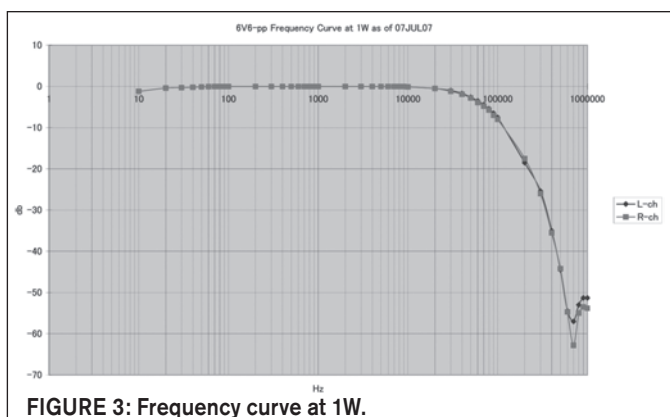
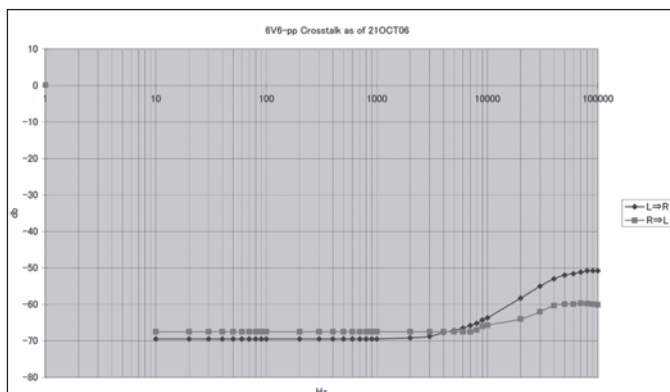
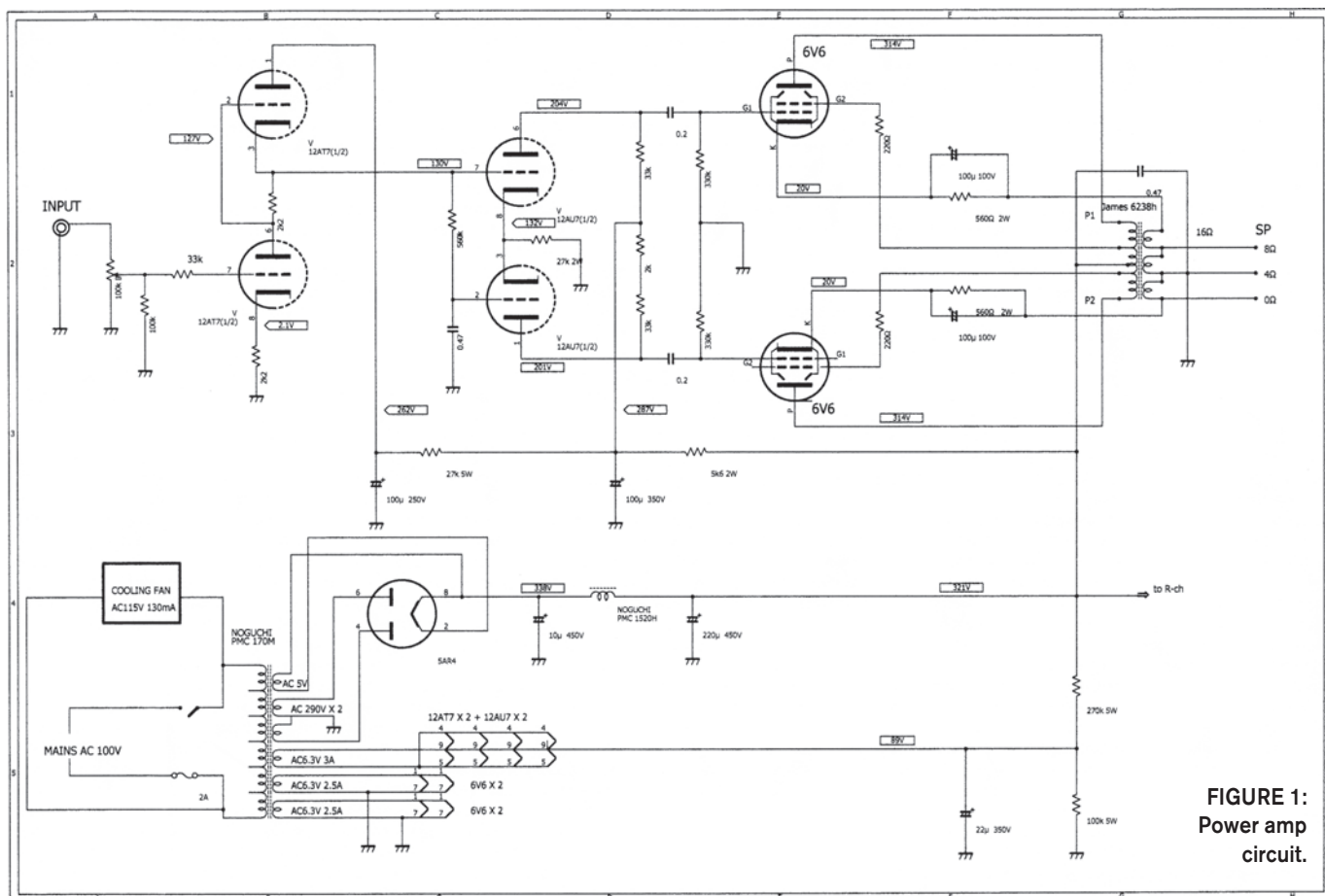
Aluminum	40cm (W) 33cm (D) 8cm (H)
	1mm thick ready-made

Fuse

2A slow blow

Miscellaneous

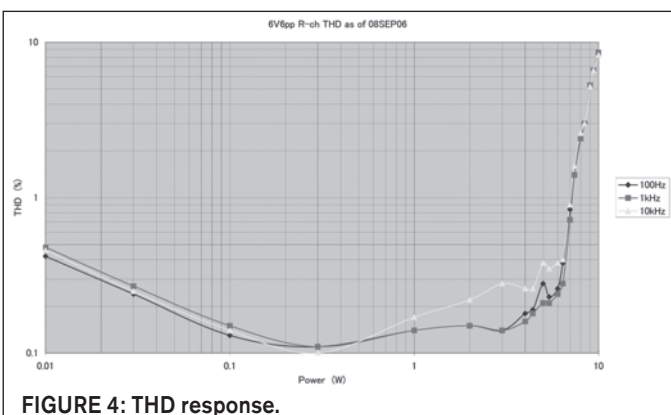
Tube sockets, speaker binding posts, RCA jacks, and so on are all normal ones I purchased at shops located in the famous city of Akihabara.



When I built this amp, I did not use the so-called ground line. In principle, I wired ground of each stage, then hooked up all ground wiring together at the handmade earth terminal placed close to the OPTs. I hoped that the method would improve crosstalk and residual noise. In addition, I have tried some small tricks which seemed to do something for the sound. With a non-NFB amp, actual manufacturing is more important.

MEASUREMENT

Basic measurement—THD, frequency response, and so on—showed good performance, except for the crosstalk. However,



MEASUREMENT EQUIPMENT

- Audio Analyzer: NF Circuit Design Block DM155B
- Signal Generator (1): NF Circuit Design Block CR-131
- Signal Generator (2): Leader LAG 120A
- Oscilloscope: Iwatsu SS-6050
- Digital Multimeter: Fluke 79

you should understand that the cross-talk includes noise. I am rather confident of a good performance, if you consider that this amp does not apply an overall NFB. The details are indicated in the graphs (Figs. 2-4).

Data not included in the graphs:

Total gain: 35dB

Residual noise (Input open)

L 1.8mV RMS R 1.9mV RMS

Residual noise (Input terminated)

L 1.6mV RMS R 1.4mV RMS

THE SOUND

How this amp reproduces the sound is another matter. I believe that any amp built by an amateur should be evaluated by a third party rather than the builder himself. Therefore, I brought this amp to the RGAA (Rajio Gijutsu Audio Amateur Club) annual meeting last October.

Rajio Gijutsu (Radio Technology) is a leading amateur audio magazine with a long history. The publisher organizes RGAA for its subscribers and offers an opportunity to demonstrate the members' products. They provided me with JBL 4312 speakers, while I brought the Revox B226 CD player and Trio L-07C preamp for my sound demonstration. I purchased the Revox and Trio units as junk pieces, and I completely restored them. (Restoration of old equipment is also my hobby.)

I replayed various CDs from Beethoven's symphony to Frank Sinatra's vocals. The comments made by several members were almost the same: They could hardly believe the amp has only 7W output power because the sound was so powerful. Bass is deep, while the mids and highs are sweet and mellow. I am convinced that this amp has a typical sound of that without overall NFB. *ax*

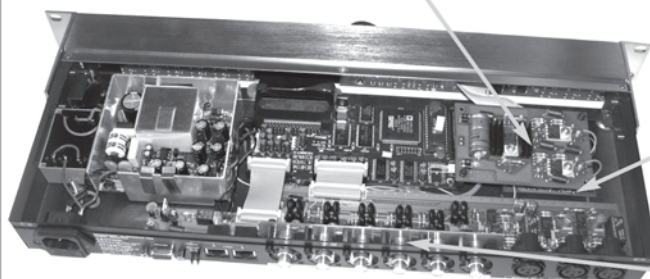
AROUND the DCX-2496...



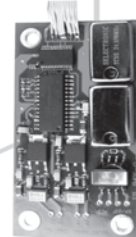
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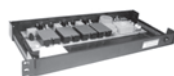
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