FORUM

TUBES VERSUS TRANSISTORS: A FURTHER COMMENT

W. J. J. Hoge

Nashville, Tennessee

The old question of "tube sound" vs. "transistor sound" which Hamm[1] raises is not, I believe, the proper question. There is a difference between most tube and most transistor amplifiers, and, surely, IC amplifiers have a sound of their own. Why?

I would like to suggest that, except in the case of IC amplifiers, that the active device used does not restrict the designer of an amplifier to a certain sound. Rather, how the device is used causes "tube sound" or "transistor sound". Otala[2,3,4] has pointed out the effects of transient intermodulation distortion in amplifiers. Transient IM is a type of distortion not measurable with fixed level signals. If a signal with sufficient level and a frequency higher than the open-loop cut-off frequency of an amplifier is fed into its input, overshoots in the circuits of the feedbacked amplifier will occur. It is possible for these overshoots to be two or more orders of magnitude greater than the nominal. Therefore, if sufficient overload margin is not provided, the signal will be clipped and will thus produce periods of 100% IM.

Casual analysis of some valve, transistor, and IC amplifiers in use in studios here in Nashville reveals that the amplifiers thought by the musicians to have the most offensive "transistor sound" are those with very low open-loop cut-off frequencies and large amounts of feedback. A poll to find the worst unit was won (?) by a console which uses a monolithic IC amplifier with an open-loop bandwidth of 2 Hz.

Conversations with several individuals at the AES 48th Convention indicated that work is being done to devise test procedures and standards to measure transient IM. Until the industry can develop and agree upon these procedures, we may be guided by this rule: "If it has an open-loop bandwidth too small to handle the desired signal, you may wind up in transient IM trouble." Most tube designs did not rely on feedback to increase bandwidth. Most transistor designs do; certainly all monolithic IC amplifiers must, because of their low (<100 Hz, typically <10 Hz) bandwidths.

REFERENCES

[1] Russell O. Hamm, "Tubes Versus Transistors—Is There an Audible Difference," *J. Audio Eng. Soc.*, vol. 21, pp. 267-273 (May 1973).

[2] M. Otala, "Transient Distortion in Transistorized Audio Power Amplifiers," *IEEE Trans.*, AU-18, no. 3, pp. 234-239 (1970).

[3] M. Otala, "Circuit Design Modifications for Minimizing Transient Intermodulation Distortion in Audio Amplifiers," *J. Audio Eng. Soc.*, vol. 20, pp. 396-399 (June 1972).

[4] Jan Lohstroh and M. Otala, "An Audio Power Amplifier for Ultimate Quality Requirements," *Audio Eng. Soc. 44th Convention Preprint.*

THE POST ULTIMATE LSH LOUDSPEAKER[1]

I. Rogue Acoustin

Professor of Acoustical Witchcraft, Mountain View University

In a truly classic revelation, Lord O. G. Hurtz disclosed a radical new loudspeaker technique for increasing the power input ratings of a system with only a moderate increase in physical size. The purpose of this note is to suggest a few improvements to this design principle.

A quick search of my catalog file disclosed that obtaining the 0.1667-ohm 50-watt and 3.837-ohm, 1200-watt resistors will be difficult for those who want to build a unit themselves. One can obviously parallel enough 25-watt resistors to obtain these values, but the construction time becomes rather long. One source for such resistors would be the manufacturers of 5–50-horsepower dc motors who use these sizes for adjusting the field current.

A better suggestion comes from the typical University Sophomore Electric Circuits Laboratory. There, it is common to employ incandescent lamp bulbs for moderate power loads to demonstrate the use of wattmeters. Thus, we can suggest that the Hurtz network be realized with parallel connected lamp bulbs for each resistor. One detail worthy of mention is that the 0.1667-ohm resistor should be realized with 12-volt automobile headlamp bulbs while the 3.837-ohm resistor should be realized with 117-volt bulbs.

In addition to ready availability, these lamps will serve the psychedelic purpose of changing in brightness in exact synchronizm with the musical dynamics. Furthermore, conversion of part of the electrical energy to light energy lessens the amount of thermal energy which must be blown away by the "whisper fans." Last but not least, tungsten is well known to have a decided change of resis-

[1] Patent applied for.

tance as a function of temperature; thus, a subtle form of distortion will be generated which should adequately simulate the modulation distortion heard when a powerful amplifier is applied to the typical 40-liter closed-box loudspeaker.

A further improvement of this modified Hurtz network can add to the depth of the psychedelic effect as well as modifying the distortion characteristics. Since the resistance of tungsten increases wih increasing temperature, we need more lamp bulbs at high power level to maintain the load impedance constant as seen by the power amplifier(s). An assortment of bias batteries and silicon diodes can be wired as shown in Fig. 1 to stagger the application of voltage to the lamps. We leave it to the reader to devise an appropriate color scheme for painting the various lamp bulbs.

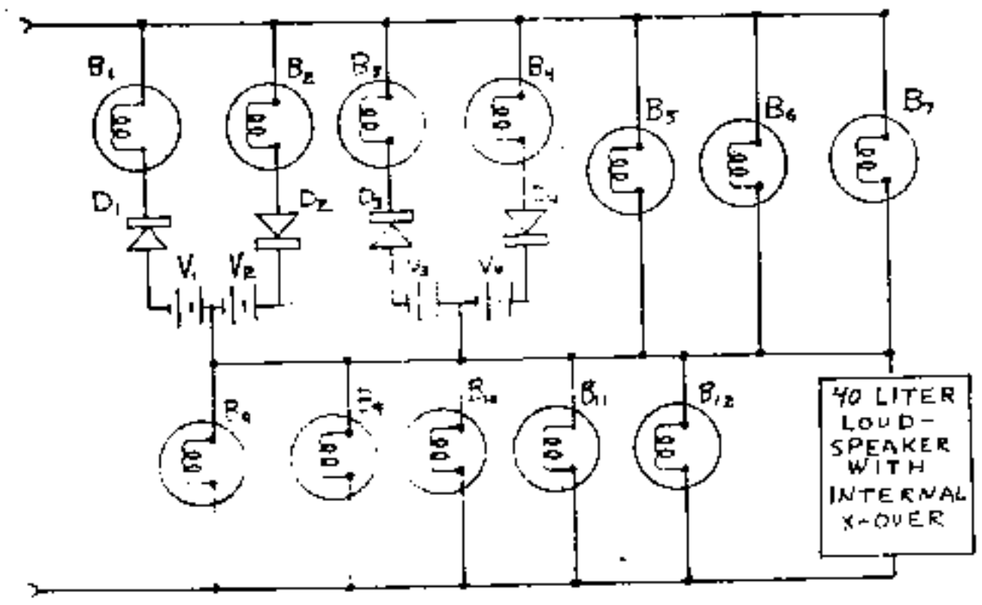

Fig. 1. An improved Hurtz network for the Post Ultimate LSH loudspeaker system.

All of these modifications were inspired by the design of Lord Hurtz's "Ultimate LSH" loudspeaker. Since my improvements have come *after* the original development, it seems appropriate to call this modified loudspeaker system the "Post Ultimate LSH." We heartily recommend its use to those investigating the Watergate affair to make the acoustic power generated in the investigation match the significance of the events.

REFERENCES

[1] O. G. Hurtz, "The Ultimate LSH Loudspeaker," *J. Audio Eng. Soc.* (Forum), vol. 22, pp. 106–108 (Mar. 1974).

ON "THE ULTIMATE LSH LOUDSPEAKER"

D. David Decibal

Unbelievable Sound, Inc., Fayetteville, N. C. 28303

We have enclosed our purchase order for 627 of your ULTIMATE LSH Loudspeakers.[1] After evaluating some 37 major breakthroughs in the past 13 months, we were pleased to note that you have achieved the final breakthrough.

Your incredible design has finally developed a loudspeaker which can handle the power produced by our Megawatt Ultralinear Wideband Superamplifier. The MUWS amplifier develops 40 000 watts rms.[2] It has achieved a few breakthroughs of its own, such as crystalline planar monolithic semiconductor devices. These devices are connected to liquid-nitrogen-cooled heat sinks for optimum thermal transfer. (For those persons not having liquid nitrogen available in their homes, a liquid nitrogen plant with refrigeration adapter is available at nominal cost.)

Please provide all speakers with oil walnut finish and polished chrome heat sink base. We would also like to know if you recommend fuses for your speakers and what value to use.

Joel Tall

Washington, D. C. 20008

As one of the original members of the Audio Engineering Society still above ground, who still remembers distinctly trying to drive a Magnavox loudspeaker with a dead storage battery, I applaud the genius who is responsible for the ULTIMATE LSH, O. G. Hurtz. Here, for the first time, is a truly adequate loudspeaker; almost every requirement of the searcher for sound fidelity is met. However, since someone, someday, will probably milk a mouse, please allow me to suggest one miniscule improvement. It would be so easy, with all that power available, to use some of it to actuate a very high frequency tweeter producing bursts in the vicinity of 27 angstroms. This wave length has the potential of renewing sexual capability, something highly desirable to those in my situation. Think about it!

Dale B. Watts

University of Colorado, Colorado Springs, Colo.

After reading the March, 1974, issue of the *Journal*, I was delighted to see that there are still people who have a sense of humor when it comes to expounding on the technical side of the field of audio. I am referring to the letter by O. Hurtz on "The Ultimate LSH Loudspeaker."[3] I feel that it was an excellent spoof on some of the practices and idealogies of some of the people in the field today.

I feel that the *Journal* should occasionally "let down its ivory tower barriers" and publish more of this type of article. Please convey my thoughts to the writer of the "paper" and encourage him, and others like him, to present the fun side of the profession.

[1] Purchase order breakdown: 610 no charge for evaluation by magazine reviewers and other critics, 14 units at 50% discount for employees, 2 units for store samples, 1 unit for spare parts.

[2] By shorting the AC wall socket at the amplifier plug with a 4-inch square copper bar, we achieved a reading on our wattmeter of 20 000 (the circuit breaker was temporarily replaced with a 100-A type). Since the wallplug had two outlets, the power rating is two times 20 000 or 40 000 watts.

[3] *J. Audio Eng. Soc.* (Forum), vol. 22, pp. 106–108 (Mar. 1974).

are not Laguerre functions, as you state, but their transform and which are not strictly all-pass, since the numerator is of lower power than the denominator, date to a much earlier period than the 50's. Lee's 1930 dissertation, presented in open literature a few years later [4] is, in my opinion, a landmark paper since not only introduces such functions to electrical engineering, but is the first concise application of Hilbert transform relations governing network amplitude and phase relations which appeared in engineering literature. Kronig and Cramers dispersion relations had been known prior to that but were apparently not applied to engineering. I used my reference [15] on transversal filters *specifically* because it explains the particular all-pass related expansions of Lee. Please observe, as I stated in the paper, that I am introducing parallel networks, not series networks as in the work of Lee. The difference is not trivial when it comes to implementation or relating sound to subjective concepts.

I am grateful for your pointing out the Wigner distribution, since I was not aware of it, nor can I find it in any of the references I used in compiling my paper. I was aware of a very similar expression formulated by Ville [5] then introduced by Woodward [6] to radar theory. I gather from the lack of references to Wigner's work that it was also not known to Gabor at the time he introduced the concept of logons, nor did Page seem to be aware of it when he tackled the same problem. The problem of negative energy of the modified Wigner distribution which is remedied by a smoothing function appears to support the statement that simultaneous parameterization in terms of Fourier transform coordinates is never exact. And isn't that what I pointed out?

The formalism of quantum mechanics is indeed rich in concepts of value to audio, but unfortunately most audio engineers may not be aware of the notation and how it can be applied to their problem. Hence my attempt at bridging the semantic gap by using audio related terminology. I personally prefer the view that one should reach for other tools when he does not get results he seeks with his present tools, no matter how comfortable they feel in use. I thought I had made that point clear.

REFERENCES

[1] R. C. Heyser, "Loudspeaker Phase Characteristics and Time Delay Distortion," *J. Audio Eng. Soc.*, vol. 17, pp. 30-41, 130-137 (Jan. 1969, Mar. 1969).

[2] M. Gardner and J. Barnes, *Transients in Linear Systems Studied by the Laplace Transformation*, (John Wiley, N.Y., 1942).

[3] G. Campbell and R. Foster, *Fourier Integrals for Practical Applications*, (D. Van Nostrand, N.Y., 1948).

[4] Y. W. Lee, "Synthesis of Electrical Networks by Means of the Fourier Transforms of Laguerre's Functions", *Jour. Math. & Physics*, M. I. T., 11, pp. 83-113 (1932).

[5] J. Ville, "Theory and Application of the Notion of the Complex Signal", *Cables et Transmission*, vol. 2, pp. 67-74 (1948).

[6] P. M. Woodward, *Probability and Information Theory with Applications to Radar*, (Permagon Press, N.Y., 1953).

THE ULTIMATE LSH LOUDSPEAKER

O. GADFLY HURTZ

Hurtz and Associates, Inc., Lost Hope, Nev.

Major Premise[2] and S. P. Canard[3] have made the final major breakthrough in loudspeaker design with their ULTIMATE LSH[1] loudspeaker.

We take the original LSH loudspeaker as a point of departure, build a forced-draft box on which to set the LSH, Fig. 1, and wire a shunt resistor R_2 of 0.1666 ohm rated at 50 W and a series resistor R_1 of 3.837 ohms rated at 1200 W, Fig. 2. This will give an effective load

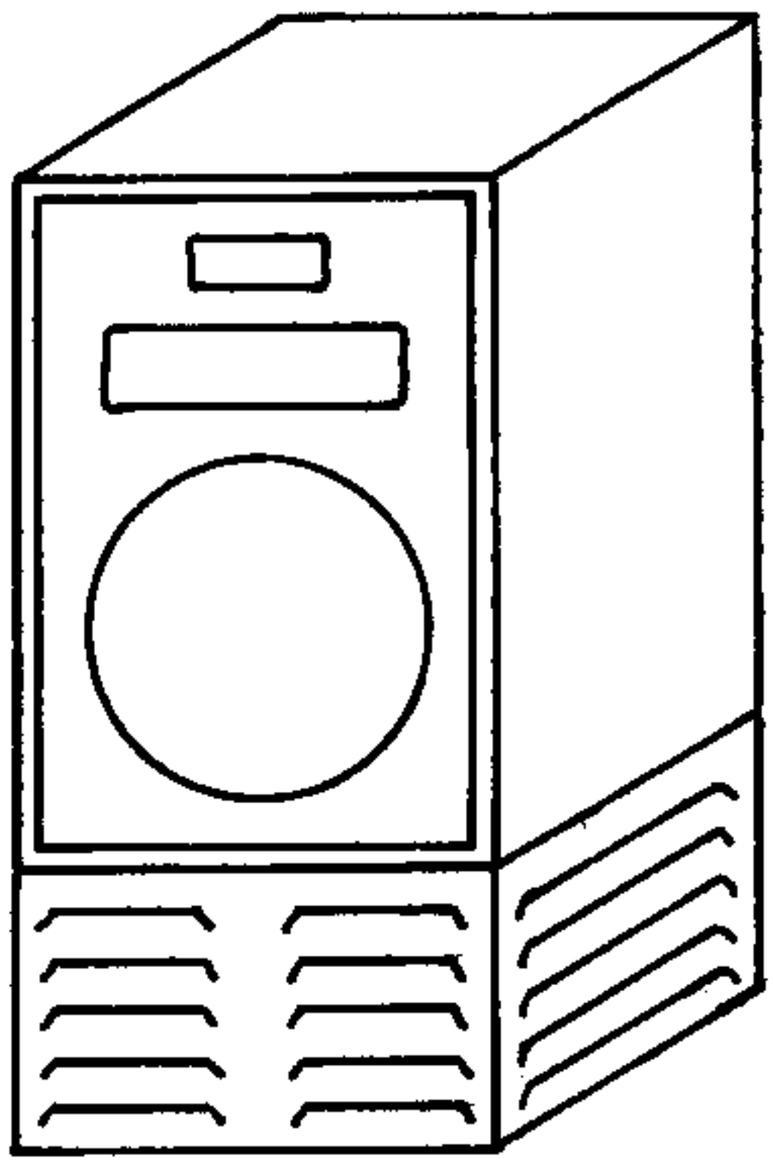

Fig. 1. ULTIMATE LSH loudspeaker on heat-sink base.

resistance of 4 ohms and a continuous power input capacity of 1200 W. The total impedance will vary from perhaps 3.999 ohms to 4.003 ohms peak at the primary speaker resonance frequency. The lay press may be quoted as saying[4] that the more nearly constant the impedance, the better. A small battery of "whisper fans" driven from 115-V 60-Hz (or 50-Hz) house current will dissipate the heat and keep the house warm. A battery of three zero-

[1] Loudspeaker and Space Heater.

[2] Major Premise, formerly with the Air Corps Horse Marines, is now Engineer with Hurtz and Associates, Inc.

[3] S. P. Canard, formerly with Proctor and Gamble Inc., is now Vice President and General Manager of Hurtz and Associates, Inc. Mr. Canard was asked to author this paper but was preoccupied with his reverse-feathered wing by which means he proposes to fly forward and backward simultaneously.

[4] A reviewer of equipment cites a loudspeaker as having a commendably low variation in impedance (1972).

phase 400-W amplifiers in series–parallel could drive this system to continuous capacity. Electric-to-acoustic efficiency will be desirably low, in full acknowledgment of the modern doctrine that to obtain highest quality the efficiency must be ever lowered.[5]

The acoustic output of the new ULTIMATE LSH at full 1200-W input is 100-dB sound-pressure level at 61 cm. Compare this to the standard LSH system which

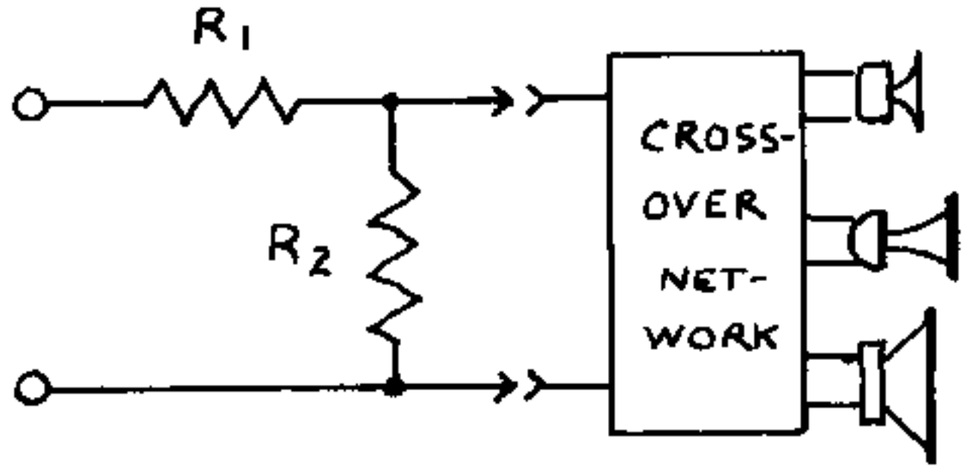

Fig. 2. Circuit for ULTIMATE LSH crossover network. R_1 = 3.837 ohms, 1200 W, continuous, 12 000 W intermittent. R_2 = 0.1666 ohm, 50 W continuous, 500 W intermittent.

produces 100 dB at 61 cm at only 1-W input. Here we have increased the input power handling capacity to 1200 times as much as the standard speaker can absorb. Also the damping factor has been modified to a value of 8/0.16 or about 50, assuming that the amplifier damping factor is infinite. The cost of this breakthrough will be nominal; the 2 resistors and battery of fans should not cost over a couple of hundred dollars (July 1973). Thus for less than doubling the cost of the speaker one has increased its power input capacity more than 1000 fold.

A quad of such speakers in four-channel will be capable of absorbing 4800 W continuous; allow 10-dB head room for transients, and the "music power" rating can be as high as 48 kW (peak). It is proposed to offer the speakers at $2000 in sets of 4, with a four-channel 48 000-W (12 000-W per channel) amplifier at the usual one-dollar-per-watt price.[6] Thus the system will cost just about an even $50 000. This seems to be about the customary ratio of amplifier-to-speaker price of 24 : 1.

Placement of the thermal unit below the LSH assures a dry environment for the voice coils.

The designers feel that this must be the major breakthrough to end all major breakthroughs. If 700 W is questioned as sufficient, here 48 000 W is offered. If low efficiency is the way to achieve quality, then a new low is achieved by three orders of magnitude. Surely a further step in this direction would be milking a mouse. The new ULTIMATE LSH must be hailed as truly the ultimate achievement.

Aftersong: To improve the weight per horsepower ratio, cavities are partially filled with 34.019776 kg of cast iron sash weights. Also a torque wrench is furnished to adjust the tweeter level control. Owner's Manual states that guarantee is voided if calibration is altered from 2200 g-lb.

---

[5] Robert Carver (*Audio*, p. 34, Feb. 1972) states, "Whenever a loudspeaker engineer makes an attempt to extend or smooth the frequency response of his design, or lower the distortion, the laws of physics demand that the loudspeaker become ever less efficient." (This law stated without proof).

[6] Hirsch (*Stereo Rev.*, p. 60, Apr. 1972) wonders if 700 W is enough.