音茶楽

OCHARAKU
Sound Customize

耳優快音（じゆうかいおん）

Ear-friendly Sound

You can see conventional canal headphones with certain specific high-tone range sounded keen. Also, we have many customer feedbacks that s sounds (i.e., sa, shi, su, se, so) sound fricative. This is due to closed ear canal resonance occurred when canal-type earphones are put on. Furthermore, adverse effects due to the masking effect cause unclear sound in high-tone range. In our product lineup of Ocharaku, Sound Customize, this difficult problem has been solved through our long-time research of auditory sense.

In May 2011 we announced the Tornado Equalizer, and the twin-equalized element system in October 2011. In June 2012 we released the Flat-4粋 (Sui) with the twin-equalized element system. With the Flat-4粋, you can hear the relevant conventionally hard-to-hear sound. Our products therefore have a high reputation among our customers, especially music buffs.

The Flat-4粋 is the first headphone and earphone in the world ever that was successful in cancelling reaction due to vibration system movement, with the twin-equalized element system and its horizontally opposed placement of element.
In October 2012, we at Ocharaku opened the door to a new stage. The newly developed Flat-4 楓(Maple) controls even cabinet sounding, and thus you can hear feeble afterglow of sound as if you saw it with our canal headphones.

Makoto Yamagishi, President and Chief Technical Executive
Ocharaku Co., Ltd.

Fig.1

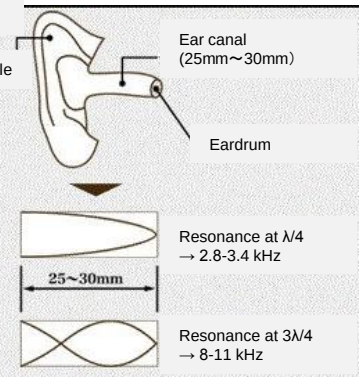


Fig.2

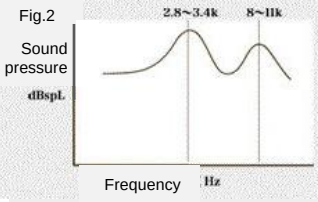
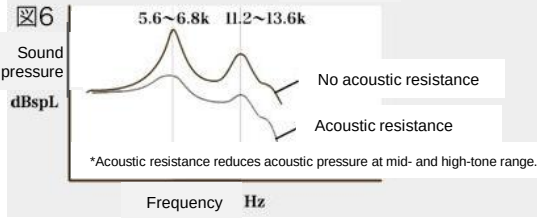


図5

図6



Mechanism to hear the sound
Sound is affected by ear canal until it reaches the eardrum.
The length of the ear canal is generally referred to as 25 to 30 mm as shown in Figure 1.
One side of an ear canal is closed by eardrum, so air column resonance occurs at λ /4 and 3λ/4 (open-tube resonance).
Figure 2 shows the acoustic pressure-frequency characteristics at eardrum when the 25-30 mm open tube reso
The acoustic pressure rises at around 3 kHz and 10 kHz due to resonance.

* In fact the effects of auricle and head reflection and diffraction, etc. show more complicated characteristics, bu omitted here for simplification.

When putting on a canal-type headphones
An ear canal is closed when the canal-type headphone is put on your ear as shown in Figure 3.
The both sides of the ear canal are closed, and thus the mode of resonance will be changed. That is, air column resonance occurs at λ /2 and λ (closed-tube resonance).

Figure 4 shows the acoustic pressure-frequency characteristics at eardrum when the 25-30 mm closed-tube resonates. The acoustic pressure rises at around 6 kHz and 12 kHz due to resonance.

This resonance occurred at 6 kHz causes keen high-pitched sound, especially the s sound (sa, shi, su, se, so) that might disturb cozy listening to music. Also, sound with higher frequency than this resonance will be hard to hear due to the masking effect.

Fig.3

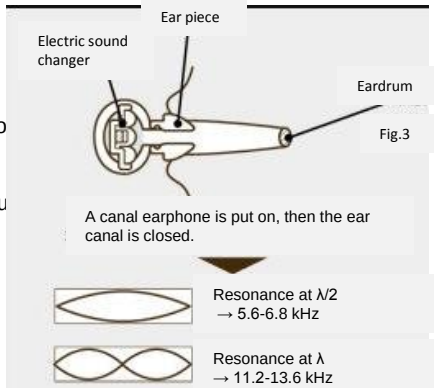
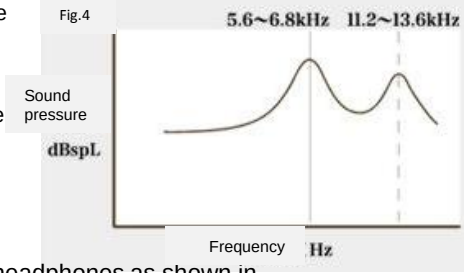


Fig.4



Handling by conventional technologies
To suppress the resonance of 6kHz;
Set acoustic resistances in series on the sound propagation path of the canal-type headphones as shown in Figure 5. Higher frequency is more likely to attenuate due to the effect of acoustic resistance as shown in Figure 6 (acoustic pressure-frequency characteristics). Although the resonance at around 6 kHz can be suppressed, the 10 or more kHz range necessary for playing music will also greatly attenuate, so balancing is needed to some extent.

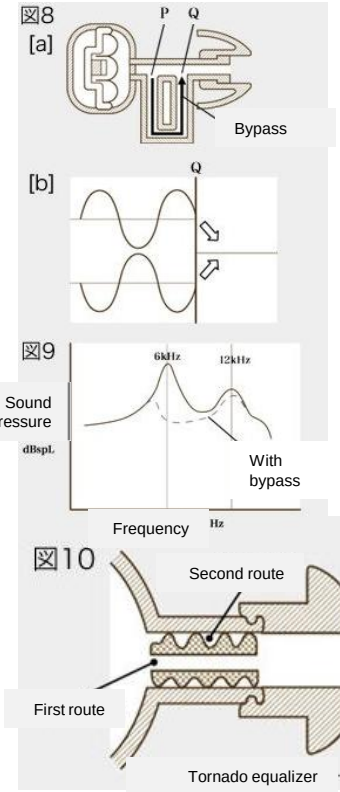


Figure 8 shows the bypass made for canal headphone sound propagation path.
To suppress the resonance of 6kHz:
Sound waves with the identical phases at the bypass starting point P will be delayed in phase at point Q.
To delay phases 180 degrees at the intended 6kHz:
λ=V/f (λ: wavelength of sound wave, V: sound velocity, f: frequency), where the sound velocity is 340 m/s and the frequency is 6 kHz. λ=340/6000=0.0566 m=5.66 cm. Therefore, half wavelength is 2.84 cm (approx. 28 mm).
If the length of the bypass is set to approximately 28 mm, the sound propagating straight-forward and the bypassing one will have opposite phases and be cancelled out each other at around 6 kHz as shown in Figure 8b.

The dashed line in Figure 9 shows the characteristics of acoustic pressure and frequency in headphones with bypass. The figure also shows that the peak at around 6 kHz is suppressed and acoustic pressure of 10 kHz or more high-tone range will not so greatly lowered.
At the same time, the masking effects in high-tone range are resolved and feeble sound can be heard.

Birth of Tornado Equalizer

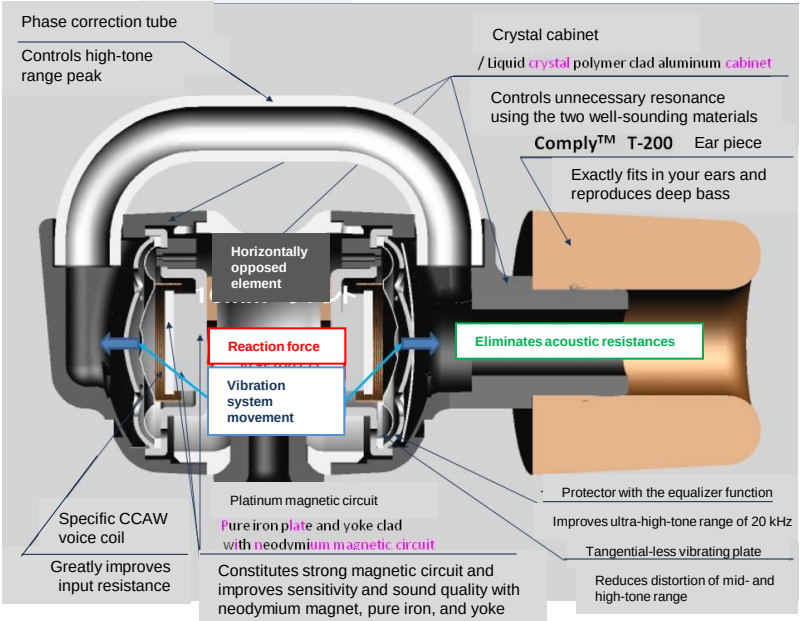
While I was considering how to make a difference between sound propagation paths of a canal headphone, an idea of applying twist came to my mind when I saw the phoenix honey orchid dancong tea (Chinese tea). Technically, to make sound propagation paths with a difference of approximately 28 mm in length in a canal headphone, hollow screw-like parts are attached as shown in Figure 10.

The difference of sound propagation paths are made by two routes; first route that runs through the center of the pipe and second route that runs helically though the aperture between the root of thread and the external wall.

The sound wave in the external route propagates like tornado, so I named this product the Tornado Equalizer. The logo of the Tornado Equalizer comes from the design of sound wave propagation.

Tornado equalizer

Tornado Equalizer Technology Patent No. 4681698



Twin equalized element system
The following four major effects can be achieved in the twin-equalized element system:

1st effect
The opposed element placement cancels mechanical vibration due to reaction of vibration system and realizes deeper bass tones than that of conventional closed types.

2nd effect
The parallel drive of twin element enhances sound pressure sensitivity in low- and mid-range tones.

3rd effect
The phase correction tube suppresses closed ear canal resonance, eliminates the masking effects, and dramatically improves sounding in mid- and high-tone range.

4th effect
Eliminates acoustic resistances. The small element dramatically improves ultra-high-tone range and realizes the spread of sound like open-air types.

Twin equalized element

Twin equalized Element System Patent No. 4953490