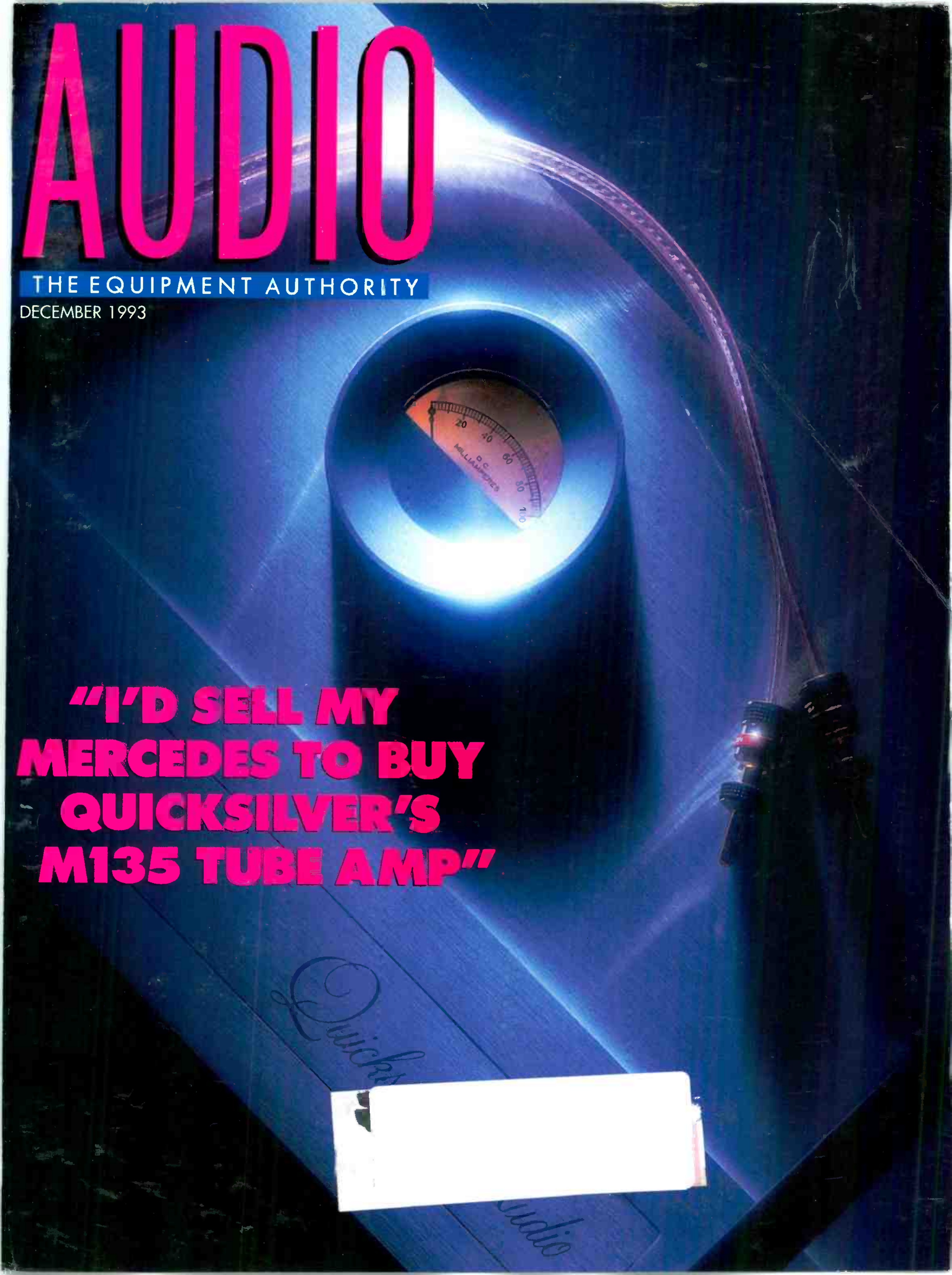
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DECEMBER 1993
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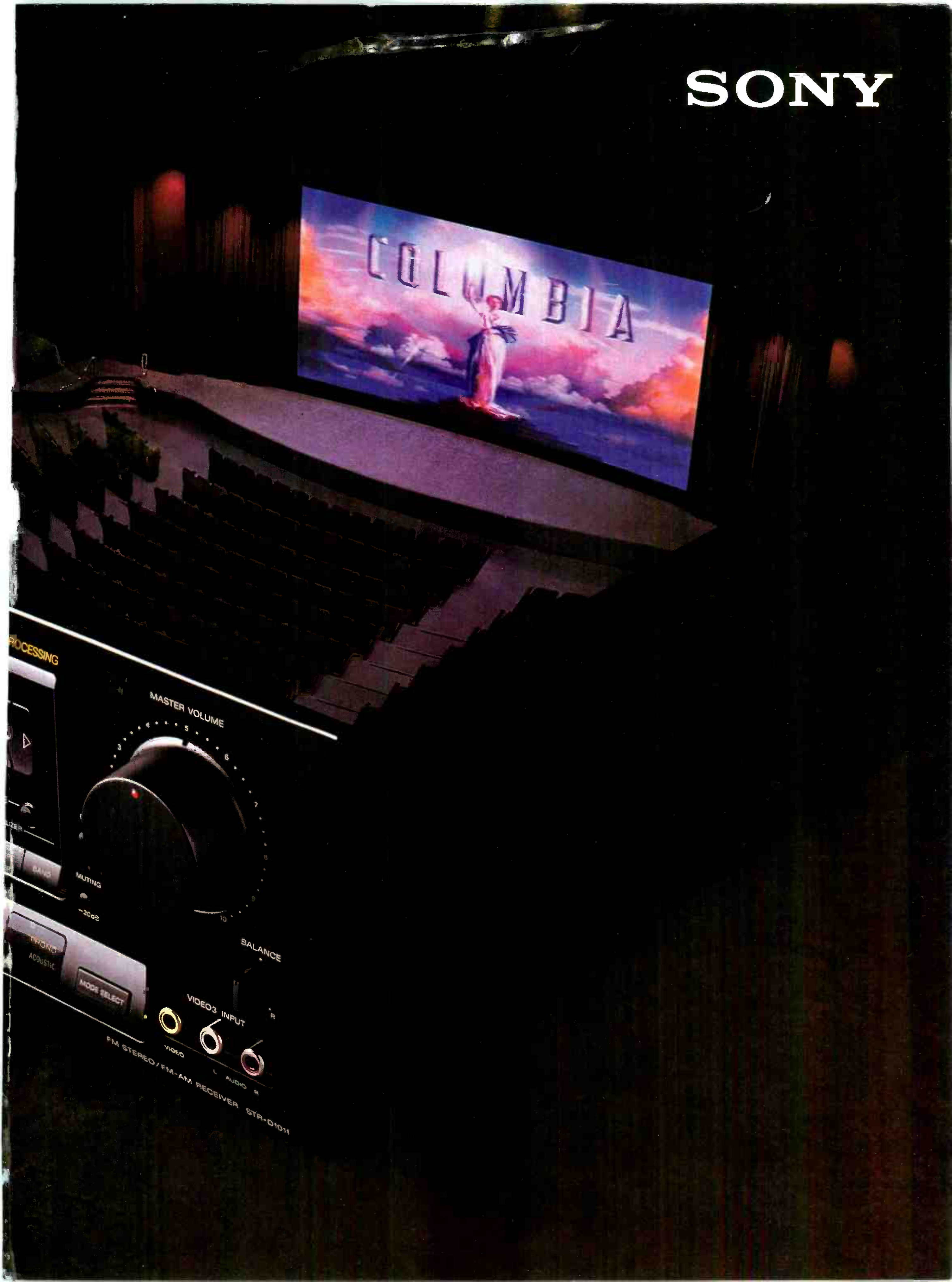
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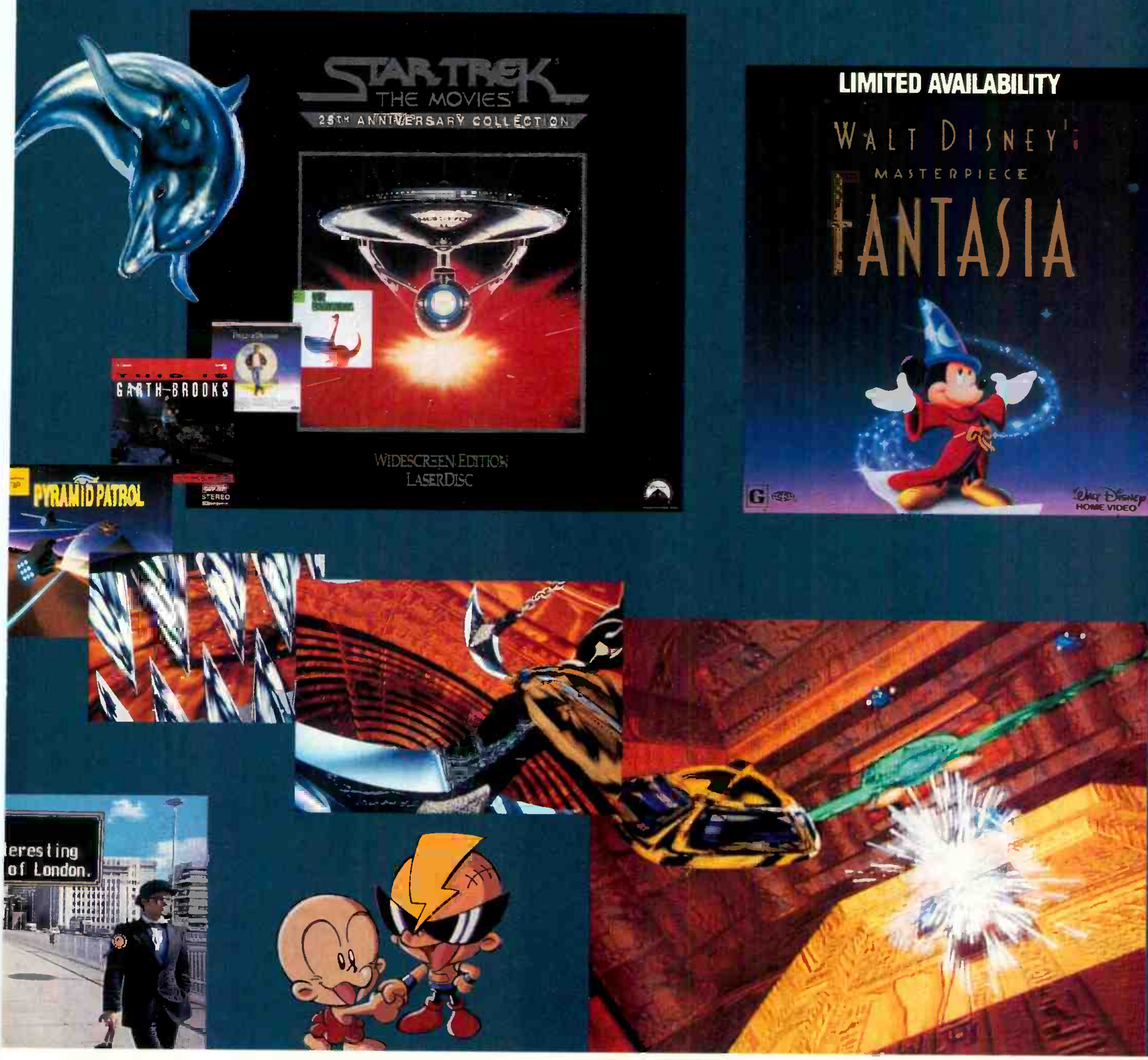

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DECEMBER 1993 VOL. 77, NO. 11

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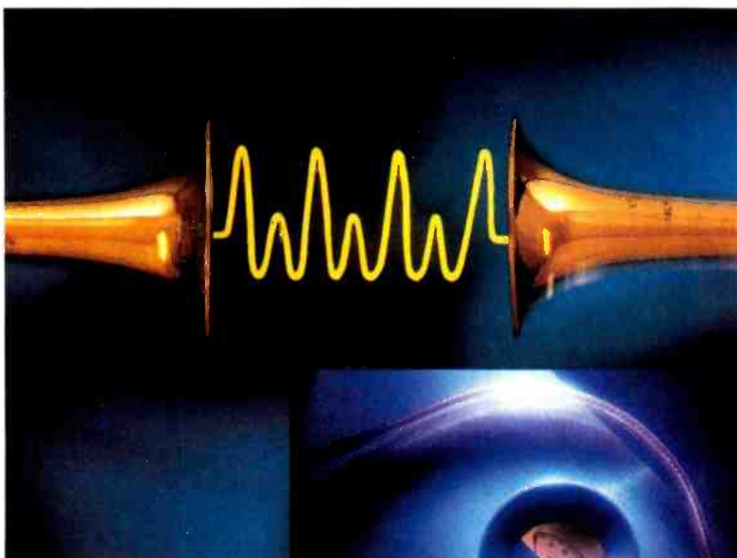

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The Cover Equipment: Quicksilver Audio M135 mono amp
The Cover Photographer: Carl Zapp

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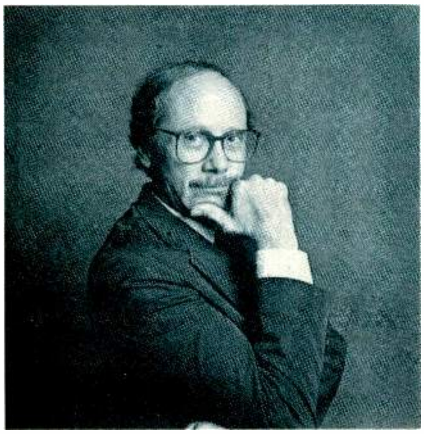
FAST FORE-WORD



It's difficult and frustrating to find CDs suitable for testing of speakers, ones which exercise all parts of the frequency spectrum with strong dynamics. Lots of CDs go through our office, most of them destined for only a play or two, because they are only fair to poor sonically. Yet, even if a disc measures up acoustically, it still needs to be played several dozen times at the Consumer Electronics Shows and many scores of times in between during speaker auditions in our listening room. Just think about doing that with music you hate or—worse—something as bland as elevator music. The result is that musical interest of the program becomes as important as the technical quality if I am to continue with my auditioning and not be put off by the music rather than the speaker.

With this in mind, I offer a few of the Compact Discs I've added to my reviewer's pile lately, along with notes about what I like about particular cuts.

The Wonderful Sound of Three Blind Mice (GS CD004). A sampler of jazz from the Three Blind Mice label. With piano, bass, and drums; the first cut, "The Way We Were," has the most piano-like piano I know on disc. Two in-office editors hate the tune so much they can't get past it to the incredible sonics. Great bass, drums, and cymbals.

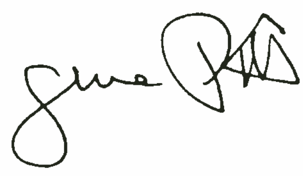
Adagio d'Albinoni (Firebird K33Y 236). Gary Karr, bass; Harmon Lewis, organ. Karr's arms must go down past his knees; he couldn't play the fantastic runs he does otherwise. Sounds like a Hungarian gypsy, what with all the schmaltz he applies, but it's spellbinding. The runs betray inaccurate voice matching between bass and midrange speakers.

Benedetto Marcello: Four Sonatas for Harpsichord (Jecklin CJEC 5001). Best-recorded harpsichord I know. I use this to show limitations in MD and DCC compression systems. This and the two discs above are available from Acoustic Sounds, P.O. Box 2043, Salina, Kans. 67402-2043; orders, 800/525-1630.

There are others, but not this time.

Dept. of Oops: We try very hard not to make mistakes in our Annual Equipment Directory, which appears in the October issue each year. Sometimes, however, things go astray—despite the best fail-safe checking systems we've been able to devise. That said, let me draw your attention to two addenda to the Big D, for Velodyne in speakers and NAD in CD players, that appear this issue in our "Signals & Noise" letters section.

Not incidentally, Velodyne will be introducing a full-range speaker, the Model DF 661, at the Winter Consumer Electronics Show. Preliminary specs include a claim of measured distortion "at least 10 times lower . . . than any speaker on the market." That's a big claim, but you may remember how well their subwoofer did in our November 1992 shootout. I look forward to auditioning the DF 661.



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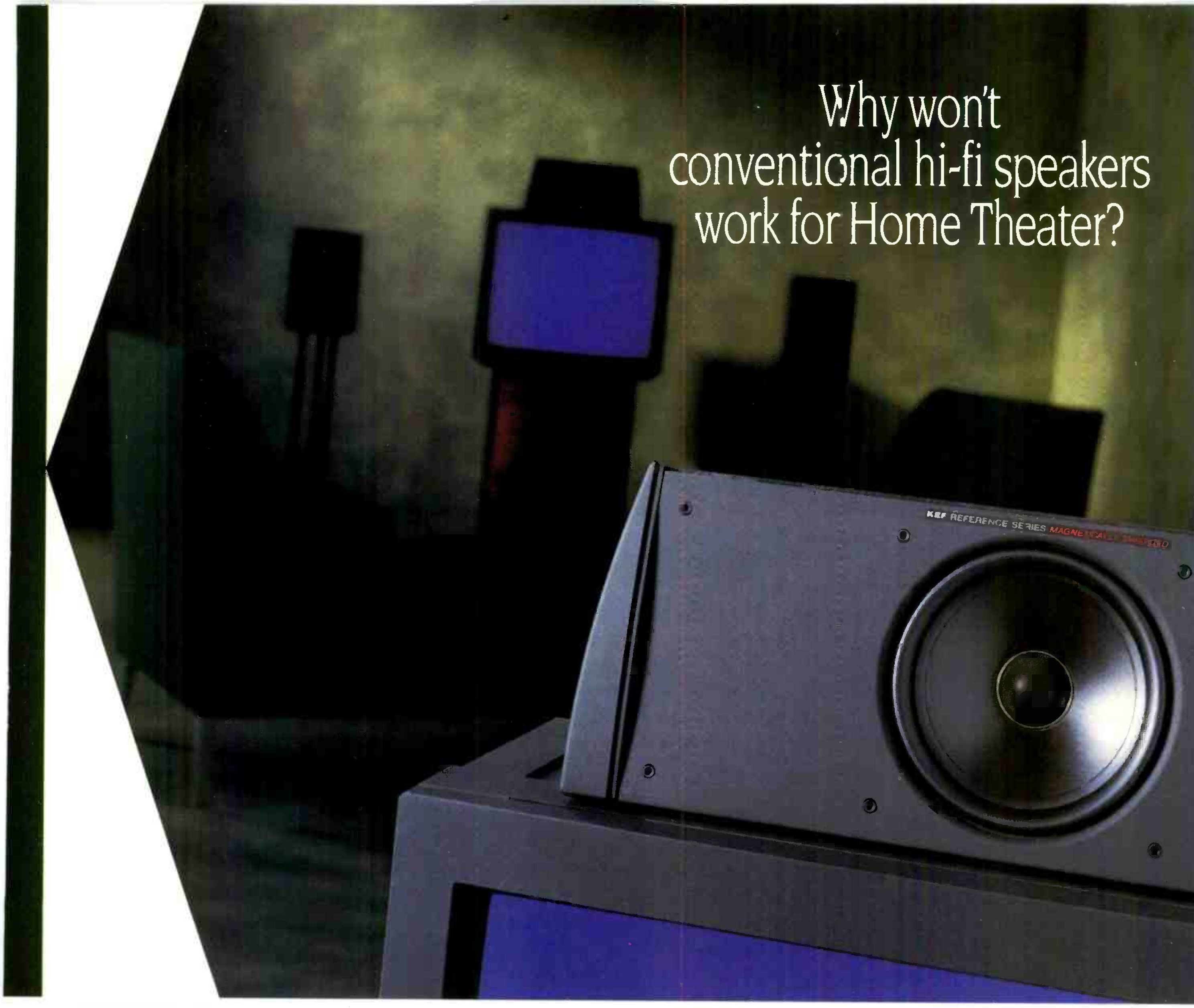

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You need three front speakers - left, right and center - to achieve realistic home theater. A stereo pair would place the dialog in the center (where it belongs) from only one listening position. You can't use conventional hi-fi speakers for the center channel, even shielded models, because their dispersion patterns prohibit raising them too high or laying them on their sides.

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Cars and *Audio* Don't Mix

Dear Editor:

I wasn't expecting it and now it's too late, but I'm still mad as hell and I'm not going to take it anymore! I'm referring to the May issue, which you blatantly tell *Audio* readers is the 19th Annual Car Stereo Directory. I don't have a car, and I'm [angry] that you wasted, in my opinion, a whole issue on automobile-related equipment and statistics. All I could do with this issue was throw it away!

Automobile users have more than one publication dedicated to autosound equipment. Why must you waste an issue? Since you so proudly state on the cover that it's the 19th annual directory, I doubt very much that my complaint is going to stop you from publishing future auto-only issues. Therefore, I'm cancelling my subscription to *Audio*, which I had just renewed to August 1995. If you want to keep me as a subscriber, extend my subscription three more issues to make up for this year's and two more years of unusable May car stereo issues.

I enjoy *Audio* very much and look forward to receiving every issue (except you know what). I've improved my audio system by following suggestions given in past issues, especially tweaking my speakers to now reproduce 30 cycles (excuse me, Hertz) to their previous 40. However, if you don't agree to the above request, I will only have lost the facility of not having to go to the public library to get *Audio*. But I will eventually read the magazine, free. Your move.

Edward Lopez
New York, N.Y.

Editor's Note: Sorry, Mr. Lopez, no deal. As you inferred, we are proud of our car stereo coverage—and we don't intend to stop it.

Having spent more than 30 years living in Manhattan, I'm aware that most New Yorkers don't have cars (although you'd never think so while looking for a parking space), and I sympathize. But I also realize that most audiophiles do have cars and would like to hear music well reproduced during the time they spend in them. That's why we try to have something on car stereo in every issue, in addition to the May issue devoted to that subject. On the other hand, we do devote a number of pages in that issue to non-automotive columns (and to music reviews, when we have the space). Counting ads, about one-third of this year's May issue was devoted to things that could be of interest to even the most dedicated pedestrians.

You could, of course, buy the other 11 issues on the newsstand. But if you insist on using your local library, it's a good one; until my car and I moved to the suburbs this year, I used the same branch. And I'm glad that, at least, you signed your letter "cordially."—*I.B.*

Looking for Maestro Gottschalk

Dear Editor:

I am looking for a copy of the Centennial Catalogue of Compositions by the American composer Louis Moreau Gottschalk, which was published in 1969 by *Stereo Review* in a separate volume, edited by Robert Offergeld. I am also looking for the magazine's annotated edition of the Gottschalk journal *Notes of a Pianist.* If any of your readers could make copies of these items and forward them to me, I would be very grateful.

C. G. Nijsen
19 Mackaylaan
5631 NM Eindhoven
The Netherlands

Ionosphere of Influence

Dear Editor:

Reading Gilbert A. Johnson's letter and Ivan Berger's reply in the March "Signals & Noise" brought to mind the many times I too have experienced the phenomenon of receiving distant AM radio stations. While camping in the middle of nowhere (the southeastern Utah desert), I have listened to several Laker broadcasts from the Los

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The DA-10 is a six-input digital to analog converter. Besides two digital tape loops with full dubbing, a digital phase inverter, muting, and a lamp to indicate good input signal, the DA-10 comes equipped with a front panel adjustable Most Significant Bit (MSB) adjustment. Using a totally discrete analog stage—as well a totally discrete current to voltage stage—the DA-10's analog stage is DC-coupled and servo-corrected to prevent DC offset. It uses a passive third-order Bessel anti-aliasing filter for minimum ringing and best group delay.

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The DA-10 is unique in that it comes with your choice of DAC cards. This means that you choose the sound best for your system and budget, much the same way as phono cartridges are interchangeable. Currently available cards utilize Analog Devices, Burr Brown, Crystal Semi, Philips and Ultra-Analog DAC's. And as newer and better DAC's are developed, Counterpoint will make them available .

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Angeles Coliseum. While attending college in Kansas, I regularly listened to broadcasts from Chicago and Little Rock. I think that what my experiences and Mr. Johnson's have in common is that they all occurred late at night. I have never received such broadcasts during the day.

The explanation for this phenomenon, as I understand it, is an interesting one. At night the atmosphere cools and contracts. As it draws closer to the earth, AM signals begin to be reflected back a great distance from their broadcast point. This reflection off the ionosphere also explains why these broadcasts tend to drift.

I believe it was my astronomy professor who explained this to me almost 20 years ago. Perhaps you can add some details.

Mark Weeks
Salt Lake City, Utah

Editor's Note: The ionosphere is divided into three layers, from lowest to highest: D, E, and F. The height and *ionization* of these layers change from day to night. In the absence of solar radiation, the layers become *less* strongly ionized; in fact, the D layer, chiefly responsible for the attenuation of broadcast signals during the day, effectively disappears at night. The other layers *rise*, further increasing the distance that radio waves can be received from the transmitter.—*K.R.*

"When Radio Was Radio . . ."

Dear Editor:

I thought I was the only one to listen to Gene Nobles and the Randy's Record Shop program on clear-channel WLAC Nashville in the early '50s ("Signals & Noise," March). That is when radio was real radio and featured interesting personalities like Nobles. Does anyone know what happened to him?

If letter-writer Gilbert A. Johnson or anyone else is interested, I have a 36-minute tape of Gene complete with commercials for Royal Crown Pomade (Elvis Presley's brand) and, of course, the famous theme song for White Rose Petroleum Jelly commercials, done only the way Gene Nobles could do them!

If the AM band would lose some of the lesser stations so the clear channels could be heard more clearly, and if management would feature knowledgeable and interesting personalities, AM radio would be worth listening to again.

Don Sieb
8297 Hillpoint Rd.
Cross Plains, Wisc. 53528

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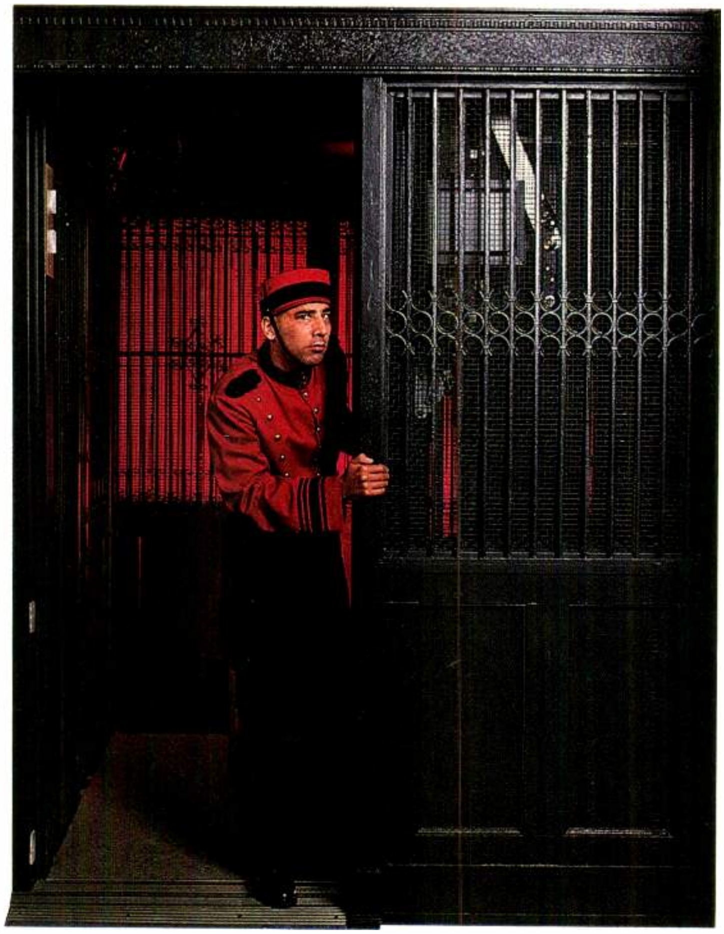
CD PLAYERS & D/A CONVERTERS

MANUFACTURER	Model (RI)=Remote Included, (RO)=Remote Optional	Disc Capacity	Decoding System; Number of Bits—Oversampling Rate	Output Filtration: Analog Plus Digital=A, Digital Only=B, Analog Only=C	Line Outputs: Fixed=F, Var.=V, Balanced Analog=B	Other Outputs: Headphone=H, Headphone with Level Control=HL, Coaxial Digital=D, Fiber Optic=F	Frequency Response, Hz to kHz, ±dB	S/N Ratio, "A" Wtd., −dB	THD, %	Elapsed-Time Display: From Disc Start=D, From Track Start=T, Both=B	Remaining-Time Display: To Disc End=D, To Track End=T, Both=B	Number of Programmable Selections	Repeat Functions: Entire Disc=D, Track=T, A-B Phrase=P, Entire Program=E	Weight, Lbs.	Price, $	Notes
NAD	502(RI) 505(RI) 5000(RI)	1 5 1	MASH 1-32X 1-32X	A A A	F F/V F/V	D H/D H/D	5-20 ±0.5 5-20 +0,-1 5-20 ±0.2	105 108 110	.0025 .0025 0.002	B B B	B B B	21 32 20	D/T D/T/P/E	13¼	299.00 399.00 499.00	

LOUDSPEAKERS

MANUFACTURER	Model	Design Principle, Enclosure or System Type	Woofer Diameter, Inches	Midrange Diameter, Inches	Midrange Type	Tweeter Diameter, Inches	Tweeter Type	Separate Level Controls? Woofer=W, Midrange=M, Tweeter=T, Superweeter=ST	Anechoic Frequency Response, Hz to kHz, ±dB	SPL, 1 Watt/1 Meter, dB	Recommended Min. Amp Power, Watts/Ch.	Crossover Frequencies, Hz	Impedance, Ohms: Nominal/Minimum	Dimensions, Inches (To Nearest Inch)	Finish	Grille Color and Material	Weight, Lbs. Each	Price, $
VELODYNE ACOUSTICS	VA 810 Series II	Powered Subwoof.	8					W	35-85 ±3		50 Inc.	85		15 x 16 x 15	Black	Black Knit	30	595.00 Each
	VA 1012 Series II	Powered Subwoof.	10					W	28-85 ±3		60 Inc.	85		17 x 19 x 17	Black	Black Knit	40	695.00 Each
	Servo F-1000	Powered Subwoof.	10					W	20-85 ±3		80 Inc.	40-100		14 x 14 x 14	Black	Black Knit	44	895.00 Each
	Servo F-1200	Powered Subwoof.	12					W	18-85 ±3		100 Inc.	40-100		16 x 16 x 16	Black	Black Knit	55	1095.00 Each
	Servo F-1500	Powered Subwoof.	15					W	15-85 ±3		250 Inc.	40-100		20 x 20 x 20	Black	Black Knit	79	1495.00 Each
	ULD-12 (w/Controller)	Powered Subwoof.	12					W	15-85 ±3		100 Inc.	85		21 x 16 x 17	Opt.	None	51	1295.00 Each
	ULD-15	Powered Subwoof.	15					W	15-85 ±3		400 Inc.	85		22 x 17 x 18	Opt.	None	76	1895.00 Each w/Amp
	ULD-18	Powered Subwoof.	18					W	13-85 ±3		400 Inc.	85		23 x 31 x 21	Opt.	None	105	2750.00 Each w/Amp
	ULD-18 THX	THX; Powered Subwoof.	18					W	13-85 ±3		400 Inc.	85		23 x 31 x 21	Opt.	None	105	2995.00 Each w/Amp



WHAT'S NEW

AudioSource A/V. Speakers

To complement existing two-speaker setups, AudioSource offers the three-piece VS 1.1 System, specifically engineered for Dolby Pro Logic applications. The package contains the VS One, a center-channel speaker with dual 4-inch woofers flanking a 1-inch dome tweeter, and two LS Ten/B speakers, each with a single 4-inch woofer and a 1-inch dome tweeter. All three enclosures have a matte black finish with black metal grilles. Price: $199.95.
For literature, circle No. 100

Scosche Alternators

To cope with the power demands of large car audio systems, Scosche offers its Powerdrive alternators to fit most cars. The line includes a 120-ampere single-output model plus dual-output models from 135 to 190 amperes. Matching regulators are also available. Prices: $413 to $804.
For literature, circle No. 102

Toshiba CD Car Stereo

The CD section of Toshiba's TX-903 uses digital filters with eight-times oversampling. The tuner section features memory presets for 18 FM and six AM stations, plus both scan and preset-scan tuning. The built-in amp delivers 14 watts per channel to the front speakers, at 1% THD; rear-channel outputs are line level. The front panel is detachable. Price: $399.99.
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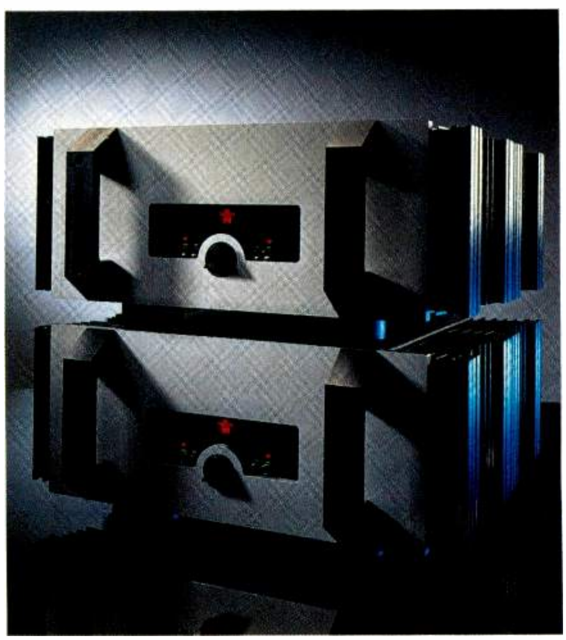
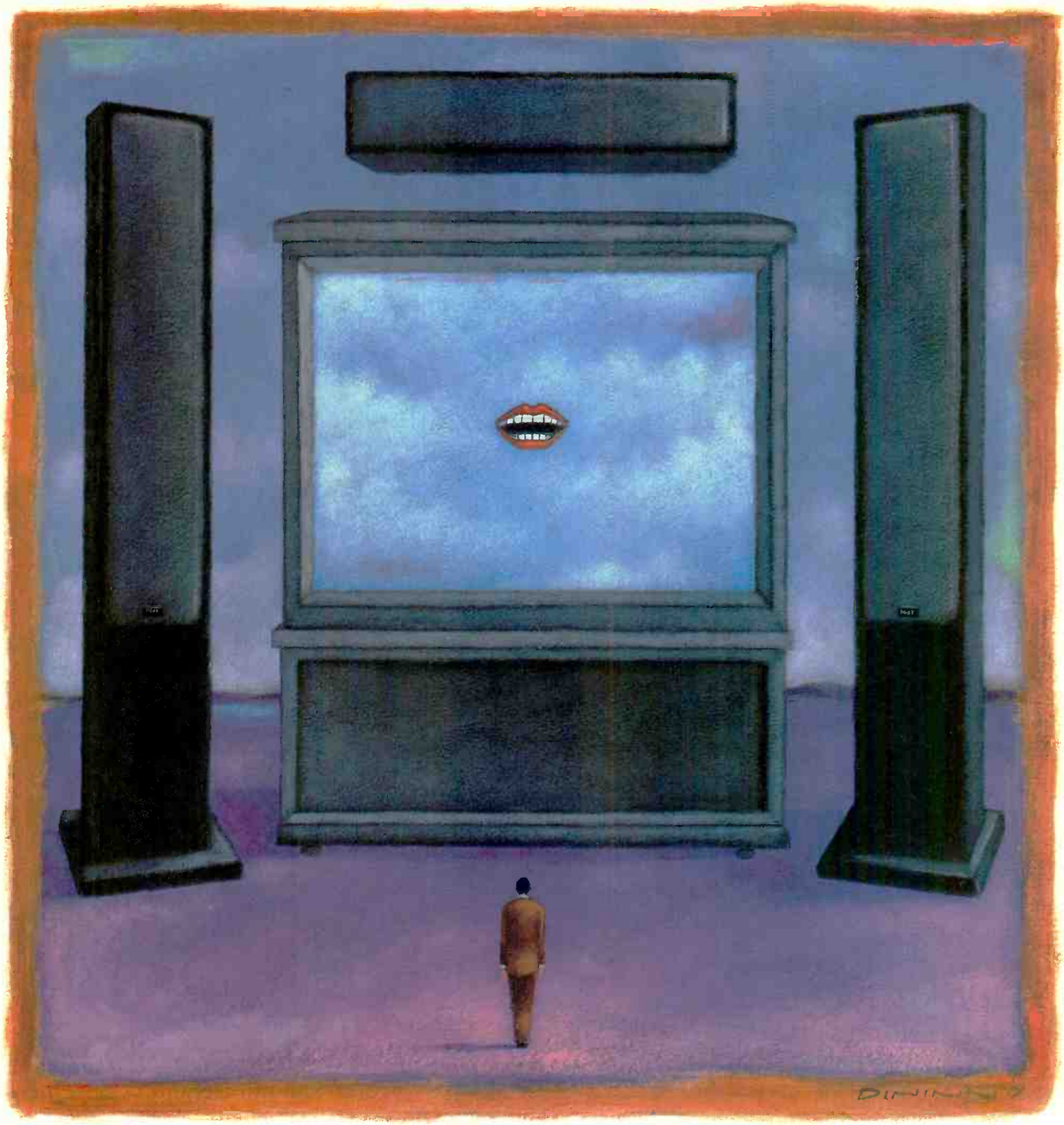


Gryphon Amplifier

Class-A amplifiers tend to be meaty, so it's no surprise that the Gryphon Reference One monoblock amps, which are rated at 150 watts into 8 ohms, weigh 175 lbs. apiece. Peak power is 5,000 watts per channel into 0.5 ohm. Frequency response is rated as 10 Hz to 350 kHz, and THD is 0.01% at 1 watt out. Price: $26,000 per pair.
For literature, circle No. 103



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Its 750 watts per channel* can effortlessly power the most esoteric speakers (at sustained 1 ohm loads), the huskiest subwoofers, and the most lavish home theater systems.

You might think such a potent amp would be a bit touchy.

Hardly.

The TFM-75 is virtually bulletproof. Flawless. It delivers pure, clean, transparent power (test it yourself with your most revealing classical cut).

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AUDIO CLINIC

JOSEPH GIOVANELLI

Bass Motives

Q. *I know that it is difficult and expensive to reproduce bass tones. But why do people seem to love bass?*—Roderick Yong, Walnut, Cal.

A. Maybe I should begin answering your question by asking why *you* like bass—if indeed you do.

Bass has been a part of music for centuries. These low notes are the foundation on which most music is built. Often, the bass note provides a "key" to the name of the chord being sounded.

I think my wife put it about as well as it can be said: "People are fascinated by extremes, such as tinkly bells and low organ tones. The tinkly instruments provide a kind of fairyland quality, reminiscent of our childhoods. Low tones give the music a foundation." The writer Chad Oliver said something to the effect that bass gives music "something to walk upon." (*Editor's Note:* And bass, unlike higher tones, can be felt as well as heard.—*I.B.*)

Adding Bass to Small Speakers

Q. *I have a small sound system that uses a 4-inch loudspeaker. Before I made an experiment, the speaker's frequency response extended down into the lower midrange.*

I made a cone out of poster board, about 5¼ inches in diameter. I taped the new cone into the loudspeaker. Now, when listening to my system, the frequency response is unbelievable. I can "feel" the bass, and it can readily be heard all over my house! Have I discovered a new way to improve bass response of small loudspeakers? Could I use this same method to make larger speakers produce greater amounts of bass?—Monte Hibler, Memphis, Tenn.

A. It appears that more than one factor is playing a part in your speakers' improved bass output.

The poster-board cone is doubtless heavier than the original cone. When mass is added to a speaker cone ("mass-loading" it), the overall acoustical efficiency is usually reduced, but the midrange output tends to drop more than the bass output does, making the bass more prominent. Another way to look at this is that adding mass lowers the resonant frequency of the speaker, which allows the speaker to produce lower frequencies.

Also, depending on how your speaker is mounted in its enclosure, the increase in cone diameter may make the speaker capable of moving more air. This, too, increases bass output.

Speaker Rot

Q. *I have the opportunity to purchase a pair of Acoustic Research AR-9 loudspeakers which were manufactured in the late '70s. Are these loudspeakers likely to suffer from the "surround rot" that I've heard so much about? The price of these loudspeakers is quite high, so I want to protect myself against this problem.*

Also, how does one recognize such "speaker rot"? What are the physical effects of this condition on the surround? What are the sonic effects? How are repairs made, if they can be made at all? Can anything be done to prevent or delay the onset of this condition?—Randy Turner, Coquitlan, B.C., Canada

A. Speaker rot mainly affects drivers with foam surrounds. It is a function of the type of foam used and of the humidity and pollutant levels present where the speakers are in use. The AR-9 did have foam surrounds, but according to AR, if no degradation (such as powdering or flaking of the foam) is visible when you remove the grille cloth, the speakers are still good.

The surround is a flexible ring of material that fastens the cone's front edge to the front of the speaker frame. If it fails, the cone will tilt downwards at the front. When this happens, the voice-coil, which is attached to the rear of the cone, won't stay centered in the magnet gap and will rub against the magnet, causing distortion.

Repairs are possible. There are firms that can replace the foam, making the speakers work properly for another 8 or 10 years before the foam must be renewed again. In the case of the AR-9, service is still available from the manufacturer; this may also be true of other speakers.

Day-and-Night Performance Change

Q. *I have an 1,800-watt line stabilizer, but even when it's on, my system still sounds much better in early morning or late evening than it does the rest of the day. Why would this occur?*—F. Luk, Lafayette Hill, Pa.

A. In order for you to determine why your system sounds best in the early morning or later in the day, you must measure the power-line voltage at various times—both when the performance of your sound system is good and when it is not. I think you will find that the performance is poorer when the line voltage is low. When the system sounds as you think it should, the line voltage is normal. I hope that you won't find the line voltage is actually higher than it is supposed to be.

I suspect that your stabilizer is designed only to prevent surges from entering sensitive equipment, not to regulate the a.c. supply voltage. It probably has no means to raise the a.c. voltage feeding your equipment to compensate for reduced voltage from the power line.

You can check this with a voltmeter. As the power-line voltage feeding a regulator falls, a point will eventually be reached where the regulator's output voltage will stop falling, and the voltage fed to your sound gear will be higher than that coming from the power line.

If your stabilizer does not provide such regulation, you need a constant-voltage transformer. Choose one that can handle the total amount of power required by your equipment, plus a small reserve for safety.

It might serve you well to check your house wiring. If yours is an older home, it may be a good idea to rewire your electrical circuit panel and house wiring.

It is possible that the voltage is varying at the meter itself. If this is the case, then your local utility company should be consulted; you should expect reasonably constant voltage from them. A

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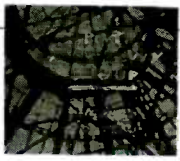

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TAPE GUIDE

HERMAN BURSTEIN

Bias Selector Setting

Q. *With some cassettes, in order to obtain proper bias as indicated by the meter on my deck, I must set the bias selector to an incorrect position. Thus, for normal bias tape I have to set the bias for FeCr, and for FeCr I have to set the bias for CrO_2. Is this acceptable?*—Carl B. Maltzman, Brooklyn, N.Y.

A. Bias requirements vary not only among tape types (Types I, II, and IV) but also from brand to brand and among varieties within a given type and brand. Tape manufacturers often change the magnetic coating of a given tape but don't change the tape name or identification, even though the optimum bias may change somewhat. It is also possible that, owing to aging components in the bias circuit, the amount of bias supplied to the record head has changed for a given setting of the bias selector. If you take these factors into account, then it is possible that for a particular Type I (normal bias) tape you would do best with a Type II bias setting. If this works, fine. The acid test is what works.

In the case of FeCr tape, it is anybody's guess as to the optimum bias for any particular brand, the variation being so great. The bias that usually comes closest to being appropriate for FeCr is Type II, the same as for CrO_2. However, I am puzzled by your reference to FeCr (Type III), which has not been on the market for a number of years. Are you perhaps referring to ferricobalt tape rather than ferrichrome? Ferricobalt, like CrO_2, is Type II.

Static Pops in Cassettes

Q. *My problem is static on cassettes, causing a "popping" sound in playback. The climate is extremely dry where I live, and tapes that haven't been played in a while cause one of my three decks to pop intermittently. Why would only one deck do this? Experts I consulted have been mystified. New prerecorded tapes never cause a problem—just my own recorded tapes that haven't been played in several months.*—C. J. Garnett, Las Cruces, N.M.

A. One remedy suggested for cassettes that produce static noise is to slap them vigorously once or twice on your palm or on a moderately hard object, such as a book. You might try improving the ground connection between the offending deck and your preamp by running a grounding wire between the two, using suitable chassis points. On the other hand, this might cause a ground loop and result in hum. Consider running a ground connection between the deck and true ground, such as a cold water pipe or other known earth ground. Have you tried replacing the cables between the deck and preamp? Finally, try enclosing the cassette and a well-moistened sponge or piece of blotting paper in a container for a couple of days.

I don't know why only one of your three decks should have this problem. I can only hazard a guess that differences in grounding arrangements could be responsible.

Improving 8-Track Playback

Q. *I have a collection of 8-track tapes that I am dubbing onto cassettes, but I am not pleased with the sound quality. How can I improve the quality of the transfers?*—Kevin H. Bennett, North Charleston, S.C.

A. The 8-track format, although capable of giving pleasure in some circumstances, isn't presently considered a high-fidelity medium. Therefore, you should not have great expectations for your transfers to cassette. Perhaps a graphic equalizer, placed somewhere in the chain between the output of the 8-track deck and the input of the cassette deck, will enable you to make frequency adjustments that will enhance the listening quality of the transfers. Base these adjustments on trial and error.

EE Open-Reel Tape Performance

Q. *I plan to buy a CD player and use my open-reel tape deck to record from CD. If I use EE tape at 7½ ips, with dbx NR on, how much fidelity can I expect? Using the same tape and dbx, what would be the fidelity at 3¾ ips?*—Byron Lloyd Taylor, Boise, Idaho

A. Using EE tape on an open-reel deck, with properly adjusted bias and equalization and with dbx NR, you should get, at 7½ ips, essentially flat response out to about 20 kHz and an S/N close to 90 dB. Such performance can replicate a CD quite faithfully. At 3¾ ips, you will typically lose about 3 dB of S/N, and response should be flat to about 15 or 16 kHz, which is still very good. Where you might notice the most difference between 7½ and 3¾ ips is in terms of wow and flutter. This depends on the performance of your deck, and you will have to let your ears decide whether 7½ ips is significantly better.

Mixing Type I and Type II Playback EQ

Q. *On prerecorded Type II cassettes (CrO2) that do not indicate whether equalization of 70 or 120 μS should be used in playback, which should be used?*—Robert Steinhaus, Chicago, Ill.

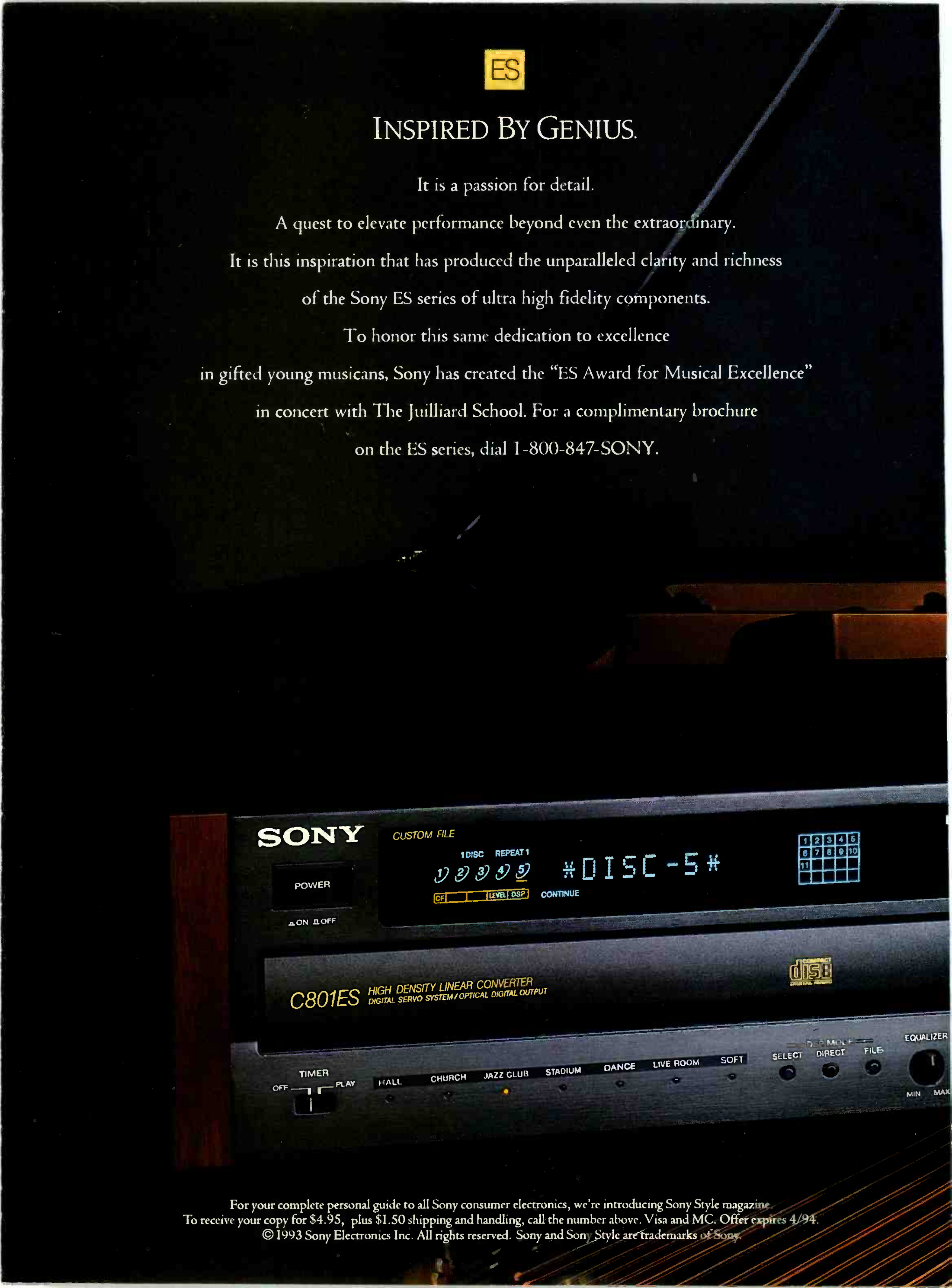
A. If a Type II prerecorded cassette requires Type I (120-μS) rather than Type II (70-μS) playback equalization, this will ordinarily be indicated on the cassette. However, there is no harm in trying both types of playback equalization. Although Type II is the appropriate equalization, it is possible that Type I playback will be more pleasurable. It will lift the treble a bit, although tape system noise will also increase somewhat. Your audio system and your hearing will determine which playback equalization is more desirable.

Making the Right Connection

Q. *I plan to use my cassette deck to record from the speaker terminals of my car's stereo. However, changing the car stereo's volume will change the deck's recording level. Is there a way to eliminate this effect?*—Ray Barnes, Milwaukee, Wisc.

A. Feeding a tape deck from speaker terminals is not the best way to manage things. You should feed your deck from the hot and ground terminals of the radio's volume control, assuming you can gain access to these terminals. This also assumes sufficient signal level at the control to drive your deck to an adequate recording level, which is frequently the case. A

If you have a problem or question on tape recording, write to Mr. Herman Burstein at AUDIO, 1633 Broadway, New York, N.Y. 10019. All letters are answered. In the event that your letter is chosen by Mr. Burstein to appear in Tape Guide, please indicate if your name and/or address should be withheld. Please enclose a stamped, self-addressed envelope.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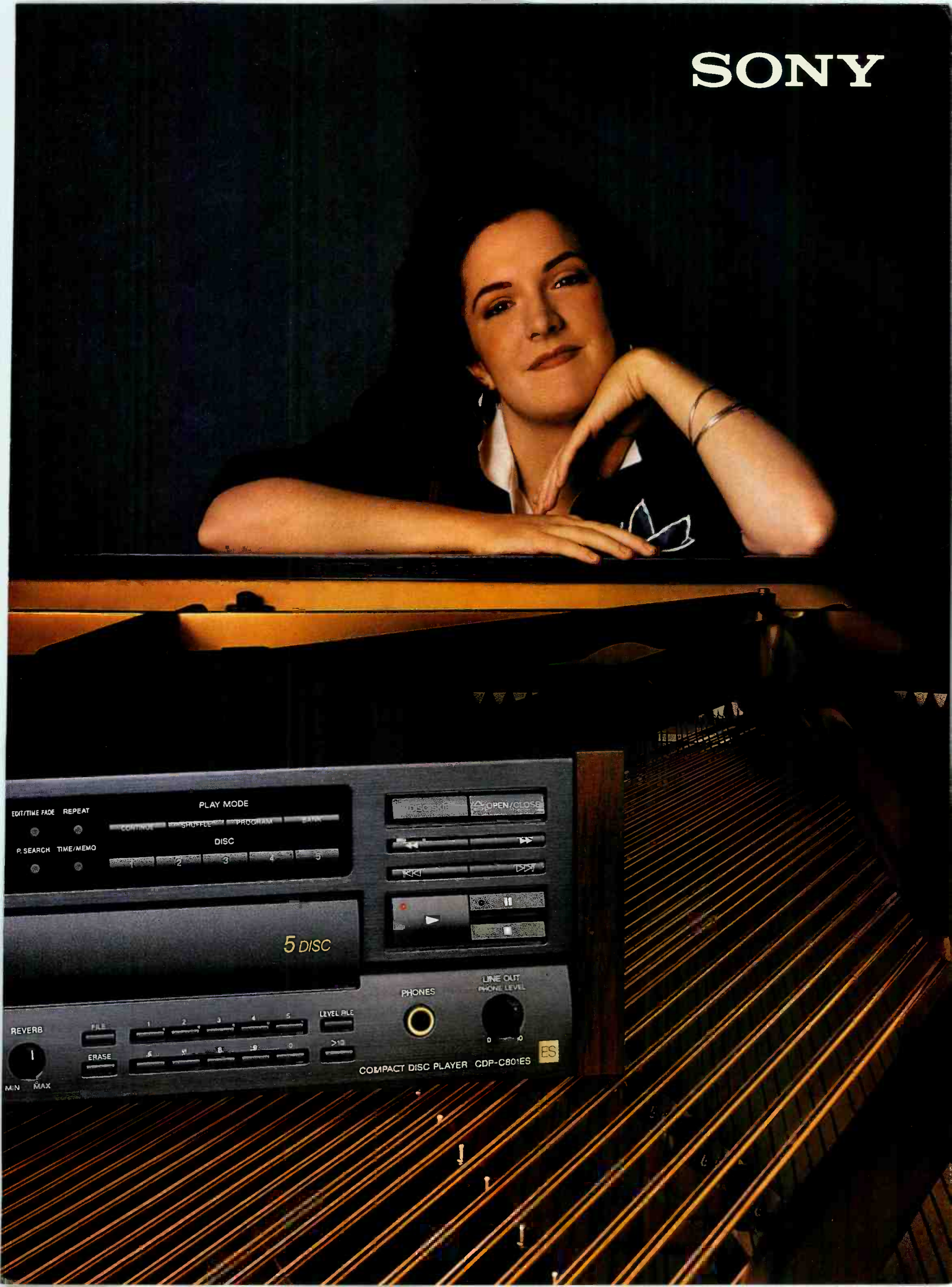
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REALITY LESSENS

We are a nation of buzzwords, and audio is merely a drop in the national buzz bucket. Buzzwords come so thick and fast that the ordinary citizen—me, for instance—gasps trying to keep up. No use! Best thing is simply to read 'em, hear 'em, and use 'em while they last. Figure out the sense, if any, as you go along. Maybe new, maybe just the same old thing in a new glamor guise. Quadraphonic to surround sound to home theater to. . .

VIRTUAL, OUR NEWEST BUZZWORD, IS VIRTUALLY EVERYWHERE YOU LOOK OR LISTEN.

Virtual. That's our newest, and what a buzz! It is virtually everywhere you look or listen. And used in a hundred ways, from purely scientific to total hokum. Entirely too much of this latter, as might be expected. Not fair to those who have something real and specific in mind, that is, an image (sound or sight) that is *not* real but seems so. What else is that but a definition of our entire art from the beginning? So what's new?

Curiously, many of our buzzwords, the shorter and juicier ones at least, originate in the professions, far from the public realms. There are as many buzzes inside the professions as outside, but the inside ones tend to have as many syllables as possible, for status and to ward off outside comprehension. Can an audio pro read a professional medical article? Highly unlikely. And vice versa. Yet the best and shortest of these terms do tend to leak out, and *virtual* is one of them.

Now, I have been entirely familiar with the technical aspect of the virtual image for at least 50 years, having viewed or projected thousands of the same in "3-D" stereo photography. You think you see it—it isn't there. Just a bundle of light rays in space. It is *real* versus *virtual*, and a decidedly valid distinction! Either an automatic weapon is real, solid metal with firepower, or it is virtual—that gun that sticks out at you from the popular "3-D" movie screen. People new to visual stereo are astounded. You try to take hold of it, and there's nothing there. Even more interesting is the frequent accidental amputations of arms and legs and heads when stereo is projected with a slightly wrong adjustment. The so-called "stereo window" (because it acts like one) should show all its "3-D" beyond the window edges, where the amputations are entirely normal—we don't see the parts beyond the window frame, as we wouldn't in real life. But project a piece of an arm *in front* of the window, and you have a grisly sort of virtual image!

Here is the origin of our audio virtual image, whether on its own or accompanied by film or video. Not quite the same, these two, ears being different from eyes. Yet intimately related, since we use two of each in similar ways. The individual stereo viewer, highly accurate and realistic, corresponds to our true binaural sound with 'phones, miked a head apart, reproduced two-channel with 100% separation. Projected stereo pictures, like loudspeaker stereo sound, are much more contrived, full of false effects yet often powerful in entertainment.

Virtual in still another sense? The English language is full of multiple meanings for one and the same

Illustration: Mary Schuck

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word. In any sort of writing—literary, engineering, or journalism—*virtual* and *virtually* are entirely unrelated to anything above. The meaning, audio aside, is, of course, *almost.* Very-nearly-but-not-quite. Is *that* what we mean in audio sound? Decidedly not.

Instead, this one is an elegant and, more to the point, usefully evasive term when you want literary protection—against everything from harsh criticism to libel. I discovered it in high school: "The Roman Empire covered virtually the entire known world." Teacher-proof! No matter that the rest of the known world, here and there, was not Roman at all.

Nowadays, *virtual* is a journalist's strongest insurance, along with legions of other handy evasives that do the same, like *ostensibly, reputedly, debatably, allegedly, essentially, purportedly, reportedly,* and even the outrageously overused *perhaps.* Maybe so, maybe not. I call it waffling. (There is plenty of that in virtual audio—in the publicity, at least.) Beware, beware. If you catch me writing "Mozart was perhaps the greatest musical genius of all time" (another handy evasion), you'll know I'm slipping. Indeed he *was* one of the greatest in Western music (still too evasive!), from his childhood in the 1760s to the present day. . . . Perhaps?

I have been prompted to all these words, of course, by the incredibly increasing use of *virtual* in practically (there's another one) all of the flood of audio print that comes my way. But a recent CD package put me into high gear, automatically. A single CD, publicity type, full of pop music.

You understand, of course, that in certain enormous circles of our U.S. musical world, "music" means absolutely all music that is *not* so-called classical. That exotic type is no more than a speck on the Hollywood horizon, or does not exist at all. So in these circles a music critic who writes record reviews is automatically pop—there is no other kind. So it is, in my case, with the *Virtual Audio CD Sampler,* a pleasing blue cardboard folder with a single CD inside, looking just like, say, a classical CD. Except for the small type, with, to quote a few titles, "Fill the Tub," "Relax," "Heavy Breathing," "Shampoo," and so on. Wrong address, friends. The pop departments at *Audio* are next door.

No, I will not review it; I will not even play it. Not my business. But the literary contents of this entirely well-meant sampler, from a company named Heyday Records in San Francisco, has me fascinated. Shows you what we can do with a simple and direct term like *virtual.*

That title. The recording, of course, is produced in Virtual Audio. Is this *almost* audio? But not quite? No, no, it's an audio sampler, so that's settled. And a full one, with 32 items and 71 minutes of play. But just what, I asked myself, is Virtual Audio? That would seem to be of some interest, yes? If it were stereo sound, we all might have a fairly clear idea as to what this means, even with the many ways in which stereo sound may be taken down on tape, not to mention reproduced. But if something is flatly announced as being recorded in Virtual Audio, we are perhaps nonplussed. Taken aback? We need some further explanation.

Open the folder, and there it is. "What is Virtual Audio?" asks the copy in boldface at the top. Followed by a paragraph of ex-

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Vol. 16, No. 5

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Stereophile, April 1993
Vol. 16, No. 4

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planation. "Virtual Audio is our own way of digitally recording in full three-dimensional sound." Does that explain everything? Next comes a further description: "V.A. recordings sound life-like and natural, unlike post-production 3-D processing systems." Aha, says my devious brain, there's more to that than might seem. These V.A. recordings are probably made "live," that is, on the scene of a public performance of some sort, rather than in a studio. Okay, a usable technique and often very successful in that speck-in-the-sky music, classical. With a good dose of connective editing. Why not in pop, too? Might save studio time charges. *But what is Virtual Audio?*

"V.A. recordings are headphone, speaker and *broadcast* compatible." That's easy to interpret. For that sort of compatibility, as we know so well, we use one or another variety of the "one-point" mike technique, two mikes occupying virtually (!) the same place in space, aimed differently. M-S does it by matrix; others point out diagonally. Very familiar, especially to broadcasters who still must severely limit the low-tone excursions in signal due to phasing differences between channels. (On CD, at least, these differences are no longer so impossible, but compatibility requires a safe technique.) With one or another technique of this sort, presumably ending up in two channels, this particular Heyday method achieves what is now a normal compatibility, and in "uncompromised high quality sound." No argument! Very likely true. *But what is Virtual Audio?*

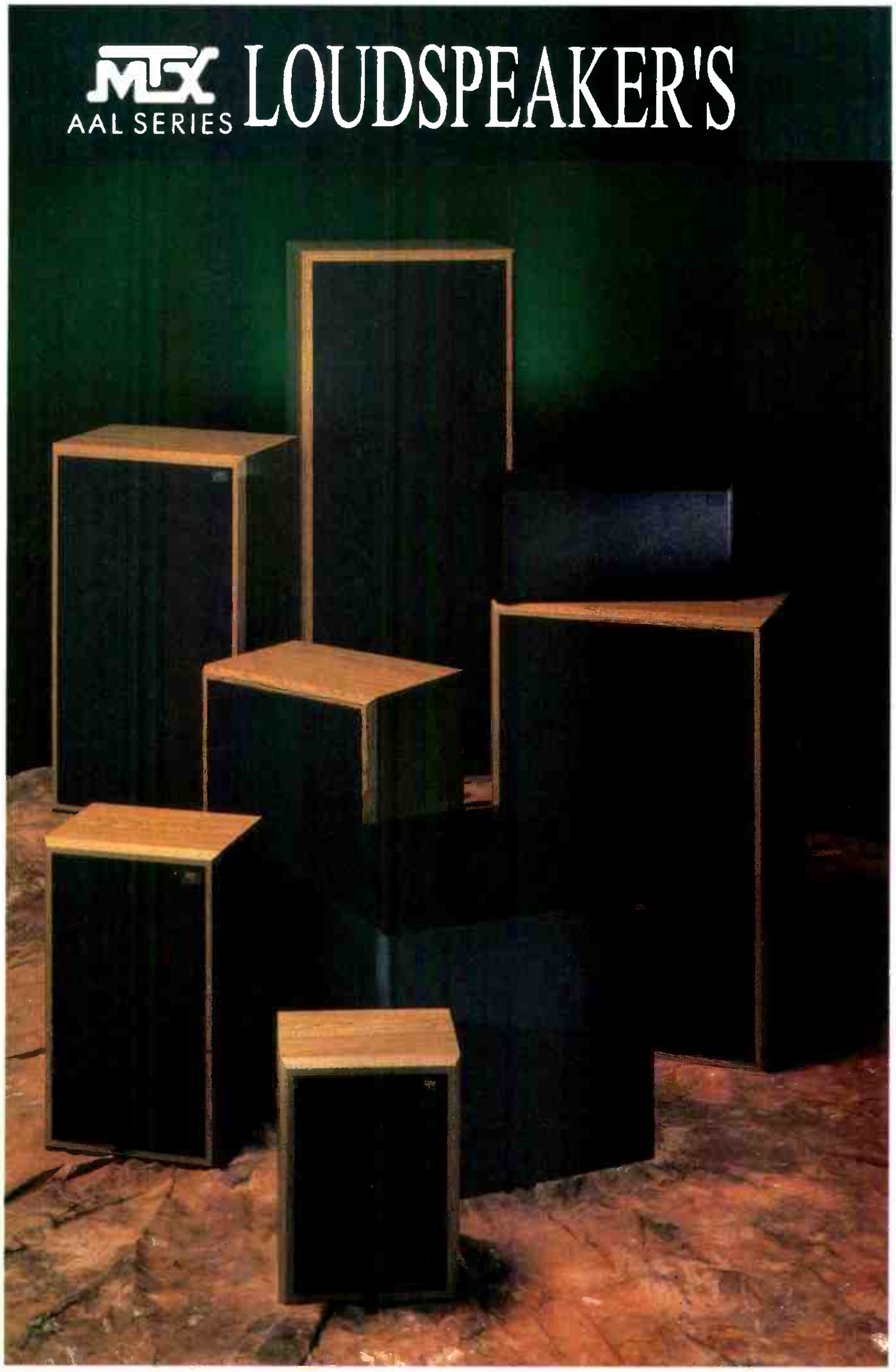
VIRTUAL MEANS ALMOST, BUT IS THAT WHAT WE MEAN IN AUDIO SOUND? DECIDEDLY NOT.

The clincher. "V.A. recordings are characterized by unprecedented clarity and a spatial sensation that gives the listener the feeling of being at the actual site of the recording." Yes, yes, but I seem to have heard this claim before. During a half-century or so of hi-fi. Even longer, back to the days of the Edison cylinder, live versus recorded sound at the Met, circa 1911. And remember the Best Seat in the Concert Hall, circa 1950? It is the eternal song, not of pop but, oddly, of *classical* music. As though *you were there*. Very possibly, Heyday Records' offerings do give this impression, as do many others of our time. *But what is this Virtual Audio?*

Well, I suppose it is Virtual in that we think we are on location when we are not. We reach out, and nothing is there. If I may say so, Heyday hardly has a monopoly on that sort of recording.

I won't belabor the point. This label is clearly following the current trend, the buzz, with the best of intentions and perhaps a fine product. Maybe I should send it on to our pop department? They probably have it already. But this leaves me still wanting to know: *What is Virtual Audio?*

A final quote from Heyday Records: "Virtual Audio is the definitive listening experience. But don't take our word for it. Listen for yourself." With that, I must virtually sign off. A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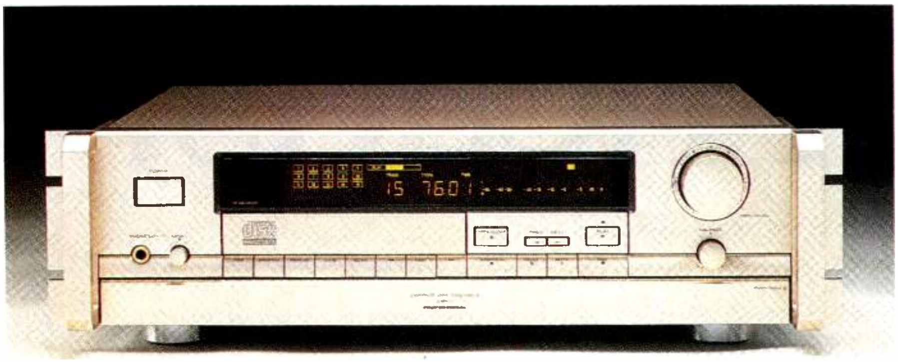
BERT WHYTE

BALANCING, ACT II



In spite of its complexity, the Marantz CDR-1 CD recorder is easy to operate.

In the October issue, I reported on the FM Acoustics Resolution Series 222 Phono Linearizer/ Preamplifier and its peerless features, principally that it affords balanced output from MM or MC phono cartridges. Thus, balanced XLR cables are used for signal transfer instead of the traditional single-ended leads using RCA plugs. I noted that the FM 222 is a vital element in my project to transfer from LP to recordable Compact Disc (CD-R) the Everest and Crystal Clear recordings I once engineered.

The transfer system I set up can best be described by following the signal flow. The balanced signal from a Koetsu MC cartridge is fed to balanced inputs on the FM 222. At that point, I can check if my preselected cartridge loading for capacitance and resistance provides a good sonic balance, or I can use the FM 222's variable DIP switches to improve or correct spectrum balance. In addition, while the initial setting for phono equalization is to the RIAA Standard, the unusual variable bass turnover/treble roll-off controls on the FM 222 permit tweaking the equalization. Thus, if the record sounds a little too bright or a bit too rolled off on the top end, I can easily correct it.

Once adjustments have been made, a pushbutton on the FM 222 allows comparison between the standard RIAA curve and the tweaked setting of the variable controls. The chosen signal is fed from balanced outputs on the FM 222 to balanced inputs on the FM 266 preamplifier. With a maximum output of 18.5 V rms, the FM 266 can easily provide optimal signal levels for recording. Balanced outputs on the FM 266 feed the signal into balanced analog inputs on a Wadia 4000 Professional A/D converter. This unit has pushbuttons to select either the 44.1- or 48-kHz sampling rate; other pushbuttons select normal or inverted polarity and 20- or 16-bit digital output. Since the CD-R machine I used, the Marantz CDR-1, is a 16-bit recorder, I chose the 16-bit output of the Wadia 4000, as it has about 1.5 dB of dither and provides a nice, clean signal, free of any spurious ultrasonic noises. The rear panel of the 4000 has digital outputs for AES/ EBU, S/P DIF-2, AT&T glass optical, and coaxial. A front-panel LED array shows input levels. I chose the coaxial digital output of the Wadia 4000 to feed the signal to the coaxial digital input of the Marantz CDR-1.

Like most other manufacturers of CD-R machines, Marantz uses the basic Philips design for CD recording according to Philips' "Orange Book" standards. For the CDR-1, Marantz has added proprietary circuitry to improve performance and reliability and to enhance convenience features. The CDR-1 operates on the Write Once, Read Many (WORM) system, which means that after a blank CD-R is recorded, it cannot be erased and used for subsequent recording.

Blank CD-Rs are quite complex and therefore quite expensive. Efforts are being made to drastically reduce their costs, but discount prices currently can run from $26 to $35! (I used TDK CD-Rs in both the more common 60-minute version and in the new 74-minute version.) The plastic substrate of a CD-R is pre-grooved in a spiral pattern, emulating the track spiral of conventional CDs. In the pre-grooves of the CD-R, a reference value of 6 mW is preset. There is a Program Calibration Area (PCA) in a section of the CD-R before the lead-in area. When a CD-R is inserted in the recorder, several trial recordings are made at

The FM Acoustics Resolution Series 222 phono unit is a fantasy component for analog vinyl enthusiasts.

between 4 and 8 mW of laser power and then compared to the stored reference value. This determines the laser power needed to record the particular disc; this is necessary because of production tolerances in the manufacture of CD-Rs. The CD-R has a green pigmented recording layer, and it is here that the laser burns the pits which represent the digital input signal.

The Marantz CDR-1 can input analog signals and digitize them with its own delta-sigma A/D converter. I preferred to use the Wadia 4000 A/D converter, an ultra-high-quality unit selected by many recording engineers (including Tom Jung, for his superb dmp recordings). I also used it because I could feed its coaxial digital output to the digital input of the CDR-1.

In spite of its high-tech complexity, the Marantz CDR-1 is easy to operate. After the CD-R is inserted and a few seconds elapse for the aforementioned calibration tests, the CDR-1's elaborate display panel informs you that the machine is ready to record. With the digital input, recording level adjustments are unnecessary. Any program material with multiple movements or selections can be manually numbered in sequence or automatically numbered if the program has digital subcodes—a conventional CD, for example.

Once a program has been fully recorded (up to 74 minutes) and you press a button labelled "Fix-up," the CDR-1 generates a final Table of Contents (TOC) and stores it in the area used for TOC on a standard CD. Henceforth, the CD-R can then be used in any standard CD player. The Marantz CDR-1 is also a high-quality CD player that employs Philips' most advanced bitstream conversion technology. Recordings made on the CDR-1 are absolute mirror images of the program material, as numerous A/B comparisons easily confirmed.

As is evident, the FM 222 makes possible the use of balanced signal lines from the MC phono cartridge, through the linearizer circuits and gain stage of the FM 222, to the FM 266 preamplifier, which provides line-level signals to the balanced inputs of the Wadia 4000 A/D converter. To my knowledge, this totally balanced phono cartridge system is unprecedented. I don't know of any other equipment that can provide truly symmetrical balanced phono signals with such high accuracy and such vanishingly low noise and distortion. In fact, the signal-to-noise ratio of the FM 222 is claimed to better existing preamplifier designs by 6 dB to 20 dB! The actual specification for equivalent input noise, below full output and from 22 Hz to 22 kHz, is 137 dBu; below 0 dBV it is said to be greater than 85.0 dB! The accuracy of the RIAA de-emphasis is ±0.08 dB over the full frequency range. The FM 222 is claimed to have 0.005% distortion at an output of +10 dB, with no high-order harmonics at all up to clipping level!

THE FM 222 PROVIDES A QUANTUM LEAP FORWARD IN THE REPRODUCTION OF MUSIC FROM VINYL LPs.

As always, special features and specifications of a component are interesting, but more important, how does it sound and does its performance enhance the music? In my opinion, the FM 222 provides a quantum leap forward in the reproduction of music from vinyl LPs. The amount of information that the FM 222 can extract from LP grooves is astonishing. This is particularly so in respect to the differences between the standard RIAA de-emphasis curve and the variable de-emphasis controls. It seems that prior to 1968, the cutting heads of the lathes were unable to perfectly cut the very high velocities present at frequencies above 10 kHz. If the cutting engineer persisted in trying to cut those high frequencies, the result was distortion and somewhat bright, aggressive high-frequency reproduction. Most cutting engineers opted to attenuate the higher end of the music spectrum somewhat. In either case, the variable de-emphasis controls of the FM 222 can restore these highs and achieve a better musical balance. Even with the improved high-current cutters of the late 1970s and early '80s, some recordings have excessive high-frequency levels. These can now be tamed with judicious use of the FM 222's variable de-emphasis controls.

Although the FM 222 is a key element in my transfer project, I will use it mainly as a high-precision phono preamplifier. Its true balanced operation and extraordinary performance are beyond the capabilities of similar equipment previously available. The common-mode rejection ratio (CMRR) of better than 100 dB across the full frequency range attests to the accuracy of the FM 222's balanced circuitry. Even with the lowest output MC phono cartridges, the FM 222 is singularly free of hums, buzzes, or any other kind of noise.

Listening to vinyl phonograph records with the balanced circuitry of the FM 222 is a revelatory experience. Depending on the condition of the record, I expect to hear some typical impulse artifacts—clicks, pops, scratches, etc.—but with the FM 222, the tape hiss and other low-level, steady-state background noises on discs are significantly attenuated. On certain records, reproduction through the FM 222 can be so quiet as to be uncanny, approaching CD playback! A case in point is my Everest recording of the Shostakovich Ninth Symphony with Sir Malcolm Sargent conducting the London Symphony Orchestra. This 1960 recording was the first stereo version of this work. It was mastered on 35-mm magnetic film and recorded in the famous Walthamstow Assembly Hall in London.

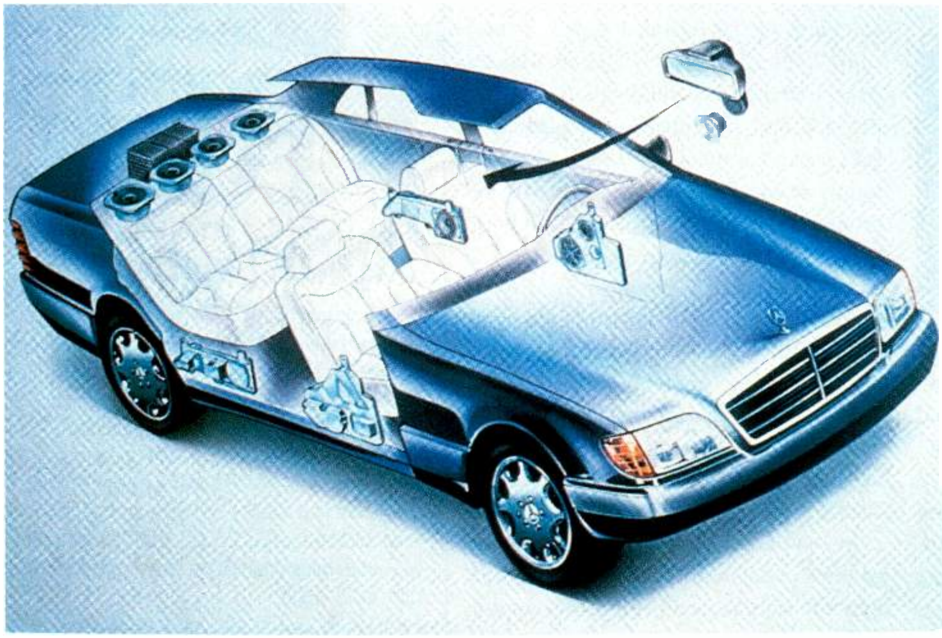
In 1980 London/Decca digitally recorded the Shostakovich Ninth Symphony with Bernard Haitink conducting the London Philharmonic Orchestra in the renowned Kingsway Hall in London. While the master was digital, it was issued on a standard LP. On playback through the FM 222, both my recording and the Decca recording are so quiet that only a stray tick or pop betrays them as vinyl discs. Balances and acoustic perspectives are different, but both are good-sounding recordings even though separated bv 20 years!

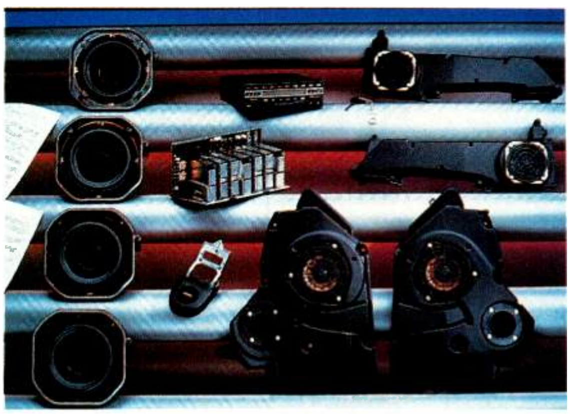
Another exceptional quality of the FM 222 playback is its capabilities for dynamic expression. With a huge headroom of +24 dB, the dynamics of any record can be fully reproduced with near instantaneous response. At around $10,000, the FM 222 is an analog vinyl enthusiast's fantasy component. If you can afford one, it will offer new insights into—and appreciation of—the reproduction of vinyl records.

As for the transfer project, all elements worked synergistically, and I have thus far "frozen" the sounds of about 10 of my Everest and Crystal Clear recordings in the digital data of CD-R! **A**

IVAN BERGER

DRIVING A MERCEDES-BOSE





Bose and Becker components for Mercedes-Benz S-class cars.

When Bose introduced their Beta sound system for the S-class Mercedes-Benz, they only showed four-door sedans (the 300SE, 300SD, 400SE, 500EL, and 600SEL), as those were the only models with the new sound system. And Bose emphasized that one of Mercedes' basic requirements for the system was that the sound be as good in the back seat as in the front. (Mercedes owners are a bit more likely to sit in back while someone else drives than owners of, say, Fords are.) So when I finally got a chance to test one over a weekend, I expected a sedan, probably the comparatively low-priced $69,900 300SE.

What I got was a sport coupe, the 12-cylinder 600SEC, which encouraged some enthusiastic driving as well as listening. And that's why I wound up with a curious cop asking me, "How much does this thing cost?"

"Frankly," I replied, "I'd just as soon not know—about half a house, I'd estimate." Eventually, I did get curious and asked; it's $132,000. (When I get my next spare few million, I'll buy a his-and-hers pair.) On the bright side, that includes the cost of the Bose stereo system, which is an $1,100 option in Europe. So you might say the 600SEC is the highest priced stereo accessory I've ever used; it's the most fun, too.

The Bose and the Benz worked well together. The sound system definitely added to the car's air of well-thought-out luxury (including—my favorite touch—a sunshade that rolled up over the rear window at the touch of a button on the dash). The car, despite performance that pressed me into the seat cushions when I stepped on the gas, was quiet enough to let me hear the system clearly. Nice package.

The system includes a Becker head unit with FM stereo, AM, and cassette; a six-disc Alpine CD changer in the trunk (the '93 sedans had 10-disc models made by Becker), plus Bose's contribution of four equalizers, seven power amps (generating up to 240 watts total), and 11 speakers. Of these, I could see grilles for tweeters at each end of the dash-top (angled up 30° from horizontal), a midrange and woofer toward the front of each door, and an additional midrange at the rear of each door, near the bottom. What I couldn't see were the four drivers concealed in the rear shelf and the center-channel tweeter. That tweeter is easy to miss; it's hidden by the rear-view mirror and aimed forward to bounce its sound off the window glass.

I had never used another Becker, and I found this one intriguingly different from the other head units

THE 600SEC IS THE HIGHEST-PRICED "STEREO ACCESSORY" I'VE EVER USED.

I've used. It's unconventional—or, rather, follows conventions I'm not used to. Across the top are 10 large numbered buttons, of which the first six are for FM presets (and disc

selection, in CD mode) and the last four for AM. That limits station-preset capacity a bit, but I found it adequate for my listening habits—and welcomed the ability to punch in any preset station directly, without having to press a band switch first. You can also use the 10 buttons, together with a shift key marked with an asterisk, to punch in a station's frequency by number. This is mainly useful for setting up the presets when you first get the car or move to a new area; the manual sensibly suggests you not try this while driving. Normally, I'd hate dealing with a row of 10 identical buttons, but these were so large and spread out that I easily found the one I wanted every time.

Below this button row is the display (immensely legible, by day or night), flanked by a pair of buttons on each side. To the left are the bass and treble controls, marked by musical notes; to the right are the asterisk button and the local/distant switch. The tone-control action is unusual, and a bit annoying. Pressing the button for either bass or treble will boost the appropriate band until maximum boost is reached, then start rolling back the boost until it becomes a cut. Pressing both buttons at once, however, resets bass and treble to their midpoints. A nicety was that tone-control settings are apparently memorized separately for CD, FM, and AM. You adjust balance by pressing the tone controls in conjunction with the asterisk key. (The front/rear fader is a thumbwheel mounted on the center console.) Both *Audio* Editor Gene Pitts and I liked the musical-note markings but disliked the tone buttons' one-way action.

On the other hand, we loved the "Volume," "Seek," and "Scan" keys in the next control row. These keys stick out almost horizontally, so they're very easy to find and flip. Gene called them "the first car stereo buttons I only had to look at once."

Between the "Volume" key at one end of the row and the tuning keys at the other lie six buttons. Only the first, "Mode," is active in radio mode, as it selects radio, cassette, or CD operation. After that come the buttons for forward and reverse tape or CD music search, tape reverse and eject, tape-type selection, and selection of Dolby B or C noise reduction in tape mode or random play of CDs. Various display options can be selected by pressing some of

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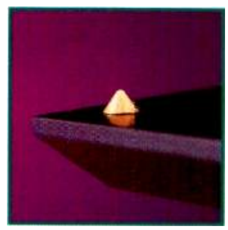

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1973 W. Cty. Rd. C2 Roseville MN 55113 (800) 359-5520 (612) 636-0367 FAX these buttons along with the asterisk key. At the bottom is the power button, tape slot, and up/down manual tuning keys. We would have found it both handier and more logical to have the radio tuning keys used for music search and fast forward and rewind, but we had no real complaints with the existing setup.

Radio reception was fantastic—even AM, which is all too frequently a stepchild. The sound of AM, however, was woody and old-fashioned, about what you'd expect from grandpa's old AM-only Mercedes, with a sibilant overload on some peaks. The sound on FM was better, and a pretty close match to the sound from CD. (We didn't have time to try cassette.) The FM and CD sound didn't have much treble, but its bass went down far and full, rather than being fat and pillowy. There was some looseness in the bass on Lou Reed's "Walk on the Wild Side" when the tone controls were at their mid positions, but this was only noticeable when the car was standing still, not on the road.

Both male and female voices sounded fairly natural. My Elisabeth Schwarzkopf test cut had none of the nasality or steeliness I've gotten from some sound systems, and exposed no really high treble resonances (though there were some subdued ones in the upper midrange). On instrumentals, however, the very top highs seemed to be missing, and triangles sounded dull or tinny rather than silvery. Gene had the feeling there was something missing in the upper midrange or low treble, just below the mild resonances I noted. My preferred tone-control settings varied with particular selections far more than usual, which suggested to me that the frequency response might be a bit skewed. A third-octave spectrum analysis showed nothing that would account for this: There was some bass boost from 50 to 200 Hz (a good idea, since road noise can mask low bass) and a shelving treble cut above 3.15 kHz. Perhaps the problem was the tone controls themselves, which seemed to have more effect on the midrange than is usually desirable.

I WELCOMED THE ABILITY TO PUNCH IN ANY RADIO STATION WITHOUT PRESSING A BAND SWITCH.

Tonality changed with fader setting. When the fader was set all the way to the rear, treble was rolled off (as it should be) and voices got a little honky. But then, who'd set the fader that way when listening seriously? (I did not have time to listen to the sound while sitting in the back.) As is usually the case, imaging also changed with fader setting. With the fader set full front, voices were centered in front of the listener; at the fader's middle setting, they moved toward the midpoint of the car. Side-to-side imaging was very good, but there was little sense of depth. (I thought it was thin as wallpaper, but Gene thought that wallboard might be a better simile.) I was surprised, because Bose systems are usually more spacious, with vaguer imaging.

For 1994, still more Mercedes models will get the Bose treatment. The higher-priced, two-seater SL class (SL320, SL500, and SL600) will be the first cars to have Bose's Acoustimass woofers; as "entry level" Mercedes sedans, the C220 and C280 will have simpler sound systems. A

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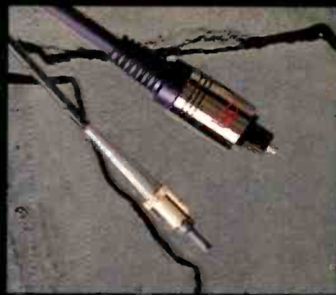

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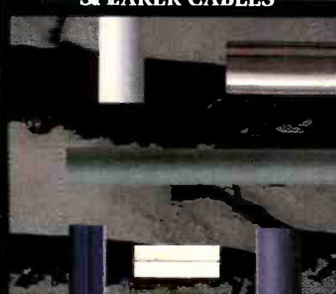

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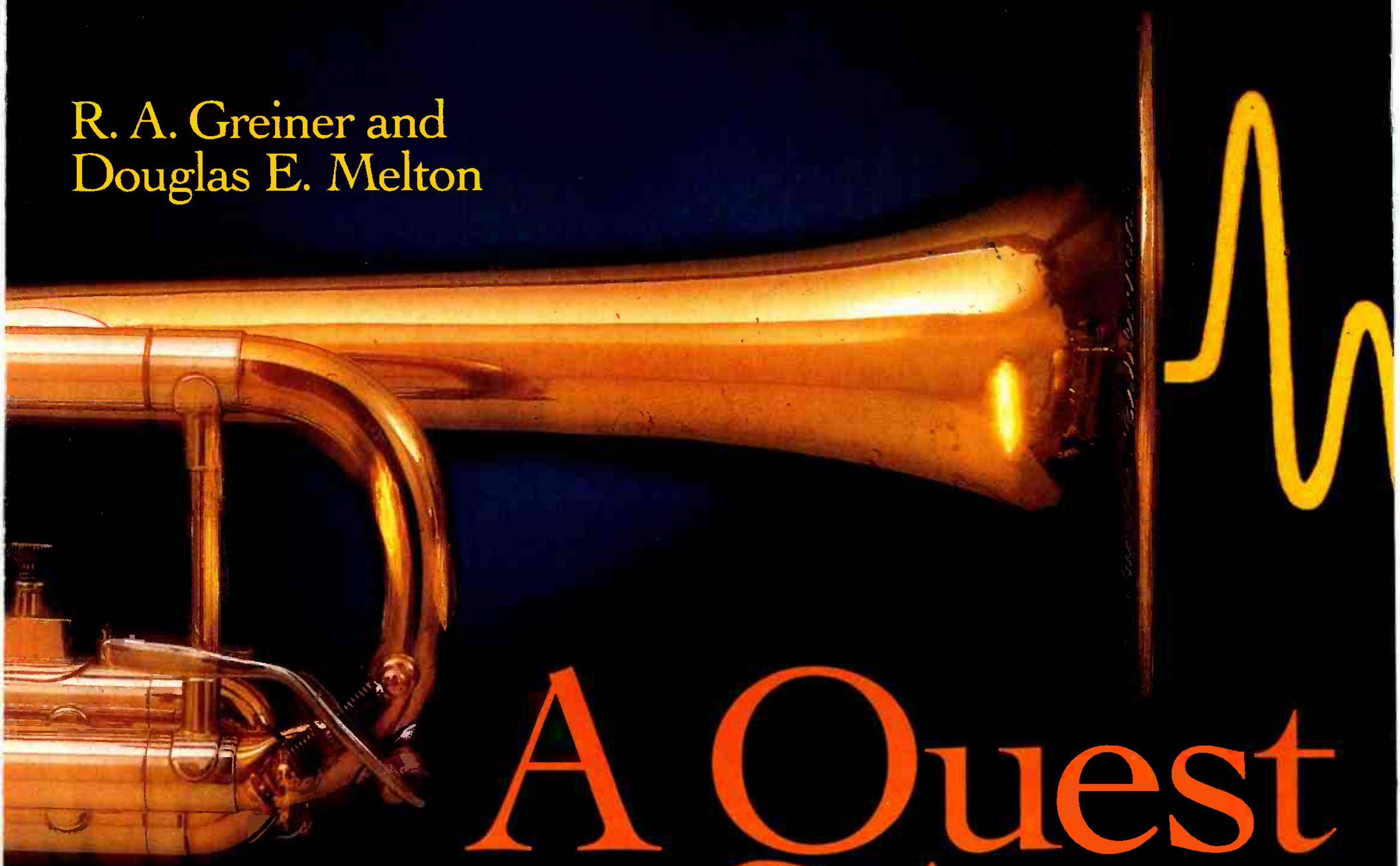
A Quest Audibility

R. A. Greiner and Douglas E. Melton



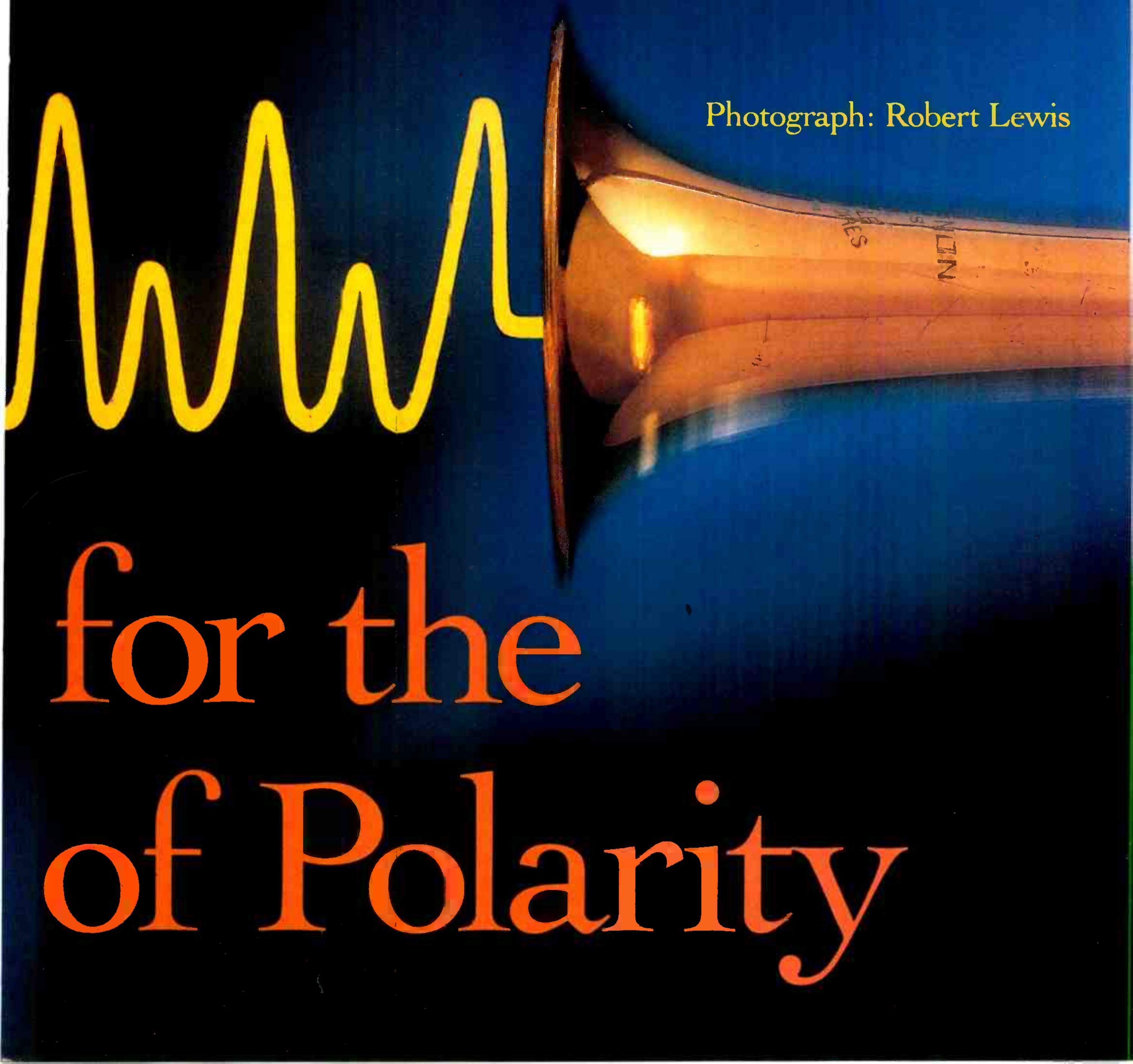
When sound is emitted by an acoustic instrument, it travels through the air in the form of compressions and rarefactions that are "picked up" by a microphone and turned into an electrical signal. The microphone may turn compressions into positive voltages and rarefactions into negative voltages (or vice versa, depending on its design). In a similar manner, when a positive voltage is applied to a loudspeaker, it may move the cone forward and cause a compression at the cone's surface. In this case a negative voltage would move the cone backward, whereupon it generates a rarefaction in the air (or vice versa, again depending on the design). It would seem reasonable that for an original acoustic wave to be "reproduced correctly," the original compressions should be reproduced as compressions and the rarefactions as rarefactions. This does not happen unless care is taken in the recording/reproduction chain to keep track of the polarity of the electrical signal at all stages. It is crucial that a compression at the microphone, which forces the diaphragm inward, result in a forward motion of the loudspeaker piston to cause a compression at the piston's surface. Figure 1 shows this concept in a simple schematic.

This article examines the audibility of changes in the acoustic polarity of musical signals. Discussions about the audibility of an inversion of the polarity of an acoustic signal, or of a change in the phase relationships of the spectral components within a signal, have been going on for about 100 years. Some interesting references from the more recent popular and professional literature are annotated at the end of this article.

Much of the discussion in the past has been about the audibility of changing phase relationships among various components in a signal presented to the ear. This article is not about the audibility of *phase* relationships within a waveform. It is about the audibility of inversion of the acoustic polarity of the signal, as reproduced by a sound system, compared to the original acoustic signal produced by the acoustic instrument. In the work described here, the shape of the waveform remained constant and unchanged; only the polarity of the signal was manipulated—i.e., it was either inverted or noninverted when played back for the listening tests. Polarity inversion is generally not identical to "phase inversion" or "180° phase shift," so terms such as phase are avoided in this discussion.

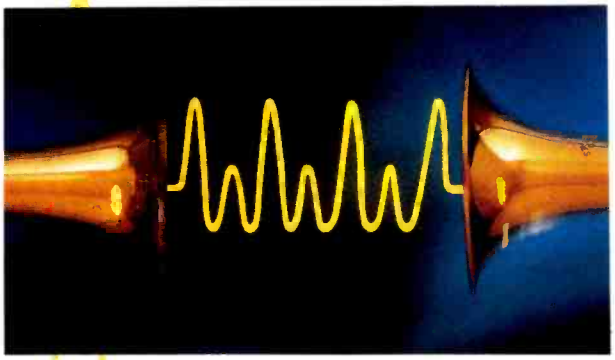
Experiments were carried out to answer the seemingly simple question: Does an acoustically generated signal sound different to the ear when it is acoustically inverted (i.e., when compressions and rarefactions in the waveform are interchanged)? While this is a "simple" enough question, the answer is actually quite hard to deter-

R. A. Greiner is Emeritus Professor of Electrical and Computer Engineering at the University of Wisconsin in Madison. Douglas E. Melton is Manager of Software Development Products at Digisonix, Inc. in Middleton, Wisc.



Photograph: Robert Lewis

for the of Polarity



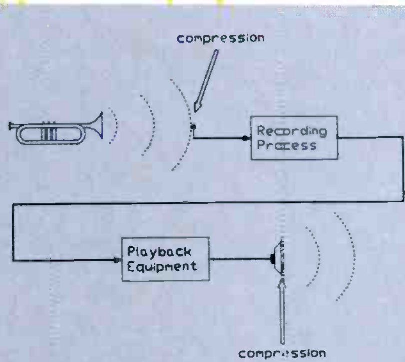


Fig. 1—Record/playback of an acoustic waveform.

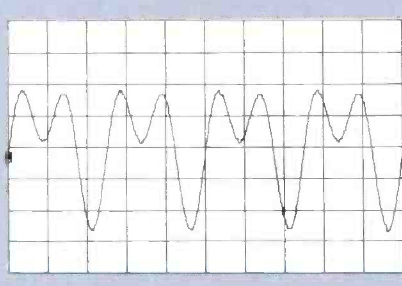


Fig. 2—Simple waveform often used in demonstrating audibility of polarity inversion.

mine. It is not possible to make an acoustic instrument perform this inversion without otherwise changing the sound in an obvious way. However, when reproducing sound with a loudspeaker, it is not only possible but usual to have an arbitrary polarity of the acoustical signal from the loudspeaker. We know that two loudspeakers, as in a stereo system, must be in correct polarity with each other for proper stereophonic sound, but this does not imply that they are in polarity agreement with the original acoustical sound wave picked up by the microphone. The speaker signals may or may not agree with the polarity of the original. Unless great care has been taken to keep track of the acoustical and electrical polarity of the signal in the reproduction chain—in the sense that an acoustical compression at the mike generates an acoustical compression at the face of the speaker—any sense of polarity is lost. While some standards exist in current practice, they are not uniformly followed.

At this time there is no clear consensus about the audibility of polarity inversion. Professionals vary in opinion, from those who simply say the issue is irrelevant to those who carefully keep track of polarity at every turn in the recording chain. The consumer market can only be characterized as totally chaotic. In common practice, the polarity of the signal throughout a reproduction system is not likely to be maintained and in consumer products is often considered of little importance.

It is clear from the technical literature that the ear's ability to distinguish the polarity of an acoustic signal, or at least a change in polarity, is very good under certain conditions and with specially designed waveforms. There is no longer argument about this fact. The "classic" waveform used to perform this experiment is shown in Fig. 2. It is a very simple waveform, consisting of a fundamental and second harmonic of one-half the amplitude of the fundamental and phase shifted by 90°. Often the audible effect of inverting this waveform is described as a change in pitch or timbre of the signal, with the pitch change being the predominant effect. Generally these experiments are carried out with steady-state tones or repetitive signals and under carefully controlled A/B testing procedures.

The technical literature shows that the ear can easily detect polarity changes with special signals.

TABLE I—*Musical program examples used for the large-scale listening tests.*

NO.	DISC ID	ARTIST/ INSTRUMENT	TRACK	START TIME	END TIME
1	SHEFFIELD CD13	McBroom/Vocal	3	0:00	1:30
2	CHANDOS CHAN8549	Clarinet	9	0:00	1:30
3	SHEFFIELD CD-KODO	KODO/Drums	2	2:01	3:33
4	GRP GRP-D-9507	Grusin/Jazz	1	0:00	1:30
5	GRP GRP-D-9503	Mulligan/Sax	3	0:00	1:28
6	TELARC CD-80220	Class Brass	1	0:00	1:27
7	LONDON 417361-2	Bolet/Piano	18	0:00	1:30
8	TELARC CD-80134	Romero/Guitar	3	0:00	1:30
9	BIS BIS-CD-258	Trombone	6	0:00	1:29
10	SHEFFIELD CD5	Grusin/Jazz	2	0:00	1:40

In light of these facts, it would be easy to argue that since polarity can be heard in some cases, why not just keep track of polarity and "have done with it"? Unfortunately it is cumbersome to keep track of polarity throughout the record/playback system, given use of multimike sound pickup arrays, multitrack mixing, and the whole complex chain of electronic control. Even if this were achieved on the recording end of the system, the consumer electronics end of the playback chain would undoubtedly remain unpredictable. Concern about absolute polarity among consumers and makers of electronic equipment is evidenced by an increasing number of components that include a polarity-inversion switch. With these components, the consumer can choose for himself which polarity gives the best perceived sound, although such a switch often seems to the listener to do nothing at all to the sound. The literature is replete with opinion about the audibility of polarity inversion; most of this opinion is anecdotal or based on uncontrolled and unverifiable individual listening experiences. The experiments reported here not only show that the quest to convincingly establish that the audibility of polarity inversion is complex, but also that the issue of polarity in music reproduction should not be cast aside as unimportant in pursuit of the goal to establish accurate reproduction of an acoustic event.

The reported results will show that polarity inversion is clearly audible in some circumstances but in many situations is not audible at all. In fact, most of the time polarity inversion is not audible. However, it is audible often enough that we suggest that the polarity of the recorded acoustical signal be traced through the entire record/reproduce chain so that the correct polarity can be reproduced at the listeners' loudspeakers. Perhaps with the advent of completely digital processing from the microphone to the listeners' loudspeakers, it will be possible to keep track of polarity easily. This has not been done with analog recording, where practice seems to be totally helter-skelter.

The Experiments

In carrying out the listening experiments, a considerable amount of time and effort went into the preparation of the listening environment and of suitable source material. This work was done between fall of 1989 and late spring of 1990. While the preparations for the tests were underway, some speculations about the anticipated results were considered and discussed at length among the researchers involved. For example, it was first thought that normal stereo listening should be used. However, in preliminary tests none of the listeners could hear the effects of polarity inversion with complex program material in normal stereo. The listening experience seemed to be far too complex to let listeners precisely and consistently identify the very subtle effects of acoustical polarity inversion.

It was clear that a simpler setup was required if polarity was to be detected consistently and reliably. With a monaural loudspeaker setup, polarity inversion became obvious when the special test signal shown in Fig. 2 was used. The clear audibility of inversion for this signal agrees with results reported in the literature. This result was obtained for headphone audition as well as for loudspeaker audition. The test signal was an asymmetrical but simple tone that is easily recognized as different when inverted, especially in an A/B testing routine. Both timbre and pitch are affected. With musical program material, preliminary tests indicated that some of the listeners could hear inversion some of the time. Both of these results were encouraging, so a monaural loudspeaker arrangement was used for the final large-group listening experiment. It was expected that a double-blind listening test would show that polarity was audible to a statistically significant extent with this experimental setup. This expectation was not fully supported, as will be described below.

Two types of listening tests were performed. The first sets of tests were performed with large groups and gave slightly positive results. The second sets of tests were done with only a few individuals, and were aimed at identifying the reasons why musical signals differ so greatly from special test tones in generating an audible difference upon inversion.

Initial listening tests were carried out using a group of about 50 students who were taking a course in audio system design at the senior university level. Enough individual tests were evaluated to assure good statistical confidence in the results. Listening tests for the large group were done double-blind.

For the large-group tests, a DAT cassette was prepared with 10 examples of music. The selections were of a great variety of music recorded from CD sources. Table I lists the program material used. The musical examples were selected because they had large asymmetries in their waveforms in the time domain, and were selected so as to highlight a particular instrument in a semi-solo passage. A preliminary, casual listening to these waveforms did not seem to show much audible effect on acoustic polarity inversion. This observation suggested that it would be difficult to obtain useful results from a time-consuming set of listening tests. A brief description of the selected musical passages follows; a selection of their waveforms is shown in Figs. 3 through 8.

Example 1, vocal. The voice waveform was highly spiked and highly asymmetrical, and showed both positive and negative spikes. The audible effects of inversion, if any, were totally obscured by musical factors of vibrato, tremolo, and intonation.

Example 2, clarinet. No examples of asymmetry were found, though the waveform was very complex.

Example 3, bass drums. These drums showed very complex transients that were highly undamped. No effects of inversion were audible.

Example 4, electric bass. These tones showed clear asymmetries in their waveforms. No changes in these musical signals could be heard upon inversion.

Example 5, saxophone. Considerable spiking and asymmetry were apparent in this saxophone tone. The musical factors, vibrato and the like, made audible detection of inversion effects impossible.

Example 6, trumpet. Spiking, but more or less symmetrical spiking, was observed for this trumpet tone. No highly asymmetrical examples of spiking were found, but this does not mean that they did not exist. This tone showed no audible effects of inversion.

Example 7, piano. No examples of asymmetry were found, despite the fact that the waveform was very complex and full of transients.

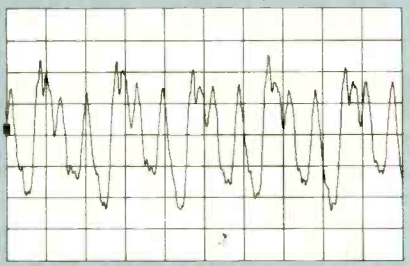


Fig. 3—Waveform from example 1, vocal.

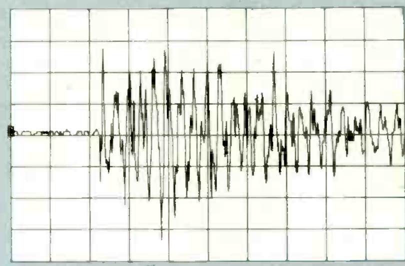


Fig. 4—Waveform from example 3, bass drum.

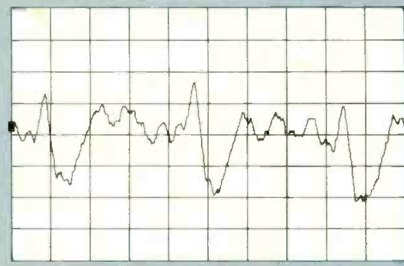


Fig. 5—Waveform from example 5, saxophone.

Example 8, classical guitar. Plucked tones, such as the guitar tone used in the experiments, neither have a very asymmetrical waveform nor show spiked compressions or rarefactions. This seems contrary to what one would expect from a highly transient tone. However, because the design of the instrument's tonal radiating surface is complex, the radiation from the plucking of a string may not predominate in the overall sound. No tones from plucked or struck instruments were found that gave anything like steady-state spiked waveforms.

Example 9, trombone. While quite asymmetrical, sustained tones, these musically played notes were not audibly changed by inversion. This is probably because the musicality of the played note introduces pitch and timbre changes that overwhelm those due to inversion.

Example 10, kick drum. Although the kick drum showed a very sharp transient waveform that was clearly asymmetrical, it was not possible to hear the effect of polarity inversion.

The musical passages were presented through one large multiway loudspeaker of high quality, in monaural mode. The room, about 20 × 20 feet, was very dead and, in fact, nearly anechoic above 250 Hz. The loudspeaker was quad-amplified, and levels were adjusted to make the system quite uniform in frequency response at the listening position. Because of the size of the loudspeaker system and the relatively modest loudness levels at which it was driven, very low distortion levels existed in the reproduced sound.

It was felt that this listening setup was suitably minimalist, so the listeners could concentrate on the tonality and timbre of the sound without being confused by stereo imaging effects and reflections from room boundaries. This, it was hoped, would optimize the audibility of the subtle effects of polarity inversion. All equipment and operating personnel were in an adjacent room. An inversion device was inserted in the signal path so that inverted or noninverted reproduction could be selected by successive pushes of a handheld button, depending on the setting of a master decision-making control. Each musical selection, of about 1½ minutes' length, was randomly selected to be unchanged or inverted each time the control button was pressed.

Of the 390 tests conducted, 227 of the responses were correct in identifying whether a change in polarity occurred when the control button was pressed. With the use of confidence interval analysis for large-sample binomial experiments, several confidence intervals were generated to estimate the true rate of correct identification. (The confidence intervals determine an upper and lower limit of the true identification rate.) The results for the large-group listening tests are given in Table II. The confidence intervals show that the correct response ratio may be very close to 0.5 if a high level of confidence is required. In this type of test, significant results are obtained when the correct response ratio deviates from 50%.

The results were also analyzed for each individual musical example; the ratio of correct to incorrect responses is given in Table III. While all of the mean scores are greater than 0.5, indicating a slight ability to detect a change in polarity, the tracks of piano (example 7) and classical guitar (example 8) yielded significantly higher correct responses.

Thus, this attempt to define the audibility of acoustic polarity inversion gives a modestly positive result. However, it is also clear that polarity inversion, which seems like a drastic modification of the signal physically, does not stand out with great audibility in most cases, i.e., "like a sore thumb."

Fig. 9—Waveform of trombone-like tone synthesized from three components.

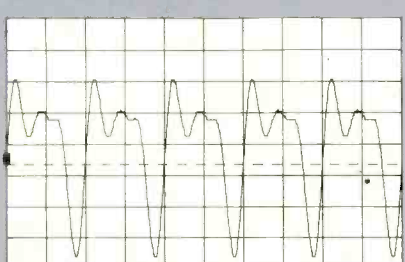


Fig. 10—Waveform of trombone-like tone synthesized from four components.

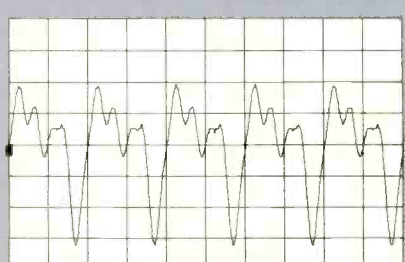
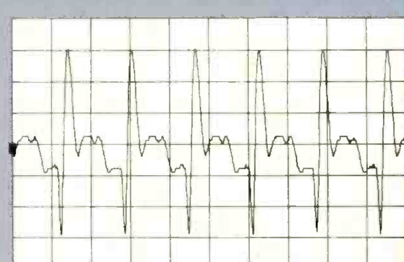


Fig. 11—Waveform of loud but relatively symmetrical tone from an acoustical trombone.



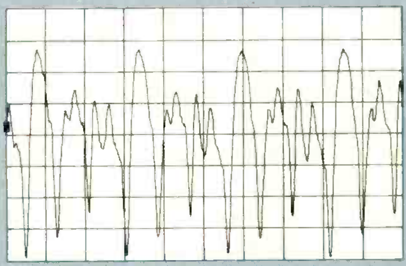


Fig. 6—Waveform from example 6, trumpet.

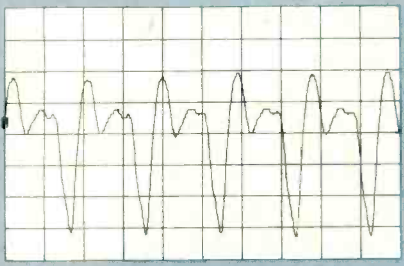


Fig. 7—Waveform from example 9, trombone.

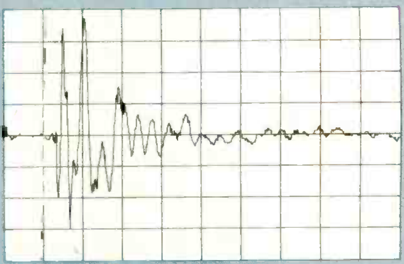


Fig. 8—Waveform from example 10, kick drum.

Since simple test waveforms demonstrated clearly audible effects when inverted while the more complex musical signals did not, several further listening tests were undertaken. The double-blind technique was not used, since in most cases polarity inversion was so obvious that there was no question it was recognized by all of the listeners. These tests were done mainly in an attempt to discover what properties of a signal make it inversion-sensitive.

It was very clear, in the listening tests, that the waveform shown in Fig. 9 was audibly altered when inverted. The timbre of the tone changes to some extent. There is also an "apparent change" in the *pitch* of the tone. The tone, inverted or not, clearly maintains the same *frequency*, since frequency is a physical phenomenon. The pitch, however, is a psychoacoustic, hearing-related phenomenon and may very well change. It is well known that pitch and timbre depend on both the intensity of the tone and its waveform. Thus, it should be no surprise that pitch and timbre are sometimes affected when a tone is inverted in polarity. In order to determine which of the waveforms were most sensitive to inversion, several waveforms were generated with a set of oscillators. Additionally, live acoustic test tones were generated, in one case with a trombone and in another with a harmonica.

Three synthesized tones were used: The "classic" tone shown in Fig. 2, a three-tone signal made to look something like an acoustical trombone (Fig. 9), and a four-tone signal made to look even more like a complex trombone tone and shown in Fig. 10. (Figures 11 and 12 show real trombone tones.) It is relatively easy to hear inversion effects in simple tones. Thus, the goal of these experiments was to create successively more complex tones with the hope of finding a point at which complexity of the tone would overcome the ability to hear inversion effects clearly. While this quest was only partially successful, it yielded some useful clues about the relationship between simple tones, more complex tones, and real musical tones and about how complexity does indeed strongly affect the audibility of polarity inversion.

With synthesized tones, such as those in Figs. 9 and 10, it was always easy to hear the effects of inverting the acoustical polarity of the signal so long as there was a very substantial asymmetry in the signal. This was true for headphones and loudspeakers and at all loudness levels. (These tones were, of course, perfectly cyclical in time and of constant frequency, since they were generated by high-precision synchronized oscillators.)

The next step was to use an acoustically generated, real instrumental tone. An asymmetrical tone generated by a trombone is shown in Fig. 11. This tone was generated live by playing a trombone in a semi-anechoic room and recording it directly to a DAT machine. The tone was a sustained note played as uniformly as possible for as long as possible. (The human lungs have limitations, and trombones take a lot of air.) Two notes were recorded. One, shown in Fig. 11, was a loud, 280-Hz tone. The tone had to be loud in order to generate spiking in the waveform; soft tones were more symmetrical and smooth. Even the loud tone showed spikes of compression and rarefaction that were relatively symmetrical. This tone did not change in perceived sound when the polarity was inverted. The second tone was a 320-Hz, harsh-sounding note. Its harshness can be seen in the very sharp spikes and great asymmetry of the waveform in Fig. 12.

When the harsh tone is presented to the ear in a test of polarity inversion, it clearly changes in both timbre and pitch. The character of this change depends on whether the spikes are reproduced as compressions or rarefactions. When the spikes for

Fig. 12—Waveform of loud, harsh-sounding tone from an acoustical trombone; the tone is spiked and asymmetrical.

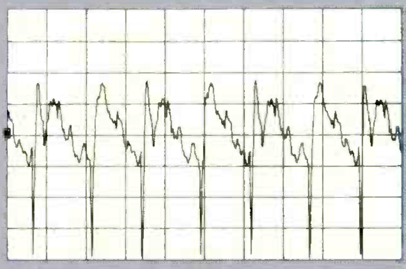


Fig. 13—Waveform of "out" harmonica note; the tone is highly spiked and somewhat asymmetrical.

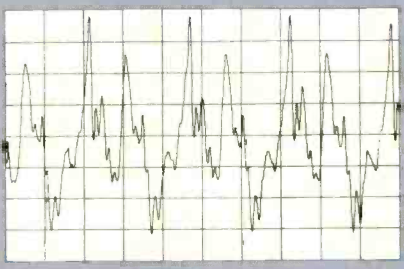
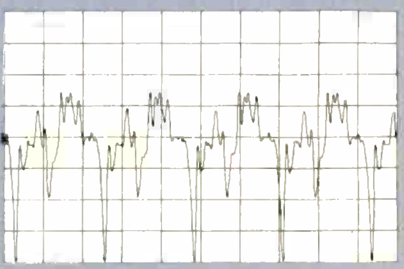
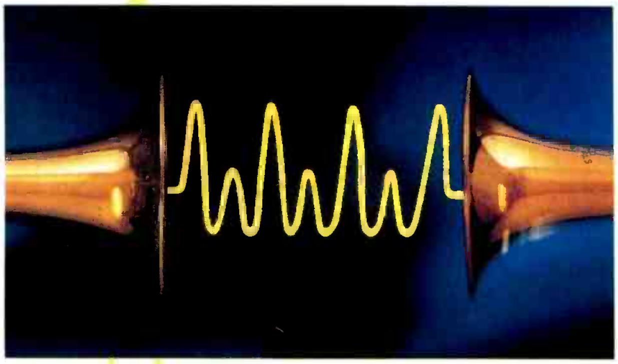


Fig. 14—Waveform of "in" harmonica note; the tone is highly spiked and quite asymmetrical.





Inverted polarity is audible often enough that it should be traced through the entire recording chain.

TABLE II—*Summary of statistical analysis results for the large-group listening tests.*

EXPERIMENT SET: 39 listeners, 10 individual tests per listener		
ADMINISTERED TEST: Ratio of no. of tests with polarity inversion to no. of tests with no polarity inversion	192/390 = 0.4923	
LISTENER RESPONSES: Ratio of "Changed" responses to "Unchanged" responses	115/390 = 0.2949	
CORRECT RESPONSES: Ratio of correct to incorrect responses	227/390 = 0.5821	
Confidence Intervals for the true ratio of correct to incorrect responses (given an infinite sample of experiments)	0.5410 0.6231	90% Confidence
	0.5331 0.6310	95% Confidence
	0.5177 0.6464	99% Confidence

TABLE III—*Analysis of large-group listening tests for individual musical examples.*

NO.	ARTIST/ INSTRUMENT	MEAN	95% CONFIDENCE INTERVAL	
1	McBroom/Vocal	0.6154	0.4627	0.7681
2	Clarinet	0.5385	0.3820	0.6949
3	KODO/Drums	0.5897	0.4354	0.7441
4	Grusin/Jazz	0.5385	0.3820	0.6949
5	Mulligan/Sax	0.5385	0.3820	0.6949
6	Class Brass	0.5128	0.3559	0.6697
7	**Bolet/Piano**	**0.6923**	**0.5474**	**0.8372**
8	**Romero/Guitar**	**0.6667**	**0.5187**	**0.8146**
9	Trombone	0.5385	0.3820	0.6949
10	Grusin/Jazz	0.5897	0.4354	0.7441

this tone are reproduced as compressions, the pitch seems lower than when the spikes are reproduced as rarefactions (acoustically inverted for the case of the trombone). This is the case regardless of other properties of the waveform, such as loudness. The change in the tone is also independent of the transducer, and it could be clearly heard on both headphones and loudspeakers. While the effect was small, it was very clear and practically everyone could hear it. Therefore, it appears that asymmetry of the signal is one property that makes a difference in the perception of the tone when it is acoustically inverted.

Since many acoustical instruments, in this case a trombone, yield sharp spikes of compression when played so as to generate a rather harsh tone, it would seem logical to retain the polarity of the acoustical signal in reproduction and present spikes of compression from the loudspeaker to the listener as well.

A second acoustical instrument, the harmonica, was used to test and verify some of the above observations. Waveforms for two harmonic notes are shown in Figs. 13 and 14. The waveform in Fig. 13 is of an "out" note, while the waveform in Fig. 14 is of an "in" note. These waveforms are strikingly complex, having both spikes and asymmetry. When the acoustic polarity of either of these signals was inverted, the tone changed distinctly. Both the timbre and the pitch of the tones were affected. When the tone was acoustically inverted from normal, it sounded higher in apparent pitch. This is interesting, since the "in" and "out" notes have spikes of compression and rarefaction, respectively. Thus, for both the trombone and harmonica tones, inversion of the correct acoustic polarity seems to yield higher pitch regardless of the polarity of the spikes.

Conclusions

If asymmetry of the waveform is important in relation to hearing polarity inversion, then several precautions and warnings about speaker systems are in order. High levels of even-order distortion (second, fourth, etc.) in a sound system might make polarity inversion more audible than it would be with a system that has low levels of distortion. Such effects have been mentioned in the literature. If nonlinear distortion is a problem with a loudspeaker, it could sound very much different at higher sound pressure levels than at lower SPLs, depending on the polarity of the signal. If a system shows great sensitivity to polarity inversion with normal program material, there might possibly be a problem with distortion in the system.

What reduces the ability to hear acoustic polarity inversion as the musical signal becomes more complex? One factor is, simply, the complexity of the music itself. There is often too much going on musically to allow a listener to concentrate on a very subtle effect. Since the perception of inversion seems to be detectable through both changes in timbre and pitch, the normal musical playing of a note—i.e., vibrato, tremolo, and instrumental filigree—will probably totally obscure the inversion effects in most cases. It is incredibly difficult to separate out the many variables involved with actual musical signals.

As some may have noted, there is a gap in understanding the listening tests described here. Few of the signals in the large-group listening tests produced large audible effects with inversion, even though they were originally selected because of their substantial asymmetry. However, instruments that had modest asymmetry, the piano and guitar (examples 7 and 8), were somewhat better identified in these tests. This suggests that asymmetry alone may not be the decisive factor in generating audible inversion effects. Most likely there are still other psychoacoustic effects, caused by attack and decay of the signal, that help the ear identify the signal's correct (real) acoustic polarity. More detailed experiments need to be done to ferret out these cause and effect relationships.

Only a small sampling of signals was evaluated in this work. However, it is certain from our listening tests that inversion of acoustic polarity is clearly audible for some instruments played in some styles and for some listening situations. It is not likely that the observed effects were an artifact of the record/reproduce system because of the considerable care taken to eliminate distortion and maintain waveform integrity.

While polarity inversion is not easily heard with normal, complex musical program material, as our large-scale listening tests showed, it is audible in many select and simplified musical settings. Thus, it would seem sensible to keep track of polarity and to play the signal back with the correct polarity to insure the most accurate possible reproduction of the original acoustic waveform. A

Authors' Addendum: The work presented here was done in 1991. (It is now September 1993.) Since then, there has been some, but not much, progress made in establishing polarity standards in the recording industry. This work is continuing at the present time. There has been some discussion in hi-fi publications and much anecdotal reporting, in various publications, on the audibility of acoustical polarity inversion. There has been nothing noteworthy in the professional literature, however, that clarifies the issue or "proves" that audibility of polarity inversion is a major factor in listening enjoyment. While it is not clear why this is the case, several factors might be: The difficulty of doing the experiments in a controlled way, as evidenced by this work; the fact that the effect of polarity inversion is small in most program material, or the fact that the effect seems to be small compared to the many other variables in the recording/reproduction processes (microphone use, room acoustics, electronic processing, and the like). Nevertheless, it seems reasonable that at some point another step toward achieving greater audio fidelity will be maintaining polarity of the signals throughout the record/reproduction chain.

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11. Johnsen, R. Clark, "Proofs of an Absolute Polarity," AES Preprint No. 3169 (K3), Oct. 1991. Description of a series of listening tests in which every listener was able to identify polarity every time, even with a mixture of musical passages; includes a long chronology of reports on acoustic polarity.

BEYOND

MARK WEAVERS

If you're like most discerning buyers of audio cassettes, you're concerned about output performance—and rightly so. And whether or not you consciously consider criteria such as sensitivity, output, and signal-to-noise ratio, you demand consistency in the cassettes you buy. That means you expect the quality and high performance of the cassette you purchase today to be consistent with the tapes you buy next month and the month after that. You also assume that your audio cassettes will deliver the same performance today as when you bought them, perhaps several years ago.

Output performance, or electromagnetic performance, can be one good criterion for your buying selection. But there are other criteria to consider as well, and over the life of the cassette, they may be even more important. Electromagnetic performance may *sell* cassettes, but it seldom is a reason that consumers return them. Instead, users are more likely to reject cassettes because they fail for mechanical or environmental reasons. I want to focus on the important issue of environmental stability—and how one very experienced tape manufacturer ensures that audio cassettes will provide long-term reliability for users.

If consumers can't easily assess the hidden factors that contribute to a quality audio cassette, how can they hope to make a wise selection? Part of the answer lies in the array of industry standards that serve as guidelines for audio cassette manufacturers. Manufacturers who are committed to quality pay heed to these standards because they represent a solid base line for consistency and long-term reliability. This attention has a payoff for consumers, who end up "buying" more than the audio cassette itself: They also gain the expertise of a cassette manufacturer who is aware of the complex criteria that must be built into a consistently high-quality audio product. In other words, if a consumer chooses cassettes from a reliable, quality-conscious

Mark Weavers is Audio Products Technical Manager for 3M's Audio and Video Technology Division in St. Paul, Minn.

OUTPUT

Environmental Stability of Audio Cassettes

ILLUSTRATIONS: BOB SCOTT

manufacturer, there's a good chance the manufacturer has already done much of the selection work by qualifying the materials and the manufacturing processes, and by carefully auditing products before they reach the shelf.

Figure 1 illustrates the electromagnetic performance of a Scotch XSII-s audio cassette, including its maximum output level (MOL) at both low and high frequencies, sensitivity, distortion, and the bias noise floor. These parameters are carefully specified and controlled by 3M along with additional criteria for component and assembly dimensions, visual appearance, functional performance, durability, packaging, and environmental stability.

If an audio cassette is not carefully designed for environmental stability, its other features, such as electromagnetic performance and durability, can rapidly become inconsequential. Among the most revealing assessments of cassette weakness are those associated with overall runnability after exposure to the environmental conditions

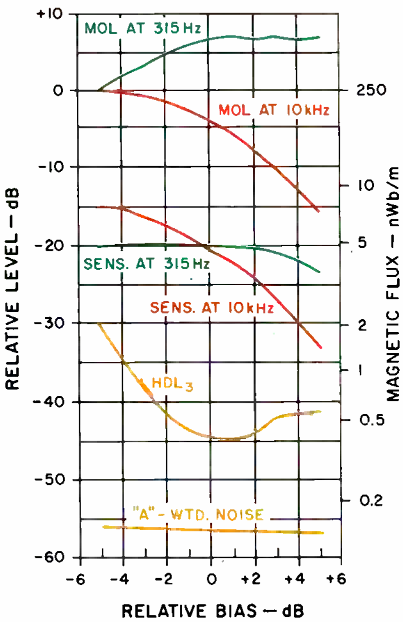


Fig. 1
Electromagnetic performance of Scotch XSII-s (Type II) cassette.

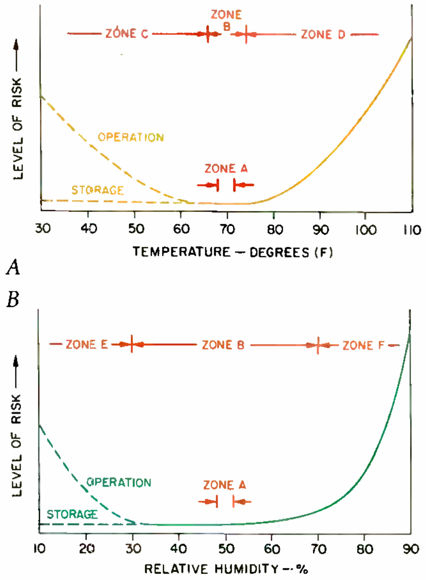


Fig. 4
Risk of performance loss due to extremes of temperature (A) and humidity (B) during operation or storage.

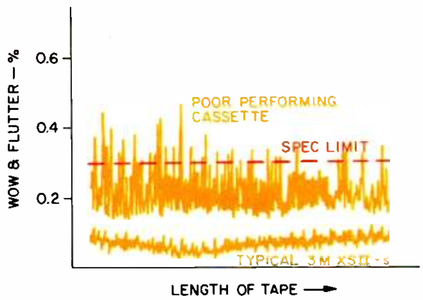


Fig. 2
Development of wow and flutter as a result of high temperature and humidity in storage.

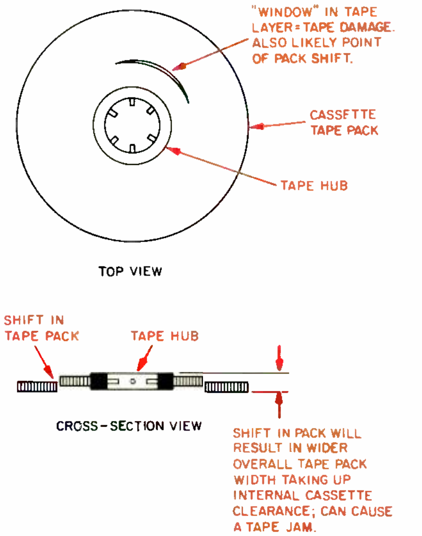


Fig. 5
Effects of cold-temperature storage with rough handling while cold.

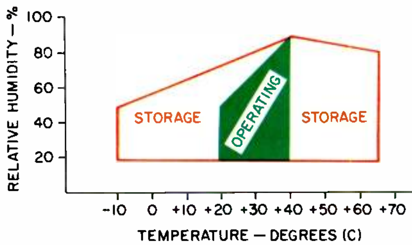


Fig. 3
Test conditions help define boundaries for optimum operation and storage of cassettes.

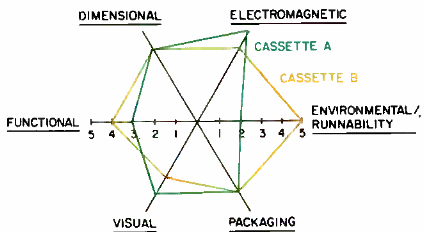


Fig. 6
Comparison of performance criteria for two hypothetical audio cassettes.

encountered in shipping or use by consumers. A dashboard or trunk on an August day in Arizona, humid conditions along the southern seacoast, or a winter in Alaska are likely scenarios for environmental damage that can shorten the life expectancy of an audio cassette. And we have not yet considered dust, sand, or dirt.

To evaluate the short- and long-term effects of these scenarios, it is possible to recreate extreme environmental conditions in programmed environmental chambers. Based on years of experience, 3M engineers have designed test conditions beyond the environmental extremes expected in real life. For example, cassette samples might be subjected to storage conditions of 150° F (65° C) and 85% relative humidity for a week or more. Following this, the samples would be tested for performance, wow and flutter (the nonuniform movement of the tape over the playback heads), and dropouts (momentary losses of signal)—with the objective being the same performance quality after the exposure as before. Figure 2 illustrates the onset of wow and flutter as a result of exposure to high temperature and humidity.

An environmental test might call for placing a cassette recorder into a chamber at 104° F (40° C) and 85% relative humidity, then measuring the operating tape performance over an extended period. It's not unusual to have the recorder fail before some cassettes do in such an environment, because of corrosion or moisture absorption in the recorder's pinch rollers or brake pads.

Environmental testing of this type helps establish temperature and humidity ranges such as those in Fig. 3, where the areas designated "Storage" and "Operating" represent test conditions for Scotch cassettes. Data from environmental tests performed regularly verify that audio cassettes will operate within the temperature and humidity boundaries outlined in the figure, and that the cassettes can be stored under the indicated conditions for a limited period of time. By establishing and assessing these limits, 3M can tighten its material and manufacturing specifications to provide audio cassettes that are mechanically and functionally reliable.

Collection of data from environmental tests helps engineers assess the boundaries beyond which audio cassettes may be likely to fail. For example, Fig. 4 depicts the risk of problems when exposing cassettes to extremes of temperature (Fig. 4A) or humidity (Fig. 4B) during operation or storage. In general terms, the greater the variation from comfortable room temperature and humidity, the greater the risk for damage to the cassette. This correlation is not meant to suggest that an individual audio cassette will inevitably fail under environmental extremes, but rather that there is more risk to the specific product because of the exposure.

In Fig. 4, zone A represents the ranges of temperature and humidity control used for establishing a reference; zone B represents the limits of ideal operating conditions or the ranges of temperature and humidity that minimize risk while still allowing for a practical degree of flexibility.

In Fig. 4A, at higher temperatures (represented by zone D on the graph) the risk level for problems rises. The tape pack may tighten, increasing the chance of dropouts from several sources: Captured or wound-in debris, impressions from a non-round tape hub lock, or impressions from the leader to the tape splice. In addition, at higher temperature, polymers used in the magnetic coatings may soften, causing tape layers to stick together. This condition can cause high torque, an excessive amount of force required to move the tape in the cassette. The result can be objectionable wow or flutter.

A cassette's output will be unimportant if it can't stand up to high temperatures and high humidity.

If temperature rises above 167° F (75° C), the halves of the plastic cassette shell might distort, destroying the fit of the cassette within the machine. At very high temperatures, the tensilized polyester backing used for audio cassette tapes could shrink, causing distortion of the tape and subsequent poor contact with the recorder heads—the result being poor output uniformity.

In contrast, the risk of damage when storing a typical audio cassette at low temperature is not great (zone C in Fig. 4A). Some loosening of the tape pack may occur, but if the cassette is allowed to acclimate to room temperature for 24 hours, the tape wind usually returns to its original tightness. If the tape is subjected to rough handling or used while very cold, loose tape layers could slip upon one another, causing "windows" to form in the cassette. Figure 5 illustrates an example of tape pack shift and the resulting windowing effect.

Figure 4B shows cassette risks associated with extremes of humidity. Studies by 3M indicate that low humidity (represented by zone E) presents no increased risks for either short- or long-term storage of audio cassettes. However, low humidity environments create the potential for greater static charge, and thereby increased attraction of airborne dust and debris. Storage in the protective plastic album case is, therefore, an important factor in long-term cassette reliability.

Environmental studies show that high humidity (zone F in Fig. 4B) can have a detrimental effect on audio cassette performance. Long-term storage in such an environment increases the risk of moisture absorption in the tape pack, resulting in jerky movement of the tape over the head surface; it is often heard in playback as high wow and flutter. If tape is not carefully formulated, increased absorption of moisture in the magnetic layers can increase the risk of clogged recorder heads.

Although the numerous criteria for assessing audio cassettes are based on varying units of measure, diagrams can be used to compare relative rankings of audio cassette characteristics. Figure 6 is an example of such a diagram based on dimensional, visual, functional, output, and environmental and runnability assessments of audio cassette performance.

Cassette A ranks high for output performance but poorly for functional and environmental reliability. Cassette B ranks high in the functional and environmental categories but somewhat lower for output performance. Cassette B would be the better choice in this example: It has good signal properties with excellent functional and stable environmental characteristics.

Clearly, output performance is the most obvious selling tool available to audio cassette retailers. But consumers should be concerned about other cassette features as well—and these less visible performance characteristics are the foundation of a tape manufacturer's expertise in technology. In addition to strong output performance, documented environmental performance helps ensure the consistency of audio cassettes and their long-term usability and reliability for consumers. A

Savoy JUMPS

Howard Mandel

The CD spines' mustard lettering on lurid purple stands out on shelves. They mark CDs from the Savoy Jazz label, which at age 50 has been revived by Denon Records. Strong cover art—women in provocative dress, vague black and white photo superimpositions, kitschy paintings—makes a big impression, too. Then there are the Savoy artists themselves: Charlie Parker, Dizzy Gillespie, Miles Davis, Stan Getz, the Modern Jazz Quartet, and Lester Young are a few of the jazz giants whose decades-old innovations, recorded by Savoy, endure for the benefit of the young lions and listeners of the '90s.

Savoy captured great music, to be sure. Digitally remastered by Yujiro Kasai, the more than 100 monaural and early stereo Savoy recordings in the Denon reissues program are mostly free of hiss and crackle, delivering the hot sounds of be-bop with fresh presence. (Many of these early albums were originally recorded by the legendary engineer Rudy Van Gelder.)

But Savoy was never meant to be a connoisseur's label. It has become that only with time and with the first release of a new recording in the old style. Pretentions to art never inspired Savoy's output; instead, classic American entrepreneurship fueled the label's aesthetic accomplishments.

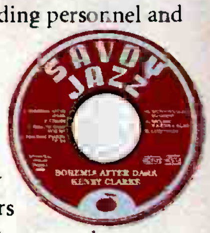
An independent company based in Newark, N.J., Savoy Records was at first owned and operated by Herman Lubinsky. Lubinsky entered the record business when a song he was trying to sell excited listeners so much they cried out for pressings. And this was from a group he'd cut when trying to demonstrate a wire recording machine! Lubinsky had stumbled on a product and a market. Like any good businessman, he hastened to supply the demand.

Lubinsky was not a knowledgeable music enthusiast, and he quickly hired producers—A & R men, in the argot of the time, including Ozzie Cadena, Teddy Reig, and Tom Walker—to oversee Savoy's twice-weekly recording sessions. These A & R men acted on intuition, interests, and preferences that they couldn't have predicted would satisfy aficionados for years to come. Their job at Savoy was clear—to bring in an album's worth of usable music at minimal cost, in two hours, if possible.

"I've read that Lubinsky would order extra takes to be recorded that wouldn't fit the album we were working on, so we'd have those takes left over to fill up other albums," Cadena recalled from California, where he has retired. "But Lubinsky wasn't that kind of guy. Instead of insisting on extra takes, he'd make me erase whatever we didn't use and save the tape for the next session, so we could record over it."

Cadena estimates he produced 98% of Savoy's releases from 1951 to 1959. Besides directing sessions featuring Curtis Fuller, reedmen Cannonball Adderley and Yusef Lateef, drummer Kenny Clarke, vibist Milt Jackson, pianist Hank Jones, and countless others, he bought masters from obscure West Coast labels for repackaging by Savoy.

"Lubinsky let me do what I wanted as far as buying and issuing masters of Boyd Raeburn's band or Ray McKinley with Eddie Sauter charts from Discovery and Musicraft. I wasn't recording my cousin, after all; I was giving him my best," Cadena says. Errors regarding personnel and composer credits remain on the Denon liner reissues, he explains, because they replicate Savoy covers and liner notes. Accurate documentation was not a priority at Savoy. "If Lubinsky had an argument with someone at a session, he'd just take their name off the album," Cadena laughs. "He did that to me a couple of times too.



"The sound of our sessions, though, was good to begin with, and I don't think Van Gelder had to do too much work to clean up the lacquer masters and safety acetates, which is mostly what Denon used. The old Bird stuff for instance, sounds great." There are seven Charlie Parker albums, recorded from 1945 to 1950 with stellar bands, which Denon has released.

Those sides, including masters and alternate takes of be-bop classics such as "Now's the Time," "Koko," "Night in Tunisia," and "Groovin' High," have never been out of print very long. Clive Davis

Again

acquired the Savoy jazz catalog for Arista Records in the 1970s. Arista issued new two-LP sets of Savoy's best-known or most influential material with new art and liner essays; they were critically acclaimed. In the 1980s, Arista sold its Savoy holdings to Joe Fields of Muse Records, who also creatively repackaged and remastered Savoys for CD.

Denon purchased the Savoy Catalog from Muse in 1991, giving responsibility for reissues and new recordings to Atsushi Hashizume. He's commissioned new Savoy albums by tenor saxophonist Ralph Moore and the Savoy Jazz Quartet as well as *Blues-ette Part II*. On this release, four surviving members of trombonist Curtis Fuller's 1959 Quintet and one capable ringer recreate the smooth blend and solid beat of a typically casual Savoy Jazz success.

"We were all freelancing then," trombonist Fuller remembers of his years at Savoy, where he worked with tenor saxophonist Benny Golson, pianist McCoy Tyner, trumpeters Thad Jones and Lee Morgan, and notable others. "Ozzie had a musical vision for that time that worked then, and works now—everyone in Japan who has a jazz collection has a copy of the original *Blues-ette*.

"As for Lubinsky," Fuller recalls, "he was so busy with production he ignored some of the niceties. One time he told me to pose for a cover photo even though I was wearing a T-shirt. 'That's okay,' he said, 'I've got a tie in my closet you can put on with it.' Well, it was his money, and he had a helluva label. The important thing is, those recordings are out again, and people can hear them."

Denon intends to issue all 300 of the vintage Savoy albums, as well as newly discovered material never before released. A

Photographs: David Hamsley

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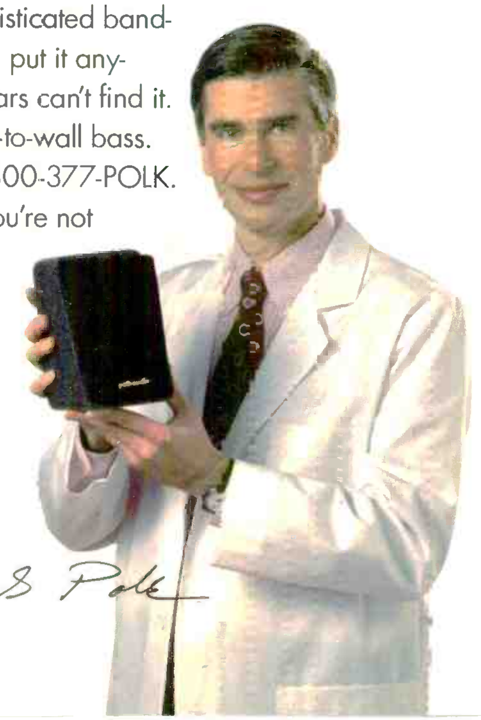

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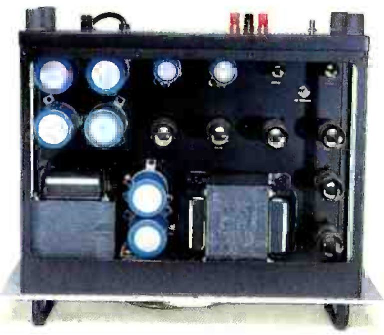
QUICKSILVER AUDIO M135 MONO AMP

As observant readers may have noticed, for some time I have been listing in my equipment reviews a prototype pair of Quicksilver Audio M135s as power amplifiers used or on hand for reference in my listening tests. Production of these tube amplifiers is now a reality, and the resulting units are a beauty to behold.

The front panel bears a not-coincidental resemblance to that of the fabled Marantz Model 9. Other aspects of construction and appearance are completely different, however. A neat design attribute is a small door in the bottom right-hand part of the front panel that swings open to allow adjustment of the individual output tubes' plate currents. Pushing the slotted potentiometer shaft in for a particular tube connects that tube's current monitor to the front-panel meter for adjustment.



Overall construction of this Quicksilver Audio amp is rugged and sensible and is designed for long life. As a traditional tube amplifier chassis, it has all major parts mounted to its top surface. These components include very large power and output transformers, numerous filter capacitors, and the tubes themselves. An open-sided box frame is bolted to the top of the chassis and the front panel to form the rectangular outline of the overall amplifier. A folded piece of perforated steel forms the top and side cover. The overall effect is of one very solid, well-made piece of gear. From the beginning, Quicksilver Audio power amps have been and presently are partially built in Santa Barbara, Cal. by a longtime friend of mine, Loren Youngman. Youngman is a precision-wiring fanatic, and his dedication to perfection contributes in a major way to the construction and sonic quality of all of the Quicksilver amps out there. Wiring underneath the chassis is all hand-done point-to-point, using terminal strips and the pins of the tube sockets. Wiring quality is outstanding, and parts quality is excellent and appropriate to expected long life.

Circuit Description

The signal circuitry of the M135 is similar to many other tube amp circuits but is

SPECS

Power Output: 135 watts into 4 or 8 ohms, from 20 Hz to 20 kHz.
Power Bandwidth: 10 Hz to 80 kHz.
Input Sensitivity: 1.5 V.
Dimensions: Chassis, 17 in. W × 8 in. H × 13 in. D (43.2 cm × 20.3 cm × 33 cm); front panel, 19 in. W × 8¾ in. H (48.3 cm × 22.2 cm); rack handles, 2 in. D (5.1 cm).
Weight: 70 lbs. each (31.8 kg).
Price: $2,800 each.
Company Address: 5635 Riggins Ct., #15, Reno, Nev. 89502.
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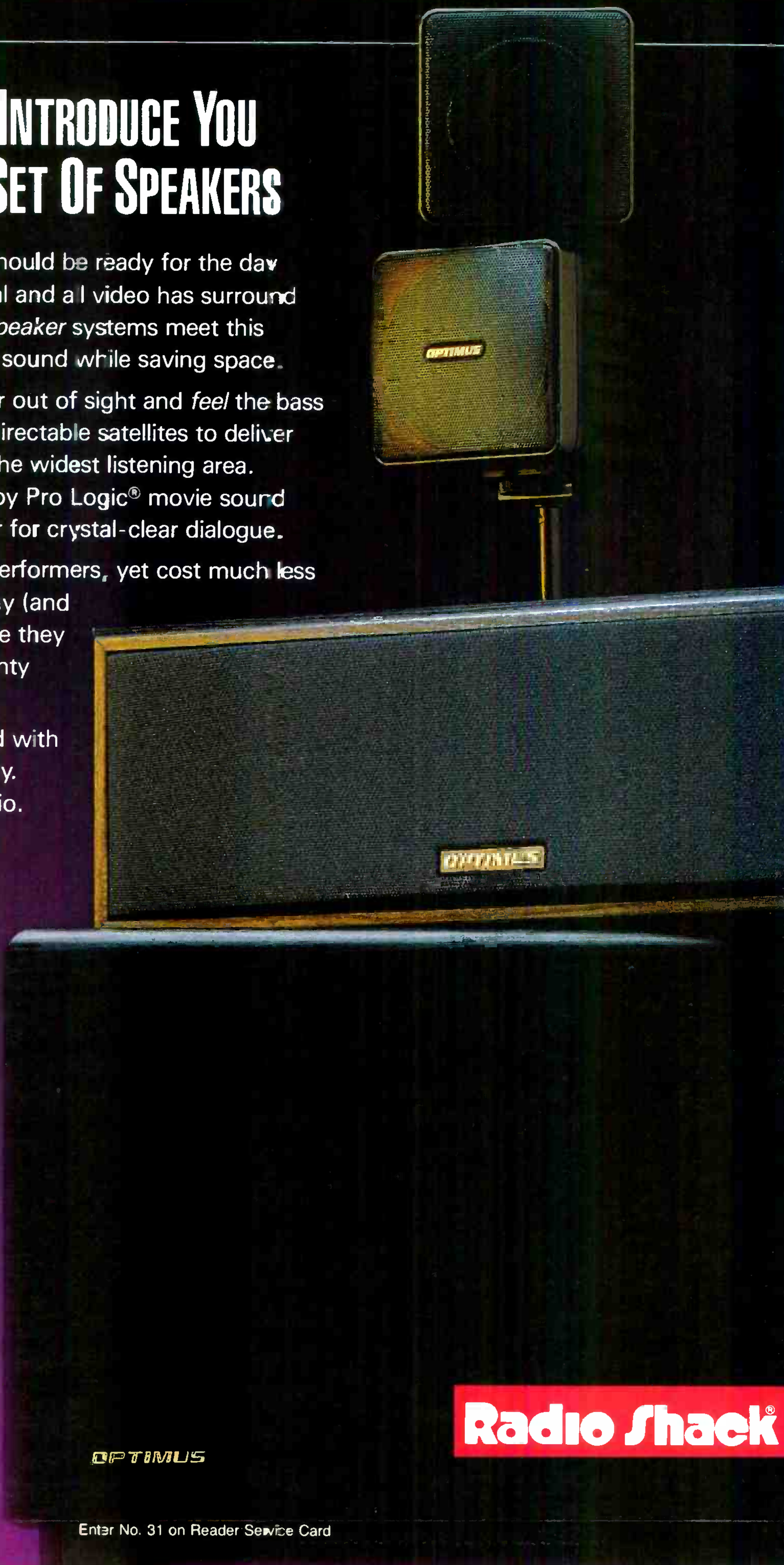

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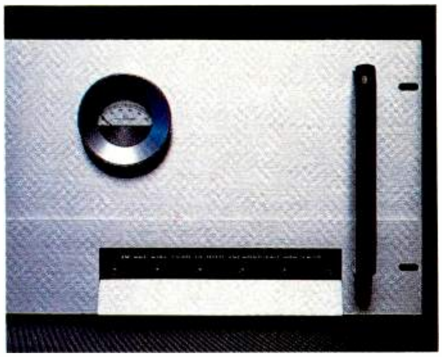

different enough to stand out. A proprietary front-end circuit, consisting of a dual triode tube, is direct coupled to a second-stage differential amplifier acting as a "long-tailed pair" phase inverter. Typically, the cathodes of such a phase inverter go to ground through a resistor. With a cathode potential of around 100 V, most designers think that there is enough of a drop in the resistor to sufficiently simulate a constant current source for the differential pair. Not

THE M135'S SIGNAL CIRCUITRY IS SIMILAR TO THAT OF OTHER TUBE AMPS BUT DIFFERENT ENOUGH TO STAND OUT.

so for sound, according to Mike Sanders of Quicksilver Audio. In the M135, this common cathode resistor is taken to a large negative supply in order to make the resistor value larger. This results in better balance in the two-phase output of the stage with equal plate load resistors. Push-pull output of the phase-inverter second stage is capacitor coupled to the six EL-34 output tubes. A separate capacitor is used to couple to each tube to permit bias adjustment of each individual output tube. The output stage is configured for pure pentode operation, with a fixed voltage feeding the output tubes' screen grids. Overall negative feedback is taken from the 8-ohm tap of the secondary of the output transformer back to the first stage of the amplifier circuitry.

Power-supply circuitry in the M135 is a bit unusual in that it has three full-wave d.c. supplies developed from the main power transformer, and it uses choke filtering in two of these supplies. The main high-voltage supply develops about +467 V for the output stage and consists of two 850-µF/475-V filter capacitors in parallel. This voltage is fed to the center tap of the output transformer and also to one lead of a filter choke. The other lead of this choke is terminated in another pair of 850-µF/475-V capacitors and is the source for the first and second stages of the signal circuitry.

A second full-wave rectified supply uses a single 850-µF/475-V capacitor, a series filter choke, and a final 850-µF/475-V capacitor to feed the output stage's screen grids with about 325 V. This operating condition of the amplifier's output stage was carefully researched, with the idea being to limit the maximum current in the output tubes so that the rated plate dissipation of the output tubes would not be exceeded.

The third supply consists of a single filter capacitor of 10,000 µF to produce –38 V for the output tube bias supply. All six bias-adjustment pots are connected from this bias supply to ground. Usually, such arrangements have series-limiting resistors from the bias supply to the pots and from the pots to ground, to limit the range of bias adjustment to a range that the manufacturer feels would cover normal adjustments of bias for his design. In the M135, however, the opportunity exists for setting the voltage at zero, with consequent excessive plate current in the output tubes. On the other hand, the complete range of –38 to 0 V allows for the use of a number of different types of output tubes other than the standard EL-34s. Personally, I would have limited how close to ground the bias could go, to perhaps –20 V. The aforementioned negative supply for the phase-inverter second stage is powered from a separate small power transformer and is full-wave rectified into a single 1,000-µF/200-V filter capacitor. I feel that

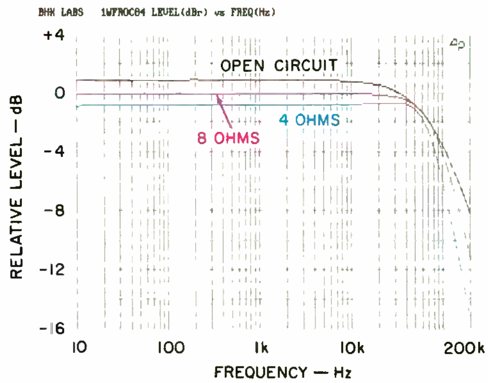

Fig. 1—Frequency response for open circuit and for 8- and 4-ohm loads.

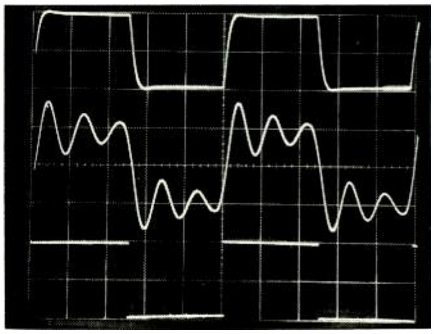

Fig. 2—Square-wave response of (from top) 10 kHz, 8 ohms (20 µS/div.); 10 kHz, 8 ohms & 2 µF (20 µS/div.); 40 Hz, 8 ohms (5 mS/div.; all 5 V/div.).

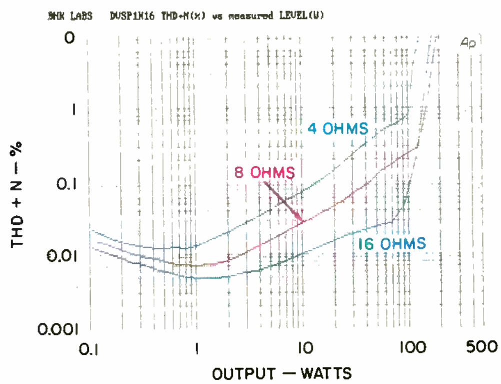

Fig. 3—THD + N vs. power, for 16-, 8-, and 4-ohm loads on 8-ohm tap.

Table I—Output noise levels. IHF S/N ratios were 95.5 dB for amp A and 90.2 dB for amp B.

	Output Noise, µV	
Bandwidth	AMP A	AMP B
Wideband	155.0	320.0
22 Hz to 22 kHz	130.0	295.0
400 Hz to 22 kHz	60.0	90.0
A-Weighted	45.0	87.0

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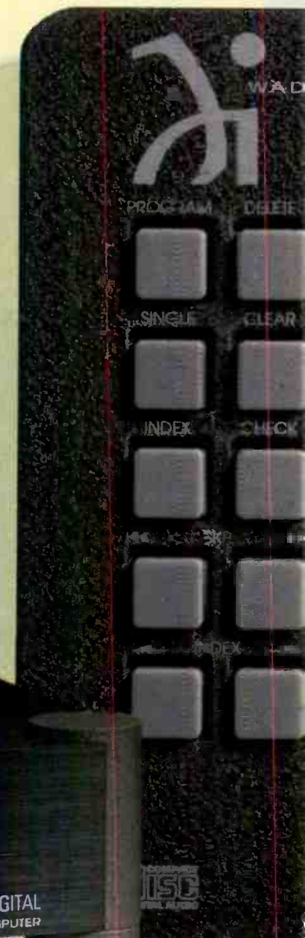

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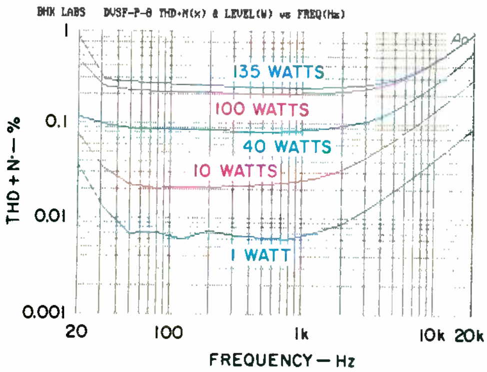

Fig. 4—THD + N vs. frequency, 8-ohm load on 8-ohm tap.

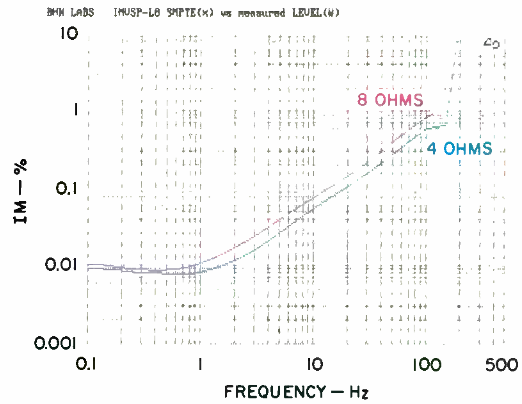

Fig. 5—SMPTE-IM distortion vs. power, 8-ohm load on 8-ohm tap and 4-ohm load on 4-ohm tap.

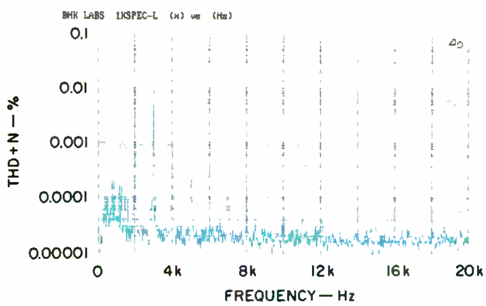

Fig. 6—Spectrum of harmonic distortion for 1-kHz signal at 10 watts.

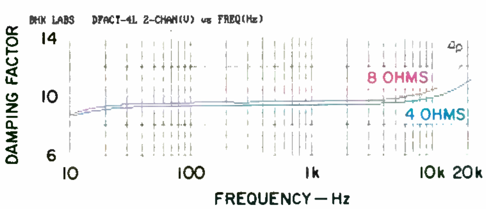

Fig. 7—Damping factor vs. frequency for 8 and 4 ohms.

these three separate supplies contributed greatly to the sense of dynamics and space that these amplifiers exhibited during my listening tests.

The output transformers used in this design were evolved over a number of iterations and represent very advanced characteristics that very definitely contribute to the way the amplifiers measure and sound.

Measurements

Voltage gain and IHF sensitivity were measured and found to be 27.8 and 27.7 dB for Serial Nos. 035 and 036, respectively (hereafter referred to as amp A and amp B). Corresponding IHF sensitivities were 115.5 and 116.5 mV.

Frequency response on the 8-ohm tap and loaded with open circuit, 8 ohms, and 4 ohms is shown in Fig. 1. Both amplifiers were virtually identical in this measurement, and the results are presented for amp A. Not shown are similar measurements on the 4-ohm tap for open circuit and for 4- and 2-ohm loading, which rolled off in the highs a little sooner than what is shown in Fig. 1. Rise- and fall-times at an output of ±5 V into 8 ohms on the 8-ohm tap were about 4 μS. Portrayed in Fig. 2 are square-wave responses. In the top trace, for 10 kHz and 8-ohm loading on the 8-ohm tap, the waveshape is well behaved. There is only a very slight overshoot, and the response is generally outstanding for a tube power amplifier. With the reactive loading of an added 2-μF capacitance in the middle trace, the amount of ringing is somewhat greater than in many other amplifiers tested. A very low amount of tilt is exhibited in the bottom trace, for a 40-Hz signal, which corroborates the excellent and extended low-frequency response of the M135.

Distortion performance was similar for the two M135s and is shown for amp A. Total harmonic distortion plus noise at 1 kHz is plotted as a function of power in Fig. 3 for 16-, 8-, and 4-ohm loading on the 8-ohm tap. Not surprisingly, the highest power output is obtained for the 8-ohm load; distortion is lower for 16 ohms and higher for 4 ohms. Power delivery into 4 and 16 ohms is good at a large fraction of the rated power of 135 watts. Results for THD + N, as a function of frequency and at different power levels, are shown in Fig. 4. The SMPTE-IM distortion, for 8-ohm loading on the 8-ohm tap and 4-ohm loading on the 4-ohm tap, is plotted in Fig. 5. There is a small difference

DELICACY, DEFINITION, TONAL HONESTY, AND LACK OF IRRITATION ARE AMONG THE BEST I'VE HEARD.

between these two curves that I can't explain. Figure 6 shows the spectrum of harmonic distortion for a 10-watt output into an 8-ohm load on the 8-ohm tap at 1 kHz. The dominant distortion products are second- and third-order, with a rapidly decaying spectrum of a few higher order products.

Damping factor was measured on both the 4- and 8-ohm taps, and results are plotted in Fig. 7. Unusual here is the increase in damping factor at the upper end of the audio range. In every case I can remember, damping factor is either decreasing at the high frequencies (usual case) or remains constant over the audio range (not usual). I think a clue to this behavior can be seen in Fig. 1, which really has more information than just the 1-watt frequency response. Showing the frequency response as a function of open circuit and of 8- and 4-ohm loadings reveals something about the nature of the circuit's output impedance. In general, the lower the output impedance, the more the curves for the different loads are the same. In the case of the M135, there is a tendency for the output impedance to become lower for frequencies above about 10 kHz, as evidenced by the curves coming closer together. Note how the curves in Fig. 1 almost coincide at about 60 kHz. This

shows the output impedance to decrease at the upper end of the audio range—which is the case in Fig. 7, where the output impedance was actually obtained by injecting a constant current of 1 ampere into the measured channel and plotting the resulting voltage as a function of frequency. Making the graph show these results as damping factor is done by manipulating the data with the Audio Precision test system's computational utilities.

Output noise for different bandwidths is listed in Table I for both units. Amplifier A is the quieter one; it produced some of the lowest numbers I have seen in power amplifiers. Amplifier B had some 60-Hz hum components and more random noise from the input tube, but results are still quite good.

For the IHF tone-burst test of dynamic headroom, equivalent power output at the visual onset of clipping was 175 and 182 watts for amps A and B, respectively. This corresponds to dynamic headroom of 1.13 and 1.3 dB. Steady-state power at the visual onset of clipping was 155 and 167 watts for the two amplifiers, yielding a clipping headroom of 0.6 dB for amp A and 0.9 dB for amp B. The differences in output between the two units are said to be a function of the saturation characteristics of the particular output tubes used.

The a.c. line current in the M135s was 2.4 amperes at idle and stayed at this level for power outputs up to 7 to 10 watts, wherein the line current increased to 4.2 amperes at an output of 135 watts. Overdriving the amps with a 2-V input tone burst, which clipped the output heavily, resulted in virtually instantaneous recovery, with no low-frequency baseline bounce. All in all, a good measured performance for the M135s.

Use and Listening Tests

Front-end equipment in my system during the review period included an Oracle turntable fitted with a Well Tempered Arm and Spectral Audio MCR-1 Select moving-coil pickup, a Krell MD-10 CD transport feeding various commercial and experimental D/A converters, Nakamichi's 250 cassette recorder and ST-7 tuner, and a Technics 1500 reel-to-reel recorder. Preamplifiers used were First Sound's Reference II, a Quicksilver Audio, a Forssell tube line driver, and a Sonic Frontiers SFL-1. Other power amplifiers included the prototype pair of M135s that I have been using for over a year, a pair of Marantz Model 9s, a Crown Macro Reference, a pair of McIntosh MC1000s, and an Arnoux Seven B digital switching unit. Loudspeakers used were B & W 801 Matrix Series 3 and Win Research SM-10s. Additional listening was done with Stax SR-Sigma headphones driven from a power amplifier with the Stax SRD-7 Professional energizer box.

When I first heard these Quicksilver amps, I was somewhat surprised to find that they sounded noticeably better than the prototype pair. Boy, these amps are good! Low-end punch, tightness, and overall dynamics are outstanding. Space, soundstaging, and dimension are among the best I've heard. Delicacy, definition, tonal honesty, and lack of irritation are also among the best I've heard. These amplifiers make the music sound more "there" and real. What is amazing is how well they kick butt when playing various percussive rock 'n' roll CDs with the volume UP! I have been enjoying music enormously with these amplifiers, you can be sure.

THESE AMPS MAKE MUSIC SOUND MORE "THERE" AND REAL—THEY REALLY KICK BUTT WHEN PLAYING ROCK 'N' ROLL.

For those who wonder how I would compare the M135s to the Marantz 9s, I would have to say that I don't wish for a pair of the 9s as I used to and would rather have a pair of the M135s. Yes, the 9s are sweet and spacious and have reasonable sounding bass, but to these ears the nod goes to the M135s for dynamics and overall better sound.

If you get the idea that I like these amps, you are right! I truly think they are wonderful devices. Plagiarizing the words of a fellow reviewer: "Sell the Mercedes and the wife's mink coat . . . ," go out and buy yourself a pair of M135s, forget about amplifiers, and simply enjoy the music.

Bascom H. King

As virtually every speaker manufacturer rushes to deliver "home theater" speakers to the marketplace, M&K amasses nearly twenty years of experience in the field—dating back to Hollywood screening-room installations in the 1970s.

M&K engineers have spent well over a decade studying the varied aspects of surround sound—including encoding and decoding; soundtrack recording; and the differences between reproducing sound in theaters and in homes.

M&K speakers *excel* in the reproduction of *all* source material. Accuracy, low coloration, pinpoint imaging, wide dynamic range, and deep-bass reproduction are all critical for music as well as film soundtracks. M&K Satellites and Subwoofers have been acclaimed for these attributes since the '70s.

And this is why M&K knows that any speaker that claims to be optimized for either music or film sound, one at the expense of the other, will never reproduce *either one* properly.

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Conventional speakers make the music and effects on film soundtracks compressed and dull. But M&K's exciting dynamics and "quick" transients give you precise 3-D imaging and a lifelike presence.

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speaker to your present system, M&K's unique timbre controls allow you to "fine-tune" the sound of your new M&K speakers to achieve the closest possible timbre-match with your existing speakers—even if they are not M&Ks.

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Beware of inexpensive "center channel" speakers. In Pro-Logic, the center channel speaker is driven the hardest, and often reproduces as much sound as the left and right speakers combined.

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Whether you choose our state-of-the-art Home THX® Audio speaker system, an add-on set of surround speakers, or anything in between, no other speakers will give you the exciting performance, sound quality, flexibility and compatibility of M&K's home theater component speakers.

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EQUIPMENT **PROFILE**

DIGITAL PHASE AP-1 SPEAKER

A single good idea or concept is all that's needed to form the basis for a new company and for that company to distinguish itself from competitors. A complete line of products can be developed and marketed based on that one concept. For speaker company Digital Phase, a cabinet design based on the concept and implementation of internal vibrating reeds forms the basis of its whole line. Digital Phase calls its concept "Acousta-Reed" technology, a development of company founder and chief designer Daryl Powell. The technology is protected by U.S. Patent No. 5,170,436, dated December 8, 1992.

INTERNAL CONSTRUCTION BELIES THE NOTION THAT THE AP-1s ARE ORDINARY VENTED BOXES.

The AP-1 appears to be a conventional two-way, tower-style vented box with a rear port. It is designed around a long-throw 6½-inch cone woofer and a small metal-dome tweeter. Both drivers are near the top of the system's front panel, with the tweeter mounted below the woofer. No surprises here.

What's not so apparent is the AP-1's internal configuration, which incorporates two shelves that have several slots cut in them. These shelves extend from side to side in the cabinet, with one shelf attached to the front of the enclosure and the other attached to the rear. Both shelves extend about halfway into the cabinet. The front-mounted shelf is just below the tweeter, and the rear-mounted shelf is about 7 inches lower, adjacent to the rear-mounted input terminal strip. The added slots break up the shelves (called baffles, plates, or platters in various parts of Digital Phase's literature) into a series of eight side-by-side fingers, or reeds, whose ends are free to vibrate.

These internal vibrating reeds are said to "eliminate the standing waves inside the speaker enclosure" and to "cancel the woofer's back wave, which is 180 degrees out of phase with the front wave of the woofer." Digital Phase states that with the

SPECS

Type: Two-way, floor-standing, patented "Acousta-Reed" ported system.

Drivers: 6½-in. carbon-fiber poly cone woofer and 1-in. titanium-dome tweeter.

Frequency Response: 35 Hz to 20 kHz, ±1.5 dB.

Sensitivity: 87 dB at 1 meter, 2.83 V rms applied.

Crossover Frequency: 3.0 kHz; acoustic slopes, 24 dB/octave.

Nominal Impedance: 8 ohms.

Power Handling: 100 watts.

Dimensions: 38 in. H × 11⅛ in. W × 10½ in. D (96.5 cm × 28.3 cm × 26.7 cm).

Weight: 43 lbs. (19.6 kg) each.

Price: $1,250 per pair; available in black or honey oak.

Company Address: 2841 Hickory Valley Rd., Chattanooga, Tenn. 37421.

For literature, circle No. 91

When Denon, with the audio industry's longest heritage of digital design and music recording, charged its most talented engineers to create a range of cost-no-object components, clearly the goal was not for immediate sales. Instead, Denon applied the most advanced technologies to improve the resolution, integrity and stability of digital data transmission to achieve accurate, transparent sound reproduction and pure musicality.

What uniquely qualifies Denon in this endeavor is that the Company shares the same dedication to music of many esoteric manufacturers, but combines this fervor with the technology and resources gained through 83 years of recording music and building record/playback components. *No other high-end or mainstream audio manufacturer can make this claim.*

The intensive research and design that has gone into the very limited edition of S-Series components could never be recouped through sales, even at their seemingly lofty prices. Instead, Denon, in keeping with its "Design Integrity" philosophy, will explore ways to incorporate many of these advances in future Denon components. But, for those of you who can afford not to wait...

TOP: The DP-S1 CD Transport is constructed using three levels of mechanical and acoustic isolation and a high resolution laser system to deliver ultra stable, jitter-free data. $8,000.

MIDDLE: The DA-S1 D/A Converter employs ST-Genlock clock and data transmission with Denon's exclusive ALPHA Converter System to achieve a full 20 bits of data integrity from any CD or other digital audio source. $7,000.

BOTTOM: The POA-S1 Monoblocks combine parallel, complementary bipolar power supplies with a full differential power MOS-FET amplifier design to deliver more than 1,400 Watts into a 1 Ohm load. $20,000 each.

DENON

Denon America, Inc., 222 New Road, Parsippany, NJ 07054 (201) 575-7810

reeds, the bass response is much improved, with lower second- and third-order harmonic distortion, and extends more than a full octave lower than it might otherwise. Furthermore, the reeds allow a smaller woofer to be used, which improves midrange performance. The reeds are also said to greatly increase the system's internal mass (the type of mass is not stated, whether acoustic or mechanical), thus making a small woofer appear to be much larger and have higher performance.

Quoting from portions of the patent:

> When installed in the cabinet, the reed fingers are activated to reinforce the bass frequencies . . . , the reed fingers being excited by sounds being emitted by the woofer in a manner similar to the excitation of a tuning fork that has been struck. Once the reed fingers have been excited, a controlled resonance is developed within the cabinet and the entire cabinet vibrates.
>
> . . . The fingers as they vibrate resonate and amplify the bass frequencies. . . .
>
> . . . The lower resonating frequencies of the baffles result in the entire platter becoming a vibrating mass, thereby increasing the bass response. . . .

The AP-1 is third in the line of five Digital Phase systems, all of which incorporate the Acousta-Reed technology. The line comprises two bookshelf and three tower-style models. The AP-1 is the smallest of the three tower systems. It has a rounded top and a solid oak base that extends out from the bottom of the cabinet. The front panel and rear of the systems are textured flat black. The grille is made from a single piece of 5/8-inch medium-density fiberboard, covered by black grille material, and is attached to the cabinet's front panel by plastic projections that mate with holes in the panel. The AP-1s are not supplied with spikes, but they could easily be attached to the bottom by an enterprising user.

The 6½-inch low-frequency driver incorporates a polypropylene cone impregnated with carbon fiber. This is said to have better damping and rigidity than cones made of other materials. The cone is anchored to the basket with a butyl rubber surround, and it is driven by a two-layer voice-coil wound on an aluminum former.

The 1-inch tweeter utilizes a spun titanium dome attached with a butyl rubber surround. It has a neodymium motor and a Ferrofluid-cooled voice-coil. The tweeter's high-energy magnet permits a quite small physical size, and it is completely self-shielded. Covering the dome is a screen that not only protects the tweeter but also broadens its dispersion; you cannot remove the screen.

A NONREMOVABLE SCREEN SERVES TO PROTECT THE AP-1's TWEETER AND BROADEN ITS DISPERSION.

Digital Phase follows the simpler-is-better philosophy for its crossover designs. The AP-1's crossover, located behind the woofer and fabricated on a p.c. board, is said to have 24-dB/octave acoustic slopes and to be aligned according to the Linkwitz-Riley configuration. Electrically, the crossover is fairly simple and contains second-order, 12-dB/octave high- and low-pass filters. A resistive divider reduces the tweeter level. The crossover contains six parts: Two inductors, two capacitors, and two resistors. Premium-quality air-core inductors and metal-film polypropylene capacitors are used.

All internal connections use large-diameter, 14-gauge, oxygen-free copper cables, which are soldered to the driver's terminals and the input terminals. The rear panel has a single pair of gold-plated, five-way binding posts mounted on standard ¾-inch centers. Bi-wire connection capabilities are available on request when the AP-1s are ordered. Two-inch-thick fiberglass lines the entire top of the cabinet.

Measurements

Figure 1 displays the tenth-octave-smoothed, on-axis, anechoic frequency response of the AP-1 without its grille; the effects of the grille are seen in an unsmoothed curve. Also shown is the port response, measured in the near field, which has been scaled to the on-axis response. An additional curve shows the effects on the axial response of woofer-port interference, which appears as a dip at 130 Hz.

Measurements were taken with the grille off, 2 meters away from the front of the cabinet, and at a point even with the top of the woofer's dust cap (following the manufacturer's height recommendation). A voltage of 5.66 V rms was applied, and the measurement was referenced back to 1 meter. It was at this distance and height that the interference notch noted in the figure was apparent. Additional measurements at other heights and distances strongly influenced the depth and width of the notch. At a distance of 1 meter, the notch depth was only half as great; at ½ meter from the system, the notch was just about gone.

The strong sensitivity of the notch to position suggested that it might be a result of out-of-phase port energy interfering with the woofer's output, and/or effects of box diffraction. Covering the port did significantly reduce the depth of the notch but did not eliminate it. With the port covered, the AP-1's bass output was much reduced in the two-octave range between about 25 and 100 Hz, reaching a maximum reduction of 6 dB at 45 Hz. Conversely, the output increased between 105 and 155 Hz with the port covered, which indicates interference. Individual near-field curves of the woofer (not shown) and port (shown) indicated that the woofer output exhibits a slight dip at 130 Hz, while the port output exhibits a corresponding peak at the same frequency.

The evidence thus points to out-of-phase port output *and* box diffraction causing the response dip. The significance of the anechoically measured dip in real-

A HOME THEATER SHOULD

world listening conditions was assessed by measuring the AP-1's low-frequency room response with the port open and closed. Under these conditions, the dip *did not* appear to be a problem, because the room curve did not exhibit much change in the notch area with the port open or closed. Apparently the room integrated the system's total output in this range and therefore it was not very sensitive to the low-frequency directional effects. The response between 20 and 100 Hz was greatly increased with the port open, however.

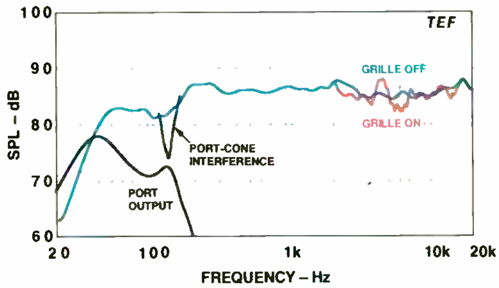

Fig. 1—Anechoic frequency response.

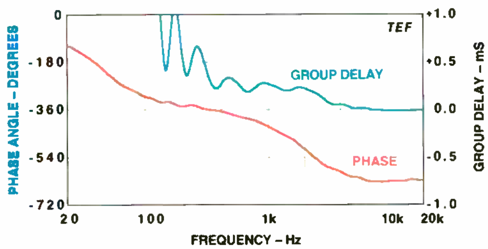

Fig. 2—Phase response and group delay.

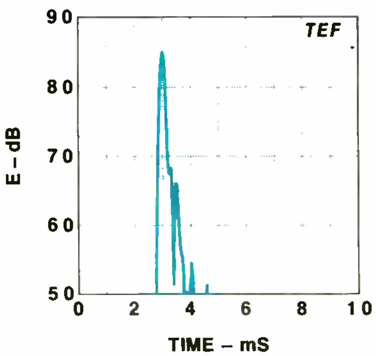

Fig. 3—Energy/time response.

The overall curve in Fig. 1 is a very flat ±1.5 dB above 190 Hz but exhibits a shelved response between 45 and 130 Hz, where the level is down about 4 dB. In reference to the low-frequency plateau, the bass response is quite strong and only about 3 dB down at 40 Hz and 6 dB at 33 Hz. The grille causes fairly significant perturbations of about ±3 dB in the response above 2 kHz. I suggest leaving the grille off for serious listening.

Averaged over 250 Hz to 4 kHz, the AP-1's sensitivity measured 86.0 dB, only 1 dB below Digital Phase's rating. Right/left matching was excellent over the whole audible range. The left and right speakers were essentially exactly matched, within the repeatability of my test gear, except for slight narrow deviations at 2 and 16 kHz, where the deviation was only ±0.5 dB.

The phase and group-delay responses of the AP-1 with grille on, referenced to the tweeter's arrival time, are shown in Fig. 2. The phase curve is well behaved and drops only 200° between 1 and 20 kHz. The group-delay curve indicates that the woofer lags the tweeter by about 0.25 mS. This offset is due to a combination of crossover design and offset of the midrange/tweeter's acoustic center.

Figure 3 is the AP-1's energy/time response. The test parameters accentuated the system's response from 1 to 10 kHz, which includes the crossover region. The main arrival, at 3 mS, is very compact and is followed by a minor peak, delayed about 0.5 mS and about 20 dB down from the main peak. Very few lower-level delayed responses are evident at later times.

Figure 4 exhibits the "3-D" horizontal off-axis responses of the AP-1. The bold curve at the rear of the graph is the on-axis response. The uniformity of the curves indicates excellent horizontal off-axis response and coverage. The dispersion at the highest frequencies, above 10 kHz, remains quite broad and even.

Figure 5 displays the AP-1's vertical off-axis responses. The bold curve in the center of the graph (front to rear) is on axis. The on-axis curve and all the curves up to +15° above axis are quite uniform. This indicates excellent coverage for listeners who are seated or standing. The curves that are –5° and lower, however, have sharp dips in the 3-kHz crossover region (not clearly shown in the graph). This indicates poorer coverage for a person who might be lying on the floor. It is quite clear why the designer chose to locate the tweeter below the woofer, rather than the other way around!

THE AP-1s DELIVERED LAUDABLE STEREO FOCUS, SOUNDED QUITE ALIVE, AND WERE ALSO WELL BALANCED.

Figure 6 shows the AP-1's impedance magnitude versus frequency. A minimum impedance of 4.9 ohms occurs at 5.5 kHz, and a maximum of 35.1 ohms takes place at 58 Hz in the bass range. The curve has a high max./min. variation of about 7.2 to 1 (35.1 divided by 4.9). This high variation, coupled with the minimum impedance of 4.9 ohms, means that the AP-1 will be somewhat sensitive to cable resistance. Cable series resistance should be limited to a maximum of about 0.066 ohm to keep cable-drop effects from causing response peaks and dips greater than 0.1 dB. For a typical run of about 10 feet, 14-gauge (or larger diameter) wire should be used.

Figure 7 shows the rather energetic complex impedance of the AP-1, plotted from 5 Hz to 30 kHz. The two large loops occur in the bass range, below 100 Hz. A slight nub is evident at 131 Hz, which corresponds to the previously mentioned notch in frequency response. The impedance phase (not shown) reached a maximum angle of +45° (inductive) at 20 Hz and a minimum angle of –55° (capacitive) at 3.2 kHz. Even with these fairly large angles, and if used singly, the AP-1 should not be a problem for most amplifiers.

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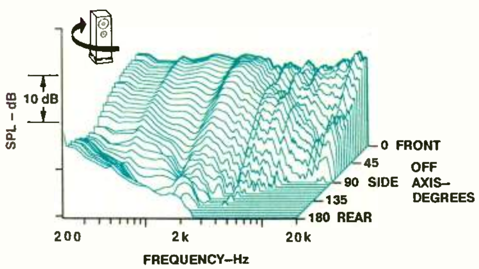

Fig. 4—Horizontal off-axis frequency responses.

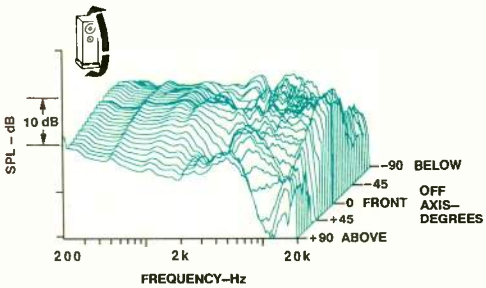

Fig. 5—Vertical off-axis frequency responses.

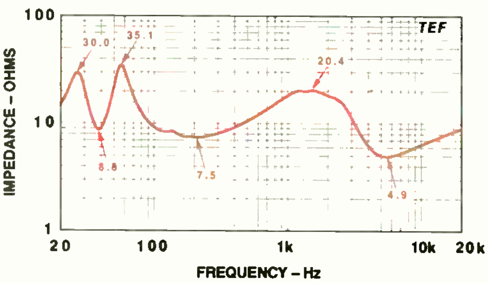

Fig. 6—Impedance.

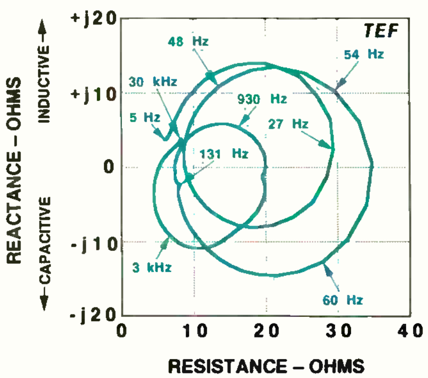

Fig. 7—Complex impedance.

A sine-wave sweep of the AP-1 revealed no objectionable cabinet vibrations or buzzes. Some activity of the rear and sides was evident, however, at and around 175 Hz. The woofer has a healthy linear travel capability of about 0.5 inch, peak to peak. Higher displacements resulted in significant audible harmonic distortion. No bad noises were generated when the woofer was severely overloaded.

The woofer's cone displacement with frequency essentially followed that of a well-designed vented-box system, with a minimum at about 39 Hz (the box tuning) and a maximum at about 51 Hz. With a sine wave of 10 V rms applied, the output sounded quite clean down to 31 Hz. Harmonic distortion increased rapidly below this frequency. Some dynamic offset distortion was evident from 70 to 100 Hz. Even with 20 V rms applied at the 39-Hz box resonance, vent turbulence and wind noise was not objectionable. On sine waves, the AP-1's clean low-frequency output could keep up with the output of other systems whose woofers are significantly larger.

Removal of the AP-1's woofer and the input connection panel on the rear reveals the internal configuration of the cabinet, including the "reeds." As previously stated, the reeds are formed by slots cut in the two internal shelves attached to the front and rear of the enclosure. In the AP-1, the shelves are made from ⅝-inch-thick medium-density fiberboard and have dimensions of about 9 × 4¾ inches. Seven 2½-inch-long slots are cut in the shelf to form eight reeds. Actually, only six of the eight reeds are free to move, because the two outside ones are attached to the side walls.

On first examining the reeds, I was quite surprised that they were so stiff. With my fingers, and using much strength, I was hardly able to move the ends of the reeds at all! Because the reeds are so stiff, I thought that they would not vibrate significantly, given typical sound pressures and velocities inside the cabinet, and thus would not affect low-frequency operation.

To test this, I performed two separate experiments after doing most of my listening tests on the system. On one cabinet, I clamped the ends of the reeds with zinc mending plates and "C" clamps. On the other, I glued the reeds together by filling the slots with wood glue. I then made careful before-and-after near-field measurements of frequency response of both woofer and port. Separately, I made side-by-side listening comparisons between the glued system and the unclamped one. I was able to measure only slight differences, ones comparable to the repeatability of my test gear and small in comparison to the differences between left and right systems measured earlier. More comprehensive and detailed tests would have to be run to completely evaluate the reeds and the operation of the cabinet.

What does have an effect, however, is the existence and locations of the reed shelves themselves. The shelves add strength and also serve to change the internal configuration of the cabinet. With the shelves, the configuration changes from a simple cavity into a divided cavity that forms a somewhat

THE AP-1s' BASS CAN MATCH THE OUTPUT OF SPEAKERS THAT HAVE MUCH LARGER WOOFERS.

circuitous route between the woofer and the port. This added channel may act as a transmission line, which can have resonances of its own. Perhaps it is one of these resonances that accounts for the response notch in the vicinity of 130 Hz. (The transmission-line-based Celestion 300, reviewed in the March 1993 issue, exhibited just such a notch in its on-axis frequency response near 100 Hz.

Figure 8 shows the 3-meter room response of the AP-1, with both raw and sixth-octave smoothed data. The speaker was in the right-hand stereo position,

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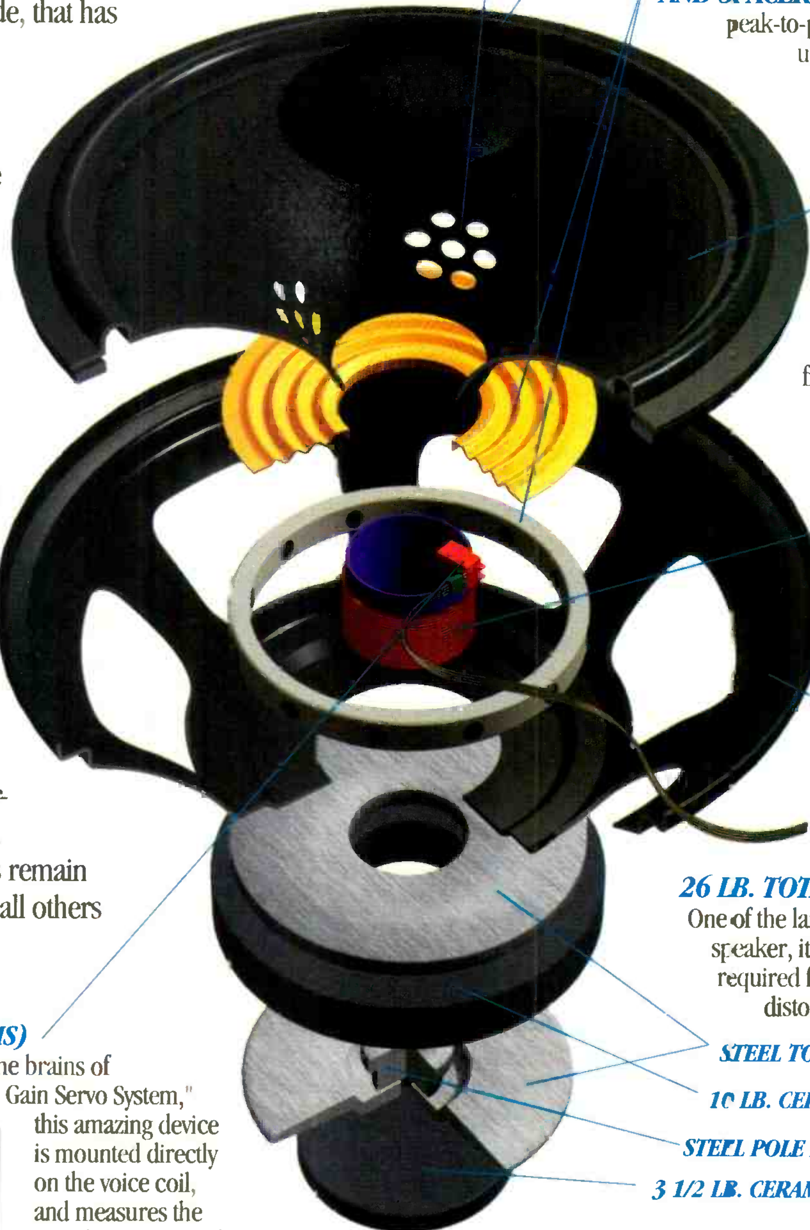

HOLE PATTERN IN CONE Used to break up unwanted standing waves radiating from the throat of the cone.

HIGH DENSITY FOAM SURROUND
PNENOLIC IMPREGNATED LINEN SPIDER AND SPACER To handle the long, 5/8 inch peak-to-peak cone excursion, Velodyne uses the strongest most durable surround and spider available.

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10 LB. CERAMIC MAGNET

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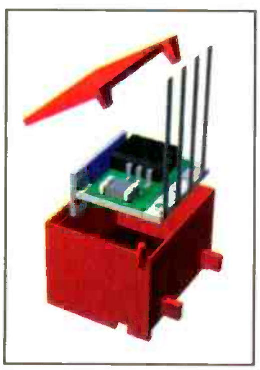

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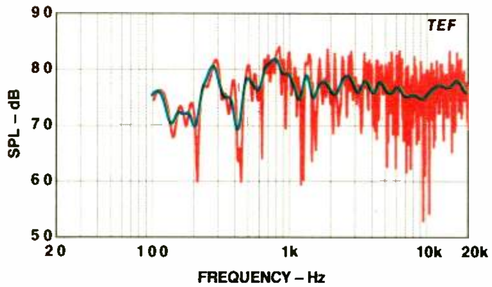


Fig. 8—Three-meter room response.

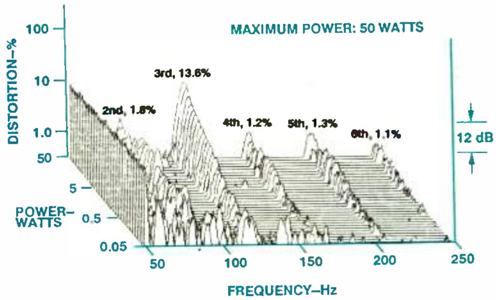


Fig. 9—Harmonic distortion for E_1 (41.2 Hz).

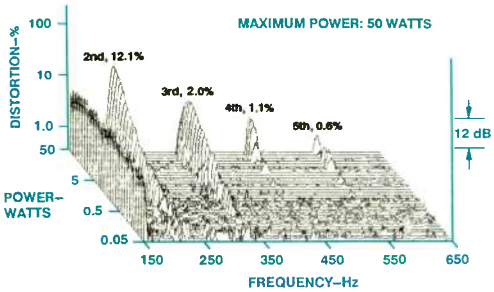


Fig. 10—Harmonic distortion for A_2 (110 Hz).

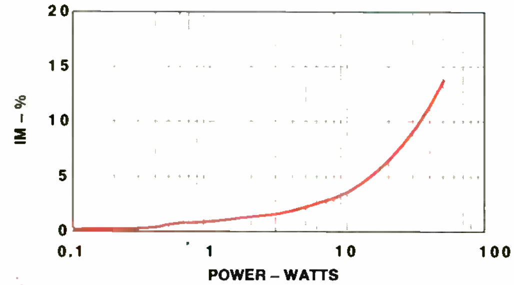


Fig. 11—IM distortion for A_4 (440 Hz) and E_1 (41.2 Hz).

aimed toward the main listening position, and the test microphone was at ear height (36 inches), at the listener's position on the sofa. The system was driven with a swept sine-wave signal of 2.83 V rms (corresponding to 1 watt into the rated 8-ohm impedance). The direct sound plus 13 mS of the room's reverberation are included.

The averaged curve fits a fairly compact, 12-dB window over the whole measured range of 100 Hz to 20 kHz. Above 1 kHz the averaged curve is even flatter, fitting a tight window of about 4.5 dB.

Figure 9 shows the E_1 (41.2-Hz) bass harmonic distortion, with maximum power limited to 50 watts. The AP-1 did quite well in this test; the highest distortion reaches a moderate 13.6% third-order harmonic and a low 1.8% second-order. Higher harmonics are even lower. Figure 10 shows the A_2 (110-Hz) bass harmonic distortion. The predominant distortion is a moderate 12.1% second, with the higher harmonics 2.0% and lower. The A_4 (440-Hz) distortion (not shown) rose only to the low level of 0.44% second; the higher harmonics were below the noise floor of my test gear.

Figure 11 displays the IM distortion created by tones of 440 Hz (A_4) and 41.2 Hz (E_1) at equal power levels. The IM rises to the moderate level of 13.6% at 50 watts. The 6½-inch woofer of the AP-1 handled both frequencies of this test. The system sounded quite clean through all the distortion tests I conducted.

The AP-1's short-term peak-power input and output capabilities, as a function of frequency and measured using a 6.5-cycle third-octave tone burst, are shown in Fig. 12. The peak input power was calculated by assuming that the measured peak voltage was applied across the speaker's rated 8-ohm impedance.

The peak input power rises rapidly from 15 watts at 20 Hz to a plateau of about 110 watts between 32 and 60 Hz. The input power then rises fairly smoothly, up to a healthy maximum of about 4,300 watts above 300 Hz. The woofer exhibited dynamic offset distortion between 80 and 125 Hz, where the cone's displacement was essentially out of the gap. Reversing the input polarity did not reverse the displacement at these frequencies.

With room gain, the maximum peak output SPL rises very rapidly, reaching a very usable 107 dB at 40 Hz. Thereafter, the peak SPL rises gradually, to 110 dB at 120 Hz, and then jumps up to the loud range of 120 to 123 dB above 280 Hz. If you define as a low-frequency limit the frequency where maximum SPL with room gain exceeds 105 dB, then the AP-1's 6½-inch woofer has higher bass output than any of the single 8-inch or smaller woofer systems I have measured, even including one that had dual 8-inch woofers.

Use and Listening Tests

The AP-1 is currently shipped with only warranty information in the packing that comes with the system. Digital Phase informed me that an extensive owner's manual will be released shortly. I was sent a

THE AP-1s BROUGHT OUT THE BEST IN WHATEVER PROGRAM MATERIAL I LISTENED TO.

comprehensive five-page white paper describing the technology of Digital Phase speakers; it's available to anyone on request.

My review samples were finished in honey oak and, with their rounded top corners and oak base, were quite attractive. The AP-1s' appearance and details of their wood grain were well liked by my whole family. Build quality was very good.

I listened to the AP-1s using a Krell KRC preamp driving Crown's Macro Reference power amplifier, which in turn drove the AP-1s through Straight Wire Maestro cabling. My reference speakers were B & W 801 Matrix Series 3s, while Onkyo and Rotel CD players provided source material.

Continued on page 94

ETYMŌTIC RESEARCH ER-4 EARPHONES

The Etymōtic Research ER-4 earphones are a perfect example of the reason that I use the term "earphones" rather than "headphones." "Earphones" is a broader term and, in this case, is a more accurate description because the ER-4s are designed to be inserted in your ears; in fact, they are different than most "in-the-ear" earphones that you see people wearing because they fit right into your ear canals.

I have known Mead Killion, one of the designers of the Etymōtic ER-4 earphones, since the late 1970s, when we both belonged to the Chicago Acoustical and Audio Group. Killion worked for Industrial Research Products, a division of Knowles Electronics, for 22 years. One of his major accomplishments there, which helped to revolutionize the hearing aid business, was his proprietary design of the K-AMP amplifier. This is a true, high-fidelity, miniature amplifier used by various companies in many different hearing aids. Presently, Killion has 18 patents in the field of hearing aids and earphones. He started Etymōtic Research in 1983, and his motto is *still* "Making things better for people."

Besides producing the ER-4 earphones, Etymōtic also makes The Musicians Earplug, which was invented by Elmer Carlson, Killion's co-worker and mentor at Industrial Research. Etymōtic makes these superior, noise-reducing earplugs under license from Knowles Electronics.

The ER-4 earphones are available in two versions, the ER-4B and the ER-4S. The "B" version was designed for binaural listening and the "S" version for stereo listening. What is the difference, you may ask? Years ago, there was some confusion between the terms "binaural" and "stereo." Two-channel recordings were being made using both spaced microphones and dummy-head microphones, as well as combinations of both.

SPECS

Transducer Design: Dynamic.
Coupling to the Ear: In-the-ear.
D.c. Resistance: Left, 100 ohms; right, 100 ohms.
Absolute Polarity: Positive.
Cord: Straight, 4 feet long, from each earphone; ⅛-inch stereo phone plug (⅛-inch to ¼-inch adaptor included).
Adjustments: None.
Weight: Less than 1 ounce.
Price: $330.
Company Address: 61 Martin La., Elk Grove Village, Ill. 60007.
For literature, circle No. 92

ETYMŌTIC'S ER-4s ARE DIFFERENT THAN MOST "IN-THE-EAR" 'PHONES, AS THEY FIT RIGHT INTO YOUR EAR CANALS.

Earphone Evaluation

PARAMETER	RATING	COMMENTS
Overall Sound	Excellent	
Bass	Excellent	"Tight bass" and "Low sounds are amazing"
Midrange	Excellent	"Bright but not harsh" and "Clear and clean"
Treble	Excellent	"Good transients"
Overall Isolation	Excellent	
Bass	Excellent	"Outside sounds felt but not heard"
Midrange	Excellent	"Excellent isolation"
Treble	Excellent	"Excellent isolation"
Comfort	Excellent	
Value	Excellent	"Good value"

GENERAL COMMENTS: Very comfortable; good fit; comfortable for long-term listening; excellent isolation from outside noises; overall fantastic sound.

As is still the case today, listeners used spaced louspeakers or earphones to listen to these two-channel recordings. Most of the recordings did not clearly indicate which recording methods were used. In fact, the famous binaural records produced by Emory Cook (a true innovator and giant in the field) in the early 1950s were made using spaced microphones!

A turning point came when an article appeared in *Audio Engineering* (the precursor to *Audio*) by Russell Tinkham that clearly differentiated between "binaural" and "stereo." Binaural was defined as listening with two ears, and stereo was defined as listening to a solid (the Greek word *stereos* means solid) sound field produced by two or more loudspeakers.

Why, then, would Etymōtic Research produce two different versions of the ER-4? Most recordings are made using multiple microphones that are placed close to the instruments and then mixed to the final two-channel format. Because the mikes are so close to the instruments, they pick up high frequencies with little loss of level. By contrast, binaural recordings are made with a dummy-head microphone system that is placed away from the instruments to achieve a good perspective and sense of space. Because most of the instruments produce less high-frequency energy out toward a normal listening position, where the dummy head and mikes are located, the high-frequency level on a recording is reduced. Compared to the ER-4B, the ER-4S has a response characteristic that is sloped downward, starting at about 1 kHz, and it is down about 5 dB above 8 kHz. This response will be better for close microphone recordings. The ER-4B is designed to produce a true diffuse-field type of response for recordings that were made with the microphones away from the instruments. Besides recordings made with a dummy head for binaural listening, you can also enjoy many of the older recordings made with spaced microphones placed away from the instruments.

I used both the ER-4S and the ER-4B, and I liked both of them. If I had to choose, I would take the "B" version. In addition to recordings made for binaural listening, most classical recordings also sound good with the ER-4B. If you listen to rock music, which is recorded with close microphones and mixed to two-channel (I find it hard to call this type of recording stereo), you may prefer the balance provided by the ER-4S. This will be especially true if you listen to portable CD or cassette players that have no treble control that would allow you to reduce the high frequencies.

IF YOU ARE LOOKING FOR EARPHONES THAT REDUCE OUTSIDE NOISE, YOU WILL FIND NONE BETTER THAN THE ER-4s.

The Etymōtic ER-4 earphones are very small, but despite this they have a serial number on the body. To distinguish the left and the right earphones, the right side is designated by a red strain relief at the transducer end of the cord. The plastic body of each earphone is 1 inch long and ¼ inch in diameter. The body extends ⅜ inch into the plastic earmold that fits over it. The earmolds have three soft plastic flanges that seal to your ears. With a tight seal, the bass is phenomenal; you will hear low-frequency sounds that you didn't even think were possible, especially from CDs. You can tell when the earphones are sealed properly: If you snap your fingers near your ear, you will hear nothing! If you are looking for earphones that reduce outside noise, you will find none better than the Etymōtic ER-4s.

Although the ER-4s fit tightly in my ears, I found them to be very comfortable, even for extended listening. If you want increased comfort, you can have custom earmolds made; Etymōtic will provide information about how these can be obtained in your area. Since the earphones are placed right into your ears and have no headband and a very light cord, it is easy to forget that you are wearing them.

Some members of my listening panel didn't like inserting the ER-4s into their ears and preferred earphones that surround the ear. Some of them were won over by the superior sound qualities and decided that it was worth placing the ER-4s in their ears properly. I asked each panel member to listen to various types of program material and write down their comments.

I measured the ER-4s with a B & K 4134 pressure mike mounted in a Zwislocki coupler. The response was essentially the same as that shown in Etymōtic's literature and followed the desired earphone response characteristic very closely. The bass was flat to 40 Hz and was down only 3 dB at 20 Hz. The treble response was close to perfection all the way out to about 17 kHz. Comments by panel members—such as "fabulous bass," "tight bass," and "low sounds are

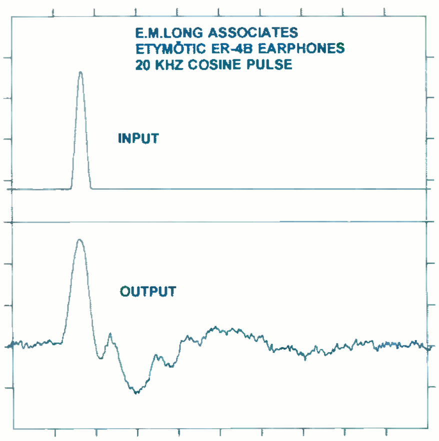


Fig. 1—Cosine-pulse test for ER-4B.

amazing"—verified that the extended low-frequency response that I measured with the coupler was heard when the earphones were sealed properly.

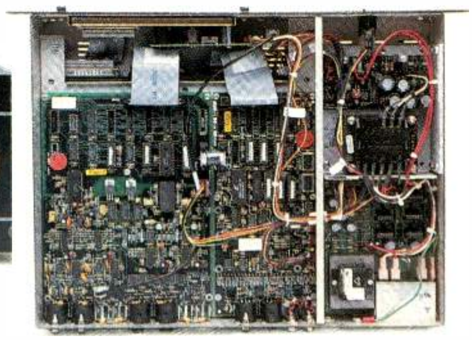
Comments about the sense of presence and articulation were: "Excellent on voices," "clear and clean," and "bright but not harsh." These remarks indicate that the equalization characteristic designed into the ER-4B is right on target. When I wrote "As Close As You Can Get" (April 1991), I stated that I chose the Stax SR-Lambda Pro Earspeakers as a reference for evaluating other earphones. In the "Auricle" review of the Stax Earspeakers (also April 1991), I mentioned I had received a prototype earphone from Etymōtic Research that would have been my other choice for a reference, but the Stax SR-Lambda Pros were available and highly regarded by many people as being, perhaps, the best available earphones. The panel members all commented that the ER-4s were brighter than the Stax reference earphones, but without being harsh. The ER-4s opened the sound and lifted the veil compared to the Stax, especially for large-scale classical music.

Figure 1 is the output of the Etymōtic ER-4 for a 20-kHz cosine input. The input pulse is shown at the top, and the output from the ER-4B earphones is below. The output, after the input has stopped, shows excellent recovery and almost no "ringing" due to delayed energy. This correlates well with a listener's comment of "very tightly controlled sound" and other comments, such as "excellent details" and "good transients." It also shows that the ER-4B produces a positive acoustical output for a positive electrical input. This resulted in comments about how easy it was to determine the correct absolute polarity when an amp's polarity switch was used while voices, brass instruments, and other asymmetrical musical sounds were being played.

The Etymōtic ER-4 earphones are efficient and can produce very high sound levels with relatively little input power. The members of the listening panel gave the ER-4 earphones an overall sound quality rating of "excellent" and an "excellent" rating for physical attributes. I personally think that they are better than the Stax SR-Lambda Pro reference earphones. When the price is considered, I think that the ER-4s are an excellent value. *Edward M. Long*

EQUIPMENT **PROFILE**

SIGTECH AEC 1000 ACOUSTIC ENVIRONMENT CORRECTION SYSTEM



This review is a result of attending the 1993 Consumer Electronics Show in Las Vegas. One of my newer interests is digital signal processing (DSP) in general and acoustic and loudspeaker correction in particular. The subject has had quite a bit of press in various audio publications in the last year. Accordingly, one of my goals at CES was to find out who was exhibiting DSP-based room and speaker equalization systems. From what I found there and from previous research, a quick survey of what is being done in this field follows.

Celestion has the DLP 600, which corrects for their SL600/600i speakers' amplitude and phase response above about 1 kHz. A small Texas company, Audile, showed a complete system consisting of a small, 8-inch, two-way speaker with a coaxially mounted tweeter along with a DSP controller/equalizer that was equalized for near perfect impulse response at a 2-meter distance. I heard this system in a private demonstration and was quite impressed; unfortunately it has not appeared on the market yet.

The Archimedes research project in acoustic room correction is a joint effort of KEF, B & O, and others; B & W is readying for market a stand-alone DSP room and speaker correction system that I heard at the Show and was quite impressed with. Snell Acoustics is working with Audio Alchemy on a new DSP room and speaker correction system and demonstrated a new speaker and DSP controller combination. Snell is said to be coming out with a DSP

THE AEC 1000 CAN GATHER AND ANALYZE ACOUSTIC SYSTEM AND FREQUENCY RESPONSE AT THE LISTENING POSITION.

controller for a number of their existing speakers shortly; Audio Alchemy will have various DSP products, including speaker and room equalization, soon on the market. Rene Besne, formerly with Threshold, has formed a new company, Quadrature, and was demonstrating a DSP-controlled speaker at the Show that I unfortunately didn't get to see. I am sure considerably more is going on in this field; the preceding is what I know of at this time.

A visit to the SigTech room at CES yielded an arrangement to evaluate the professional AEC 1000. This model, introduced into the pro audio market early in 1992, includes a full array of features useful in recording studios: A PC interface card and cable to link the AEC 1000 with a computer for room measurement/filter design; a remote control; built-in A/D and D/A converters, and a built-in microphone preamp. A consumer version, the TF10DA-RM, is planned for the "home engineer" interested in measurements and filter design. It will be identical to the AEC 1000

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but FCC-certified for home use. A more basic home model is also on the way; the TF10D-3 will have the same circuits and programming for loudspeaker/room correction, but not the built-in converters, preamp, room-measurement/filter-design capability (this will be done by the dealer), or remote control. It will also have a less austere, audiophile look.

The basic idea of the AEC 1000 was developed some 10 years ago at Acoustic Research in Massachusetts by Robert Berkovitz and Ron Genereux. Their system could correct for room problems below 500 Hz only, due to speed limitations of DSP technology at that time. With the advent of modern, high-speed digital signal processors, a spinoff company, SigTech, was formed to develop a new product, with engineering led by Genereux. The AEC 1000 is the result of this effort.

The AEC 1000 hardware consists of a main processing unit; a small, eight-bit, half-length interface card for communicating with a host IBM PC or compatible computer; a remote control, and an interconnect cable for host/AEC 1000 communication. The included software runs on the host computer and allows measurement of a room's acoustic response at the listening position (or any other position), display of various measured and computed curves, and generation and installation of the room-correction filters (up to four different ones) in the AEC 1000 unit. Once the desired filters have been installed, the host PC is not needed; the AEC 1000 then operates as a stand-alone digital room-correction filter. An appropriate measurement microphone is not supplied and must be procured separately. (A number of satisfactory mikes for this purpose exist, ranging from models that cost less than $200 to the expensive industry-standard B & K 4133 microphone.)

Signal input and output facilities on the main processing unit consist of balanced (XLR connectors) and unbalanced (RCA connectors) for the analog inputs and outputs, a balanced microphone input with switchable 48-V phantom power, and digital AES/EBU (XLR), S/P DIF (RCA), and EIAJ RCE-9601 standard optical (Toslink) inputs and outputs. Sampling frequencies of 44.1 and 48 kHz are accommodated.

The remote-control panel has nine pushbuttons, three alphanumeric displays, and a two-channel, LED level meter distributed among its three function areas. In the left section, the left-most switch controls the intensity of all the alphanumeric displays. Another switch selects signal inputs, and the selected input is shown in a display. In the middle section, two pushbutton switches increment the input and output gain up or down in a complementary manner for analog I/O, and a dual LED ladder meter indicates operating level for input or output (depending on how the system is set up with the host computer program). The remote's right-hand section has four pushbuttons with LED indicators for selecting one of the four programmed filter positions; a fifth switch bypasses the correction-filter function. An alphanumeric readout in this section indicates the name of the selected correction filter.

The AEC 1000 is rack-mountable width, 3½ inches high, and 13 inches deep. About one-third of the internal volume is taken up by power supplies. The remaining space, devoted to signal and processing circuitry, is vertically partitioned into two parts by a metal plate. Two p.c. boards are mounted on the top of this plate. The smaller of the two is for the AES/EBU and S/P DIF inputs and outputs and associated processing circuitry. This board features digital transmitters and receivers by Crystal Semiconductor. The larger board is for analog input and output circuitry. Among the various chips on this board are an A/D converter by Crystal Semiconductor and a D/A converter by Analog Devices. A short jumper cable couples these two boards; it is surrounded by a large ferrite core, probably to reduce noise coupling in the interconnection. On the bottom side of the dividing plate is one large board, where all the DSP action is. On this board are the master 56001 DSP controller with 24 Motorola 56200 finite impulse response (FIR) filter chips, 12 per channel. This board is heavily populated with other digital chips, including three Intel flash memory chips that hold the coefficients for the four user filters. Two wide ribbon cables connect the top boards with this DSP board. A third ribbon cable, coupled to a front subpanel connector, is for communication to the host computer. Also mounted to this subpanel is a small p.c. board containing the microphone preamplifier. Accessible behind a removable front panel door is a switch for +48 V phantom power, an XLR

SPECS

Digital Inputs and Outputs: AES/EBU XLR transformer-coupled (three), S/P DIF RCA phono (three), and EIAJ RCE-9601 high-speed optical (two).

Analog Inputs and Outputs: One pair balanced XLR, one pair single-ended RCA phono, and one balanced female XLR with switchable +48 V phantom power.

A/D Converter: 18-bit sigma-delta type.

D/A Converter: 18-bit, eight-times oversampling digital filter with noise shaping.

Digital Filter: Delay, less than 2.0 mS; DSP engine, 250 MIPS with 48/56-bit precision; taps per channel, 2,544 at 44.1 kHz or 2,316 at 48.0 kHz.

Filter Memories: Four sets of filters in programmable flash memory.

Dimensions: 17 in. W × 3½ in. H × 13 in. D (43.2 cm × 8.9 cm × 33 cm).

Weight: 17 lbs. (7.7 kg).

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mike connector, a mike preamp gain control, and the host computer's connector.

The AEC 1000 software permits the gathering and analysis of acoustic system time (impulse response) and frequency response at the listening position. Data from several microphone positions in the close vicinity of the listening position is obtained and analyzed for severe bass and lower-midrange frequency response nulls. If one of the responses is better in this regard, it is selected for filter generation. The operator then, via the software, generates the filter-correction coefficients and loads them into the DSP filter. With the graphics feature of the AEC 1000 software, it is possible to view the resulting time and frequency responses of the correction filter, the resultant correction of the original responses, and the original uncorrected responses. A handy feature is the ability to compare the viewed response with one other of its kind (frequency or time). The end result of the correction-generating algorithm is called a "target" response. The normal, or default, target criterion is flat response. However, there are two ways to modify the resultant overall corrected response. The first is by having the algorithm seek a defined response other than flat. There is a neat little utility in upcoming software that will allow arbitrary curves of target response to be generated. Further, there are a number of supplied predefined curves of various high-frequency roll-offs and bass contours to add to the arsenal of target responses. This method requires that new acoustic measurements be made for every target response desired. The other way to modify results is with a supplied set of presets that modify the extent and the frequency range to which the filter matches the target response. Additionally, each segment band can be individually adjusted as to extent of equalization effect. If too much bass boost is being generated in the low end, for example, another adjustment will cut off boost below selected frequencies.

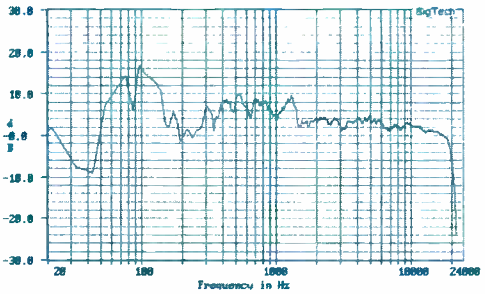

Fig. 1—Uncorrected frequency response of right channel of B & W 801s.

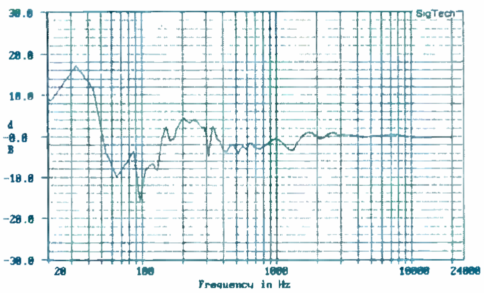

Fig. 2—AEC 1000 frequency response of correction filter for Fig. 1.

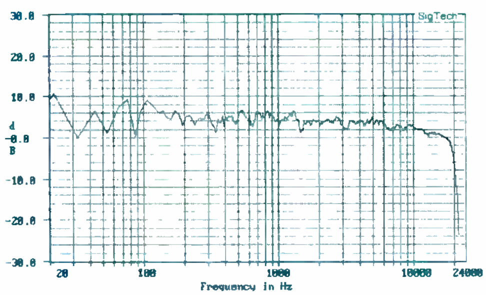

Fig. 3—Resultant calculated frequency response.

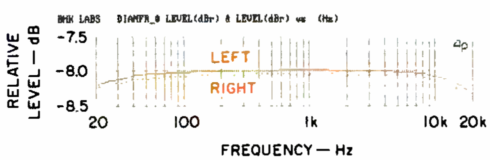

Fig. 4—Response of AEC 1000, digital in and analog out, bypass mode.

Theory and Circuit Description

The SigTech system is really more than a particularly adaptive frequency response filter set. The difference between this device and, say, an analog filter with the same frequency response is that the AEC 1000 actually reduces the effects of some of the early reflections. It does this by deriving the coefficients for the corrective filter from the uncorrected system impulse response that contains those reflections. It would be theoretically possible to actually cancel the full frequency range of a reflection, but if that were done, you would have to listen with your head in an absolutely fixed position—hardly an exciting prospect. Accordingly, SigTech's filter-generation algorithm only corrects for high-frequency aberrations in the direct sound of the speaker and increasingly concentrates on lower-frequency effects further into the measurement time record. In other words, only the lower-frequency effects of reflections are taken care of.

SigTech has done a very interesting thing in the design of the AEC 1000. Normally, digital filters have very good frequency resolution at the top end of their frequency range but much poorer resolution at the low end. This is a natural result of the mathematical techniques that are used to create them; each frequency interval, on a *linear* scale, is assumed to have equal importance. This means that the range from 19,020 to 20,000 Hz has the same importance as the range from 20 Hz to 1 kHz! SigTech has harnessed the power of the DSP chips in its unit to reverse this situation and has produced filters with resolutions more suitable for audio. This is accomplished by the use of a "segmented filter" approach that treats the audio frequency range as eight separate smaller bandwidths. The result is a single digital filter with resolution suited to audio. The alternative would be to split the signal into different bands and filter them separately, which could introduce various types of distortion.

I received schematics of the AEC 1000 but cannot reveal the particulars, as I had

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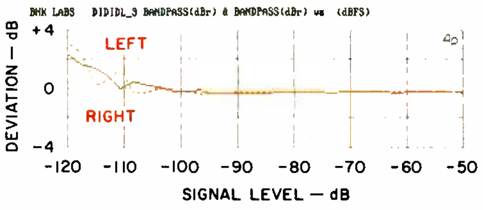

Fig. 5—Deviation from linearity, S/P DIF digital in and out.

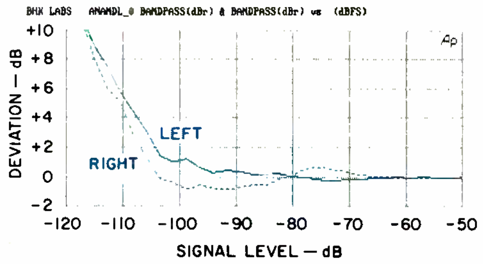

Fig. 6—Deviation from linearity, analog in and out.

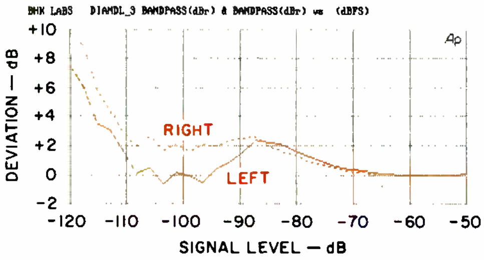

Fig. 7—Deviation from linearity, digital in and analog out.

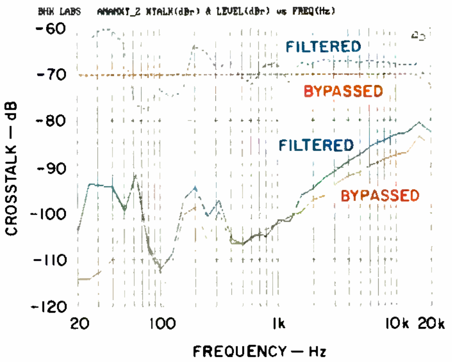

Fig. 8—Crosstalk vs. frequency, analog in and out.

to sign a confidentiality agreement. However, in a general sense, I can describe the signal flow scheme: AES/EBU or S/P DIF digital inputs or analog inputs are selected for processing. Digital input signals go into a digital receiver chip, where the signal is reclocked and serial data-output lines are generated as L/R clock, bit clock, master clock, and interleaved data. At some point in the digital signal path just described, the effective data signal level is divided in half by a shift-right operation. This is done to give some headroom in the filtering operation for frequencies that need boosting. Analog inputs are digitized by a Crystal delta-sigma one-bit A/D converter. Similar outputs to that generated by the aforementioned digital receiver are provided by the A/D output. After selection, the digital inputs' serial signals or the digitized analog serial-signal lines are passed on to the digital filter section. This DSP filter is a 250-MIPS (million instructions per second) engine consisting of a Motorola 56001 orchestrating 12 Motorola 56200 FIR chips per channel. These filters, 2,544 taps long at the 44.1-kHz sampling frequency and 2,316 taps long at 48.0 kHz, are programmed by the software running on the host computer. Up to four different filters can be loaded into the nonvolatile but electrically programmable flash memory on the DSP board, and they are selected either from the remote or from the PC (if connected to the AEC 1000). Another mode bypasses the DSP filter. Bypassed or filtered digital output is passed into an eight-times upsampling, digital low-pass filter and then into a multibit D/A converter chip. Recovered analog output is then passed on to the output amplifiers, which provide both unbalanced and balanced outputs. At the same time, the bypassed or filtered digital output is passed into a transmitter chip that generates the digital outputs.

Measurements

Figure 1 shows the smoothed right-channel frequency response of my B & W 801s measured with the SigTech system at my listening position, with the speakers in the first position in which I used them. I observed a number of overall characteristics here. The first is that the frequency response above 1 kHz is smooth and gently sloping downwards to 20 kHz. The second is that there is a dip in the response in the area around 350 Hz, which corresponds to the first floor-bounce cancellation region. Third, a broad up region exists from about 80 to 150 Hz. And finally, there is a substantial null in the area from 35 to 40 Hz. Figure 2 is the frequency response of the correction filter generated for the right channel, as displayed by the SigTech program. Figure 3 shows what the SigTech system says the response for the right channel would look like when the corrections are factored in.

When I obtained a more detailed low-frequency resolution by actually measuring the input/output response of the filter in Fig. 2 with my Audio Precision system, I noted something else. The output level was about –15 dB in the frequency region above where the equalizer was doing something. I had to reduce the digital input level this much to prevent overload in the filter with the admittedly excessive bass boost that this filter represents. I first noted the filter-overload phenomenon in my system when I was independently measuring the acoustic response of my setup with MLSSA and LMS systems. In this arrangement, the external measuring system stimulus was fed into the AEC 1000's analog inputs. The S/P DIF digital output of the AEC 1000 would still go into the S/P DIF input of the external D/A converter I was using. When the LMS sweep got down to the region of 30 to 40 Hz, I heard this distortion and wondered what manner of corruption this was. Reducing the excitation level into the AEC 1000 eliminated the distortion. I could have achieved the same result by changing the SigTech unit's input sensitivity while keeping the original analog signal input level. However, with the digital inputs, there appeared to be a limitation in the design, in that there is no provision to reduce the drive level to the filter in order to prevent overload with filter boosts above


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6 dB. Getting back to Figs. 2 and 3, I realized that I could not have such a filter with so much boost and use the digital input. Also, I shouldn't have accepted so much low-frequency boost in general, because it was too sharp a curve and would probably ring (as it appeared to do, which is mentioned later in this review). I then created a new filter, with reduced boost below 50 Hz, by using the filter-creation option discussed earlier.

Table I—Noise levels of left channel, in dB.

ANALOG IN/ANALOG OUT

Bandwidth	BYPASSED	FILTERED
Wideband	−78.8	−81.2
22 Hz to 22 kHz	−91.7	−92.7
400 Hz to 22 kHz	−92.2	−93.3
A-Weighted	−94.0	−95.2

ANALOG IN/DIGITAL OUT

Bandwidth	BYPASSED	FILTERED
Wideband	−101.9	−100.0
400 Hz to 20 kHz	−102.2	−100.7
A-Weighted	−105.8	−104.3

DIGITAL IN/ANALOG OUT

Bandwidth	BYPASSED	FILTERED
Wideband	−75.8	−78.2
22 Hz to 22 kHz	−93.6	−96.0
400 Hz to 22 kHz	−94.0	−96.2
A-Weighted	−97.1	−99.5

DIGITAL IN/DIGITAL OUT

Values relative to digital full scale. Off is digital zero, and −130 is digital on at −130 dB relative to full scale.

	BYPASSED		FILTERED	
Bandwidth	Off	−130	Off	−130
Wideband	−114.3	−101.6	−114.2	−100.0
400 Hz to 20 kHz	−114.8	−101.8	−114.8	−100.3
A-Weighted	−118.0	−105.4	−118.0	−103.7

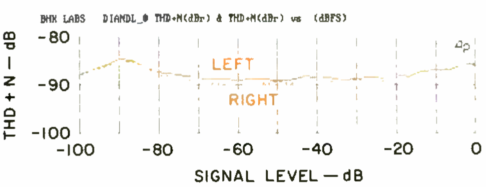

Fig. 9—THD + N, digital in and analog out.

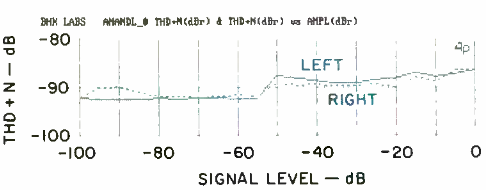

Fig. 10—THD + N, analog in and out.

I next set out to measure other performance aspects of the AEC 1000. Frequency response was measured for the four possible combinations of input and output modes with equalization bypassed. The digital-in/digital-out response was absolutely flat from 20 Hz to 20 kHz and, therefore, didn't need to be plotted. Figure 4 shows the response for digital in/analog out. In both modes (neither shown) of analog input/digital or analog out, the presence of a sharp low-pass filter started attenuation at about 18.7 kHz. The response for analog in/analog out was similar to the response in Fig. 4 but with the additional roll-off starting at 18.7 kHz and down 3 dB at about 19.7 kHz. Response with analog in/digital out was similar to the curve in Fig. 4 in the high end but had virtually no bass attenuation at 20 Hz.

Deviation of input/output linearity was measured for a number of digital and analog input/output combinations. Figure 5 is for digital input and output with the S/P DIF connectors. Figure 6 is for analog input and output, the 801 filter in, and an input sensitivity of +8 dB. Another condition, not shown, was measured with the input sensitivity increased to +20 dB in order to accommodate the bass boost of Fig. 2 without filter overload. Not surprisingly, the deviation from linearity runs into noise about 12 dB sooner. Input/output linearity for digital input and analog output was a bit more complex. There was a noticeable difference in the input/output linearity between having the filter in and out.

Figure 7 is a final plot of deviation from linearity, with S/P DIF input and analog output of the AEC 1000 alone. Putting my nitpicking hat aside, I must say that all of the linearity curves shown are really not that bad. I have seen a number of well-respected D/A converters perform a lot worse.

Noise levels for the left channel are presented in Table I; results for the right channel were essentially the same. For digital inputs, there are two conditions: A very low input level way below the measured noise level (−130 dB) and digital zero.

Crosstalk versus frequency in both directions was measured in all four input/output modes. Crosstalk with digital input/digital output, referenced to digital full

THE SIGTECH ACTUALLY REDUCES THE EFFECTS OF SOME OF THE EARLY REFLECTIONS.

scale, was better than −130 dB up to 10 kHz, either with the 801 filter in or in the bypass mode. The crosstalk relative to the actual output levels, which are down about 6 and 8 dB, respectively, for filter-in and bypass modes, would be reduced by these amounts. With analog input and digital output, crosstalk, referenced to digital full scale, was better than 120 dB down from 20 Hz to 20 kHz with filter-in and in bypass mode, except for a singularity at about 1 kHz that was about −110 dB in the left-to-right direction. As in the digital-in/digital-out crosstalk, the actual crosstalk relative to signal output level would be reduced 6 and 8 dB, respectively, for filter-in and bypass modes. In the digital-input/analog-output mode, crosstalk in both directions was about the same and was better than −120 dB up to 1 kHz and decreased to about −92 dB at 20 kHz. In both directions, crosstalk for the analog-input/analog-output mode was somewhat poorer than that for the previous modes, i.e., better than 80 dB down from 20 Hz to 20 kHz and with some 60-Hz hum components limiting the amount of low-frequency crosstalk. This is shown in Fig. 8 for the 801 filter in and in the bypass mode in the left-to-right direction. Note that the plotting resolution of the filter-in frequency response is not terribly accurate, and the system was allowed to clip in the region of maximum filter boost.

Total harmonic distortion plus noise as a function of frequency at full level and 1-kHz THD + N as a function of level were measured for all four input/output combi-

nations. Starting with distortion versus frequency, I measured distortion in the bypass mode only. With a correction filter installed, the distortion magnitude versus frequency tended to look like the inverse of the filter function, i.e., it was lowest when the filter gain was high and consequent output was highest (and vice versa). The digital-input/digital-output mode yielded the lowest numbers: About 0.002% from 20 Hz to 2 kHz, rising slowly to about 0.0024% at 10 kHz, and reaching about 0.0039% at 20 kHz. Both channels were essentially identical in performance. For analog input/digital output, distortion was less than 0.003% from 20 Hz up to about 15 kHz and rose to about 0.008% at 20 kHz. The channels measured very closely. In both of the preceding modes, where the output is digital and the distortion is measured with the digital distortion function on my dual-domain Audio Precision System One, the measurements quoted are percentages of the output level, as in analog THD + N measurements. As mentioned previously, digital output levels are about 6 and 8 dB down from digital full scale for full input modulation; consequently, distortion as percentage of full scale, as is frequently quoted, would be correspondingly lower. The two remaining modes with analog output had a bit higher distortion of around 0.005% over the band from 20 Hz to 20 kHz.

Total harmonic distortion plus noise versus level, with a 1-kHz frequency for the two digital output modes, measured about the same at –101 dB relative to digital full scale from 20 Hz to 20 kHz. Figure 9 is a plot of this measurement for digital input/analog output, and Fig. 10 is for analog input/analog output.

Overall, the lab measurements on the AEC 1000 are pretty good. They are also comparable to the results for many good D/A converters, which generally have somewhat simpler processing circuitry.

Use and Listening Tests

My first hands-on experience with the AEC 1000 was when Jim Prescott, an engineer from SigTech, came up from Los Angeles and set up the system with me. At that time, I had Win Research SM-10 speakers set up in my system. Prescott used a microphone that he had brought with him. One fear that I had was that I would have to set up a desktop computer near my audio equipment in order to connect it to the AEC 1000. I thought it would be a pain to have it that way. Not to worry! The interconnect cable is long, 25 to 30 feet, so I could leave my computer where it normally resides. With the software loaded, we were off and running.

We first positioned the mike near where my head would be when listening and then placed it in other positions, on either side of this nominal position. Next, we analyzed these measurements, looking for the least aberrated response in terms of excessively deep nulls in the low and low-mid frequency area. Prescott thought that the nominal position was okay to use for the measurement, in view of his experience with the AEC 1000 system in various rooms. It wasn't long before the correction filters were generated and loaded and we were listening to the results.

Equipment used in the setup at that time included a Krell MD-1 CD transport and a PS Audio UltraLink D/A converter connected to a First Sound Reference II passive preamp via a 2-meter pair of Music and Sound Masterlink LP interconnects. Output of the Reference II was connected to the signal input of a Crown Macro Reference power amplifier with a 1-meter pair of Masterlink LP interconnects. The SigTech was interposed between the Krell CD transport and the PS Audio D/A converter using the SigTech's S/P DIF I/O. In the measurement mode, the analog outputs of the SigTech fed another input of the First Sound Reference II passive attenuator.

THIS SIGTECH AEC 1000 IS A VERY POWERFUL, WELL-EXECUTED, AND USEFUL PRODUCT.

Listening results at that time revealed a more natural timbre in the range from 70 to 500 Hz, and I was initially very enthusiastic about the results. After Jim Prescott's departure, I started learning how to operate the system myself and began measuring with a B & K 4133 microphone. After comparing my new measurements with the ones done with the mike Prescott had brought, I realized that the latter results began to roll off in the last octave (10 to 20 kHz) compared to those made with the B & K. Otherwise, the responses looked about the same. Prescott had installed a flat target response, a full-range filter, and a filter modified by a preset called "MINHI1." This still has a flat response criterion but stops the equalization correction above about 1 kHz. With this preset, the natural high-frequency response above 1 kHz, which was gently sloping down to 20 kHz and was surprisingly uniform, was preserved. Switching between these filters quickly showed me that the flat high-frequency response obtained with the flat target filter was a bit too bright, and the natural high-frequency response of the system without correction was more musically correct. This has been SigTech's finding in a lot of situations where the speaker response is smooth above 1 kHz. I then created a number of filters and loaded them in.

After a period of experiencing the effect of this kind of equalization, I noticed that audience applause sounded a bit more natural and less colored even though a lot of the frequencies in this sound weren't being equalized. I then started listening to the sound of the system in the bypass mode compared to the sound with the SigTech removed. Increasingly, I realized that the sound with the SigTech was subtly degraded in the areas of space, dimension, and resolution.

I recently received a pair of B & W 801 Matrix Series 3 loudspeakers, and generated a series of filters for them. I again found that applause sounded more natural with equalization. Most music sounded temporally more natural with equalization, but I again found myself listening to the system without the SigTech. It's funny how different people respond to the various aspects of a sound reality. In spite of the more natural timbre for a lot of music with the equalization, there was an important part of the sound reality that, for me, was preserved better with the equalizer not in the signal chain. This points up to me that it is obvious that "bits is not bits." The design of digital processing signal paths regarding audio signal quality is just as critical, if not more so, as in analog design.

My friend Geoff Cook, who listens very critically, came over and heard the setup at

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one point. He felt that the digital equalizer sounded better than he thought it would. We were playing a Water Lily Acoustics recording of some Indian music, and Geoff noticed a low-frequency pulsing every time the tabla was struck. Sure enough, with the equalization in, the woofers were ringing with a healthy excursion when this instrument was struck. With the equalization out, no such thing happened. I felt that it was time to take the AEC 1000 out to the lab and start formally measuring it. Before I removed the AEC 1000 from my system and took the PC-host card from my in-house computer, I wanted to independently measure the effects of the SigTech equalization with other acoustic measuring systems. With MLSSA and LMS measuring systems, I compared the acoustic response at the listening position with the SigTech equalization in and out. Results compared closely to the AEC 1000 measurements.

After making the lab tests, I reinstalled the AEC 1000 in my audio system. As a result of moving the 801s and my listening chair around and measuring the different responses with my LMS system, I had moved the 801s further back towards the wall and also moved my listening chair rearward by about 3 feet. Measuring this situation with the SigTech system and creating a set of MINHI1 correction filters, I found the bass boost required was quite a bit less than in the earlier setup with the speakers in the original positions. Again, in listening to the system with the correction filters in, the tonal balance in the midbass region was improved. However, the overall sound was noticeably less transparent and more irritating in the high frequencies.

In conclusion, the AEC 1000 is a very powerful signal processing system and a well-executed product. In recording studio environments, it is no doubt very useful. In home situations, it is sure to help get more neutral tonal results, and for many readers, that may do the trick. For my situation and listening priorities, I have mixed feelings. On one hand, it did definitely make for a more honest frequency balance in the upper bass region. On the other hand, it seemed to add some edginess and take away some resolution, space, and detail. If it did the former and not the latter, I could recommend it with full enthusiasm.

Bascom H. King

DIGITAL PHASE

continued from page 76

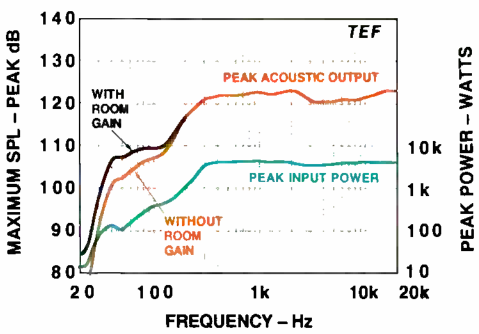

Fig. 12—Maximum peak input power and sound output.

I first listened to the AP-1s with an incredible percussion disc, *The All Star Percussion Ensemble* (Golden String & Co., GS CD005), which includes percussion versions of several well-known symphonic pieces. The AP-1s sounded quite impressive, with an open and revealing character that reproduced the percussion instruments with high realism. The percussive transients were handled very well, coming across with excellent impact and control.

I was quite impressed with the AP-1s' bass output on acoustic string bass, especially considering the size of the woofer. On jazz trio material (piano, acoustic bass, and drums) on tracks 1 and 2 of *The Wonderful Sound of Three Blind Mice* (Three Blind Mice, GS CD004), these speakers again scored very highly in realism, particularly on the piano, and reconstructed the trio soundstage very well.

The AP-1s could not keep up with the heavy bass kick drum on several tracks on *The Sheffield Track/Drum Record* (Sheffield Lab CD-14/20). They just did not have the bass wallop of the B & Ws, particularly at high levels (not many systems do). On the other hand, the AP-1s could reproduce on satisfyingly large scale most of the pipe organ material I have, even including the demanding "Pictures at an Exhibition" (Dorian DOR-90117), where the powerful pedal notes caused a minimal amount of intermodulation distortion. A number of speaker systems I have evaluated have had problems with this material.

On the stand-up/sit-down pink-noise test, the AP-1s did an excellent job. Hardly any change in tonality was evident between the two positions. Overall, the AP-1s' spectral balance on pink noise was fairly similar to that of the B & Ws but had less bass and wasn't quite as smooth. (The smoothness of the B & W speakers is legendary.)

On third-octave pink noise, the AP-1s' fundamental output at 20 and 25 Hz was not usable. However, even at fairly high input levels, the sound of the resultant distortion was not that bad, due to the low-order nature of the harmonics. Maximum output at 31.5 Hz and above *was* quite effective and could reach very usable levels.

As compared to my reference speakers, some additional upper frequency vocal harshness was evident on "Next to You, Next to Me," on *Extra Mile* by Shenandoah (Columbia CK 45490). Yet I must admit that these vocals tend a bit towards harshness anyway. As is often the case on cleanly recorded vocals, however, such as Custer LaRue with the Baltimore Consort on *The Daemon Lover* (Dorian DOR-90174), the AP-1s exhibited no harshness.

On classical orchestral material the stereo focus and soundstage reconstruction of the AP-1s were particularly good. Re-creation of mono center image was quite stable and of minimal width. (Close right/left matching is required for a narrow center image, since any dissimilarities spread the image.) Reproduction of male voice was natural and exhibited no tubbiness. These speakers could play quite loud and clean when program material required it.

All told, the AP-1s did an accurate and quite satisfying job on most of the material I threw at them. As all-around systems, they demonstrated a fine capability to bring out the best in whatever I listened to, and exhibited good bass control and extension. Bass capability, considering woofer size, was excellent. These speakers sounded quite alive, were well balanced, and delivered admirable stereo focus. Although they couldn't play at rock *concert* levels, they did do justice to live jazz combos and cathedral pipe organ. Considering their price and fine all-around performance, the Digital Phase AP-1s would be a good addition to any audiophile's system. *D. B. Keele, Jr.*

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AURICLE

SONANCE AGI-1 AND RGFI-1 ISOLATORS AND LA-1 LINE AMP

Sonance made its mark by producing top-quality in-wall loudspeakers when "in-wall" was synonymous with "P.A. sound." Since then, the company has branched out to offer a full complement of amplifiers and black boxes aimed at the custom-installation market. Since custom installation includes do-it-yourselfers, I thought I'd take a look at three of Sonance's tiny toys: The RFGI-1 r.f. ground isolator ($55), the AGI-1 audio ground isolator ($160), and the LA-1 line-level amplifier ($160). The first two aim at severing hum-inducing ground loops; the third is a variable-gain line amplifier that is useful in matching disparate source levels.

Company Address: 961 Calle Negocio, San Clemente, Cal. 92673.
For literature, circle No. 94

Ground loops are the bane of audio and audio/video systems, especially when an installation extends over many rooms. Consumer audio products almost invariably use single-ended input and output circuitry, in which the signal return path and the interconnecting cable shield are one and the same. (Professionals shun this type of hookup like the plague, but cost considerations usually outweigh best engineering practice in consumer gear!)

When widely separated components are plugged into different a.c. outlets and lashed together with lengthy feed cables, several kinds of ground loops can occur. One is the chassis-to-chassis connection through the cable shield with a return through the power line. Another is simply the multiplicity of chassis-to-chassis connections through the cables and their respective shields. These loops act like giant antennas in which circulating currents are generated by any magnetic fields that intersect the loop.

Since magnetic fields surround every wire in which current flows, they abound in the home. They're commonly generated by 60-Hz power lines but can also exist in the vicinity of a TV, where they are caused by the deflection yoke or by the electron beam in the CRT. These "hum fields" ("buzz" fields near a TV) cause current to flow in the cable shield(s) and, since the cable shield is part of the input circuit in single-ended connections, the hum is injected right into the amplifier.

The Sonance RFGI-1 r.f. ground isolator is designed to break the ground loop that might be caused by an incoming cable signal feeding your TV or VCR. It's a simple passive device with input and output "F" connectors hooked up through series capacitors chosen to have a low impedance at r.f. frequencies but a high impedance in the audio band. The high audio-band impedance reduces hum-field currents, while the low impedance in the r.f. region permits the cable signal to sail on through. If you see "hum bars"

IF YOU SEE HUM BARS ON YOUR TV, YOU MIGHT WANT TO GIVE THE RFGI-1 A TRY.

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(horizontal bars that move vertically through the picture), the RFGI-1 is worth a try. And, if audible hum disappears when you disconnect the cable feed, the RFGI-1 may solve the problem.

The AGI-1 audio ground isolator is designed to sever *audio* ground loops. It's a unity-gain active device powered by a line-plug transformer. Two ICs (one for each channel) read each input signal differentially, i.e., respond to the *difference* between the signals on the center conductor and the shield, and generate a single-ended output whose ground is not referenced to the input ground—thus breaking the loop. An AGI-1 can be useful when hum is caused by lengthy connections between a source component and a remote power amp or subwoofer, and to isolate dirty TV audio feeds from your amp. In all cases, it's best to place the AGI-1 near the final amp or powered subwoofer to minimize the cable length between it and the power amp.

BENCH TESTS CONFIRM THAT THE AGI-1 AND LA-1 ARE AS NEUTRAL AS NEUTRAL CAN BE.

The LA-1 line-level amplifier is not meant to squelch ground loops; it's designed to facilitate level matching among components. The device provides a gain of up to 15 dB and has individual screwdriver-adjusted gain controls for each channel. Since the controls are "full range," the LA-1 can be used to reduce or increase the volume. It also can come in handy if you need to run a long interconnect between a source component and your preamp. It has a low output impedance and may be more adept at driving cable capacitance than your source components are. Like the AGI-1, the LA-1 is powered by a line-plug transformer and is designed to be left on at all times. Power drain for either component is less than 7 watts.

Bench tests confirm that the two Sonance audio components are as neutral as neutral can be. Distortion at 2 V out is under 0.0015% across the audio band on the LA-1 and half that on the AGI-1. Either device can supply 6.7 V or more at clipping, and crosstalk is negligible (below −90 dB from 20 Hz to 2 kHz on the LA-1, below −110 dB over that range on the AGI-1). Even at 10 kHz, crosstalk is 70 dB down on the LA-1 and 96 dB down on the AGI-1.

LA-1 response is within +0.0 dB, −0.15 dB from 20 Hz to 50 kHz; AGI-1 response is within +0.0 dB, −0.11 dB from below 10 Hz up to 100 kHz. A-weighted noise clocks in at −94 dB re: 0.5 V (−116.5 dB re: clipping) on the LA-1 and −100.2 dB re: 0.5 V (−117 dB re: clipping) on the AGI-1. AGI-1 voltage gain is −0.05 dB (which is mighty close to unity) and perfectly balanced between the channels. With level controls fully advanced, LA-1 gain is 15.5 dB and balanced within 0.03 dB. (Setting those controls at lower levels and maintaining channel balance could get dicey.) Both have low output impedance (470 ohms) and adequate input impedance (31 kilohms on the LA-1, 40 kilohms on the AGI-1).

If the hummies and buzzies plague you, give a look to these Sonance toys. They may fix the problem and won't cause sound pollution of their own. *Edward J. Foster*

CAIG PRO GOLD CONTACT CONDITIONER

I am an engineer at a sound-recording studio in Southern California; we also install high-end car audio, home audio, and home automation equipment. I am responsible for maintaining all audio/video and communication equipment, and I find that many customers, as well as engineers, frequently seem confused about just what to do with high-performance connectors.

Company Address: 16744 West Bernardo Dr., San Diego, Cal. 92127; phone, (619) 451-1799; FAX, (619) 451-2799.
For literature, circle No. 95

As technology has improved over the years, more demand has been placed on all interconnecting cables and connectors. With cables costing as much as $300, it is extremely important to keep connectors clean and protected from the atmosphere.

Most high-end equipment and cable connectors are gold-plated. One of the reasons for gold-plating is to provide the best signal transmission and to help prevent oxidation and contamination buildup on the surfaces. As some people know, even gold-plated connectors are subject to wear, abrasion, and atmospheric contamination. What many people don't know, however, is that once the gold-plated surface is broken, the base metal (usually copper) is immediately subject to oxidation.

Many companies manufacture contact cleaners, lubricants, enhancers, protectors, etc. Having tried virtually all of them, I can recommend only two options. One is to clean every connection every few weeks with a solvent such as trichlorethane or petroleum naphtha. (Freon TF was once the best solvent, but it is very costly due to tight manufacturing restrictions, and these days one must consider its destructive effects on the ozone layer.)

The second option is to use a product called ProGold, by CAIG Laboratories, the people who have supplied us with Cramolin for many years. According to the manufacturer, ProGold is one of their next-generation products. They state that it not only cleans, protects, and conditions the connector's outer surface (gold-plated, nickel, or silver) but also molecularly bonds and seals the base metals that cause most of the problems.

I have noticed that after a period of time even gold-plated surfaces get dull or tarnish and that when the surface is scratched or worn the base metals become exposed. Also, since gold is very porous, the base metals can actually whisker through the gold and then oxidize.

In my own experiments with ProGold, I found that even after six months the surfaces were still clean. Evidently CAIG has done their homework. Two major problems with the other enhancers and lubricants are that they don't perform well on different metals or don't reduce (or prevent) r.f. interference due to different metals coming together in a connection. ProGold seems to take care of both.

Anyone spending money on audio, video, and other high-performance equipment should definitely test a sample of ProGold. In my view, the added insurance is well worth a few dollars. *J. D. Stein*

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Hyper-(hi´pər) [[<Gr *hyper*]] *prefix* over, above, beyond, surpassing

Balance(d) (bal´əns) [[<LL *bilanx*]]

1 general harmony between the parts of anything, springing from the observance of just proportion and relationship; esp. in the Arts of Design
2 stability or steadiness due to the equilibrium prevailing between all the forces of any system

Hyper-Balanced cables are also available in full-balanced configuration (with XLR connectors).

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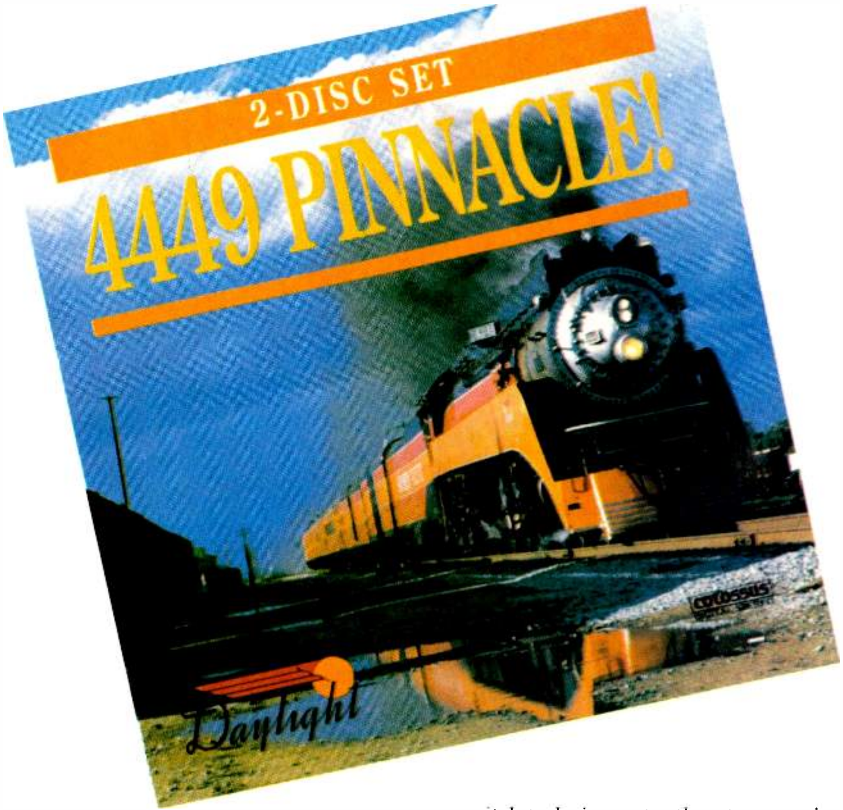

4449 Pinnacle!
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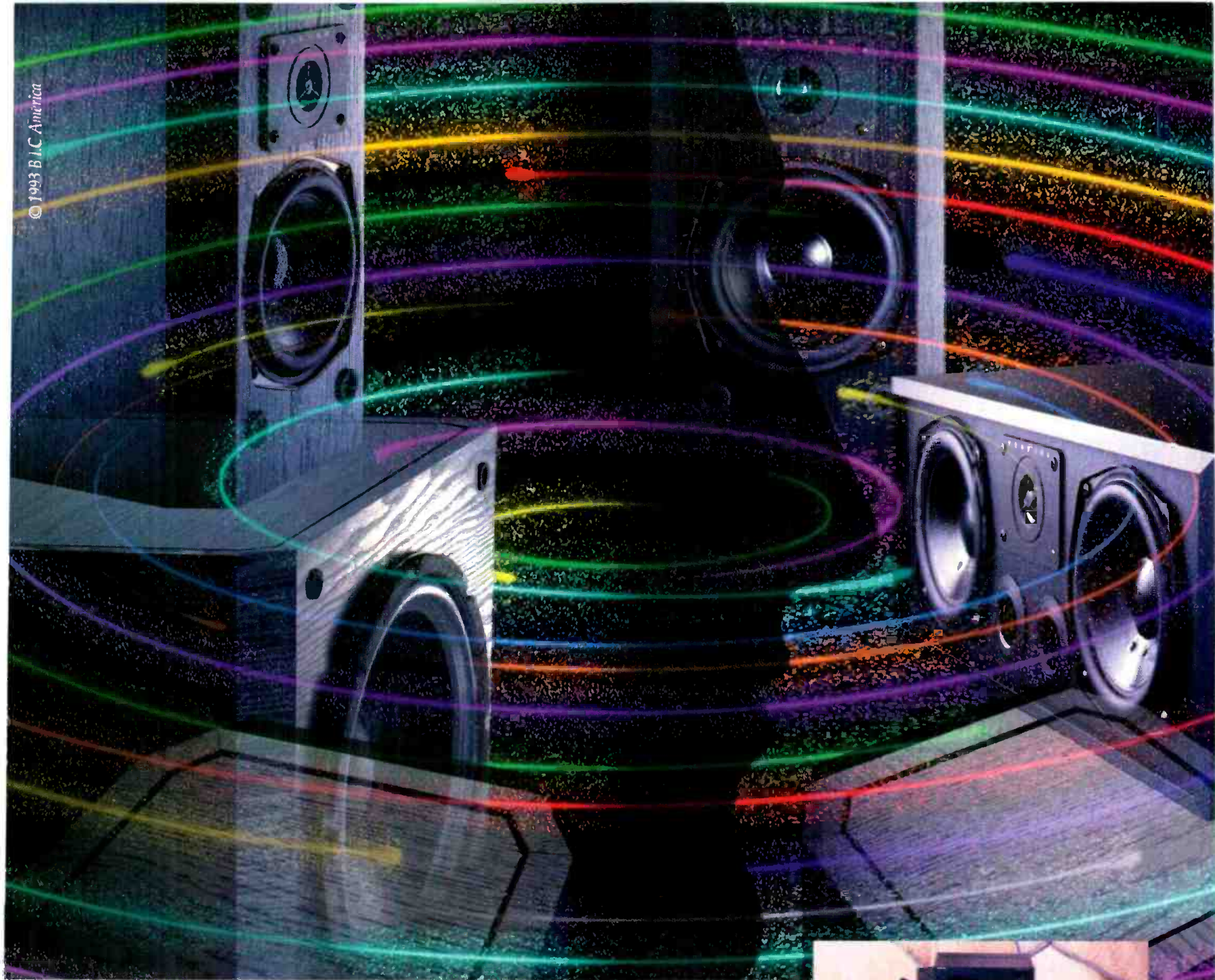
Classical? By every parameter, yes. *Music?* By all sorts of standards, also yes! By now, at least in the U.S.A., the sounds and the sights of steam railroading are entirely in the artistic mode, even when money is made from ticket sales, precisely like the occasional cash that live classical music brings in.

Brad Miller, a latter-day rail recording enthusiast in the tradition of that pioneer O. Winston Link, has applied a full range of advanced digital techniques to the steam train, where Link, in the '50s, was the first to use mono magnetic tape to its most imaginative extent for the same end: The sound of steam engines in your living room. An outlandish, purely arty idea! Trains were not designed for living rooms, nor was most of the music we call classical. Yet there they are, both of them, thanks to an appeal that proved far wider than the mere practicality of their original forms.

I haven't touched all the Miller train CDs, for good reason: We would need another magazine to cover such things along with our "regular" music. I took on this set with some apprehension because as an art, the sound of steam is very tricky to work with for true dramatic effect on disc. Far too many such recordings are no more than a monotonous series of dismally short excerpts all sounding more or less alike, even with profuse notes as to technical details. Link, working in mono (occasionally stereo in his later work), had a real genius for setting the scene—creating moods, country sounds, background—in which his trains were heard to magical effect. Not even Miller, with all the latest, has yet to match him. But I hear real signs of a Link heritage, even if it may be by chance. These recordings exploit the marvelous silence of the CD, the impact of tiny sounds against a velvety nothing, and in contrast the enormous rhythmic pounding of a mighty locomotive going all-out at high speed. Mono, stereo, surround in all its forms, the task of production is basically the same—an artistic, synthetic construction that does not so much re-create the steam mystique as enhance it in new aesthetic ways. Exactly like the recording of an opera! In both, the basic sound is live, the finished product highly edited.

I loved, for instance, the long opening cut on the first disc here, almost eight minutes. Nothing. *Almost* nothing. (I knew better than to turn up the volume!) Little sounds of high pressure, breathing, small hisses, clanks. You slowly realize that it is a vast engine, the fabulous 4449 of the Southern Pacific (SP) just standing there next to you, steamed up, getting ready to go. Such a fine suggestion of latent power! This is classical drama, any way you listen.

ANY WAY YOU LISTEN, THE 4449 PRESENTATION IS CLASSICAL DRAMA.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Miller's edited excerpts are mostly short, but they lead easily one to another, some 28 on the two discs. His annotations are interesting, including specific places, titles, dates, and times for those who want the details, and perhaps equally important, a frank account of the exact editing procedures that hook different occasions together, even more than one train at a time. Excellent. And the long, final high-power haul at full speed, before entering Salem, Ore. on the SP main line, is quite awesome. Other engines and trains are involved, for variety, but you quickly get to recognize the 4449, the bright orange and black streamlined train that has been displayed in many parts of the country, by the characteristic low-pitched steam whistle, a major triad, and by its peculiar *one*-two-three-four chuff. (Oddly, the engine also has a diesel-style air horn, probably because younger Americans don't recognize the steam-whistle warning but react to the diesel blast!)

Technical details include the use of the Colossus recording system and much, much more. But what matters is the artistic quality of the presentation and the expert, ultra-smooth editing and pacing. Without that, Colossus would be less than colossal.

Edward Tatnall Canby

Classiks on Toys: The Enchanting Sound of Toys
Symfunny Orchestra, Robert Lafond
ATMA ATM 2 9706

This CD from Quebec is a must-have for those seeking a change of pace in the Christmas music avalanche—and especially if you have children in your house. It's a great disc to inveigle children into the classics!

Clever, delightful, often lovely versions of 15 of the expected classical themes are arranged by Robert Lafond and played with high musicianship on toy recorders, xylophones, trumpet, plastic guitar, piano, and harmonica, among others. The entire toybox of instruments runs up a bill of $229.65 Canadian. There's also a *Jazz Classiks on Toys* from the same sources.

John Sunier

Prokofiev: Alexander Nevsky Cantata, Op. 78; Lieutenant Kijé Suite, Op. 60
Janis Taylor, mezzo-soprano; Milwaukee Symphony Orchestra and Chorus; Zdenek Macal, conductor; Margaret Hawkins, choral director
KOSS CLASSICS KC-1016
CD; DDD; 59:40

A rare conjunction of audio manufacturing and record producing, under one corporate entity! (Not counting, of course, the biggie labels, who do everything.) Anybody who reads *Audio* knows Koss headphones, the business founded in 1958, the first "stereo" 'phones for wide consumer use. (Permoflux 'phones in 1952 or so made an earlier beginning before there were stereo discs or cassettes.) Anyone who knows human nature is aware that the most commercially adept fathers often produce the most aesthetic sons, absorbed in the ways of Great Art rather than prosaic business! Here, the phenomenon produced an integral division of Koss, Koss Classics, run in the most altruistic and high-minded way by John C. Koss' son, Michael J. Koss, all within the company. And that's a good thing. Meanwhile, Koss 'phones just continue right on. There's even a full-page plug for them included in the CD booklet.

The artistic branch of Koss has taken on one of the newest of our traditional-type symphony orchestras, the Milwaukee, as its centerpiece for recording, though it also plays elsewhere. This is a Milwaukee production of the two well-known Prokofiev works, both originally composed as film music, adapted (for good reason) as "classical" independent works. The earlier, "Lieutenant Kijé," has a preposterous plot concerning an officer who never existed and the necessity to kill him off. It is full of delightful tunes and twisty harmony and counterpoint; I "fell" for the little trumpet tune way back and never forgot it. As for "Nevsky," almost every big college or local chorus/chorale now sings this work with joy and appreciation. Indeed, from the early times of film with music, "Nevsky" showed what music tied directly to pictures could *really* be like. It has been an all-too-infrequent inspiration ever since, ignored by 90% of today's film industry, so far as I can see.

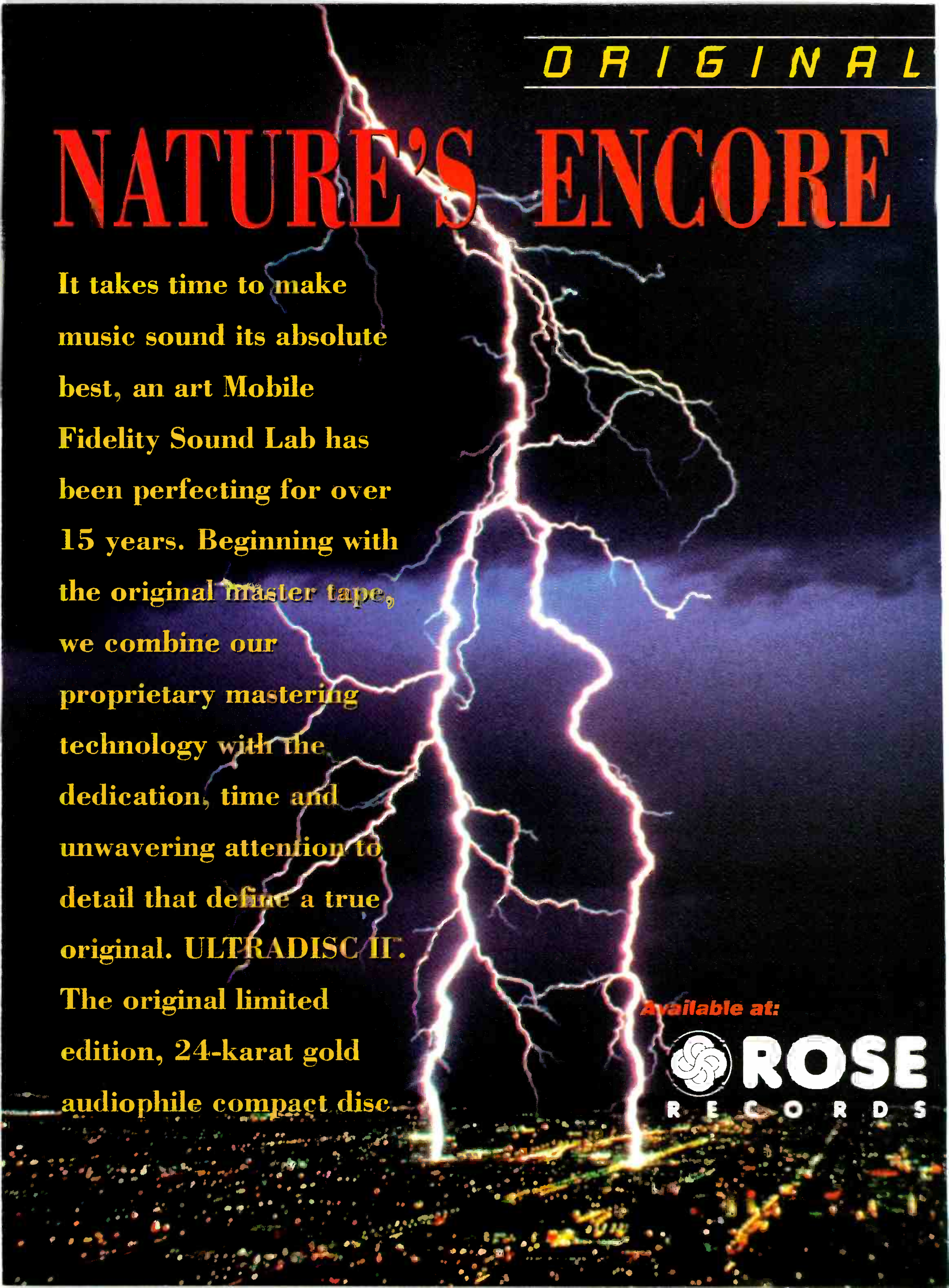
Why? They aren't musically interested. The Russian producer Sergeii Eisenstein, one of the greats, *was* interested, and I must quote, for readers in or near film/video production, these Eisenstein words about Prokofiev:

> Prokoviev works like a clock. This clock neither gains nor loses. At night we look at the new sequence of film, by morning the new sequence of music will be ready for it. My mind is always easy because I know that exactly at 11:55 a.m., a small blue automobile will come through the gates of the film studio.... I could not understand how, after looking at a sequence no more than two or three times, he managed to catch the emotional spirit, the rhythm and structure of the scene so as to be able to produce its exact musical equivalent the very next day....

This, friends, is how *all* movies and videos should work, in a wonderful ideal world, Hollywood included!

The large-scale Milwaukee performance is sincere and a bit naive sounding, as though the score were unfamiliar and the (mild) dissonances startling. Well, maybe that's the way things are at the Milwaukee. But it is also fresh and full of goodwill, both orchestra under its Czech conductor and chorus. The mezzo-soprano soloist is at stage distance and at low volume, good technique for today but not too well projected even so. No great fault, and *much* better than too close and too loud.

Edward Tatnall Canby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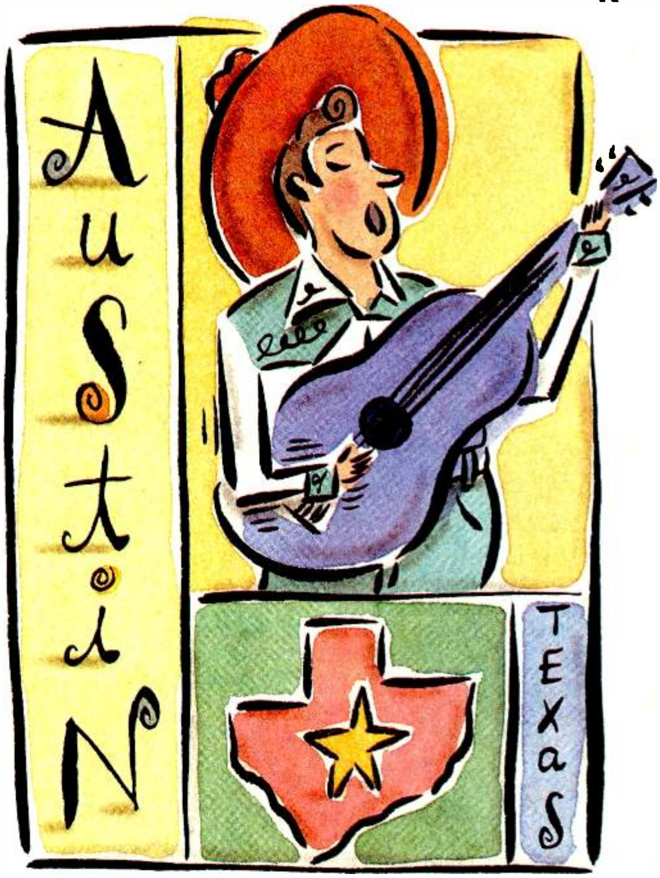

LONE STAR STATEMENTS

VARIOUS ARTISTS

Broken Spell
David Halley
DOS RECORDS 7003
CD; 43:57
Sound: A–, Performance: A

Love & Trust
Michael Fracasso
DEJADISC DJD 3205
CD; 47:30
Sound: A–, Performance: A

What It Is
Stephen Bruton
DOS RECORDS 7002
CD; 43:10
Sound: A–, Performance: B

Maybe it's something in the water. Maybe it's the lack of heavy industry that keeps the air clean. Whatever it is, the constant stream of great songwriters gravitating to and emanating from Texas' capital city is astonishing, and it's nothing new. Austin has given us Townes Van Zandt, Jerry Jeff Walker, Willie Nelson, Nanci Griffith, Joe Ely, Tish Hinojosa, Lucinda Williams, Guy Clark, Lyle Lovett, and Jimmie and Stevie Ray Vaughan, to name just a few. And the tradition continues with David Halley, Michael Fracasso, and Stephen Bruton.

David Halley recorded an album in 1990, but not for release in the States. Only England's Demon Records would issue the superb *Stray Dog Talk*, although Dos Records will reissue it in upcoming months. Thus, *Broken Spell* could be considered his American debut. Halley has multiple strengths. He's a fabulous, dexterous guitarist and an emotional singer. As a tunesmith, he has a gift for constructing sturdy and lilting melodies, and as a poet, a knack for compelling and pointed lyrics. The songs here are most often about crises of faith, tellingly related. "Bill W." is as good a song about the homeless as I've heard. "Man of Steel," about just what makes up a hero and just what is heroic anyway, is largely built on extended rhymes with the word "steel." The album's sequence is deft, with peaks and valleys, and it is exquisitely performed. Strongly recommended.

So is Michael Fracasso's *Love & Trust*. His voice has a high, lonesome tenor that hooked me quick. From the Hollies-esque opener "Thing About You" and continuing throughout, Fracasso's confidence is unmistakable. He populates his songs with people you get to know well in four minutes—like the

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poor henpecked husband in "Wake Up! George," the restless girl who was "One That Got Away," or the loser-in-the-country on the weeper "Door #1," sung with Lucinda Williams. With excellent performances and production by Mark Hallman, Fracasso presents his songs convincingly.

Others have recorded Stephen Bruton's songs, most recently "Getting Over You," performed as a duet by Willie Nelson and Bonnie Raitt on Nelson's *Across the Borderline*. Bruton produced Alejandro Escovedo's exquisite 1992 album, *Gravity*, and played lead guitar in Raitt's band. Bruton's own album is good but not great, limited mostly by his scratchy voice and delivery. While he's best suited to rockers like "This Train Is Gone" and "The Face of Love" (which features Lou Ann Barton's vocals), he acquits himself on his duet with Raitt, "Too Many Memories." The album's strengths are Bruton's songs and friendly, ingenuous manner as well as his fine guitar work. Others may do his songs better, but I can't help liking Stephen Bruton's debut quite a lot. (Dos Records, 500 San Marcos, Suite 200, Austin, Tex. 78702; DejaDisc, 537 Lindsey St., San Marcos, Tex. 78666.) *Michael Tearson*

The Voice
Mavis Staples
PAISLEY PARK 9 26049-2

Mavis Staples brings a lot to the party, but this one belongs to Prince, since he wrote most of the songs here and, as executive producer, oversaw *The Voice*'s creation while delegating "production" duties to proxy holders like Ricky Peterson. The reason why this album works far better than others where Prince impresses his usual ingenues with his singular vision is that Mavis has such a strong musical and personal identity; Prince cannot simply supply one of his outtakes and stamp her voice on it. Prince is writing *for* Mavis and, having worked with her previously, has a greater understanding of her immense capabilities. That's the up side.

The down side is that there is no "Respect Yourself" or "I'll Take You There" or even "Let's Do It Again." For all Prince may be, he isn't Curtis Mayfield or Mack Rice. But because he has such a large following, perhaps more people will be exposed to Mavis Staples' awesome talent, and that's a good thing.

Jon & Sally Tiven

This Is How It Feels
The Golden Palominos
RESTLESS 7 72735-2

Through their varied incarnations, Anton Fier's Golden Palominos have remained an ambitious musical think-tank. Their latest entry, *This Is How It Feels*, draws on the previous GP talents of Bootsy Collins (guitar) and

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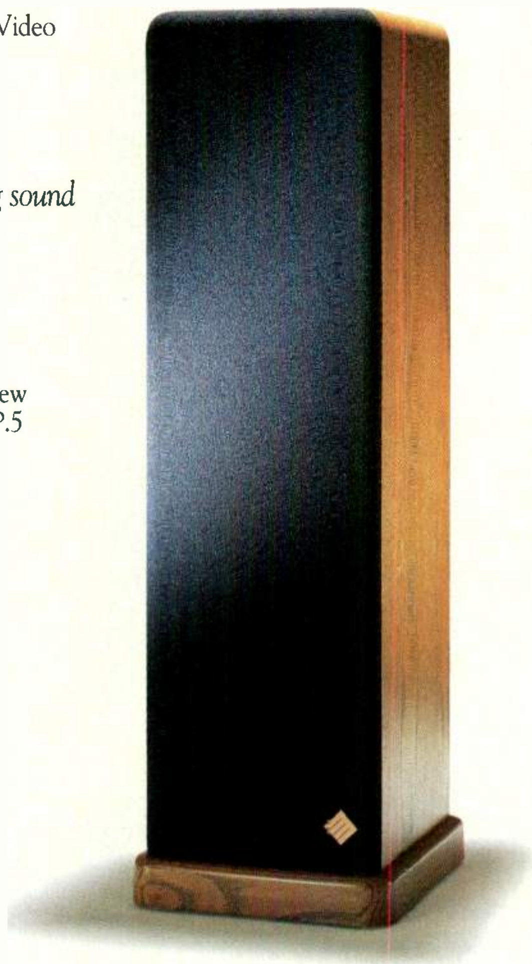

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Bernie Worrell (organ), newcomers Lori Carson and Lydia Kavanagh (vocals), and Fier's own driven percussion. The opening track, "Sleepwalk," sets the amorphous funk-dub mood for the rest of the disc. Carson's often breathy vocals on the title track, "I'm Not Sorry," and "The Wonder" are sensuously revealing. Unfortunately, the bulk of *This Is How It Feels,* with its pseudo-funk jams featuring Bill Laswell's gutless basslines and Matt Stein's various loops and effects, comes off sounding assembled on a production line by surgeons.

Tom Ferguson

From Nashville to Memphis: The Essential 60's Masters, Volume I
Elvis Presley
RCA 66160-2

The difference between thin Elvis, king of rock 'n' roll, and fat Elvis, king of Las Vegas, is the years 1960 to 1970. See Elvis get hip with sideburns, turquoise jewelry, sequin jackets, and a George Jones "hairdon't." Hear Elvis kick off the decade with rock ("Little Sister") and knock it off with schlock ("Suspicious Minds"). Don't buy this four-disc box until you've fully appreciated the music of thin Elvis, though you might buy it for shock value.

Mike Bieber

The Familiar
Roger Eno with Kate St. John
GYROSCOPE/CAROLINE CAROL 6601-2

After the spritely gallop of "Our Man in Havana," which opens the album, *The Familiar* settles into a verdant, calming breed of music. Kate St. John, formerly of Dream Academy, blends her oboe and *cor anglais* and, on several tracks, her lyrics and ethereal voice with Roger Eno's piano to make an album of lovely music. String quartets, clarinets, and guitars occasionally flesh out Eno's ideas, and Bill Nelson's production couldn't be more tasteful. In harried times, of which I've had plenty of late, *The Familiar* is an island of sanity.

Michael Tearson

FAST TRACKS

Buffalo Skinners: *Big Country* (Fox/RCA 66294-2). On *Buffalo Skinners,* a far cry from this Scottish quartet's impassioned and charmed Celtic rock beginnings, singer/leader Stuart Adamson writes and sounds as if he's digested too many AOR radio formulas. Mark Brzezicki's thunderous drumming and Tony Butler's agile bass work can't save this disappointing and trite formula rock. **T.F.**

Just Another Band from East L.A.: *Los Lobos* (Slash 9-45367-2). Titled as if talent like theirs is readily available for the Swifty Lazars of the world, this two-disc compilation affirms that Los Lobos is in reality the best band to emerge from Tinseltown in 25 years. A nice tribute, and a great introduction for those who have only heard "La Bamba." The accompanying book illuminates their Mexicali heritage and L.A. cowpunk subculture. **M.B.**

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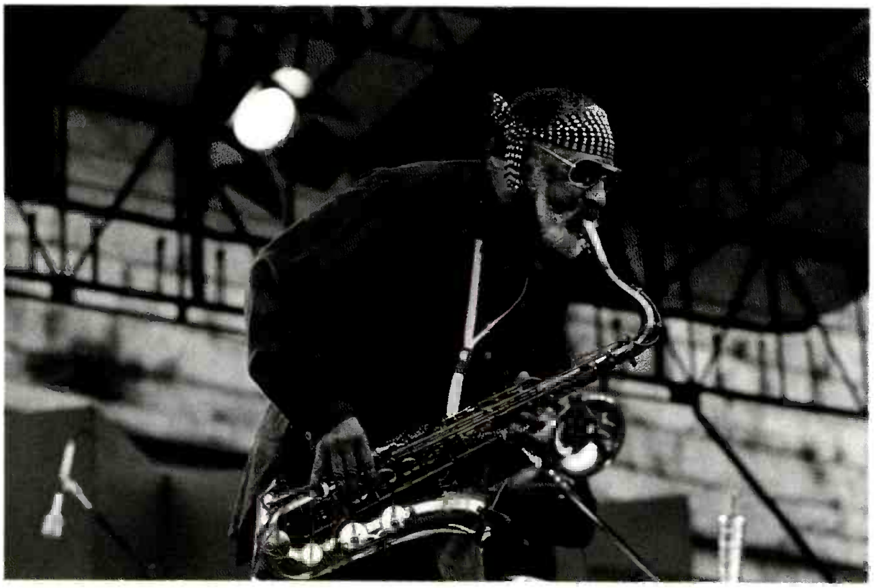
WISH
JOSHUA REDMAN

OLD FLAMES
SONNY ROLLINS



Wish
Joshua Redman
WARNER BROS. 9 45365-2
CD; 61:45
Sound: A, Performance: B+

Old Flames
Sonny Rollins
MILESTONE MCD-9215-2
CD; 55:17
Sound: A–, Performance: A

Tenor saxophonist Sonny Rollins' legendary status is due to more than just his sound (monstrous power one moment, tender intimacy the next) and his improvisational skills (dancing in and out of song structures with utter authority). His renown stems also from a constant renewal, a relentless process of moving on. Whether it has meant time off (Rollins has taken notable sabbaticals), experimentation (performing in a piano-less trio or with the likes of Don Cherry), or defiance (his insistence on employing electric bass despite criticism), Rollins has remained his own man.

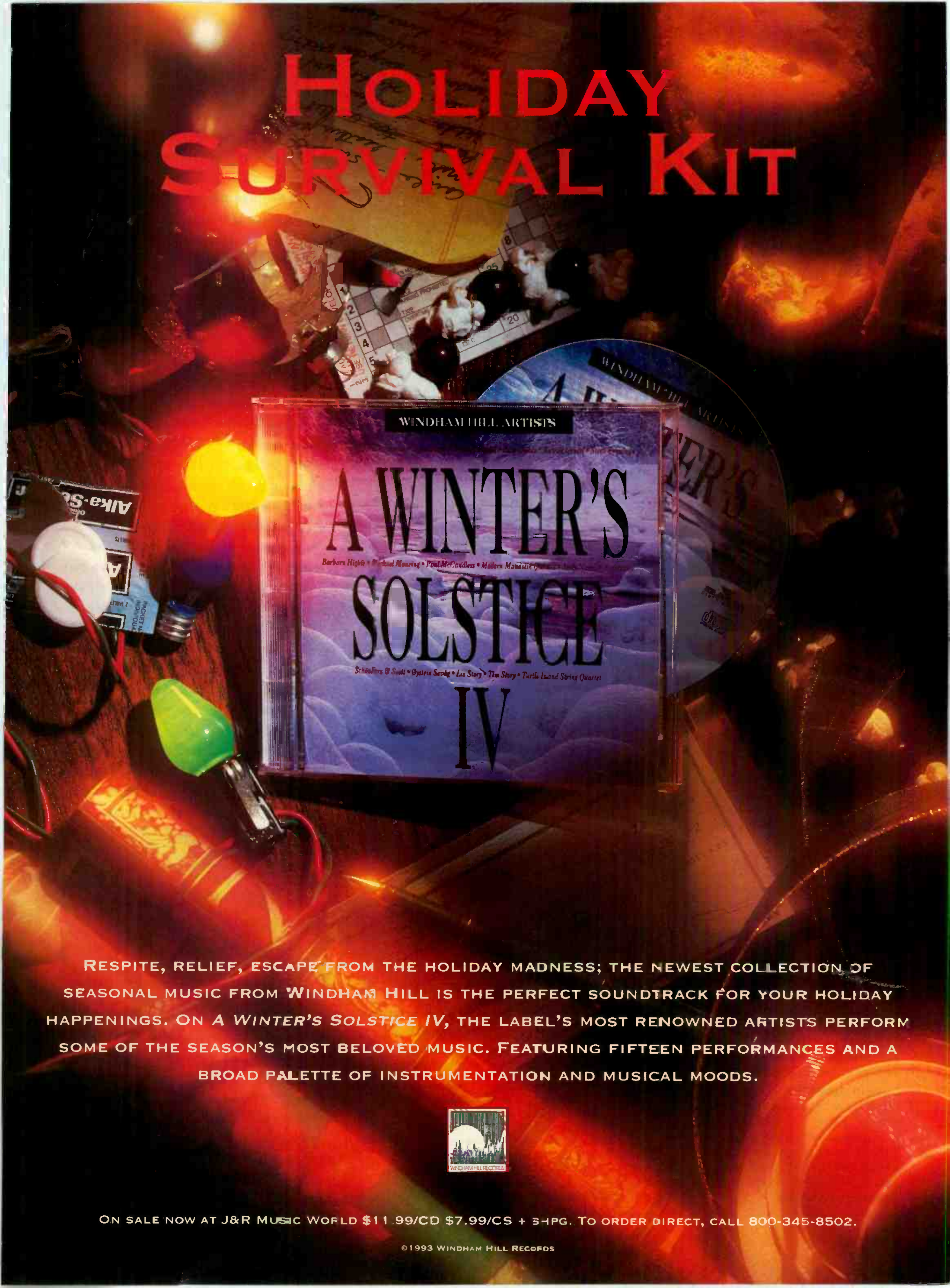
On his latest Milestone release, *Old Flames,* Rollins revisits familiar musical territory. With pianist Tommy Flanagan, bassist Bob Cranshaw (a longtime Rollins associate), and drummer Jack DeJohnette setting an elegant pace, and with trombonist Clifton Anderson's flattering harmonies, Rollins tosses the melodies around in thoughtful, carefree style, taking his characteristic liberties with each.

For "Darn That Dream," which opens the disc, and Ellington's "Prelude to a Kiss," the album's closer, Rollins is framed exquisitely by a brass choir of Anderson, the flugelhorns of Jon Faddis and Byron Stripling, Alex Brofsky's French horn, and Bob Stewart's tuba, conducted and arranged by Jimmy Heath. Heath creates dense, intricate harmonies that at times seem to anticipate Rollins' own harmonic ventures. Rollins' irrepressible spirit comes across most forcefully, perhaps, on the lone original composition, "Times Slimes"; its simple, descending theme leads Rollins into a deep well of improvisation.

Rollins embraces the familiar without stepping back in time; his innovations are rooted in a sense of the here and now that can only result from a lifetime of experience.

The hype Joshua Redman has received could all too easily have swal-

Photographs: ©David Gahr



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lowed his sound. The distractions are many: There's the family name (see: Redman, Dewey), there's the fascinating bio (Joshua earned honors at Harvard and acceptance at several Ivy League law schools), and there's the "young lion" cross to bear (see: Marsalis et al.).

But Redman appears able to sidestep any such self-consciousness. His references to Dewey Redman are no more—or less—obvious than those to Sonny Rollins or Gene Ammons. He plays the saxophone by choice; it was not forced upon him, and his career began largely as a year off before law school.

Evidence that Joshua Redman is now on the right career track can be found in his sound. Smooth and assured, it allows him to drop references and to project an emotional honesty far beyond his years. On *Wish*, Redman's follow-up to last year's stunning debut, these qualities make for a seamless mixture of familiar compositions, originals, and thoughtful reinterpretations. Only a cover of Eric Clapton's "Tears in Heaven" (an obvious nod to radio programmers) seems out of place. Otherwise, Redman moves from Ornette Coleman's "Turnaround" through his own "Soul Dance" to a cover of Stevie Wonder's "Make Sure You're Sure" with a confident seamlessness. No doubt that's based on the tight weave provided by his stellar quartetmates, guitarist Pat Metheny, bassist Charlie Haden, and drummer Billy Higgins. They free Redman to explore harmonic detours, with Metheny doubling figures and biting off solos here and there.

REDMAN'S STUDIO SESSIONS BARELY HINT AT HIS POWERFUL LIVE IMPROVISATIONS.

The two live tracks that close the album—recorded at the Village Vanguard—reveal what is perhaps most impressive and most promising about Redman. However well played, thoughtfully conceived, and sonically polished these first two albums are, they barely hint at the powerful flights of improvisation Joshua Redman routinely takes live. *Larry Blumenfeld*

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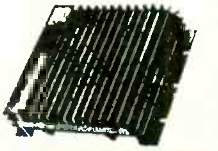

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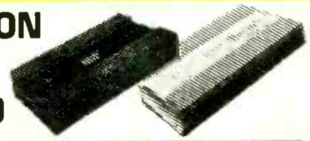

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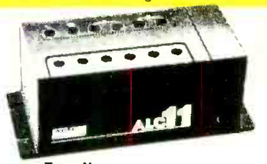

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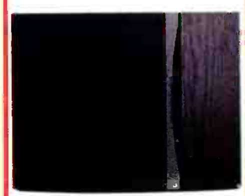

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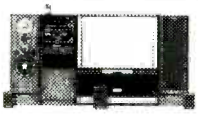

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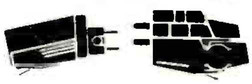

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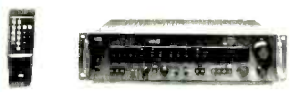

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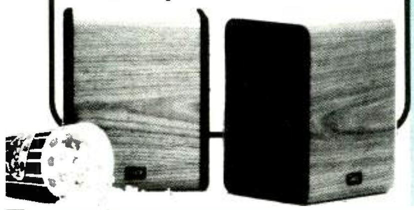

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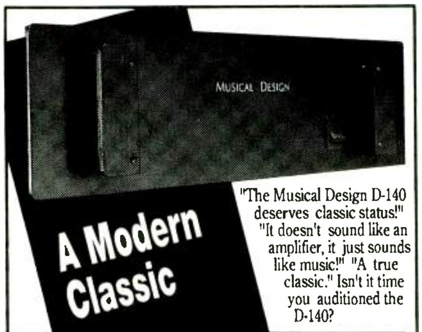

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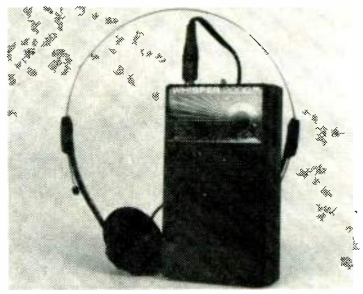

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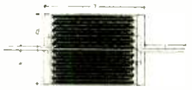

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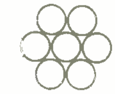

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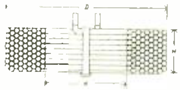

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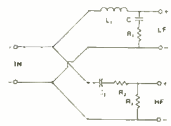

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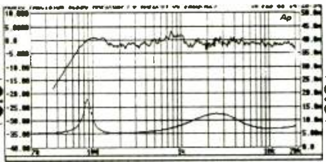

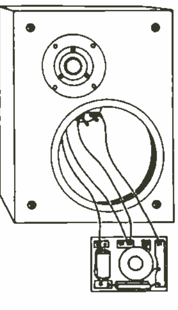

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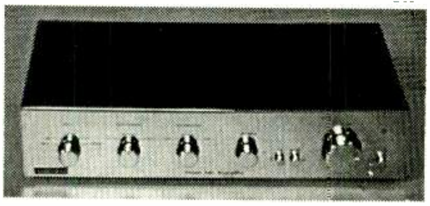

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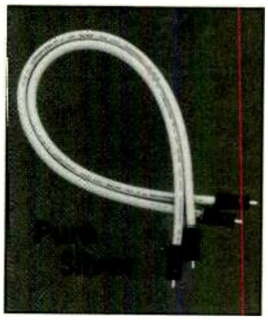

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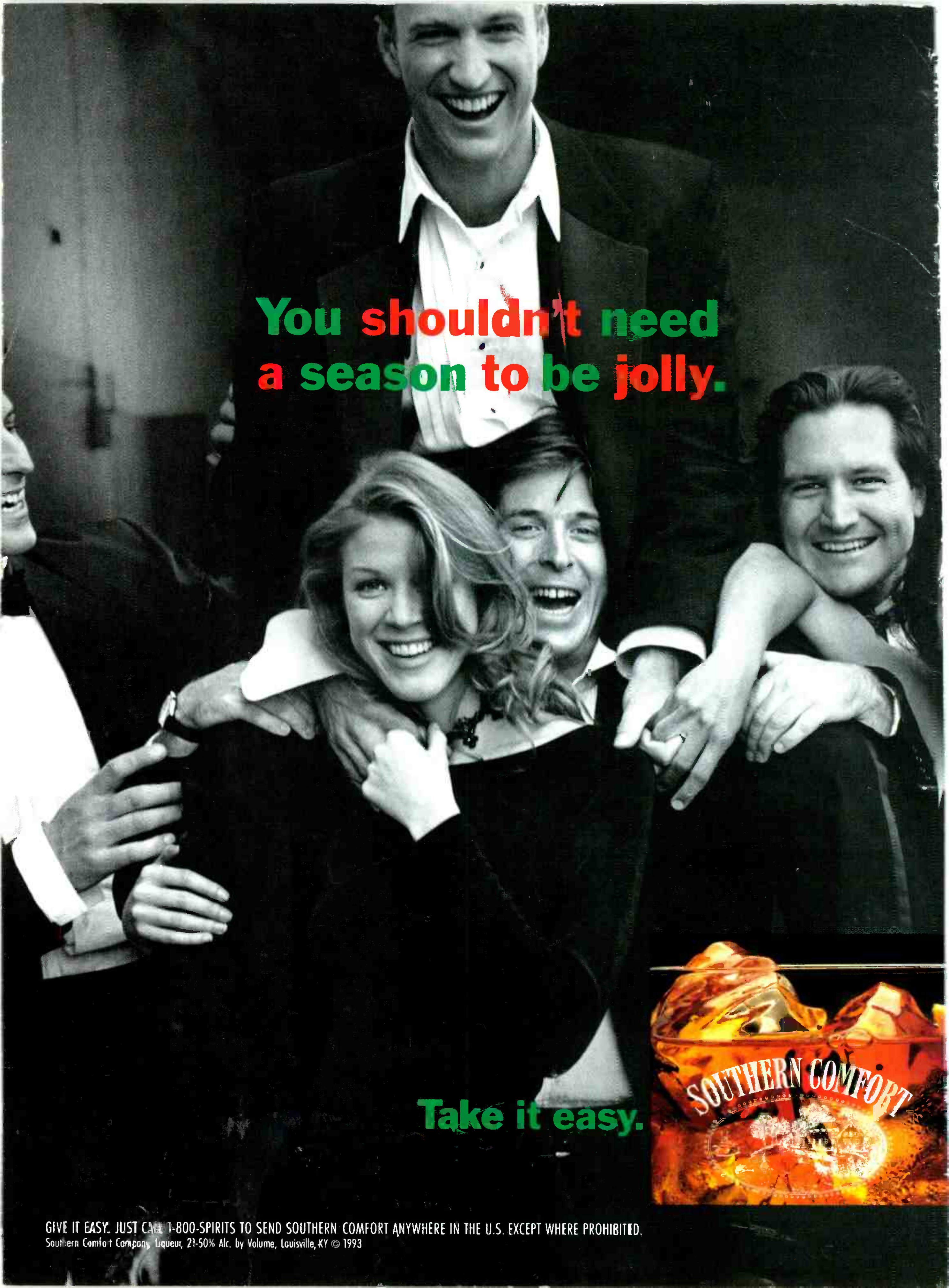

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