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INTERVIEW: THE MAN BEHIND MOTOWN'S SOUND

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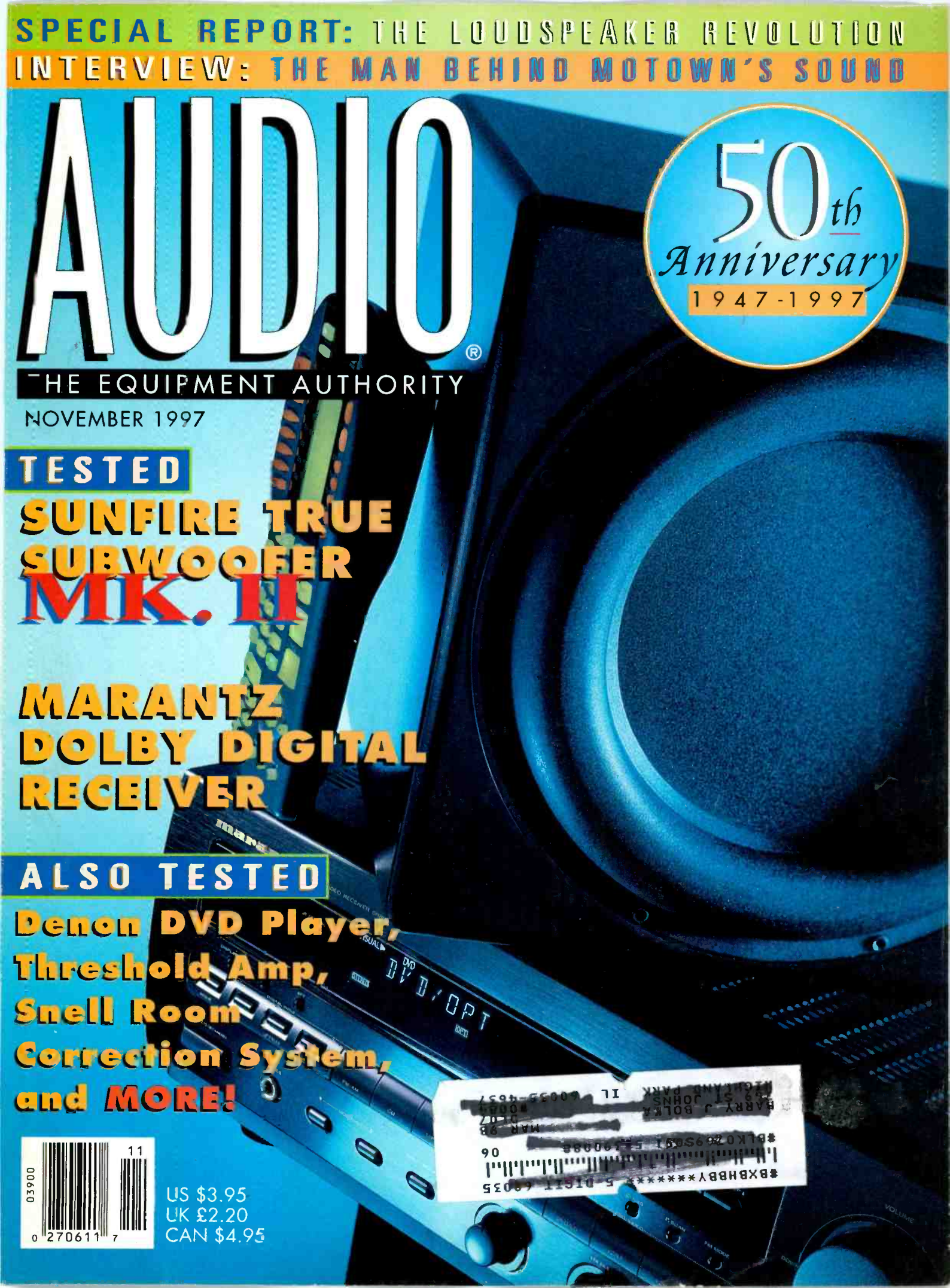

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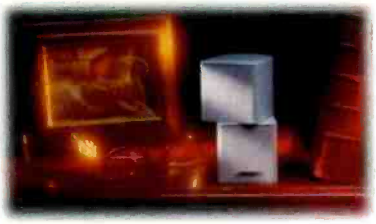

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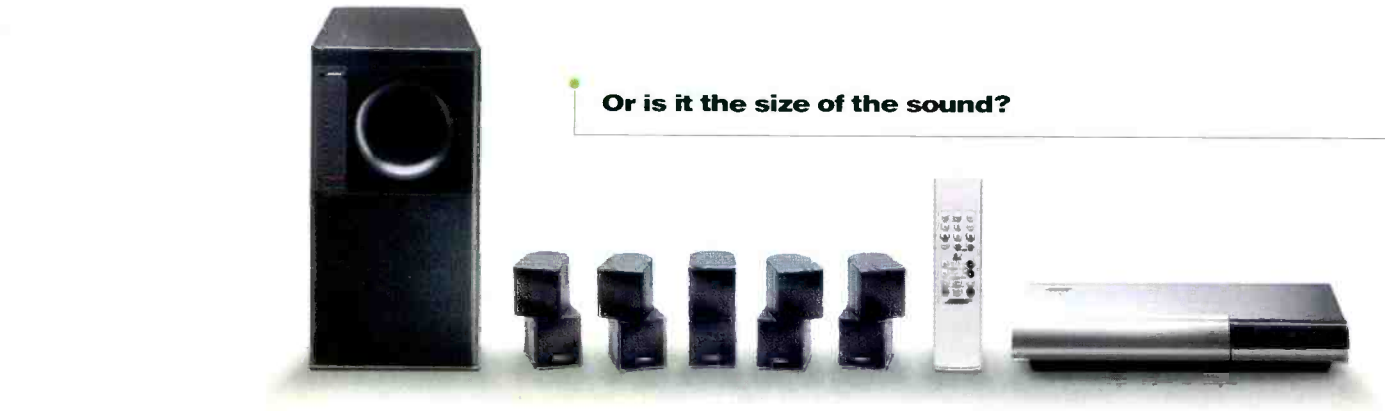

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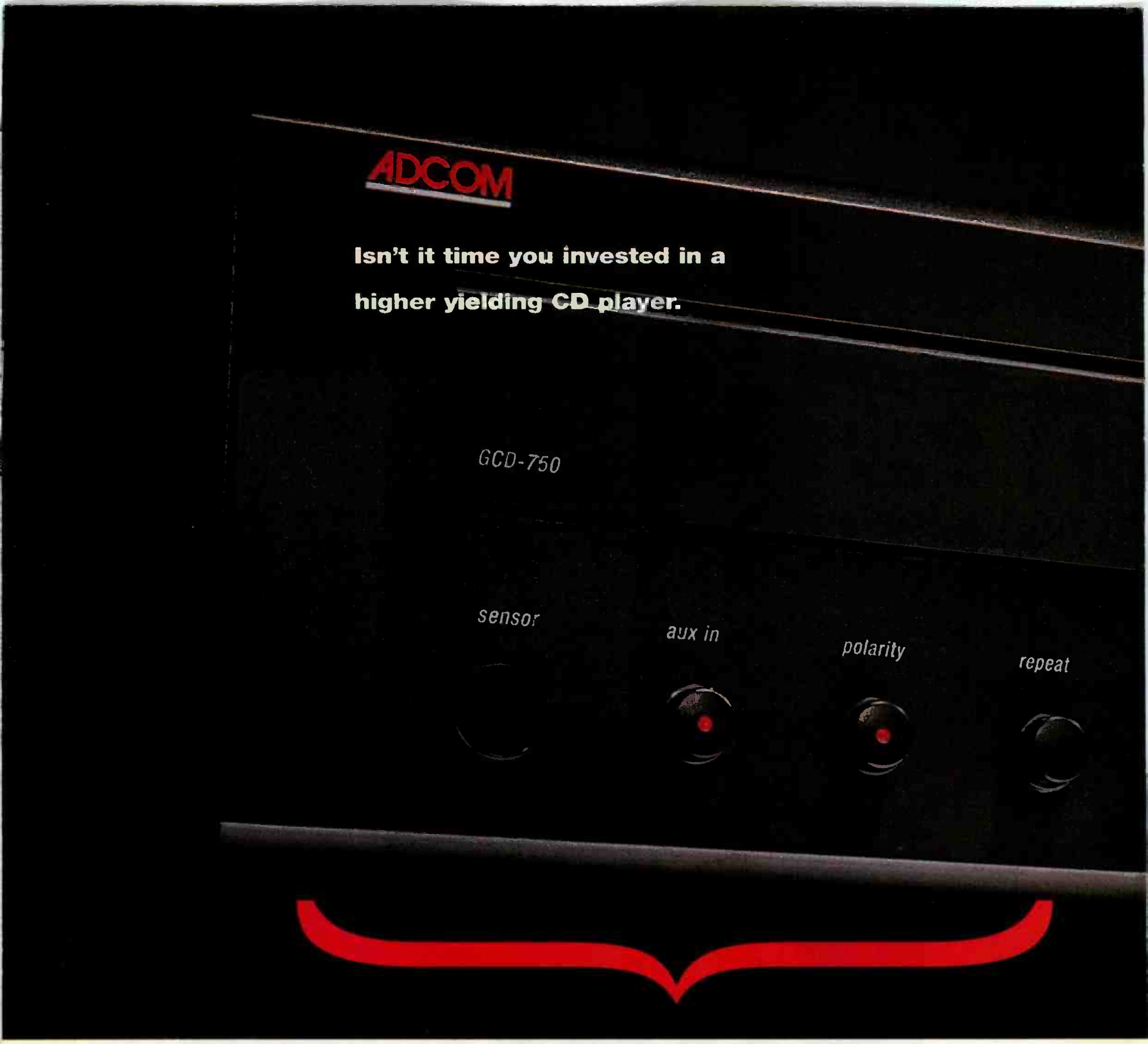

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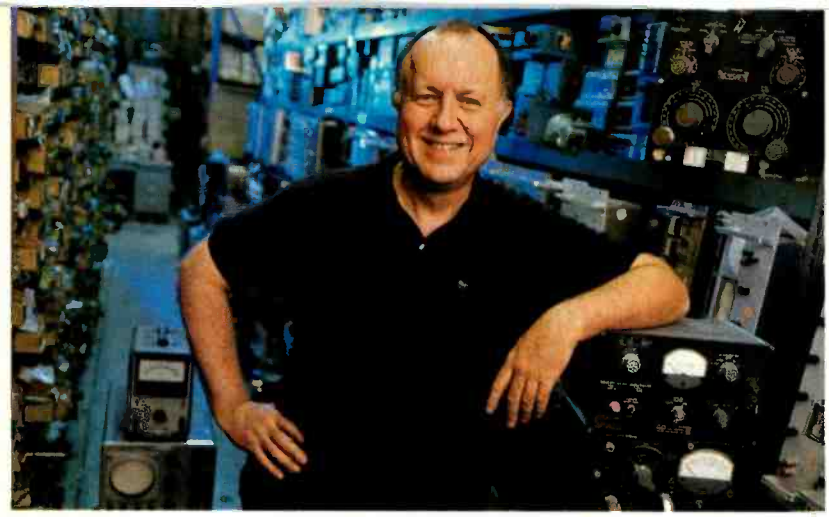

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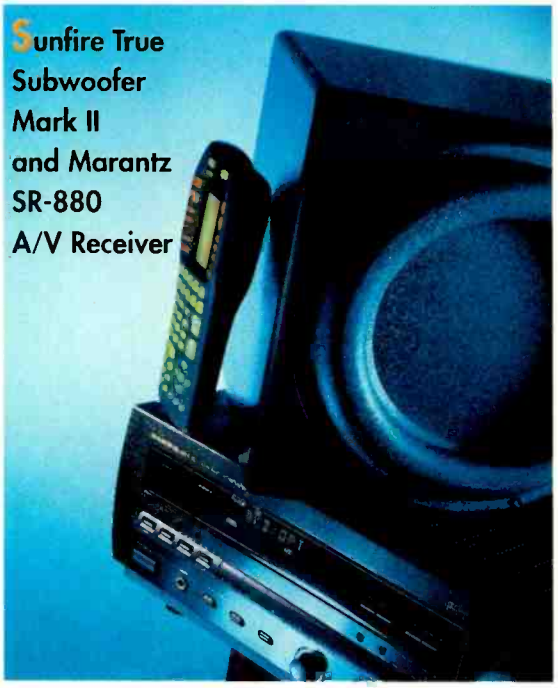

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RECORDINGS

Cover Photographer: Bill Kouirinis Studio
Cover Equipment: Sunfire True Subwoofer Mark II powered subwoofer and Marantz SR-880 A/V receiver

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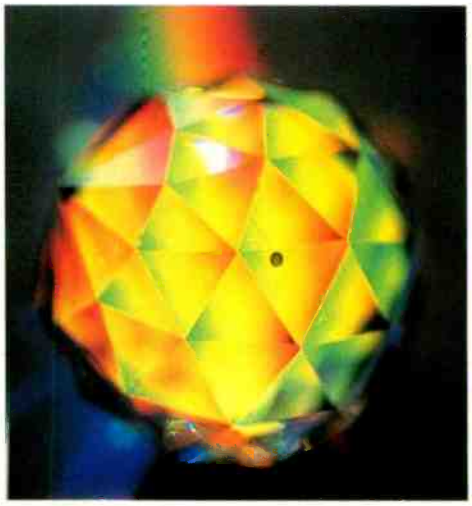

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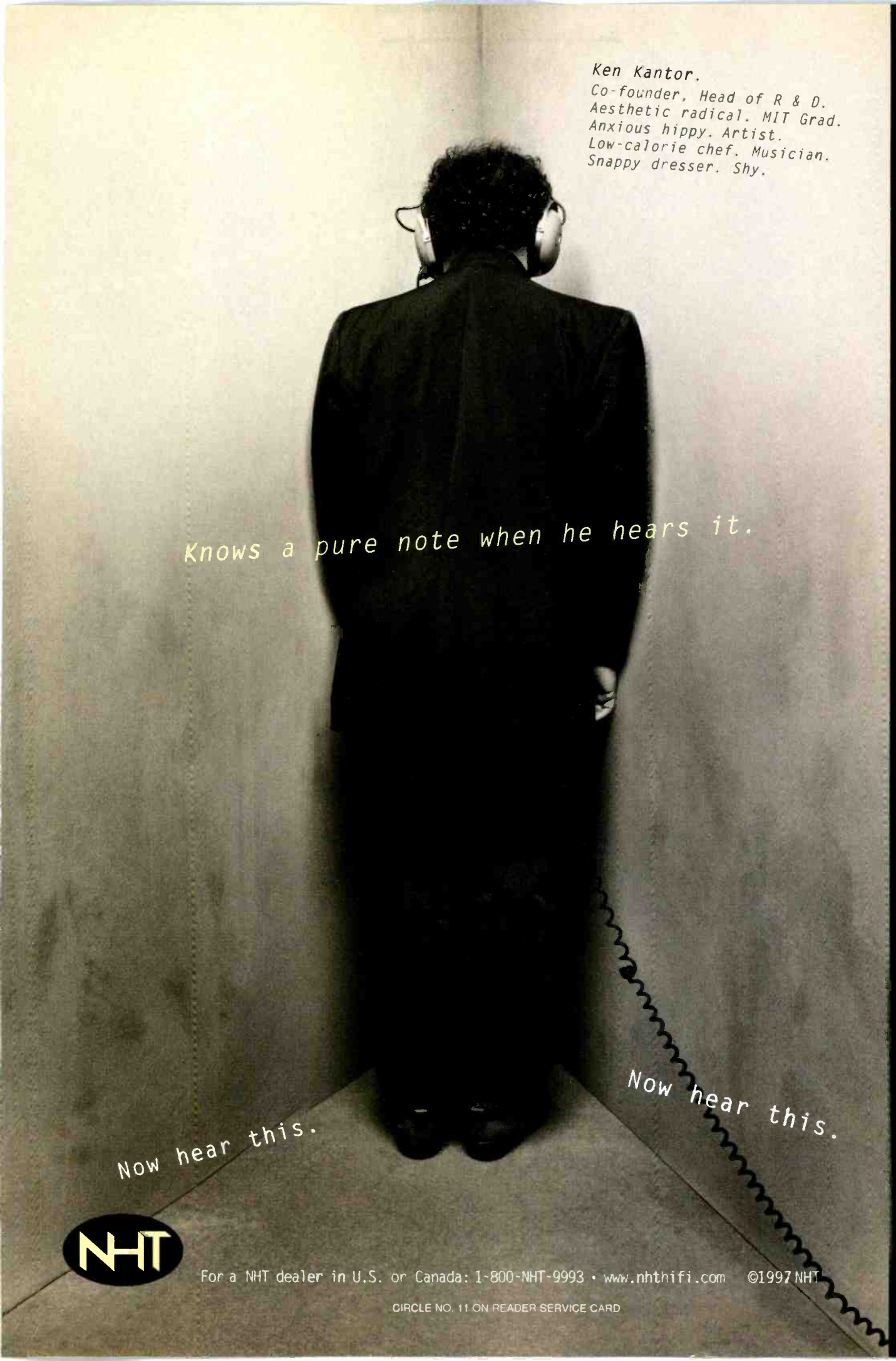

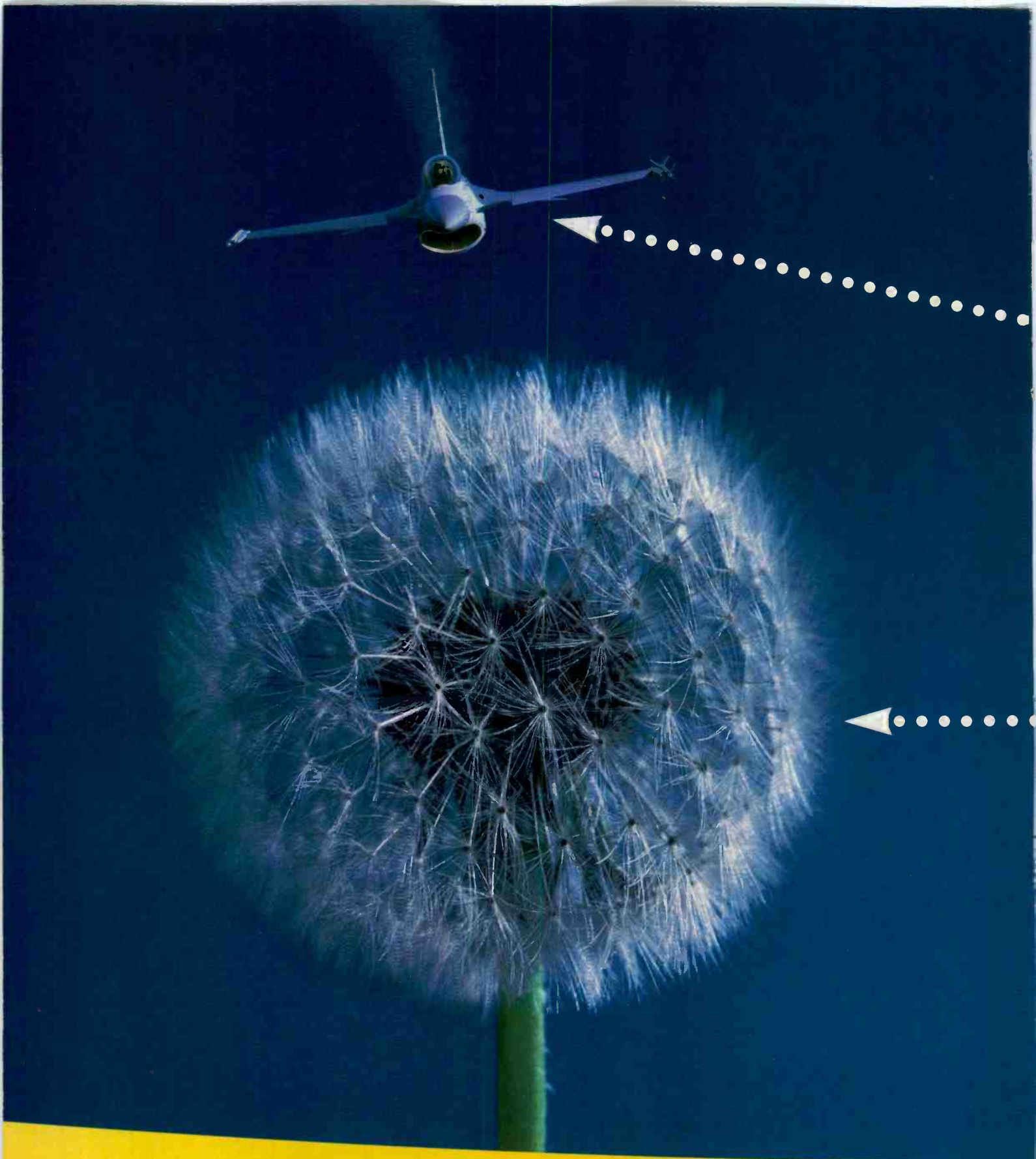

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FAST FORE-WORD

Divx. Now there's a name that trips off the tongue. Try saying it six times real fast. Divx is a mutant DVD format dreamt up by a bunch of Hollywood lawyers and largely underwritten by Circuit City. The company the two organizations have formed to market the concept (originally known as Zoom TV) is called Digital Video Express—hence, Divx.

Here's how it works. You buy a Divx player, which incorporates the extra circuitry required for playback of Divx discs in addition to regular DVDs and CDs. This will set you back about $100 more than an otherwise identical non-Divx DVD player. The discs themselves are just like ordinary DVDs except that their encryption scheme is on steroids. Not only is the encryption harder to break than that of conventional DVDs (start warming up the Cray), but it gives the studio that released the disc control over how you use it. Starting when you first slip the disc into your player, you have two calendar days of unrestricted access, during which you can use it just like any ordinary DVD. For this privilege you pay about $5 up front. When your 48 hours are up, you can simply trash the disc or you can hold onto it in case you might want to watch it again in the future. More viewing time will cost you, however, to the tune of a few dollars per additional interval of access. Or you can pay a higher fee (probably around $20) for unlimited access—sort of. The disc will still play only on the special Divx players, but if it is ever played on somebody else's Divx machine, that person will get charged accordingly.

Say what? Well, here's where it gets really deep. When you buy a Divx player, you get an account with Digital Video Express. And when you install it, one of the connections you will make is to your phone line, so that the player can report your viewing activity back to the home office, which will use that information to bill you for usage beyond the initial access period and for use of other people's discs. Divx discs will be individually serialized, so the player (and thus Digital Video Express) can keep exact tabs on which Divx discs you watch and how much you watch them, and of who "owns" each disc that is viewed on your player.

The basis for this new format's mass consumer appeal must be obvious to you by now, no? In fairness, it must be said that Divx's obnoxious elements are leavened with some positive ones. The idea is to allow a sort of convenient, one-stop video "rental" procedure, in which there are no late fees and you never have to return anything. But is eliminating those return trips worth the complication and confusion that will follow in this system's wake? And is it worth a format war (the one we thought we'd avoided)? For make no mistake, Divx versus DVD will be a format war.

At this writing, in early September, studios supporting Divx are Disney, Universal, Paramount, and DreamWorks. Two of these, Disney and Universal, have also committed to release conventional DVDs; the other two have said nothing one way or the other on that subject. And Fox has said nothing about either. Every other major studio is already in the DVD business, though it is possible some will decide to do Divx as well (this spy versus spy, pay per peek stuff being something of a studio mogul's wet dream). Companies who have said they will supply Divx players are Matsushita (Panasonic, Technics, and Quasar), Thomson (RCA, ProScan, and GE), and Zenith, and I doubt that the list will get any longer. The system is supposed to launch next spring.

I expect Divx will fail. Its meager benefits won't be enough to overcome the system's inherent irritation and confusion factors. (I can't wait to hear Circuit City salespeople trying to explain to customers the difference between DVD and Divx.) Its legacy will be consumer confusion, slowed sales of DVD players, and, most disappointingly, delayed entry of some studios into the regular DVD market.

It is also sad and discouraging to see manufacturers of the stature of Thomson, Matsushita, and Zenith involving themselves in such a putrid mess. Digital Video Express's CEO says that Divx has been under development for three years. During that time, did the company approach the DVD consortium about incorporating Divx into the DVD standard? If not, why not? If yes, how do the just announced Divx player suppliers explain themselves to their existing DVD customers? And if Divx succeeds, how will they square themselves with the legions of furious buyers of their own months-old DVD players? If it fails, what will Divx buyers do with their discs when their Divx players eventually die—store them with their CEDs?

In light of all the above, my advice is to do what I'm going to do: Just say no to Divx.

AUDIO

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PHILIPS

Digital 101?

Dear Editor:

I could rave like a madman on speed at this moment, but I won't. Instead, I will raise one issue that none of you geniuses in the audiophile press understand: Anything prior to the D/A converter in the audio chain does not have a sound. Period.

Digital code does not care about anything in the analog world. Not resistance, impedance, or cable thickness and material. Nor is it concerned with speed, focus, or imaging. The digital world cares only that it gets the proper data at the proper rate at the proper time. That is all. It's not a turntable!

If a CD transport or a hard drive delivers all its data, it will have no effect on the end result no matter who makes it or its price tag. If the cable to the D/A converter passes all the data without corrupting or altering the data flow, it also will impart no sound. If the data flow is corrupted, the D/A converter reads the errors and may decode them incorrectly. Then, the sound suffers.

If you want to test CD transports and digital interconnects, you need only test them for data transmission. *That is all.* Every other attribute (except build quality) is pure, unadulterated crap!

Maybe I could tell you about how the different hard drives in my Macintosh sound when I record and mix with Deck II audio workstation software. If that sounds stupid, what about Anthony Cordesman's "Auricle" on the Mark Levinson No. 31.5 CD transport (May issue)? That piece was sheer idiocy.

This stuff has got to stop. You are spreading disinformation and promoting ignorance. In your 50th year, it's time to lead the way to true digital enlightenment.

Jeff Henning
Upper Darby, Pa.

Overseas DVD

Dear Editor:

Ken Kessler recently wrote about the zoning of DVD players and discs by geographical region ("Mondo Audio," June). What about a Frenchman (like me) buying here in the U.S. a high-end DVD player with a 50/60 Hz power supply, like the $3,500 Meridian 586. Could I use it in Europe, providing I used discs I had bought here in the U.S.? Once back in Europe, will I be able to find a mail-order company that would provide me with U.S. discs (at half the European rate)?

J.L. Olivier
Chicago, Ill.

Editor's Reply: Yes, you would still be able to play discs bought in the U.S. Your chances for obtaining a mail-order supply of such discs from overseas are hard to assess, however. I wouldn't count on it.—*M.R.*

The Proof Is In The Sales

Dear Editor:

I am puzzled that Ken Kessler would question our feelings in the U.S. that CDs are too expensive when Europe pays more ("Mondo Audio," June). In truth, we on both continents are being ripped off, one less than the other. Kessler might have researched profitability factors, too. In classical music—reportedly a dying genre—large up-front payments to artists and waning sales make for profit problems aplenty. Ultimately, classical music sales must be increased by acknowledging the wonderful depth of feeling that we classicophiles experience. The success of a medium is defined by sales, not by its pure merits intrinsically contained.

All marketing schemes can fail. Companies try to build profitability on tried and true methods. Do it better than they do and you will be showered with inestimable riches.

Michael Janket
Putnam, Conn.

Binaural Brood

Dear Editor:

I greatly enjoyed Floyd E. Toole's two articles on "The Future of Stereo" in the May and June issues. Glad to read that the "two-channel stereo stalemate" has been broken, and I appreciate the author's recognition of what I feel are among the two best ap-

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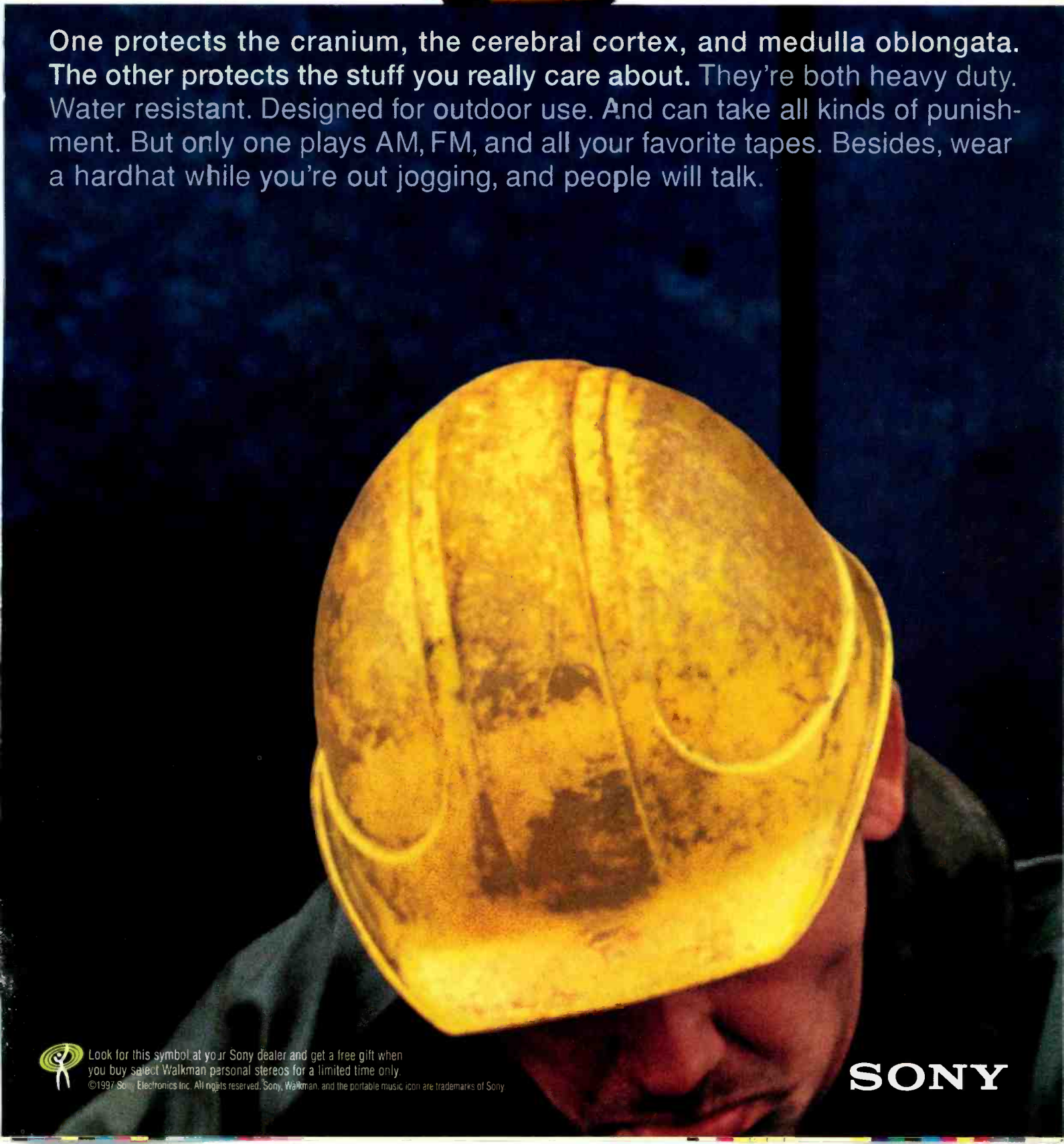

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SONY

proaches to breaking it: Ambisonics and binaural sound.

Multichannel/multispeaker designers are currently trying to re-invent the wheel (and doing it badly from the demos I've heard). Convincing multichannel sound has already been extremely well done by Cooper, Gerzon, and others and requires only three or four transmission channels instead of six. It's called Ambisonics.

My experiences with binaural sound underscore Floyd Toole's remarks about the battle of auditory versus visual cues. They also apply to crosstalk-cancelled two-speaker playback and Ambisonics. The brain strains to make sense of a sound coming from, say, 60 feet in front of you in a cathedral when you are staring at a wall of your non-reverberant listening room a dozen feet away. That is why on my binaural radio program "Audiophile Audition" (broadcast by 120 FM stations coast to coast), I always suggest that headphone listeners darken the room or close their eyes. This also can help with the frontal localization problems of binaural sound, as does leaving on the speakers if you are facing them.

Given the millions of standard stereo CDs available, I cannot fault Toole's reference to "the few existing commercial examples [of binaural recordings]," nevertheless I think of the more than 125 binaural CDs and cassettes that we sell (most exclusively) via The Binaural Source as more than "a few." Toole's references section, which cited sources for Ambisonics, would have been more complete had it also included The Binaural Source (Box 1727, Ross, Cal. 94957; 800/934-0442.) Call for a catalog; binaural demos may be downloaded at www.binaural.com.

John Sunier
The Binaural Source
Kentfield, Cal.

DVD and HDTV: A Happy Couple?

Dear Editor:

After reading Edward Foster's May "Profile" of the Sony DVP-S7000 DVD player and the Sony DVD ad, a question arises: Will DVD be compatible with the new digital HDTV standard just approved by the FCC? I note in Sony's ad that the DVD system will support "over 500 lines" of resolution. The HDTV standard calls for more than 1,000 lines of resolution. Will DVD be obsolete in just the few years it will take to migrate from the current NTSC system to the new HDTV system?

Ray Segura
New Orleans, La.

Editor's Reply: Current DVDs and DVD players will be compatible with HDTV in the sense that they will play on HDTV sets. The current standard does not provide for HDTV signals on DVDs, however. There is work underway to develop the technology necessary for HD-DVD (blue lasers, advanced pressing methods, etc.), but full realization is some years off, and when HD-DVD does arrive new players will be required (though the new players will also play regular DVDs).

There are other issues as well. Even if the technology were available now, it would be some time before the installed base of HDTV receivers became large enough for manufacture and distribution of HD-DVDs to be economically attractive

to movie studios. This is because it will take a number of years for HDTV broadcasting to become widespread and because initial prices for HDTV receivers will be very high. Mitsubishi recently announced that it expects to introduce HDTV sets late next year with prices starting at about $8,000. I have not heard any television manufacturer mention a price below $6,000. So it will take a while for the prices to work their way down into the mass-market range—several years into the next century, I would guess.

Meanwhile, there are some interesting things that could be done with HDTV receivers to enhance the reproduction quality of standard DVDs. Movies can be coded on DVD at their native 24-frame-per-second rate (or easily converted back to it from 30 fps). With a digital video connection to a suitably configured HDTV set, movies on DVD could be progressively scanned (no interlace) at 72-fps, with each frame being scanned out three times in succession to prevent flicker. This in itself would provide some improvement in image quality, but beyond that, with progressive scanning it becomes quite easy to do line doubling, since no compensation is required for motion between fields. Although the image still will not be full HDTV quality, it will be significantly better than is possible on NTSC sets. So the short answer is, I don't think DVD will be made obsolete by the introduction of HDTV.—*M.R.*

Now Serving Tapers

Dear Editor:

Where has Corey Greenberg been hiding? While he's just rediscovered live taping ("Front Row," August), there's a large, long-standing community of folks who regularly tape live performances. They're known as "tapers," and bands like the Grateful Dead, Phish, and many others have set aside entire seating sections at their concerts for them. It's been in response to their needs that high-quality, low-cost miniature recording equipment has emerged.

A community of audio professionals has grown to serve these folks: Core Sound has been part of it for seven years. Among our products is the widest variety of miniature true-binaural (in-ear and near-ear) and cardioid clip-on microphones designed especially for tapers. (They're also in use at many pro studios, multimedia production houses, and universities.) We feel that our mikes are the best in their category and at their prices, producing the most realistic recordings with very low distortion at even the extreme sound-pressure levels found in the mosh pit at rock concerts.

We also build the widest variety of 7-pin interface cables for Sony's portable DAT recorders and devices that translate between coaxial and optical digital signal transmission.

Readers can learn about the taper world by subscribing to the Internet's DAT-heads mailing list (Core Sound's Web address is www.panix.com-moskowit).

Len Moskowitz
Core Sound
Teaneck, N.J.

Erratum

The September "Auricle" on the Paradigm Reference Active/20 speaker mistakenly referred to it as having a sealed enclosure. It is actually ported.

WHAT'S NEW

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MovieWorks 5.1 is intended as a compact, six-speaker home theater system for playback of music or Dolby Digital (AC-3) 5.1-channel soundtracks. It includes Multipole surround speakers with selectable bipole or dipole radiation patterns, a 150-watt powered, acoustic-suspension subwoofer with a 12-inch driver, a shielded center-channel speaker with dual mid-bass/midrange drivers, and shielded left and right satellites, each with a long-throw, 4-inch mid-bass driver and 1¾-inch tweeter. Price: $1,799 factory direct or at Cambridge SoundWorks retail stores.
For literature, circle No. 100

MONITOR AUDIO SPEAKER

A trilayer ceramic alloy that Monitor Audio calls Ceralloy is used for the diaphragms of the four drivers in the Studio 60, a three-way double bass-reflex system. Ceralloy is said to yield near-perfect piston action, with no breakup or bending modes to cause distortion. Two 17-centimeter bass drivers cover frequencies from 26 to 375 Hz, where a third 17-centimeter driver takes over up to 3.5 kHz. A 2.5-centimeter gold-dome tweeter handles the upper treble. Frequency response is specified as 26 Hz to 28 kHz, ±3 dB, with a maximum output level of 115 dB at 1 meter. Price: $10,995 to $15,500 depending on finish.
For literature, circle No. 102

PSB SPEAKER

A slimmer, deeper enclosure and thicker front baffle (to lessen diffraction and minimize cabinet resonances, respectively), a wider vent to eliminate port noise, and a less imposing footprint (to better reconcile performance with home decor) are among the distinctions of PSB's flagship Stratus Gold*i* speaker, the successor to the Stratus Gold. The drivers—a 10-inch woofer, 6-inch cone midrange, and 1-inch dome tweeter—and three-way design remain unchanged. Price: $2,399 per pair in black ash or dark cherry; $300 additional in high-gloss black.
For literature, circle No. 101

BOSE CENTER CHANNEL SPEAKER

Measuring just over 3 inches tall, the VCS-10 center-channel speaker is said to deliver realistic reproduction of dialog in any home theater system. The slim enclosure houses four 2½-inch drivers: two for low frequencies in a flared-port enclosure and two in an array that is claimed to produce a large, consistent sound field. The VCS-10 also includes electronic protection circuitry. Price: $229 each.
For literature, circle No. 103

WHO THINKS:

Compact Disc Players

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Integrated Amplifiers

Surround Sound Processors

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Tom Miiller, The Audio Adventure, Vol. 2, Issue 11

RB990BX Power Amplifier

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Mark Block, The Audiophile Voice, Vol. 2, Issue 1

RB980BX Power Amplifier

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Thomas J. Norton, Stereophile, Volume 15, No. 11

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Ultra High Fidelity Magazine, Volume 44

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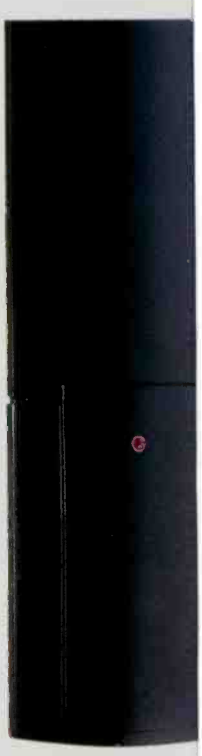
Thunder speaker wire from Woods Industries is said to deliver audiophile sound quality at an affordable price. Made of oxygen-free copper, it is designed with a flexible rope lay for easy handling and installation. Thunder wire is flame-retardant, UL-approved, and safe for in-wall applications. Prices, two-conductor, 50-foot spool: 16-gauge, $19.99; 14-gauge, $26.99; 12-gauge, $36.99. Prices, two-conductor, 100-foot spool: 14-gauge, $49.99; 12-gauge, $69.99. Prices, 500-foot in-wall wire, two-conductor: 16-gauge, $159.99; 12-gauge, $319. Price, 500-foot in-wall wire, four-conductor: 16-gauge, $219.
For literature, circle No. 104

ALLSOP RECORD CLEANER

Jim Allsop, whose father developed the Orbitrac LP record cleaner, says the device has been updated and reissued as the Orbitrac 2 because of the renewed interest in LP records. The compact design is supplied in a storage case with two 1-ounce spray bottles of cleaning solution, two lint-free cleaning pads, a cleaning brush, and a nonskid cleaning base. The replaceable cleaning pad change from white to yellow they absorb groove contamin and are said to be good for as n as 100 cleanings. Price: $34.9
For literature, circle No. 107

Radio Shack Wireless Headphones

You needn't be in the same room—or even in the house—to enjoy music from your stereo on the PRO-100 wireless headphones. The 900-MHz transmitter works through walls and floors and is said to operate as far as 150 feet away from your audio system or TV (the transmitter plugs into any headphone or audio-out jack). The headset has controls for volume, fine tuning, and on/off and is powered by rechargeable nickel-cadmium batteries for as long as five hours on a single charge. Price: $129.99.
For literature, circle No. 105



Nagra Preamp

Nagra portable open-reel recorders are legendary among pro film and sound recordists. The PL-P tube preamplifier, with a built-in moving-coil step-up transformer, is the company's debut in the audiophile arena. Its DC power-supply comprises eight NiCd D cells fed by an external AC charger. The preamp operates in pure Class-A mode, with the output-stage vacuum tubes coupled directly to the output connectors. Input and output levels are adjustable, and a "modulometer" monitors both output level (in volts and decibels) and battery voltage. Phono input capacitance is also adjustable. Price: $9,500.
For literature, circle No. 106

Day Sequerra TV/FM Ante

The Metro 360 indoor antenna intended to optimize reception of and TV signals in dense metropol areas. A built-in, low-noise bipol RF amplifier with an isolated pow supply is coupled to a fan monop antenna element; the combinatio is said to naturally reject multipa interference and electrical disturbances and yield high signa strength. Price: $129.
For literature, circle No. 108

AUDIO CLINIC

JOSEPH GIOVANELLI

Upgrading AC Power Cords

Q *I want to upgrade the 18-gauge AC power cords, which have two-prong polarized plugs, on my audio components. I plan to install IEC power outlets that use the third, U-ground prong. Of course, my new power cords will have that extra ground wire. How should I terminate that ground on each device?*—Charles F. Sprague, Ventura, Cal.

A Why do you find it necessary to upgrade your power cords? Are the present ones unable to carry the current demanded by the device to which it is connected? Are their jackets cut, thereby exposing the conductors?

Chances are that none of these questions have "yes" answers. Therefore, I see no benefit to changing the power cords; in fact, there might be a loss. There have been instances where that extra ground wire has given rise to hum resulting from ground loops induced by these ground wires.

If you still decide to make these changes, the ground wire from the U-ground pin must be wired to the chassis of the associated device. You should fit a spade terminal to the end of the wire. Loosen a cover hold-down screw and slip the spade under it; then retighten it.

Voltage Sag vs. Output Power

Q *In the "Equipment Profile" of the Carver A-760x amp (May) Ed Foster notes that the amp's output power was adjusted for "sagging line voltage." Since this is a real-world issue, I wondered to what degree line voltage influences an amplifier's power output. The amp I own produces 700 watts rms, and the AC line drops 3 volts or so under this condition.*—Tyson Baldridge, Richmond, Va.

A If sagging line voltage were the only factor, you would tend to lose about 3% of the amp's total power output. However, this would be true only when the amplifier is producing its full rated power output on a continuous basis. Assuming good power-supply filtering, the capacitors' charge would normally take care of peak voltage sag. Such a power loss would not be audible, even though it could be measured.

It isn't quite this simple though. You also must consider what losses occur within the power transformer during peak power demands. Further, what is the sag of secondary voltage, even if the line voltage is held constant? I suspect that these real-world problems are at least as significant as sagging line voltage, and perhaps even more important. Again, let's hope that the filters can hold a charge long enough to accommodate peak demands in power output, maintaining voltage to the output stage when both the line and secondary voltages fall somewhat. In other words, the losses *within* some power transformers will be of greater significance than those resulting from any reasonable amount of power line voltage sag.

If a manufacturer wanted to do it, regulating the entire power supply would eliminate any decrease in power output, because the voltage would remain constant even with power-transformer losses or drops in line voltage.

Despite anomalies in line voltage and within power supplies, amplifiers still produce very little distortion—in most cases far below the audible threshold of detection with musical program material. Consequently, I believe we should disregard such minor flaws and just enjoy our hi-fi systems.

There will always be exceptions, of course, such as poor house wiring, which may cause severe line-voltage sag. If you own your own home, you might have an electrician install heavy-gauge wire and run a circuit dedicated to your sound system. However, I don't think it's advisable to install a circuit breaker capable of more current just because the wire can carry it. Naturally, you'll want to keep the run as short as is practical. A

If you have a problem or question about audio, write to Mr. Joseph Giovanelli at AUDIO Magazine, 1633 Broadway, New York, N.Y. 10019, or via e-mail at JOEGIO@delphi.com. All letters are answered. In the event that your letter is chosen by Mr. Giovanelli to appear in Audioclinic, please indicate if your name or address should be withheld. Please enclose a stamped, self-addressed envelope.

IVAN BERGER

SURROUND SURPRISES

Illustrations: Beata Szpura

I have my purist side and tend to be skeptical of any audio process that attempts to simulate something else. But surround simulation circuits have dealt me two pleasurable surprises recently.

The first was the Sound Retrieval System (SRS) in the Pioneer DEH-P835 car stereo ("Spectrum," September). With it switched in, I heard little surround effect (although that might have been because of my car's acoustics or various other settings in my system). Instead, the soundstage seemed to deepen and soloists moved from dead ahead of me (a position I can accept) to the car's centerline (which I find preferable). Overall, the sound seemed more tightly focused with the SRS.

The second surprise came at the press introduction of Toshiba's new SD-3107 DVD player. Like every DVD player I know of, it has digital outputs for Dolby Digital Surround (AC-3) and stereo analog outputs that can convey Dolby Surround via a Pro Logic decoder. But it also has Spatializer "3-D" Stereo, a process designed to simulate surround from just two speakers.

I could see one reason for this: to bring surround to consumers who choose to buy a DVD player now and build their systems up to full home theater audio later. But I was surprised that Toshiba also provided for using the Spatializer circuits along with Dolby Surround.

According to Toshiba, the combination "fills in the gaps in the sound field, making a seamless transition between the front 'point-source'. . . and. . .rear 'ambient effect' speakers." In practice, it also brings out sounds that otherwise might be buried in the mix. At the press demonstration, Toshiba played a scene from *The Bridges of Madison County*, where Meryl Streep walks through a covered bridge. Switching in the Spatializer circuits during Pro Logic playback made me far more aware of sounds from the pigeons nesting in the bridge and from the stream beneath it. The effect seemed very natural, not exaggerated. I'd have to hear it on more scenes from different movies before I decided just how universally useful the Spatializer/Pro Logic combination is, but I did find it rather intriguing.

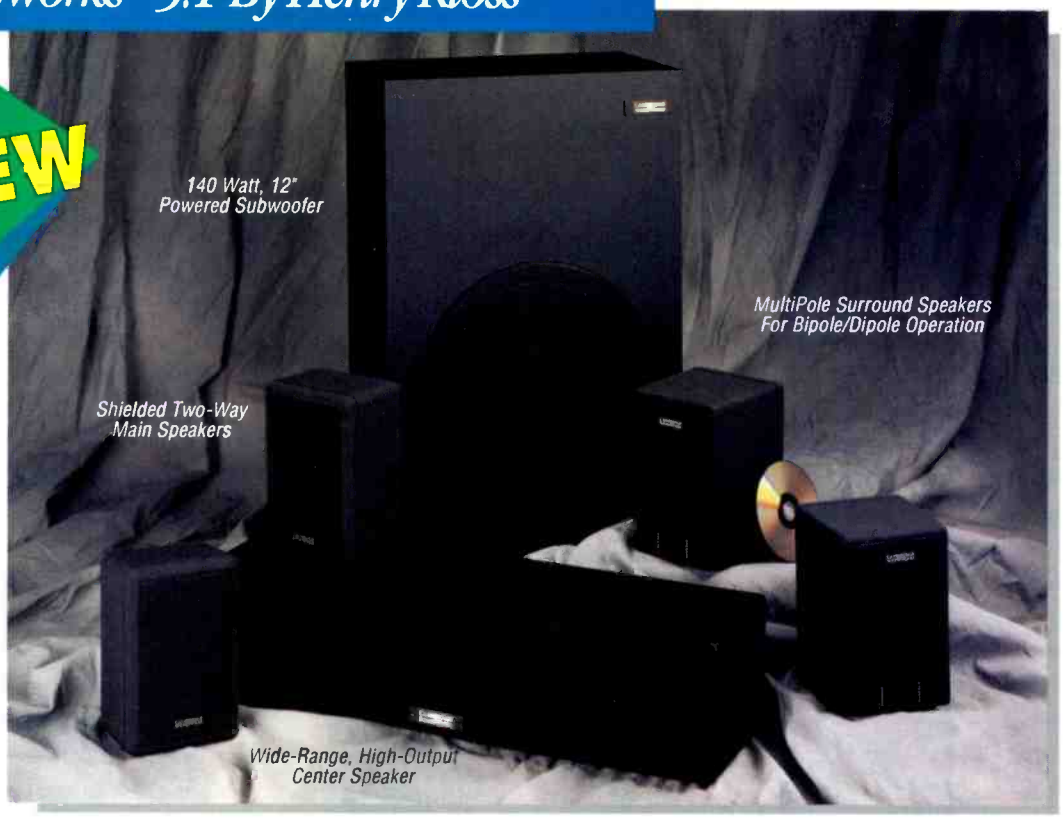
Actually, I already get simulated surround at home, but that's by accident. My bedroom TV sits high in a cabinet, so my size-12 feet won't obscure the screen when I watch at bedtime; my VCR, laserdisc player, and other electronics sit just above it. Because my AR-M1 speakers aren't shielded, I put them on top of the cabinet, just inches below the ceiling. That should put the sonic image disturbingly high above the screen, compounded by the fact that the AR-M1s' front panels tilt back, aiming their sound more at the ceiling than my ears. But I never feel the sound source is too high—and sometimes, on surround-encoded material, I hear sounds coming from behind me. (For whatever reason, this effect was most noticeable on the old *Northern Exposure* series.) What's more, the only sounds that seem to come from the rear are sounds that should appear there—no dialog or other sounds that should be up front.

SALESMANSHIP

"People sometimes ask the weirdest things," a manufacturer tells me. "Once, at a hi-fi show, someone asked me, 'What's your bias speed?'

"I had no idea what he meant, so I just told him, 'It's eight—fastest in the industry.'"

MovieWorks™ 5.1 By Henry Kloss



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The main speakers in *MovieWorks 5.1* are a two-way, shielded design with excellent tonal balance, wide dispersion and pinpoint stereo imaging – everything you'd want in a high-quality speaker to reproduce both music and sound effects. They will fill even a large room with accurate, natural sound...without filling the room with big speaker boxes.

High-output center speaker.

The center speaker is a new high-output, wide-range design with natural tonal balance and superb dispersion. It has two 5 1/4" midrange/midbass drivers and a tweeter identical to that in the main speakers, for seamless blending of soundtracks. Bass reach is significantly lower than most center speakers. Its dynamic range can handle even demanding soundtracks, and dispersion is broad enough to cover all listening positions.

MultiPole surround speakers.

The surround speakers in *MovieWorks 5.1* are a high-output design using MultiPole technology that allows you to choose between dipole (diffuse radiating) and bipole (direct radiating) sound.*

With the growing popularity of Dolby Digital® 5.1 surround sound, which sends discrete signals to the left and right rear speakers, there has been controversy about what kind of radiating characteristic is best for surround speakers. For virtually all of today's movie soundtracks, we recommend dipole radiator designs because they do a superb job reproducing surround effects so everyone in the room hears them correctly.

For some 5.1 channel mixes, however – those with signals spread between the two surround speakers in true stereo – bipolar direct radiators can be advantageous. In particular, music recordings with vocalists directed to surround channels sound better with our MultiPole speakers set to their bipole position.

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MovieWorks 5.1's powered subwoofer is amazing – it's the one everybody likes. It has a heavy-duty, long-throw 12" woofer and a robust 140-watt amplifier with electronic crossover. *Boot* says it "is an aural atomic bomb...gracefully played frequencies down to an awe-inspiring 21 Hz!...nothing short of phenomenal."

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* Unlike seemingly similar systems, our MultiPole speakers, when switched from dipole to bipole operation, affect a very broad range of sound – not just very high frequencies. This difference is crucial to proper performance.

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CIRCLE NO. 8 ON READER SERVICE CARD

DIGITAL DUETS

Tired of singing solo in the shower? Digital technology may have solutions for that.

One such solution, Virtual Vocals, already exists, albeit not yet in consumer products. This technology "creates additional harmonies in real time from a live vocalist," according to IVL Technologies of Victoria, B.C., Canada. The company says this enables it to "double a singer's voice for a richer, more professional sound." (It's also said to be able to change a voice's timbre or apparent gender and to correct a singer's pitch.) So far, it's available only in professional equipment, but that situation may soon change. The technology is now available for Motorola's 56000-series digital signal processing (DSP) chips, which are used in some high-end consumer audio equipment and some sound systems for PCs. There are no immediate plans for waterproof voice-doublers you can shower with, however.

More advanced—and farther in the future—are computer systems that will let you sing duets with Presley or Pavarotti and let you hear how Beverly Sills would sound with Pete Seeger's voice. A major challenge? More like a series of them.

To begin with, we demand more from synthesized voices. People will accept synthesized violin sounds that would make a violinist cringe yet are quick to recognize when voices—the instruments we're most familiar with—sound less than perfect.

Further, the voice is probably the most variable of instruments. Even within one language, we can generate a vast variety of sounds, and the variety is vaster when we take all languages into account. Individual voices differ so markedly that we can usually identify a familiar one from a few words on the phone, even if years have passed since we've heard it. People's voices change for temporary reasons, such as colds or fatigue, for permanent reasons due to aging, and because they've been trained in specific vocal techniques. And you may say the same phrase dozens of different ways to convey different meanings and emotions. (Stan Freberg's "John and Marsha" recording told a whole story through two voices simply repeating each other's names with differing inflections.)

So where does a researcher begin? It depends on the researcher. Some scientists are concentrating on the components of vocal sound, others on how voices flow from one sound to another, and still others on how sonic changes affect a word's meaning.

Ken Lomax, of Oxford University, is analyzing the components of voices and of vocal techniques. According to a recent article in *New Scientist*, a British scientific weekly, he's correlating Fourier transforms of vocal harmonic content over time with singers' actions and intentions. Crescendos, for example, change not only volume but frequency content, with higher harmonics making up more and more of the tone as we sing louder (a phenomenon known as spectral tilt). Singers usually start each note a bit off pitch, then correct it. A vocal synthesizer must be able to re-create a complex mix of vocal properties—such as overtone structure, pitch, spectral tilt, amplitude, and rate and depth of vibrato—vary them correctly over time, and follow such musical intentions as "crescendo," "start," and "slur" (there are only about 20 of them, Lomax says). A vocal synthesizer must also be able to generate the vowel and consonant sounds of each song's lyrics and give them the proper emotional emphasis. And it must make natural transitions between sounds.

Scientists are tackling various aspects of these problems, and they're confident of finding solutions to them. But neither they nor synthesizer makers, says *New Scientist*, think singing synthesizers will be a factor in music for a few years yet.

FORMAT FOLLIES

When I moved to the suburbs a few years ago, my audio system was one of the first things unpacked and set up, but my turntables had to wait. In the last few weeks I've gotten them up and running—and brought home a DVD player to try. Those two events set me musing on the formats of my various audio and video recordings. It's quite a list.

In phono discs alone, I have 78-, 45-, and 33⅓-rpm records. That's actually three-and-a-half formats, since among the LPs I have a few CD-4 quadraphonic recordings; they require nothing special in the way of arm and turntable but do require a special cartridge. I have no 16⅔-rpm discs, but that's just as well, as I have nothing to play them on.

In tape, I have full-track mono, half-track mono, half-track stereo, quarter-track stereo, and quadraphonic, at various speeds from 15/16 to 15 inches per second, with gear that can play all but the 15/16-ips tapes. I also have cassette, of course. Somewhere, I have one cartridge each in the 4-track, 8-track stereo, and quadraphonic Q8 formats. But they're strictly souvenirs, as I no longer have an 8-track player and never did have a 4-track.

My collection includes CDs and DATs, of course. I also have a few DCC tapes and MiniDiscs but no hardware to play or record them—souvenirs again.

In video, I now have VHS, S-VHS, VHS-C, 8mm, Hi-8, and laserdisc—plus the new DVD.

If you like, you can count up how many formats I have. I'm afraid to.

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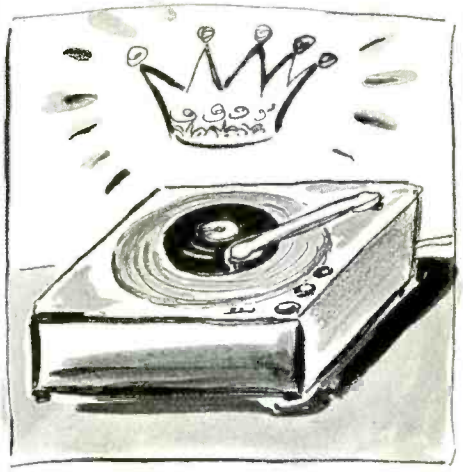
CIRCLE NO. 67 ON READER SERVICE CARD

SINGLES VS. ALBUMS

A recent issue of *Billboard*, the major trade magazine of the record industry, showed that about 80% of all the recordings sold in the U.S. these days are albums. That hasn't always been the case. When I was a kid, the vast majority of pop records sold were singles, and singles of opera arias



or other brief works probably accounted for a hefty share of the classical market. As I recall, my own initial record library was a batch of singles—pop, comedy, and operatic, mixed.

Originally, an album was a book, like a photo album. It had pockets for the discs, plus liner notes. In the 78-rpm days, you might have the option of buying some or all of the discs, at a dollar or so apiece, and of paying another 50¢ for the album. Turning to a 1917 *Victrola Book of the Opera*, I find listings for opera arias as singles but no listings for complete sets.

The LP changed all that. A complete album was now as convenient to play as a single, even if you didn't have a changer, and an LP didn't cost much more to press. By The Beatles' day, albums had grabbed so much of the market that it paid to produce albums that were viewed and produced as an artistic whole, a careful sequence rather than just a collection of songs. Still, singles had big sales, too, even though they were mostly at 45 rpm while the albums were at 33⅓. By the time CD came out, however, singles had lost a lot of their steam; the CD single never did catch on. Even so, I note that for the first six months or so of 1997, singles were selling about 16% better than the year before, while album sales were up only 5%.

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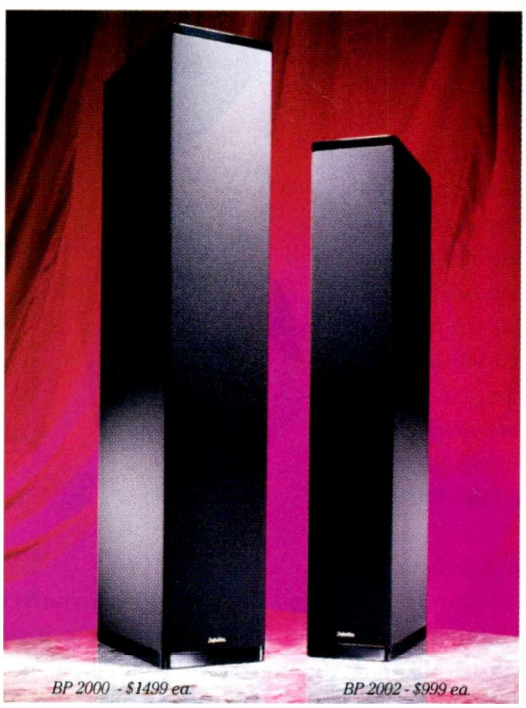

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CIRCLE NO. 12 ON READER SERVICE CARD

KEN KESSLER

MAD COWS AND ENGLISHMEN

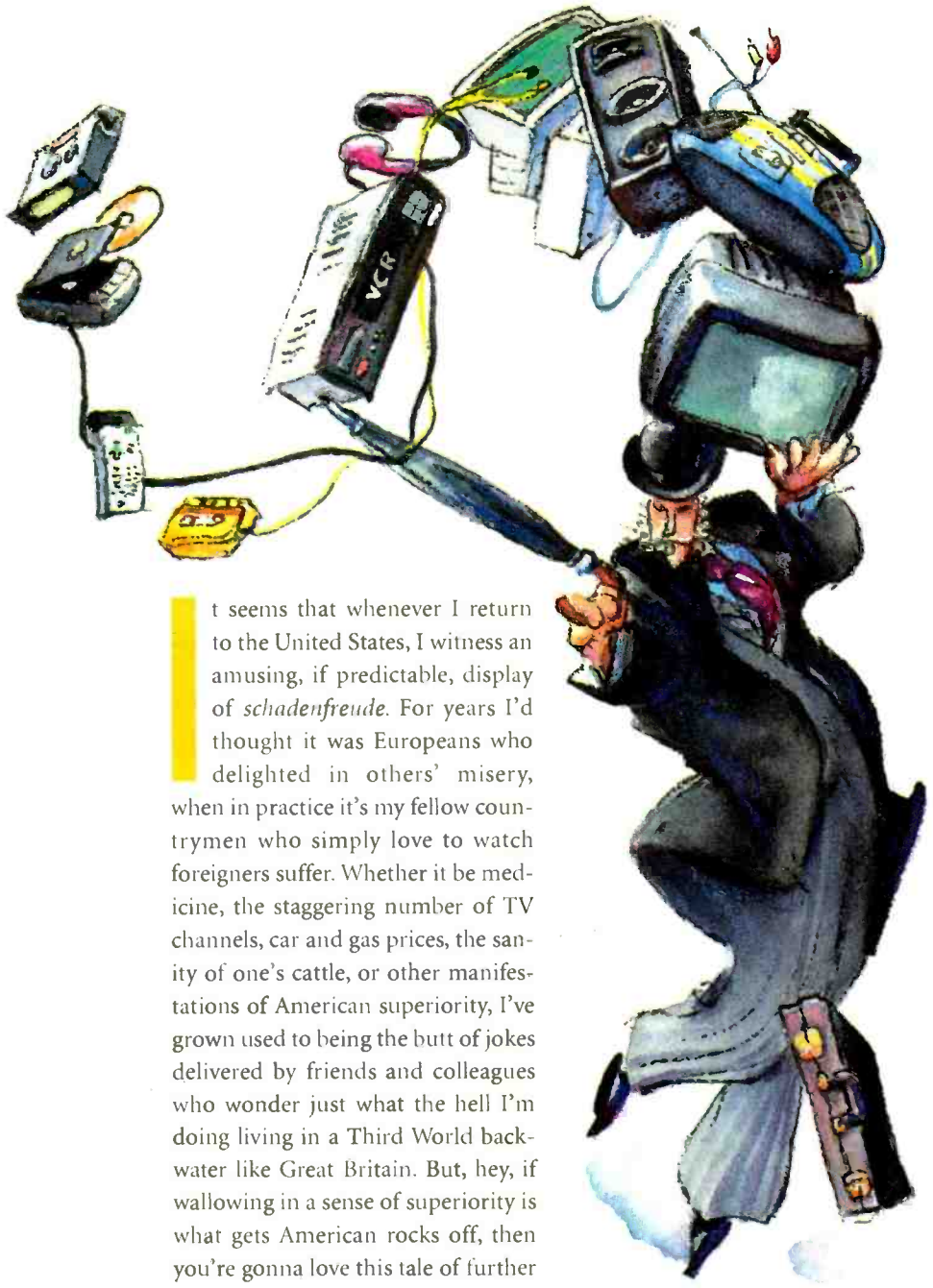

Illustration: Philippe Lechien

It seems that whenever I return to the United States, I witness an amusing, if predictable, display of *schadenfreude*. For years I'd thought it was Europeans who delighted in others' misery, when in practice it's my fellow countrymen who simply love to watch foreigners suffer. Whether it be medicine, the staggering number of TV channels, car and gas prices, the sanity of one's cattle, or other manifestations of American superiority, I've grown used to being the butt of jokes delivered by friends and colleagues who wonder just what the hell I'm doing living in a Third World backwater like Great Britain. But, hey, if wallowing in a sense of superiority is what gets American rocks off, then you're gonna love this tale of further Euro-idiocy.

Should any of you disbelieve the reports that the U.S. economy is booming during Bill Clinton's second term, it's still a safe bet that not one of you would swap it for what's happening in the U.K. Those readers who happen to be manufacturers can almost kiss their British sales goodbye. In a nutshell, the new British government—the Labour Party, led by champagne socialist Tony Blair—has issued an edict that could, quite easily, serve as a death sentence for independent retailers. You can almost see the multiples and chain stores that are supposed to be the target of this legislation secretly rubbing their hands with glee as the smaller shops go broke.

Here's what's happening. Lamebrained, ill-informed, but, I must admit, well-meaning British TV shows and magazines have decreed that the electrical, hi-fi, TV, and VCR markets suffer from price fixing. You know the sort of "investigative" reporting I mean, in which the do-gooder consumerist progeny of Ralph Nader treat anyone making any sort of profit from any type of retail sale as some kind of demon spawn. And that's without checking what the margins really are on the sale of a major-brand TV set or VCR. Hell, that's without even knowing what a profit margin is or why it's needed.

What the government has done is to outlaw recommended retail prices. That's not the same as retail price maintenance, banned decades ago, wherein manufacturers told the retailers exactly what prices should be put on products "or else." Rather, what's disappearing are the guide prices, the "suggested" retail prices, which give a consumer some idea of what the product should cost (if not quite what it's really worth). What led the consumerists to shout "Foul!" was the teensy disparity between prices from shop to shop, on enough goods to suggest some sort of conspiracy. Had they bothered to investigate properly, they'd know that the prices were within a few pounds of each other because the margins were already stripped to the bone, not because the various retailers were in cahoots with each other.

Mind you, it's not specialist audio that's under *direct* threat so much as the consumer electronics of which mainstream journalists are more aware: the aforementioned major-brand TV sets and VCRs. (Go on, call a mainstream magazine and say to

its features editor, "Sony, Krell, JVC, Vandersteen, Hitachi, Cello." Do you need any clues as to which names will be recognized?) What caused the stink was the emergence in the U.K. of American-style warehouse outlets and coops and consumer clubs, where you go to buy corn flakes, peanut butter, and macaroni by the gross. It seems that these outlets also want to sell TVs and midi-systems alongside the soap powder and have screamed loud enough for government ears to hear that the major brands won't supply them. And, as is the British wont, an investigation by utterly unqualified civil servants was called for, logic be damned.

The warehouse guys argue that they have every legal right to buy and then resell TVs, midi-systems, and VCRs just like a regular consumer electronics retailer. And, according to the letter of the law, they're correct. Plus, they want to sell the gear at prices so low that they can't be matched by shops with properly trained staff, service departments, demo facilities, factory warranties, or any of the other niceties one pays a bit extra for if one wants something more than a sealed box. Just about the only way a consumer electronics manufacturer can refuse to supply its goods to a shop—a cattle-feed store or a sex-toys store or what have you—is to prove that the store's credit worthiness is suspect.

So how does a high-end manufacturer or distributor avoid selling high-performance, specialist equipment to a shop equipped only to sell flashlights? How does a major brand keep its TVs from ending up in some fly-by-night toilet? With difficulty, entailing such excuses as "All of our stock is allocated until next year" or, in an attempt at being even more discouraging, "You have to stock the entire line." What has protected the specialist sector for so long is that the really sleazy outlets don't want obscure high-end audio equipment; they couldn't care less about it. What they crave are goods with household names that virtually sell themselves. And because such shops have no trained sales staff, demo facilities, service departments, et al., their overheads allow them to work on margins of around 5% to 10%. Or less.

Now you might be thinking, "Yo! Another hundred bucks off a 27-inch TV!" But in your greed, you're forgetting that once you

leave that store, you're on your own. Worse, the stuff tends to be parallel imports, so even the warranties are a bit iffy, despite British law being so fiercely protective of the consumer that the retailer has to look after the goods no matter what their origins. Admittedly, TVs are about as reliable a product as you can buy. (And since anyone with half a brain knows how to calculate the floor space needed for said purchase, you can't go far wrong in even the most barn-like of these outlets.) But once it gets to things a shade more complicated (computers are the obvious candidates), it really is a case of caveat emptor.

Some of you are probably figuring I'm trying to protect an endangered species that possibly deserves to be extinct. However, if that endangered species—the independent consumer electronics store—disappears completely, then all that's left are the mass-market dreck-meisters. This isn't survival of the fittest; it's survival of the products from companies big enough to play ball with retail empires of equal market clout. And if the little guys disappear, so do the only retail outlets likely to carry decent hi-fi equipment.

IF THE LITTLE GUYS DISAPPEAR, THEN SO DO THE ONLY OUTLETS LIKELY TO CARRY DECENT HI-FI GEAR.

Friends tell me that it's already getting that way in America and that we in Europe get a skewed idea when we read American hi-fi magazines. Like, that every town has a purist audio dealer or two and that you can find a shop with conrad-johnson or Thiel or Avalon as easily as you can find the major Japanese makes. But Europeans aren't that naive. What amuses us are the sleazoid American marketing practices that we've been spared all these years. Example: A U.S. importer advertising a product in American magazines as "Now $299!!! Was $349!!!" So I asked him, "How can you say 'Was $349' when you know damned well that it never 'was,' since the product has only just been launched, and every one you've sold went out at $299?" He merely shrugged and told me that's the way of the world, and if I've got a beef, I should level it at every car maker who gives a rebate. So I countered with, "But it's still sleazy. Do people really take that bullshit? I mean, real Americans, the world's sharpest consumers? They fall for that and think they're getting a bargain?" His reply was, simply, "Yup."

Such cynicism leads to other thoughts. If British law prevents a supplier from refusing to sell stock to any credit-worthy retailer, how come a back-street used-car dealer with enough cash in the bank can't buy new Ferraris or Rolls-Royces at trade prices? How does Rolex get away with having only one retailer per town in the U.K., regardless of the quality of the other jewelery stores? And yet we find Sony and Panasonic and the like being told that such controls—designed to ensure the quality and integrity of the retailer—can no longer be applied to consumer electronics.

It gets worse. One of the tackiest consumerist shows on television planted a camera in a hi-fi shop and suckered a rep from one of the major Japanese brands into (nearly) confessing that it couldn't have his company's products because the brand wanted to maintain its prestige and protect its loyal, quality retailers. Or, to put it another way, the shop in question was, uh, not up to scratch by that brand's standards. (I won't comment on the nature of the shop where the ruse occurred.) The screams of "Protectionism!" were heard in every consumer electronics boardroom in the U.K. You'll be pleased to know that the company stuck behind its rep and that the industry as a whole thought the entire episode was shabby and misguided. But not the current government, which is too stupid to discern the difference between a shop with knowledgeable staff, good demo facilities, and a repair department and what may be nothing more than a glorified garage.

Buried in the Department of Trade and Industry's 10-page press release about the Monopolies and Mergers Commission's recommendations is a crucial paragraph:

> The MMC found two complex monopoly situations existing which operate against the public interest. The first complex monopoly situation involves all suppliers of reference goods who suggest or recommend retail prices and all retailers of reference goods who use or influence such prices. The second complex monopoly situation involves all suppliers of reference goods who select dealers to be supplied on the basis of certain criteria.

Or, to put it another way: Manufacturers cannot even suggest guidelines, only the actual trade prices on which to add margins (large or small), and selecting one's retailers on the basis of "certain criteria" is pretty much a no-no. Right after the DTI missive appeared, the British Federation of Audio released this:

> Following the Press Notice issued from the Department of Trade and Industry (DTI) on 30 July 1997 regarding the decision of Margaret Beckett, President of the Board of Trade and Secretary of State for Trade and Industry, to act on recommended retail prices and certain restrictions of supply in the domestic electrical goods market, the British Federation of Audio (BFA) is in a position to clarify an important point.
>
> The Monopolies and Mergers Commission (MMC) has previously confirmed to the BFA that *hi-fi separates do not fall within the terms of reference as detailed in its report. The BFA can confirm that proper hi-fi separates are therefore specifically excluded from the Government's proposals.* [Italics mine.]
>
> The BFA and the MMC agreed to these exclusions as long ago as January 1996.

Whoopee. Like, uh, this is going to protect specialist shops that—whatever the BFA thinks—can sell British hi-fi only because they sell enough mass-market stuff to support it. In other words, the sales of Sony TVs and JVC VCRs finance a goodly proportion of the shops selling "proper hi-fi separates."

An astute American friend, when asked by a European colleague what her politics were, made the balanced confession that, "When it comes to people, I'm a liberal. When it comes to business, I'm a conservative." Not too ironically, the Liberal Democrats and the Conservatives just happen to be the alternatives to Labour.

As for living in a Third World backwater like Great Britain, haven't you figured it out yet that I'm simply a masochist? A

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CIRCLE NO. 21 ON READER SERVICE CARD

COREY GREENBERG

VOODOO CHILD (SLIGHT REMASTER)

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As if I needed any more evidence to prove my supreme suckerhood, let me state right here at the beginning that I always have been and always will be powerless to not buy whatever new Jimi Hendrix CDs the market dangles on a stick in front of my spinning hamster wheel. I've yawned at new Elvis CDs, catnapped through countless hip jazz compilations, drool-snored at the Stones remasters. But when it comes to Jimi Hendrix's first three albums, 1967's *Are You Experienced?*, 1968's *Axis: Bold As Love*, and 1969's *Electric Ladyland*, I can't help but pony up the dough every few years when the record companies release yet another series of remasters on the premise that this time, they've finally nailed them.

They never have, of course, but what can I do? I'm in this for the long haul. It's like the running of the bulls for me at this point—no matter how many times I get gored in the belly and tossed over the crowd, my eyes just glaze over and my wallet jumps out of my pants. Man, I bought my very first Hendrix CD a year before I even owned a CD player! It was an early German PolyGram disc of Jimi Hendrix's *Smash Hits*, and I used to sit there and stare at it for hours, wondering what secret sonic doors it might unlock compared to my well-worn Hendrix LPs. As it turned out, the CD sounded terrible; it wasn't until Warner Bros./Reprise here in the U.S. finally mastered his catalog for CD a few years later that Jimi Hendrix made his proper digital debut, with decently mastered CDs of *Are You Experienced?*, *Axis: Bold As Love*, and *Electric Ladyland*. They sounded pretty good—not as good as the records, but hey, it was Jimi Hendrix on CD! Of course, I had to buy all three.

WHEN I SEE NEW HENDRIX REISSUES, MY EYES GLAZE OVER AND MY WALLET JUMPS OUT OF MY PANTS.

Then, a few years after that, MCA acquired the Hendrix catalog and issued newly remastered CDs with engineer Joe Gastwirt at the helm. I thought, initially, that the MCA discs were an improvement over the Reprise CDs, but they sounded much duller on top, as if Gastwirt had tried getting rid of analog tape hiss (common to late '60s masters) and had thrown the highs out with the bath water. I finally decided that the MCA CDs were not really a worthwhile improvement over the Reprise discs, but hey, it was, after all, newer Jimi Hendrix on CD! Of course, I had to buy all three.

So now it's a few years later, and suddenly I'm faced with yet a third reissue of these same three @#%! Hendrix CDs. Hendrix's family has finally won back the rights to his catalog, and now they're working with MCA to revamp the entire series. The amazing thing is that this is

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CIRCLE NO. 7 ON READER SERVICE CARD

the first time that the original engineer of the sessions, Eddie Kramer, has been involved in the remastering of the Hendrix albums. And to top it off, Kramer claims that these new Hendrix CDs are the first discs to be mastered from the *original* master tapes—not third- or fourth-generation backup copies, as he alleges were the source for the earlier Reprise and MCA CDs.

The good news is in the listening—this new batch is a sonic revelation. For the first time, the Hendrix CDs really do sound better—a lot better—than the discs that came before them, or even the original vinyl, for that matter. The low bass of these new discs is so much better than it's ever been before, with a fatness and definition to the bass lines and drums that just hasn't been heard before on any of the CDs. I have no problem accepting Kramer's claim that this is the first time the original flat masters were used to produce CDs of these recordings; layers of haze (not the purple kind) and congestion that plagued the older reissues are gone, replaced with a sweet, natural clarity that brings these late '60s recordings fully up to a standard that compares with anything being produced today. And unlike the Gastwirt-engineered MCA discs, these new Hendrix CDs have a clean, sparkling high end that really opens up the sound of the guitars and vocals. For the first time, I don't hate myself for running out and buying the latest Hendrix remasters, because they really did nail them this time. (Of course, I reserve the right to jizz again the next time, when they *really* nail them).

As it happened, I had all three of these new Hendrix CDs with me on a plane recently when someone swiped my CD wallet while I was in the can. So rather than go buy these *fershluggina* CDs again, I called up MCA's publicity department and scammed not only a new set, but also a chance to talk to Eddie Kramer about the remastering project. Even without the scammed replacement CDs, it was a tremendous privilege to talk to the man responsible for engineering my three favorite records of all time.

Okay, let's skip to the audio geek stuff. Do you remember what equipment you used at London's Olympic Studios to mix the first Hendrix records?

Paper headphones. . .just kidding. At Olympic, it would've been the big Tannoy 15s [a popular British studio monitor with a coaxial 15-inch woofer and concentrically mounted horn tweeter] in custom cabinets. There were four of them, since we were four-track—two horizontally and two vertically—which became the same system we ended up using later at The Record Plant in Los Angeles. Then later, at Electric Lady studios, we used the Altec—good grief, not the 604s, but the larger, boxier ones with the big horns in them. I can't remember the bloody name of them.

What about the monitor speakers used for the MCA remastering sessions?

You'd have to ask George Marino at Sterling Sound, where we did the remastering. He just recently changed his monitors. They're a Canadian speaker, tall, god knows what they are—I'm not a hi-fi nut! [*Editor's Note:* We asked, and Alex Kydd, Director of Studio Operations at Sterling Sound, confirmed that George Marino's monitors are Energy Veritas V2.8s.—*A.L.*]

LISTENING TO THESE REMASTERED CDs, I HEAR THINGS IN THE MIXES I'VE NEVER REALLY HEARD BEFORE.

I'm guessing that the monitor amplifiers back at Olympic Studios in the '60s were tube units, probably. Or did you have solid-state amplifiers back then?

What's solid state? [*Laughs.*] There was no such thing. I don't think they had solid-state amps in those days, although the console was transistorized, a beautiful-sounding Dick Sweatman board.

Listening to these remastered CDs, I hear things in the mixes I've never really heard before—subtle finger noises on the strings, vocal inflections, breaths, drum leakage in the vocal mikes. Did you hear things in the remastering process you hadn't been aware of before?

Oh, yes, of course, although I wouldn't say that was a function of the monitors so much as a function of the fact that we were using the original flat masters as opposed to the EQ'd tape copies. I'd say for 85% of the material, it's the first time the masters were used to make CDs.

Did you have any interest in using CEDAR or Sonic Solutions' NoNoise to remove the analog tape hiss?

Whaaat?! You want me to puke now? It's a criminal offense. People who do that should be hung, drawn, and quartered. It's a joke. You know, there are so many of these techno-boffo brilliant guys who think they know everything about sound, and they know absolutely screw-all. I say, just play the original tape. Play it at 15 inches per second, put some nice EQ on it, and make it sound good. Make it sound like the original. I mean, all this nonsense and bollocks about rolling off the top end and getting rid of the hiss—aw, please!

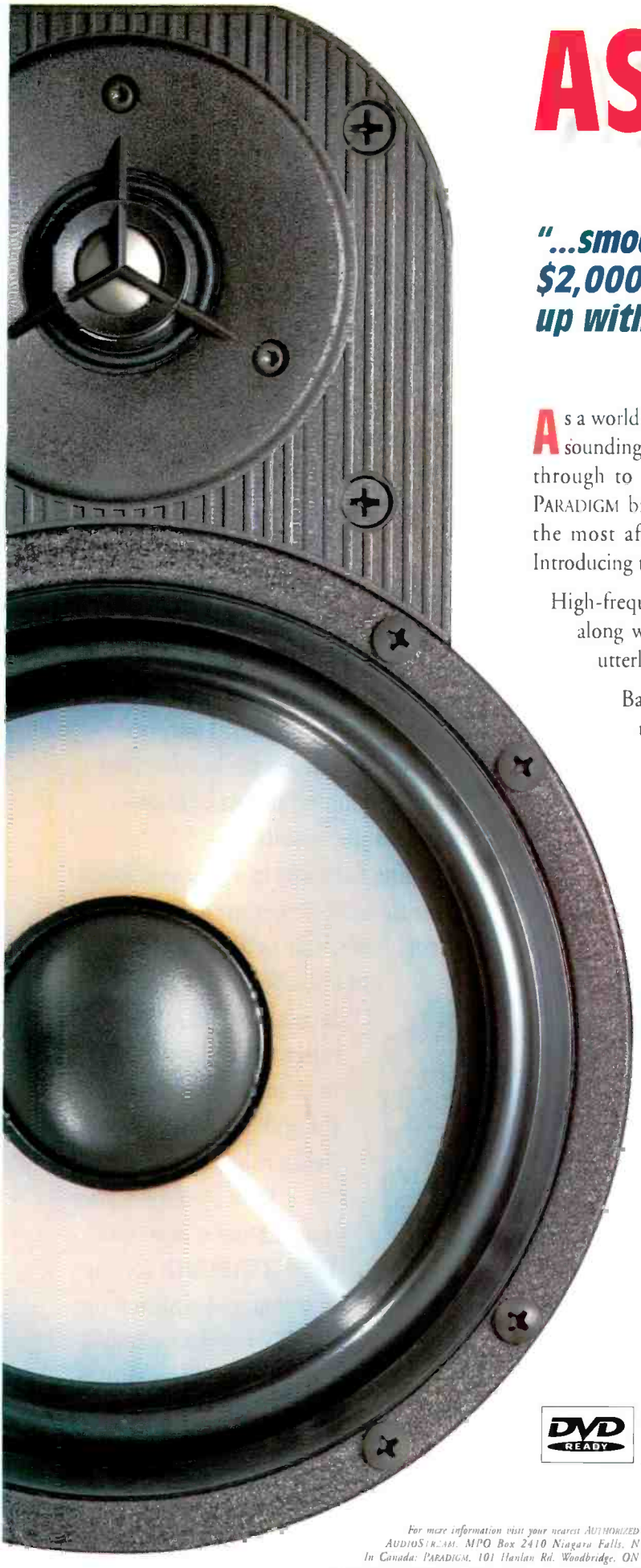
When you were remastering the new CDs, were you aiming for as linear and transparent a transfer as possible, or were you trying to create CDs that would sound good on the average hi-fi system?

Oh, I didn't even think about the average system. What I was interested in was re-creating and enhancing the original tapes and making the CDs sound like I remembered the tapes in the studio with Jimi—bringing them back to life, basically. We used the George Massenberg A/D converter to transfer the analog tapes to digital, which is a very nice unit. Very musical, I think.

Some of the earlier Hendrix CDs, such as the MCA* Kiss the Sky *compilation, had this really nasty-sounding high end, along with what sounded like a touch of DSP stereo enhancement. Were you tempted to go back and do things to the mix that you wished you'd done back in the late '60s?

I could have taken tremendous liberties, but I didn't. You can't overstep your mark; you have to be very conscious of what was recorded originally. The models we had, those flat tapes, made life a lot easier because all of a sudden things jumped out of the speaker at you, without any EQ at all. You just need the tiniest bit of EQ to make the bass sound ridiculous if you want it to, so you have to be quite conservative. I think what I did was enhance what's on the tape and make it sound as natural as possible. Once you have those original flat masters, things just pop out automatically. Stereo imagery is better, and the bottom and top ends are a lot better.

The first thing I noticed was how nice the highs are on the new CDs, how extended and sweet they sound compared to the pre-



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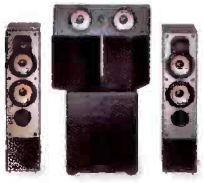

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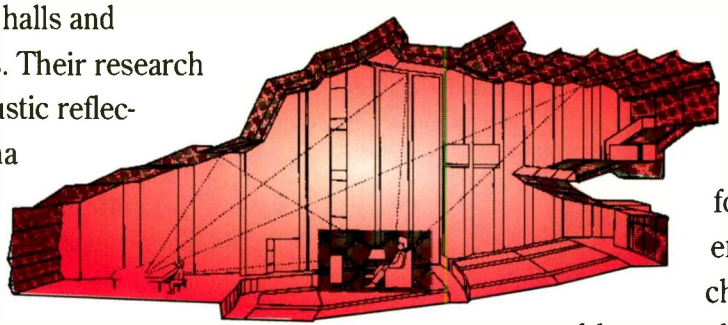

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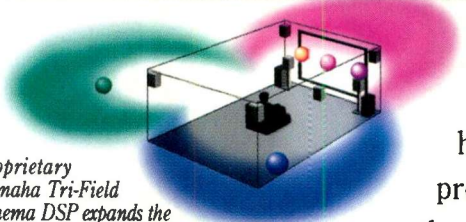

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vious CDs and even my original LPs, which sound considerably duller.

Absolutely. And it's amazing, because when you think about how old the tapes are, there were no dropouts. No baking of any tapes was needed. All the tapes survived intact. We were very, very lucky. The original recordings of Jimi's first albums were on BASF tape, and that stuff didn't drop out. I have a 30-year-old BASF quarter-inch mix that I just transferred, and it's perfect. It plays perfectly—absolutely no dropouts, no shedding, no nothing. That's a tribute to the way they made tape in those days.

Another thing I noticed right away was the improved sense of "3-D" phasing effects sprinkled throughout Electric Ladyland. *They've always been there on the LPs and were a little bit more audible on the CDs, but nowhere near as clear as on these newly mastered discs.*

Yes! I call them "spectral effects." All that phasing stuff, that was really tricky to do. I was screwing around with all kinds of transformers, phasing, half-phasing, three-quarter phasing. We actually got some of the imagery to sit behind your head. . . .

Well, that's what I was going to say, because on the first track of Ladyland, *"And the Gods Made Love"...*

Mm-hmm, that's it...

. . .there's this ball of hiss that just comes over to you from the speaker plane and then sucks into your head and sort of scrambles your brain, even without the acid. So that's an intended effect?

Absolutely. All that stuff was intentional. We were just screwing around, trying to make things sound weird! [*Laughs.*] I think we succeeded!

I always wondered if that was intentional or not, because nobody else I knew had ever heard the effect. I guess you do have to have your speakers set up properly in stereo to image accurately, but when you hear it, it's really cool! I've never heard anyone do anything like it since.

Oh, we tried and tried to get it. See, we got it a couple of times, but it was by accident. When you hear it, it's there for brief moments, because we could never hold it, to keep it in that three-dimensional sphere. It was always, "Oh, we got it, quick! Aw," and then it's gone! [*Laughs.*]

There's also a lot of beyond-the-speaker imaging on some of the tracks—for example, on Electric Ladyland's *"Still Raining, Still Dreaming."*

That's right, that's another thing we were doing. We tried to make the sounds walk to the sides. Experimentation was the name of the game: Try to push the envelope and get as crazy as you could. There was a lot of freedom, which unfortunately we don't have as much of these days.

When you were remastering the CDs, did you listen to any of the original LPs as a point of reference?

Oh, believe me, we had A/B listening sessions with the Warner material, the Polygram stuff, the Track stuff. We had original albums and CDs; we had everything to compare with what we were doing. I'd say, of the older versions, the original Reprise stuff was okay, but it was all from EQ'd copy tapes. The new MCA discs are the first to be transferred from the original flat masters.

Recording engineers are famous for owning the world's worst hi-fi systems. You've already said you're not an audio nut, but what kind of system do you have at home?

It's decent. I've got a pair of Luxman tube amps, a Luxman tube preamp, a Nakamichi CD player, a Technics turntable, and my old corner Klipschorns. It's not the greatest system in the world, but it's okay. I mean, it's just music—we're just trying to make music sound better, that's all. Don't worry about the technical stuff. Just listen from your heart.

So what's next as far as the MCA Hendrix reissue series goes? I know there are plans to release a remastered Band of Gypsys, *but are there any other gems left at this point for you to work with?*

I just finished remastering a new album of Hendrix studio material that will freak you out when you hear it. I don't know if I'm allowed to tell you the title, but it'll be out in the fall. All I can tell you is that it's all unreleased material, and I remixed a bunch of stuff; we found some of the original multitracks, which had never been mixed before. This is such a great little album! Actually, not a little album—it's 70 minutes. And none of this stuff has been out in CD format before. The fans are going to go out of their minds.

And I'll be right there with a bull's horn poking through my lung once more.

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by Ivan Berger

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Speaker designers are increasingly shifting their focus from refinement to revolution. Refinement has taken us a long way, dramatically improving the performance of traditional speaker drivers—cones, domes (a cone variant), and electrostatics and other planar types—all of which work by moving surfaces back and forth, like the pistons of a gas or diesel engine. But the more refined a technology, the less further refinement can be wrung from it. As more and more of the big bugs get worked out, development shifts toward nibbling back the minor ones. That doesn't stop many speaker designers from advancing the art, but it does make others wonder whether it's better to polish technology that already gleams or to try fresh approaches.

It also makes marketers wonder how they can sell speakers that look just like the old models, operate in the same ways, and sound better but not greatly different—especially when the old ones sound as good as ever. (As one noted designer put it, "Thirty-five million pairs of speakers have been sold in the past 20 years—and most of them still work.") It gets harder each year to make traditional speakers that are New and Improved in ways plainly perceptible to the average buyer.

So, speaker makers lately have been looking hard at nontraditional driver technologies: new planar drivers like those from NXT ("Mondo Audio," February 1997 issue), Noise Cancellation Technologies (NCT), and American Power and Light; rotary subwoofer "motors" like ServoDrive's woofers and Phoenix Gold's Cyclone; older designs like the Walsh and the Heil Air Motion Transformer (AMT); and an application of ultrasonic technology that could totally revolutionize speaker design (if it gets out of the starting gate). Since that's the most revolutionary—and controversial—of them, let's start there.

HyperSonic Sound

You can't hear ultrasonic waves. But Elwood Norris of American Technology Corporation (ATC) in San Diego, California, plans to use them as the basis of a revolutionary new loudspeaker, which he calls HyperSonic Sound.

The basic idea goes back to the 18th century, when Italian composer and theoretician Giuseppe Tartini noticed that interference between two sound waves of different frequencies could generate a third sound whose frequency is the difference between the other two. (Such difference frequencies can also be generated when electrical signals mix; this causes intermodulation distortion in audio but is used deliberately in tuning superheterodyne radios.) What Norris realized was that the difference produced by interference between two ultrasonic frequencies can fall into the audible range—and that this has interesting implications for a speaker. Mix the output of a transducer delivering, say, 200 kHz with one whose output can be varied from 200 to 220 kHz, and you wind up with difference frequencies of 0 to 20 kHz—the audio band, and then some.

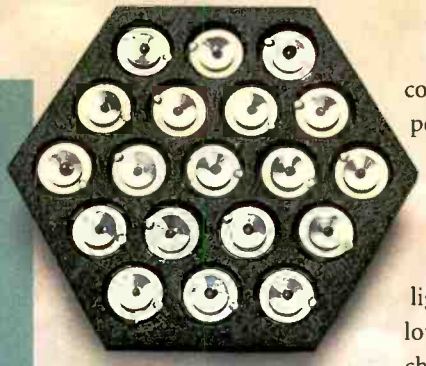
Paradoxically, such a system could cover a wider range of audio frequencies than any conventional speaker while operating over a mere fraction of an octave. The band from 20 Hz to 20 kHz is about 10 octaves, whereas the range from 200 to 220 kHz is only about a 10th of an octave—a 100-to-1 difference. It is much easier to make a driver linear over a 10th of an octave than over even two or three whole octaves. An ultrasonic difference-tone system could therefore do without the multiple drivers and crossovers that conventional speaker systems need in order to cover the full audio range.

Norris also claims that the HyperSonic system would make distortion less of a problem, since most, if not all, of it would be harmonics of the two ultrasonic frequencies—far above the human hearing range. And the close coupling of the small transducers required should ensure well-nigh perfect phase and time response.

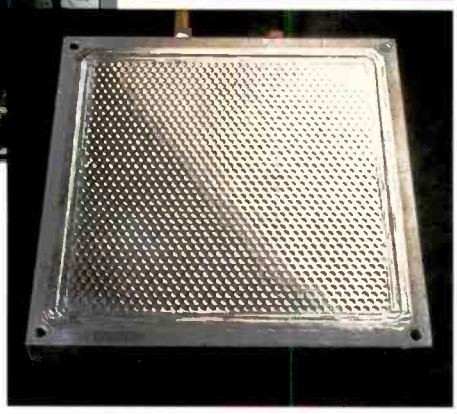
A speaker's directivity at any given frequency depends mainly on the ratio between the sound's wavelength and the size of the driver reproducing it. So

Photo: ©Yamamoto/Photonica

Elwood Norris of ATC, with recent HyperSonic transducer prototype



Early HyperSonic prototype, with piezoelectric drivers and hand-glued whizzer cones



The recent HyperSonic prototype, with electrostatic transducers

with almost all conventional speakers, directivity varies with frequency—a problem that need not occur with a transducer reproducing less than an octave. As a result, a HyperSonic Sound speaker's coverage should be very even.

It would also be very narrow. For broad coverage, a driver must be less than half the size of the smallest wavelength it will reproduce. But at 200 kHz, the wavelength of sound is about 0.0678 inch, and it would be hard to get much output from a transducer half that size. In fact, ATC uses transducer arrays to increase power handling (which narrows the beam still further). The dispersion of the prototype arrays is about 6°, according to Jim Croft of Carver Corporation (ATC's first HyperSonic Sound licensee). There are ways around this, from curving the array to aiming its beam at a curved reflector (a billiard ball would do). On the other hand, such tight beams of sound can be aimed, and ATC sees potential use for that capability.

"For example," Norris says, "you could mount a bunch of transducers on a ball, controlled by a surround decoder." Instead of running wires to speakers at five points in the room, you'd just run wires to the ball, then mount passive reflectors in the desired "speaker" positions. Another ATC idea is to "build an array of transducers on a hemisphere and fire them in sequence to sweep a sound," perhaps adding a steerable extra channel to today's 5.1-channel home theater systems.

Norris also claims that such narrowly focused sound avoids a lot of problems with room acoustics; there's less reflection because the sound scatters less, reducing room interactions by as much as 50 dB. To accomplish this, you'd have to ensure that the sound reaches the listener's ears before hitting a wall so that any reflections the listener then does hear will reach him well after the original signal. Aiming the HyperSonic speakers directly at listeners would also enable very precise imaging control, says ATC.

There are applications where beamed sound is best anyway. In car stereo, for example, a HyperSonic system could deliver separate programs to each listener. HyperSonic sound systems for computers would focus sound to minimize annoyance to occupants of adjoining workstations. Narrow sound beams could deliver private messages across reasonably long distances. A focused beam of infrasonic sound, at 10 to 12 Hz, could be used for crowd control, to temporarily disable key agitators (one of Norris's more controversial claims). Norris says: "We can add a level of directionality to audio frequencies that are traditionally not directional, a kind of spotlight effect—not total directionality with low bass and subsonic, but a directional character. The audible sound has been created in a highly directional column (unless you disperse the ultrasonic wave). Therefore, once the ultrasonic component has been attenuated by distance or a screen, the audible component will maintain its directionality (to our surprise and delight). We've demonstrated that we can project sound across a field, almost 500 feet, and shine it like a flashlight beam. Even up close, outdoors, if you point the speaker straight up you hear no sound."

Norris says the sound can also be made to materialize in midair. As he explains,

Speaker makers lately

"Air absorbs ultrasonics—the higher the frequency, the quicker the absorption. At 200 kHz, an ultrasonic wave is 3 dB (50%) down at 3 meters and rolls off further as the distance increases. Audio dissipates in space from the point where the carrier rolls off, which means it would seem to originate along the line where this rolloff takes place." Norris cites that as a reason for the sound's directionality. A grille cloth would also attenuate the ultrasonic frequencies, so presumably, sound from a grille-covered HyperSonic speaker would seem to originate at the grille itself.

A grille cloth may prove necessary. ATC dismisses concerns about possible harm from the system's ultrasonic beams, pointing out that ultrasound is now used in medicine for sonograms (which ATC claims is based in part on technologies Norris helped develop) and to speed the healing of bone fractures and other injuries. (Cats and dogs shouldn't be bothered, either, because they hear only up to about 40 kHz.) In a demonstration at *Audio*'s office, no one mentioned any discomfort. But at least one speaker researcher, caught directly in the beam of ATC's prototype speaker from only a few inches away, reported severe aural pain at

that instant followed by discomfort that persisted for several days.

This makes me dubious about another potential application cited by ATC: hearing aids. I'm not skeptical of ATC's claim that a HyperSonic hearing aid could eliminate feedback squeals, because the sound would be generated at the eardrum, not right behind the microphone. I also believe the claim that such a hearing aid could reproduce the entire audio spectrum yet still fit in the ear. But I do worry a bit about possible effects from the ultrasonic frequencies, even though the levels involved would be minuscule. (Norris also claims that HyperSonic speakers wouldn't cause feedback in concert or public-address sound systems, even if pointed directly at the microphone, adding that he suspects it might be because of "a slight, broadband phase shift.")

But enough about what the HyperSonic system does. How does it do it? Norris is hardly the first inventor to try producing sound from the difference between two ultrasonic frequencies. The problem has been getting the carrier signals to generate the required sum and difference frequencies, a process called intermodulation or heterodyning. The big mystery about HyperSonic Sound is how Norris gets the signals to heterodyne, which none of ATC's 19 patent filings on the HyperSonic system explains. Intermodulation occurs only when there's some nonlinearity involved (which is why nonlinear audio components produce intermodulation distortion). So where is the nonlinearity coming from? One authority I consulted told me, "The nonlinearity needed must come from the air or from the transducer; if it's from the transducer, then I'd expect distortion, too." Others believe the nonlinearity may be in the listener's ear.

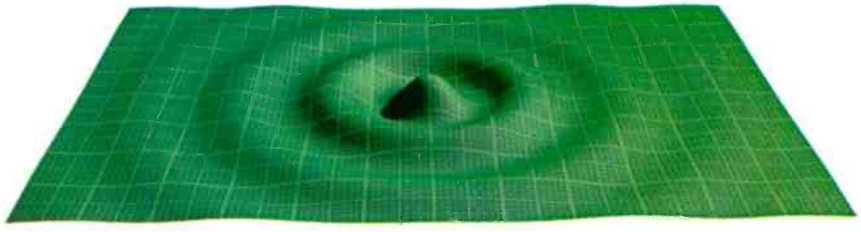
Norris has added to the confusion. During his demonstration at *Audio*, he said, "I worried that I'd need to make air nonlinear. But Helmholtz showed that the nonlinearity is amplitude-related, like a rubber band that is linear for small stretches but not for large ones." Later on, however, Norris said, "Air is nonlinear at all amplitudes." Yet researchers I've consulted doubt that air is nonlinear enough, unless the carrier levels reach 140 or 150 dB SPL.

In any case, Norris no longer seems to be relying on air as his mixing medium. "If you rely on acoustical events in the air, it's so haphazard that the effect is observable but useless," he told *Business Week*. He's now using a single transducer to generate, effectively, both ultrasonic tones. Norris recently promised me he would disclose just how he gets his signals to intermodulate as soon as certain key additional patent applications are filed, adding: "What surprises me is how everyone's missed the secret of generating the difference tones—and a lot of big companies have tried. An acoustical engineer couldn't have invented this, but I came from an electronics background. Still, there is an acoustical effect, which I missed at first, too."

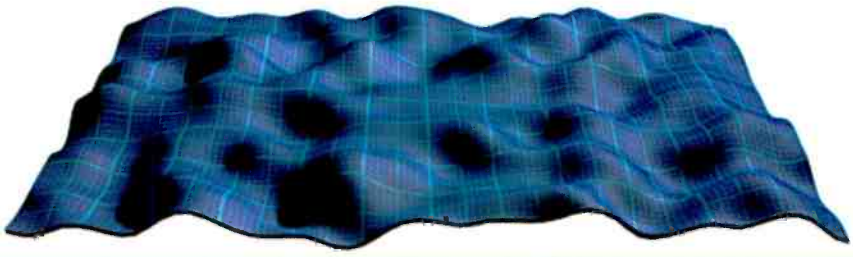
In HyperSonic speakers, the variable frequency must be amplitude-modulated so that simple rectification of the signal mix will yield sound. This creates sidebands above and below the carrier frequency. Norris says these sidebands "dance in and out like skirts, in opposite phase. Where the audio signals produced by these sidebands mix, as they do at bass frequencies, they cancel out." The prototype I heard exhibited rapid cancellation below 200 Hz and almost no output below 160 Hz, which Norris readily acknowledges. He says this problem can be solved by some carrier-to-sideband manipulation, but the analog filters he used in his demo weren't up to the job. He's working with Motorola on a custom DSP chip that will perform the modulation and then "kill the lower modulation sideband and fold its energy back into the upper sideband."

have been looking hard at nontraditional driver technologies.

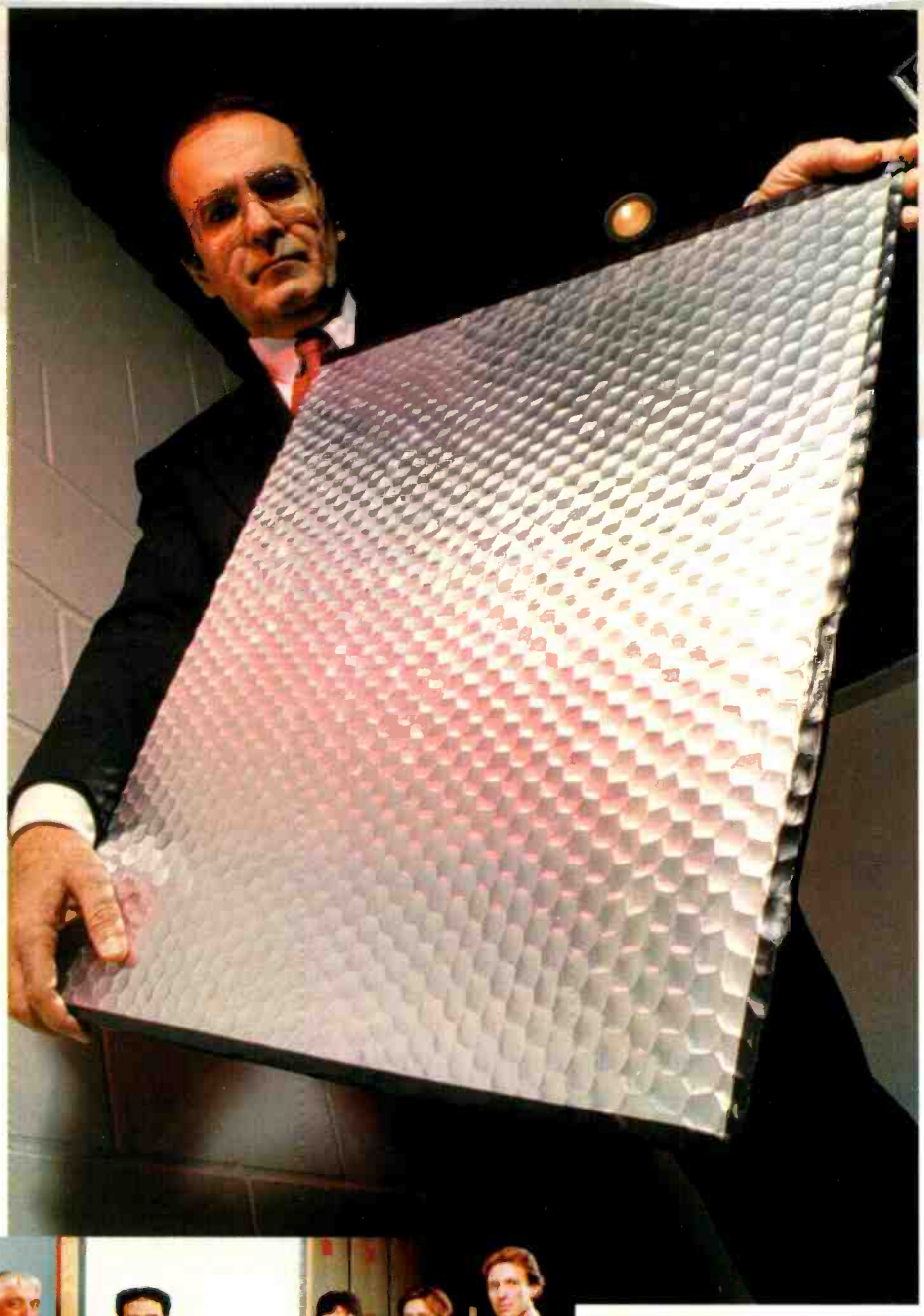
What I heard at Norris's demonstration, late in 1996, was a hand-built prototype. It was intended strictly as proof of principle—"Still Kitty Hawk," according to Norris. The transducers were piezoelectric microphones, which he used as drivers: "Transmitters are too sharply peaked," he said. Since microphones haven't much power-handling capacity, a cluster of 17 was used, with sequin-sized whizzer cones hand-glued to each to help them move enough air. Some of the hand-glued parts had come loose, causing distortion, and the sound rolled off not only below 200 Hz but also above 11 kHz. Overall, the prototype sounded like a small transistor radio—but it did work. About a month later, at the Consumer Electronics Show, ATC held another demo, using a slightly bigger transducer array, better whizzers, and improved electronics.



Applying signals to a stretched-membrane speaker produces coherent ripples.



Applying signals to an NXT panel produces complex bending waves.



Farad Azima, chairman of NXT, shows off the thinness and light weight of a prototype NXT panel.

NXT staff and executives hold two speaker panels, one disguised as a picture.

The power required of that amp will be modest, 50 watts or less per channel. And the current required will be even more modest, since the drivers will have very high impedance. ATC claims very high efficiency for the HyperSonic speaker design, about 10% versus 0.5% or less for conventional speakers, due to a closer acoustical impedance match to the air than conventional speakers can boast. A white paper posted on ATC's web site (www.atcsd.com) claims output up to 120 dB at all frequencies and a power requirement no greater than 50 watts. According to Norris, "You can get a difference signal with greater amplitude [presumably, displacement] than the two ultrasonic signals together because of the vast difference in the energy level of a high-frequency wave at a given amplitude." Further, he has said that "the difference tone has 63% (4 dB less) of the combined equivalent energy of the two carriers plus the sidebands" and that "for 110-dB audio, the carriers should probably be about 125 dB SPL." These are contradictory statements. But Norris has also said that the effect depends on distance and that "it drops off so much with distance that you can measure more audio than carrier at some distances." Says Carver's Jim Croft, "The HyperSonic Sound system's conversion efficiencies are quite high. We are able to have the baseband audio demodulate to within a dB or two of the carrier level and, in some cases, equal the carrier level. The final conversion efficiency—from power amp output, to single-sideband carrier level, to baseband audio level—is still subject to further testing with our new transducers to determine how good it can get. But right now the total system efficiency appears to be above 50% and is climbing. The narrow-band ultrasonic transducer can be quite efficient, and the techniques for which ATC has applied for patents create the difference tones in a new, coherent manner that is also quite efficient. The mathematical analysis at this time suggests that total system efficiencies of over 80% are achievable."

The flat-panel speakers

Others are skeptical. Says one, "Suppose they could make a broadband, high-fre-

The actual drivers, Norris says, will have little in common with either of these prototypes. Their elements will be electrostatic, not piezoelectric, and, like electret microphones, will require no polarizing voltage sources. These elements will not be hand-glued but will be fabricated on multi-element wafers, like ICs, and then etched and wired in parallel. The wafer has been described as "Oreo-sized" by Norris and as "3 or 4 inches in diameter" by others. No matter what the size, each wafer will have about 10% more transducers than it needs, in case some don't come out right. The system will be sold with an amplifier that will self-optimize its output impedance to the number of transducers on the wafer that are actually active.

Heil driver used in Precide Kithara speaker

quency source at 200 kHz that were 25% efficient and could produce 167 dB SPL, a level high enough to make the air nonlinear, over an area of 10 square centimeters. This is a power density of 4 watts per square centimeter and an output of 40 acoustic watts, requiring 160 electrical watts to produce. (It is also a dangerous sound level: 165 dB SPL can acoustically levitate stone, and 170 dB will light a cigarette from acoustic friction.)

"The acoustic output of a constant-volume-velocity source [one whose excursion diminishes with increasing frequency] falls 6 dB per octave as frequency decreases. Even if 100% of the volume velocity were converted to audible sound, at 1.5 kHz, some seven octaves below the carrier, the level would be 42 dB down, or 127 dB over a 10-square-centimeter area. While that sounds like a lot of dB, it is 1/16,000th the power density of the carrier and, from a point source (which the dimensions dictate), is about 86 dB at 1 meter. An output of 86 dB is usually acceptable for a 1-watt input, but not at full power. This problem grows larger as frequency decreases, suggesting that, while the conversion mechanism works down to (and below) 20 Hz, the driver would have stopped being audible many octaves above. (The threshold of hearing at 20 Hz is about 80 dB.) Decreasing the carrier frequency would help the loss of efficiency and reduce acoustic streaming losses (not included in the example). A 50-kHz carrier has a +12-dB edge over a 200-kHz carrier, for instance."

All of the skepticism could, of course, be blown away when ATC reveals the full details of its system. So far, only Carver Corporation has licensed the HyperSonic Sound technology. But if it works as Elwood Norris says, Carver won't be the only licensee for long.

Plane Speaking

Far removed from ATC's point-source technology, but nearly as radical, are the latest planar speaker designs. Where cones and domes generate sound by moving small diaphragms large distances, planar speakers move the same volumes of air by moving large diaphragms short distances. Traditional planars use thin, light, flexible diaphragms and distribute the needed driving force over the diaphragm's surface, either through electrostatic attraction and repulsion between a charged grid and a charged coating on the diaphragm or, as in Magneplanar speakers, through a flat voice coil printed on the diaphragm and a large, distributed set of magnets. These speakers are all dipoles, radiating signals from the front and back in opposite phase.

The most striking difference between the new planars (from NXT, NCT, and American Power and Light) and the old is their use of rigid diaphragms, which can be driven from a few discrete points rather than requiring distributed drive. This, in turn, allows the use of conventional moving-coil or piezoelectric actuators. (Not entirely conventional, however: Some planar speakers from American Power and Light have moving-magnet rather than moving-coil actuators because, with today's lightweight magnets, they have lower moving mass.)

Rigid-plane speakers offer both acoustical and practical benefits. On the practical side, they can be mounted in or on almost any flat surface, including wall-hung pictures, the sides of computer monitors (piezoelectric actuators are nonmagnetic—perfect for this), or projection screens (American Power and Light offers projection screens using its flat-driver technology). The first application I saw of such technology, NCT's Top Down Surround Sound, used panels in a car's headliner; it struck me as unsettling for music but a very good method for listening to traffic reports, phone calls, and other spoken material. The panels' light weight is obviously a benefit in cars and airplanes. And NXT and NCT, at least, have said that their transducer panels can be molded into special shapes for custom applications.

The main acoustical benefit of these speakers is that the sound falls off more slowly with increasing distance than the sound from conventional speakers does. This carries many advantages. In home theater, it makes it easier to balance front and surround levels for all seats, front to back. (As NCT puts it, "Not a sweet spot—a sweet space.") In a car, it lets the sound of the front speakers reach listeners in the back at levels that won't blast the driver's ears out. In public-address systems, it requires fewer drivers to produce fairly even sound volumes over large areas. According to Werner Eymann of Eymann/Marquiss, the European distributor for American Power and Light, "The energy radiation does not beam but sprays," which means that powerful reverberations won't mask subtle recorded information about the recording venue's acoustics. He says that this spray of music is less likely to be heard through walls by neighbors or other family members. Eymann points out that rigid-plane speakers do not have cabinet walls to introduce spurious resonances or edge diffraction and that the speaker's output is phase-correct.

It may be significant that the companies leading this wing of the speaker revolution all have had some involvement with active cancellation of acoustic noise. NCT was one of the first to introduce noise-cancelling headphones. Stanley Marquiss, of Ameri-

are as radical as HyperSonic Sound, but radically different from it.

can Power and Light, has also worked in this field. And the development of the NXT speaker was a direct outgrowth of noise-cancellation research. Kenneth Heron, who was working for Britain's Defence Research Agency, tried using damping panels to cut background noise in fighter cockpits, only to discover that the panels were actually radiating sound instead of absorbing it. After he filed for patents on this discovery, his idea was licensed by the Verity Group, which owns Mission, Cyrus, Wharfedale, Quad, and Roksan; Verity has since set up a subsidiary, New Transducers Limited (NXT), to develop and license this panel-speaker technology.

The NCT and NXT approaches overlap, and the two firms have cross-licensed their patents. "Our breakthrough was finding a way to transfer energy linearly to a large, flat diaphragm," says NCT, "a unique patented method of coupling [actuators] to maximize energy transfer to the membrane, particularly at low frequencies." I'm told NCT's patents chiefly concern ways of mounting the actuator, or exciter, whereas NXT's patents are more concerned with optimal placement of actuators on the panels.

The NCT system uses piezoelectric exciters, which are flatter than the electromagnetic exciters used by NXT and have no magnetic fields; NCT's Flat Panel Transducers (FPTs) have clamped edges and usually more than one exciter per panel. Although the panels can be painted or covered with wallpaper or pictures, NCT says, "You wouldn't want to paint an original oil onto them; the vibration would flake that paint." The FPTs produce sound through a combination of bending and pistonic motion. As you'd expect, they are dipoles, whose front and back waves are in opposite phase, so some sort of baffle is required to keep the rear wave from cancelling the front wave at low frequencies or to make that rear wave reinforce the front wave. (The latter, of course, increases the speaker's efficiency and bass output.)

At first glance, the NXT approach seems only slightly different. Its prototype panels have used moving-coil exciters, as do cone and dome drivers, although piezoelectric or moving-magnet drivers could also be used; the panel edges are free. However, their "distributed-mode" operating principle is distinctly different and extremely unconventional. Cone and dome drivers attempt to push and pull the air as a perfect piston would, ideally moving as one surface without ripples or subsidiary vibrations. Stretched-panel speakers, such as electrostatics, have coherent ripples. An NXT panel, by contrast, carries complex bending waves over its entire surface. The panel is also a dipole, but only up to about 250 Hz; above that, it operates as a bipole, with its front and back waves essentially in phase rather than 180° out of phase.

Getting this right involves juggling myriad variables: panel dimensions and other physical characteristics, location of the drive point (usually just one), and type of panel mounting. The most crucial parameter is the ratio between the panel's bending stiffness and its mass. The math involves fourth-order integration and finite-element analysis. If the results are a bit off, the speaker's frequency response will be peaky; if they're far off, says NXT, "The panel will, of course, radiate acoustic energy, but it will not be a speaker anymore."

Why bother? Because distributed-mode operation appears to have some interesting advantages. The sound from an NXT panel is diffuse rather than coherent—like the output from a piano soundboard, according to Stan Curtis, of Wharfedale. NXT says this reduces the response irregularities often caused by destructive interference. The resulting radiation pattern, a fat figure-8, is said to vary far less with frequency than that of a typical cone loudspeaker—again, a broader sweet spot. Because the sound is diffuse, it seems to get around obstacles better, so sound quality shouldn't change much if someone walks in front of you while you're listening. That diffuse sound should be a natural for surround speakers, yet in a demonstration I heard, it did not seem to diminish the panels' ability to act as front speakers in a home theater setup.

Frequency response is claimed to be "of the same order of flatness as conventional speakers," even before taking the claimed reduction in room-response irregularities. And strange as it may seem considering the contorted look of distributed-mode vibrations, the resulting minute movements help keep the diaphragm and exciter well within

Close-up view of a Walsh driver from German Physiks (top)

The Phoenix Cyclone rotary driver

Cutaway view of a Walsh speaker system from Ohm Acoustics

their linear ranges, which is said to keep distortion low. Further, the minute travel of the panel surface and the voice coil reduces the generation of back-EMF; according to NXT, that and the simple nature of the panel's mechanical impedance make this speaker an almost purely resistive load and thus very easy for an amplifier to drive. Light panel weight and restricted travel are also said to give the NXT speaker fast transient response.

In the demos I've heard, the NXT drivers sounded reasonably good and the NCT drivers slightly muffled. But these were far from being production units. When those come, they'll be from licensees: So far, NXT has signed NEC, Samsung, and Peerless as well as the Verity Group's Mission, Quad, and Wharfedale; NCT has signed a development pact with the Harman Professional Group; and Johnson Controls plans to build FPTs for use in cars. As to American Power and Light, its Planar Transducer (PT)—a flat, free-piston device—is in production.

Golden Oldies

Another product of American Power and Light, the V-Driver subwoofer has drivers facing each other across a deep, V-shaped notch. (I've seen diagrams of this system with conventional cone woofers as well as with flat panels, hinged at the apex of the V and controlled by linear actuators.) One of the claims made for this arrangement is speed, since the air-mass acceleration within the V is the sum of the opposing drivers' accelerations.

A similar effect, differently produced, was at the heart of the old ESS Heil Air Motion Transformer invented by Oskar Heil, a technology that is now back, from Swiss manufacturer Precide. In this design, a rectangular diaphragm, with a voice coil of conductive strips bonded to it, is folded into deep vertical pleats within a magnetic field. As the signal voltage fluctuates, the voice coil is alternately attracted to and repelled by the magnets, opening and closing the pleats. Instead of pushing and pulling air like a piston, the Heil driver alternately squeezes the air out and sucks it back in. This yields increased air-mass acceleration and high air velocity, despite short diaphragm movements. The diaphragm has comparatively low mass and, because its driving force is distributed across its entire area, should be relatively free from breakup.

Precide manufactures Ergo headphones and two speaker models (the Aulos and Kithara) using Heil technology. Precide says that its Oskar Air Velocity Transformer (AVT) incorporates improvements made by Oskar Heil since the ESS version. These are said to include a more even magnetic field, a structure that gives the driver almost 360° dispersion, more rigid mountings, softer, less harsh-sounding diaphragms, and better phase coherence.

Another golden oldie back in a new form is the Walsh driver—which, unlike the AMT, never went away. Like some planar speakers, the Walsh (named after inventor Lincoln Walsh) uses bending waves, but in a very different manner. Although its transducer is a cone, the Walsh driver, unlike conventional cones, faces downward rather than at the listener. It has very steep, long sides and is excited in a different way from conventional cone speakers: Instead of being pushed and pulled, the Walsh stands still while acoustical waves ripple down its steeply raked sides, subtly bending the cone as they pass over it.

The horizontal components of these ripples push and pull the air, creating sound waves. If the cone's materials and slope are chosen properly, each ripple will reach the bottom of the cone just in time to generate a sound wave that's perfectly synchronized with the other waves it's generated on the way down. For example, if the ripple takes 0.2 millisecond to roll down the cone, it will generate a sound wave at the bottom of the cone 0.2 millisecond after generating one at the top. Since sound travels through air at a bit over 10 inches per millisecond, the sound wave generated at the top of the slope will have traveled 2 inches outward from the driver's center. But if the cone's radius is 2 inches greater at the bottom than the top, the wave it generates will start out 2 inches further from the center than the wave from the top. As a result, these bottom and top waves (and all those in between) will move in parallel, radiating a cylindrical sound field. (By changing the slope or material of the cone, the sound field can be made conical; Ohm Acoustics' shortest Walsh model, the Walsh 100, uses this technique to aim the sound slightly upward.) Whatever the radiating pattern, it should be the same at all frequencies, ensuring perfect time and phase coherence and uniform polar response. Other claimed advantages are excellent impulse response and a very wide listening area.

The sound from an NXT panel is diffuse rather than coherent—like the output from a piano soundboard.

In practice, however, it's difficult to make a Walsh driver that performs well over the entire frequency range. Therefore, both Ohm Acoustics (which was first to produce Walsh speakers, back in the early 1970s) and German Physiks (which has been selling them for 3 years) offer two-way systems. Ohm uses Walsh drivers to reproduce the bass and midrange, while German Physiks (which calls its version the DDD Bending-Wave Converter) uses them for midrange and treble. This difference seems to be based on differing views of optimum directionality. German Physiks prefers 360° radiation, which is inherent in Walsh drivers throughout their passband and is easily achieved from low-frequency drivers of almost any type. Ohm, on the other hand, feels that restricting the speaker's radiation reduces room interactions, so it directs the highs to a conventional tweeter while blocking off part of the Walsh driver's rear output. This controlled pattern also enables you to angle the speakers for a time-intensity trade-off, a common way of stabilizing the stereo image for off-axis listeners.

The Incredible Exploding Football

Another way of making omnidirectional speakers has been available for several years from mbl-Akustigeräte, of Berlin. The mbl

"isotropic" driver is a spheroid made of flexible strips that are interconnected by soft plastic. The strips are fixed at the top and are driven at the bottom by a magnet and voice coil. The voice coil's action alternately compresses and stretches the strips; the resultant increase and decrease in the spheroid's radius generates the sound waves. This is the closest approach I've seen to the often-voiced idea of a pulsating-sphere driver, which itself is the practical embodiment of the theoretically perfect point source. Three mbl models sold in this country use this technology. Models 101C and 101D use three isotropic drivers: a football-shaped woofer, a nearly spherical midrange, and a tweeter resembling a squashed sphere; Model 111 uses isotropic drivers for the upper midrange and treble and cone drivers for the lower midrange and bass.

Motor-Driven Bass

Two other companies' wildly unconventional woofer designs turn out to have come from one inventor, Thomas Danley, holder of 16 patents on loudspeakers and other acoustical and electromagnetic systems. What these designs have in common is motors that turn instead of moving back and forth like the motor (voice coil and magnet) of a conventional cone driver.

Rotary motors offer several potential advantages. Unlike voice-coil motors, which become nonlinear when pushed to their extremes, rotary motors are designed to turn indefinitely, with no nonlinear areas of operation. Moreover, since these motors need not be attached directly to the cones, they can be made large enough for good heat dissipation. This not only increases power-handling capacity but also keeps output from dropping off during sustained high-level signals; when voice coils heat, their resistance rises and the power delivered to the speaker drops.

But though none of these woofers has a voice coil, two of them—originally made by Intersonics, now by ServoDrive—do use cones. One, the BassTech 7, is a large horn designed to be used in clusters in commercial sound systems. The other, the ContraBass, is a conventional-looking box with a 15-inch active driver and an 18-inch passive radiator at each end. Inside, a single servo motor moves both drivers via a heavy-duty belt system that converts the motor's rotary motion into linear motion; rigid shafts transfer the motion to the cones. Because the ServoDrive speakers handle only bass frequencies (the ContraBass's rated bandwidth is 15 to 125 Hz between –3 dB points), the low-inertia motor does not turn at high speed, so it should have no problem reversing to follow signal oscillations. The cones move in opposite directions (excursion is rated at ¾ inch, peak to peak), which means both move in or out simultaneously. This poses less strain on the motor, as the woofers are mechanically out of phase so that the forces on the cones are opposed rather than additive. But acoustically, the two woofers are in phase at all times, yielding an omnidirectional radiation pattern. Originally designed to reproduce wild elephants' 14-Hz chest tones over vast distances, the ContraBass is now sold for use in commercial sound systems. It is rated to deliver 114 dB SPL at 1 meter continuously at 16 Hz, which might lead some home bass freaks to cheerfully ignore its 37-inch height, 120-pound weight, and black carpeted exterior.

Danley's other motor-driven woofer design, the Phoenix Gold Cyclone, was originally devised for car stereo systems, though a home version is now under development. The Cyclone is conceptually more complex than the ContraBass but mechanically simpler: It uses a rotary impeller that eliminates the need for the ContraBass system's rotary-to-linear converter. The impeller, which looks a bit like a washing machine's agitator, has the same area as a 12-inch cone, but its 38° rotation gives it the same air-moving capacity as a 12-inch cone with 3 inches of travel. The impeller turns within a 12-inch cylinder that separates the acoustical output from the radiator's front and rear surfaces, but the assembly still requires a 3-cubic-foot enclosure; the entire Cyclone driver assembly drops easily into the same size hole as a conventional 12-inch woofer. The home version will have its own enclosure and sophisticated electronics, including an unusual feedback scheme. The ServoDrive and Phoenix Gold woofers may not be the most radical of the designs discussed here—I think the ATC HyperSonic system takes that honor—but their rotary drive systems definitely make them revolutionary. A

COMPANY ADDRESSES

American Power and Light, 6085 Old Sacramento Rd., Plymouth, Cal. 95669; 209/245-4689; info@americanpowerlight.com; www.americanpowerlight.com

American Technology Corp. (ATC), 131124 Evening Creek Dr. South, San Diego, Cal. 92128; 619/679-2114 (fax: -0545); www.atcsd.com

Carver Corp., P.O. Box 137, Woodinville, Wash. 98072; 425/482-3400 (fax: 425/778-9453); www.carver.com

Ergo, c/o May Audio Marketing, 10524 Lexington Dr., Suite 300, Knoxville, Tenn. 37932; 423/966-8844 (fax: -8833); mayaudio@aol.com

German Physiks, c/o Allusion Audio, 1401 Avocado, Suite 505, Newport Beach, Cal. 92660; 714/759-1005 (fax: 714/644-0461); mail@allusionaudio.com; www.allusionaudio.com; mail@German-Physiks.com; www.German-Physiks.com

mbl, 8730 East Via de la Luna, #13, Scottsdale, Ariz. 85258; 602/991-8001 (fax: -8797); www.mbl-hifi.com

New Transducers Ltd. (NXT), Stonehill, Huntingdon PE18 6ED, England; 44-0-1480-451777 (fax: 44-0-171-589-7771); info@next.co.uk; www.nxt.co.uk

Noise Cancellation Technologies (NCT), One Dock St, Suite 300, Stamford, Conn. 06902; 203/961-0500 (fax: 203/348-41060); www.nct-active.com

Ohm Acoustics, 241 Taaffe Place, Brooklyn, N.Y. 11205; 718/783-1111; www.ohmspeakers.com

Phoenix Gold, 9300 North Decatur, Portland, Ore. 97203; 503/288-2008 (fax: 503/978-3381)

Precide, c/o Jason Scott Distributing, 411-E Caredean Dr., Horsham, Pa. 19044; 215/773-9600 (fax: -0332); www.jason-scott.com

ServoDrive, 1940 Lehigh Ave., Suite C, Glenview, Ill. 60025; 847/724-5500 (fax: -4847)

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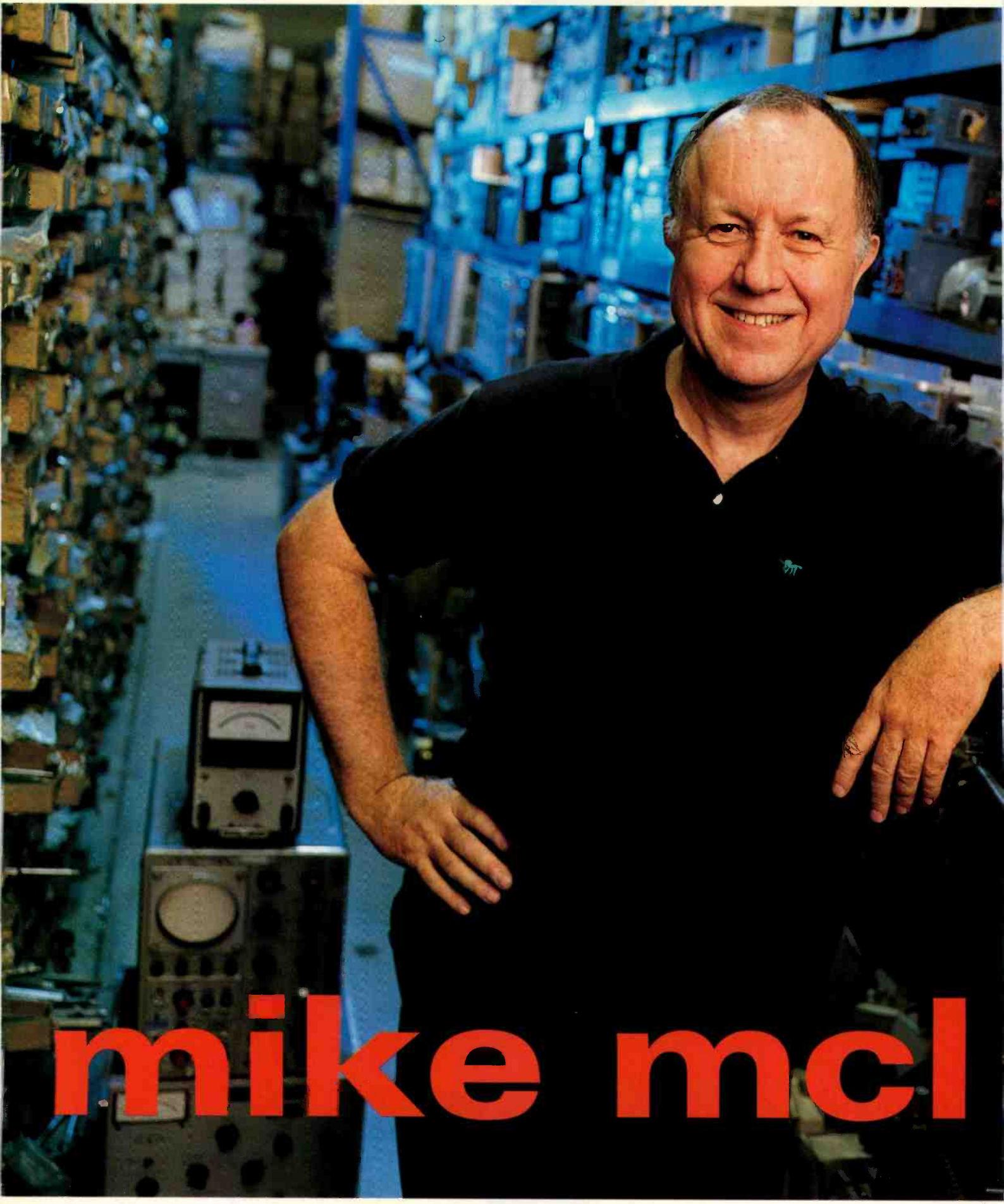


Photograph: ©1997, Stephen Harvey

BY D. W. FOSTLE

A living room wall in Mike McLean's southern-California condo is covered with records. Fifty feet of meticulously crafted cabinetry encases an immense collection. When Martha Reeves, Marvin Gaye, Mary Wells, Smokey Robinson, Stevie Wonder, The Supremes, The Temptations, and The Four Tops set the hooks of their hits into the mind of a nation, Mike McLean was Motown's chief technical engineer. Although he rejects any theory of his own importance, it is difficult to exaggerate his impact on "The Sound of Young America." As the maximum Motown technologist, McLean designed, built, or specified nearly everything in the Detroit studios.

Typical items in the McLean archive: Sir Thomas Beecham and the London Philharmonic on Columbia Masterworks 78s; von Karajan conducts the Berliner Philharmoniker; box sets of virtually any opera recorded interposed by the cubic yard with Beethoven, Berlioz, and Brahms. There *are* Motown sides in this vast accumulation, but very few. After a hard day at Hitsville, Mike McLean often relaxed with a six-pack and the Wagner Ring Cycle.

MASTER OF THE MOTOWN SOUND

It's not really surprising that his taste would run in that direction. McLean's father Archie collected art, antiques, and Persian rugs (the family home was furnished like a minor annex of the Detroit Institute of Arts). His prime passion, however, was classical music. Starting in the late '40s, his house became a gathering place for men who shared that love. They listened, and they talked of the music and the devices that could re-create it in their homes. Hi-fi was young, and, in the company of those men, so was Mike McLean. What follows is the story of how the boy reared in that musical tradition came to be a man at the epicenter of a new and utterly different genre, and of how the now-legendary Motown sound was created and captured in the studios he designed. D.W.F.

D. W. FOSTLE WORKED FOR MIKE MCLEAN AT MOTOWN FOR TWO YEARS IN THE EARLY '70S. DESPITE THE EXPERIENCE, THEY STILL SPEAK.

Mike, how did you get a job at Motown Records when you were just 20 years old?

I was very excited about the idea of buying a $2,000 Ampex 351-2 portable tape recorder, because, like my mentor Max Stroup, I wanted to go out and record orchestras. I had a fantasy about how I would do this if I could only acquire the right equipment. Max worked at Chrysler, as an acoustical measurements engineer. He believed in keeping busy, so at night he'd build Williamson amplifiers for hi-fi hobbyists. So my dad got one. I grew up in surroundings where people liked to build high-quality audio equipment and listen to classical music.

Session musicians during a break in recording at Motown studios.

Mike McLean, Chief Technical Engineer of Motown studios, circa 1966.

Stroup played clarinet in the Plymouth Symphony Orchestra, so he was in a position to make recordings. He had a big Klipsch horn-loaded speaker that he'd built, and he recorded using a Stephens condenser mike, which was a remarkably high-performance, natural-sounding omnidirectional microphone. Back in those days I had two experiences that were awesome and thrilling: One was listening to Max's tapes, which had this wide, almost supernatural dynamic range—no compressors, no nothing. Compared to 78-rpm records or LPs, it was just breathtaking; drums had tremendous impact, and there was a stunning clarity to the instruments. The other was hearing the live, mono FM broadcasts done with a Telefunken U-47 condenser mike hung over the University of Michigan Band. You'd hear these fantastic transients—the impact sounds took your breath away. It was hi-fi heaven.

How old were you then?

Somewhere between 9 and 12 years old. Max Stroup got me all jazzed up. My heroic image of what was cool was to own an Ampex in a beautiful black case, just like Max's. By the time I was 19, I needed a job. The last job I'd had was in a gas station for 50 bucks a week. I was in a pretty tough position, lusting for this $2,000 machine. It was a total obsession, driving me crazy. I looked in the paper, and lo and behold, there's this ad in the *Detroit News*: "Electronic Technician, must have knowledge of Ampex equipment." I didn't have a car at the time; my license was confiscated for hot-rodding. I called up my friend John Windt, and he drove me down to the Hitsville building at 2648 West Grand Boulevard, in Detroit, Michigan. It was a cold winter day in January of 1961. I was interviewed by Berry Gordy, and he took me into the control room. They had an Ampex 351 two-track, which they were using as their multitrack, and an Ampex 400 like the one old Max used. That was for the final mono mixdown. There was an old 1930s-vintage Western Electric broadcast console. They'd put the band on one track and the lead vocal on the other, then mix the two together.

When Berry took me into the control room, he turned up the monitor. There was a hum, and he asked me why they had the hum. I said, "Well, maybe that's an open grid; maybe you have an input without anything plugged into it picking up hum." He asked about four or five questions of that nature, and he seemed to be extremely pleased. I went home, and two or three days later they called and asked me to come back. I took the bus down, and they hired me. Seems to me I held out for $50 a week, which was what I had got for pumping gas and greasing cars.

Twenty-six hundred dollars a year?

I guess that's right. That certainly is a conservative salary by today's standards. I had to subdue my obsession with this tape recorder; I could deal with having my own Ampex machine later as long as I had access to them. I was hired as a maintenance technician.

So they were recording hits like "Money" and "Get a Job" with two Ampexes and a prewar Western Electric console. What other gear did they have?

The monitor system consisted of two Electro-Voice Aristocrat cabinets, which were designed to be used with a 12-inch speaker, but they had mounted a 15-inch Altec-Lansing 605A Duplex coaxial in each one. The 605 was a descendant of the 604 series; it was characterized by very high efficiency and a tendency to be very heavy on the midrange. It was a real earbuster. When you had a bunch of brass playing loud and turned that speaker up, you could really do a number on your ears. The speakers were up near the ceiling in each corner of the control room, but they lacked bass and were thin-sounding.

MOTOWN

MY HEROIC IMAGE OF WHAT WAS COOL WAS TO OWN AN AMPEX IN A BEAUTIFUL BLACK CASE.

These speakers were driven by a Pilot Radio stereo amplifier, 35 watts per channel, with a pair of EL-34 output tubes. Same outputs and similar circuits to the Dynaco Stereo 70. There was a companion Pilot preamp that was used as the monitor control.

How many positions on the Western Electric board?

I believe that console had eight 600-ohm rotary pots made by IRC. It came with the old Western Electric preamps, which had big tubes from the 1930s, with five or six prongs on them. Four Altec broadcast preamps had just been added to replace the preamps built into this old funky console. And they'd just bolted a Fairchild 660 mono compressor/limiter into the rack. Today the Fairchild has become something of a cult classic.

What sort of mikes did Motown have in 1961?

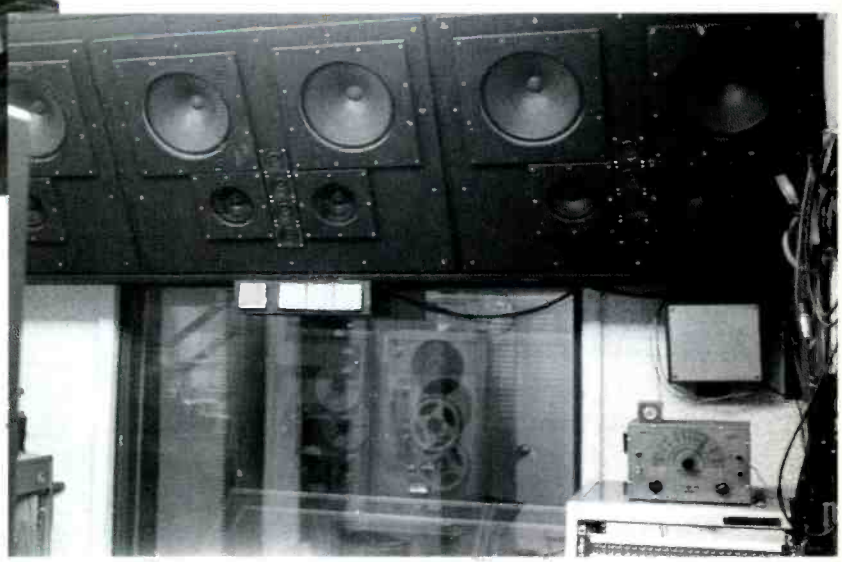
There was a Neumann U-47 and a U-48. I'm not sure, but one may have had the Telefunken name on it. I think there were a couple of Electro-Voice 666s, two RCA 44-BXs, and an RCA 77-DX. That's all I remember. They'd just gotten the Neumanns and were having a lot of trouble with them. There was a chronic problem with overloading the mike preamps because of impedance mismatching. The first solution was to back away from the mike. Eventually, we learned to put an impedance-matching pad on the output, which made the Neumanns compatible with American preamps.

Marvin Gaye

Who was engineering sessions at this time?

The number-one guy was Robert Bateman. He was a very talented fellow and was producing a group called the Satin Tones. His sidekick was Brian Holland. In those days, Robert Batemen was the big shot, doing all the mixing. Berry would come in and say, "C'mon Robert, I'll show you how to make you a better mix." They'd go back and forth, doing their thing about how to do a good mix; Brian would stand by, a hangdog little helper. Berry Gordy worked the same way, a kind of one-man record-making machine, working out arrangements and everything else.

Early studio monitor setup at Motown utilized Bozak drivers.



Are you saying Gordy and Bateman went out on the floor and adjusted the drum mike?

Absolutely. Whoever was producing the session would press "Record" on the Ampex, move mikes—whatever. Sometimes Berry would play piano on Robert Bateman's sessions, and Robert sang backup on Berry's. Sometimes Berry sat at the board when Bateman sang with his group. They were doing all of this stuff. Robert Bateman was a very brilliant, creative person, and what he accomplished was remarkable.

Were the early Smokey Robinson sessions done that way?

Either Berry Gordy or Robert Bateman would mix those. Smokey, at that time, was not into mixing. Later on, Smokey did some of his own mixing. The basic idea back then was that if anybody had a bright idea for a hit record, we'd all figure out how we could get the thing on tape.

What did they use for reverberation then?

They'd just built an echo chamber in the attic of the Hitsville building in Detroit. That was the only building then. The chamber was very crudely made with some parallel walls, some flutter echo, and poor sound isolation; as I remember it, they just nailed up some plasterboard. There was a door at each end. It was about as basic as you could imagine. Pop Gordy, Berry's father, was in the construction business, and he had one of his guys build it to verbal instructions. I think the chamber had an RCA 44-BX microphone. What the speaker was I can't possibly remember. My experience over the years is that it doesn't make much difference what you use in a chamber.

So that was Motown at the time Barrett Strong cut "Money (That's What I Want)" for Berry Gordy?

Yes. However, I will say this. Because of the flutter echoes in the chamber, it had an unusual characteristic sound that seemed to be highly favored by many people who used it. In fact, some consider it

to be one of the major constituents of the Motown sound. We built much more sophisticated chambers with non-parallel surfaces, thicker, harder walls, beautifully polished and varnished plaster—all the things it said to do in Harry F. Olson's book [*Musical Engineering*]. They didn't seem to think those fancy chambers were as satisfactory as the crude original one with flutter echoes.

So a big contributor to the early Motown sound was that primitive chamber?

Apparently, yes. On the other hand, in his autobiography, *To Be Loved*, Berry Gordy says that the EMT-140 reverberation plate was the best. We bought the first one about three months after I arrived. The 140 was a great big plate of 1/32-inch-thick steel, stretched on a frame. Moving one was like moving a piano. Eventually we built a doghouse for the EMT plate outside the building. We knocked a hole in the basement wall to duct warm air to it.

What did Motown use for equalization?

There was a Pultec EQP-1A and an old, passive, 600-ohm Hycor. That, plus the Fairchild limiter, was the basic setup. It wasn't long before we ordered two more equalizers. One was the general purpose EQP-1A, and the other was a Pultec MEQ-5 that added more flexibility to midrange EQ. Those were New York-caliber professional pieces.

And cult gear today. So what was the next big project?

It was a console. But we were totally mystified. We didn't even understand what was required to design a simple, passive, 600-ohm resistive mixing network. When I got a copy of Howard Tremaine's *Audio Cyclopedia*, it was like manna from heaven.

We wanted a three-bus board to be compatible with the three-track, half-inch tape machine standard. We got a bunch of war-surplus relays—brand-new, beautiful, hermetically-sealed relays—for the bus-assign matrix. Wiring that gave me something to do for about three weeks.

So Motown then was build first, design later?

There was a tendency to think up a part of the system that we'd need, then design just enough to build it. When you have 12 inputs and three outputs, you need a lot of relays there. In this early period I'd sit around assembling electronic stuff, waiting for some crisis to arise.

This is the same console with the Emcor frame that's now in the Motown museum?

The same one, with many later modifications. We never actually used the relay box I built. Another thing we did at that time: I was crazy about Bozak speakers. I thought they were great because I was a hi-fi fan, and my Dad and I had them at home. So I thought they would be better. The fact of the matter is that this was a totally sideways move. It was even dumber than that, because the Altec-Lansing speaker was an industry standard. So we went into some weird hi-fi thing, hardly a move forward.

THE FIRST BOZAK WENT INTO BERRY GORDY'S OFFICE FOR LISTENING TO REFERENCE ACETATES.

The first Bozak went into Berry Gordy's office for listening to reference acetates. Pop Gordy, Berry's dad, made the cabinet. "Wait'll you hear this, boss. These are so great!" That's what I said. So there was a different sound in Berry's office from in the control room.

It sounds like the console took a while. . .

It was a hodgepodge mess. Meanwhile, there was a lot of talk about how we had to get a three-track, half-inch machine. When we went to New York, all the big boys were using that. And, of course, we wanted sel-sync, which allowed you to overdub. Back then, a three-track Ampex sold for about $5,000, the price of a new Cadillac. In the meantime, my obsession with having my own recorder led me to the point where I thought, "What the hell, now that I've had a chance to work on these Ampex 351-2 machines, and to look at the manuals and keep them going, maybe I could build one." There was a recorder built by Edgar Lesher, who was an aeronautical engineering professor. As a sideline he was building recorders in his basement that were similar to an Ampex 351 in concept. The price was much more reasonable, and I bought one of his bare decks for $300; my old man lent me the money. I scavenged a head assembly, built the electronics, and eventually got the thing going.

Smokey Robinson and the Miracles, left, and, below, the Temptations.

Building your own recorder was training for building the Motown three-track?

Training in the sense that these possibilities became blindingly real to me. I could see that the circuits were simple enough that I could cookbook copy them. You know, why not? What the hell, I've got the same machine if I do this, why pay $2,000? My game plan, having grown out of

Photographs: Hulton Getty/Tony Stone Images

the lust to own an Ampex, was directly transferable to a three-track for Motown.

So I proposed this to Berry Gordy, and he was a little wary at first. He thought it was pretty weird. He's wondering: "McLean's a genius, but he's gonna build me a three-track recorder like at Columbia studios in New York? He's gonna put it together himself? That's a little far-fetched." But to me it was no big deal; I knew how to punch a chassis, mount tube sockets, wire parts, and follow a schematic. The Lesher deck solved the transport problem.

The Supremes

How long did it take you to convince Berry Gordy that you could brew up a three-track at less than a quarter of the price of the real thing from Redwood City?

It took a few days. The third time I nagged him, he said, "All right, let's do it." I was just a little too confident, and he was just a little too hungry for a cheap three-track. So I started to hand-draw the circuits; I got one circuit from the 351, another from an Ampex 600, and one from an Altec mixer, for the outputs. By the fall of 1961 we had a 98%-complete three-track and part of a console. That's when Berry told me I was now in charge of the engineering department and raised me to $80 a week. He really pumped me up. I'm thinking, "Zowie! Wow! Now I'm the chief engineer!"

The three-track record/mix board in Motown's studio in Detroit, circa 1963. "Please, Mr. Postman" was the first hit recorded on the three-track.

So I hired a couple of friends, and we went on a crash program to stick it all together and get the three-track setup running. I think "Please, Mr. Postman" was the first hit recorded on the three-track.

What was the basic setup?

We had an Altec 1567-A mike mixer for track one, the lead vocal, and ran that through the Fairchild 660 limiter. The rhythm section was routed to an Ampex MX-10 mixer and laid down on track three. The rest of the band—the horns, back-up vocals, and whatever—was on track two through the console. Tracks two and three were cut together, and the lead was sometimes an overdub. It got hairy when there were strings. Sometimes the reverb was recorded on the tracks; other times it was added later. Same for EQ. Different people worked different ways. Everything was recorded and mixed on that one board.

But it was just like a city there. Every day new people arrived. Berry Gordy hired his brother, George, and said "I'm going to make you a mixing engineer." Berry would listen to the mixes that his brother made and send him back to try again. An evolution gradually took place. They would bring in new people who weren't skilled and have them work the night shift, learning how to mix. They worked on the albums, which didn't have nearly the same quality requirement as singles. All these lame tunes that weren't good enough to release as singles would wind up being mixed by these characters on the night shift for the albums. The attitude was: "Now we've got a hit, we've got to get the cover album out." That was a whole different level of production, which was much less quality-oriented. It didn't have to be diddled and fiddled to the nth degree; they were just filling up an LP.

What was the rest of the process?

The end product, as far as magnetic tape was concerned, was always a mono, quarter-inch, full-track master tape at 15 ips. That went to the disc room to get a reference acetate cut. Gordy and his buddies would sit there and evaluate the acetate. They'd have several acetates for a single, a whole reel of masters of the same tune that were cut on acetates. Berry might try a mix, or Brian Holland or Robert Bateman or another producer might do one.

They'd kick it around, listening in Berry's office. I have a picture in my mind of Berry listening to some early Temptations stuff in that room. It was very rudimentary—just the Bozak speaker, a Dynakit amp, a turntable, and a few chairs. He'd say things like: "We got to remix this and bring out the violins, and we got to have a better rhythm in this little part here. Push it up to get more feeling." They'd run down and do another mix. The mixes were sent to Bell Sound, in New York, to have the reference acetates cut. That was an incredible pain in the ass, so Berry decided we had to have our own reference acetate cutter. I went to New York to buy a disc lathe in 1962. As far as he was concerned, there was no such thing as listening to the tapes. A

NEXT MONTH: MIKE MCLEAN, BERRY GORDY, AND THE QUEST FOR THE TRUE SOUND.

SURGEON GENERAL'S WARNING: Smoking Causes Lung Cancer, Heart Disease, Emphysema, And May Complicate Pregnancy.

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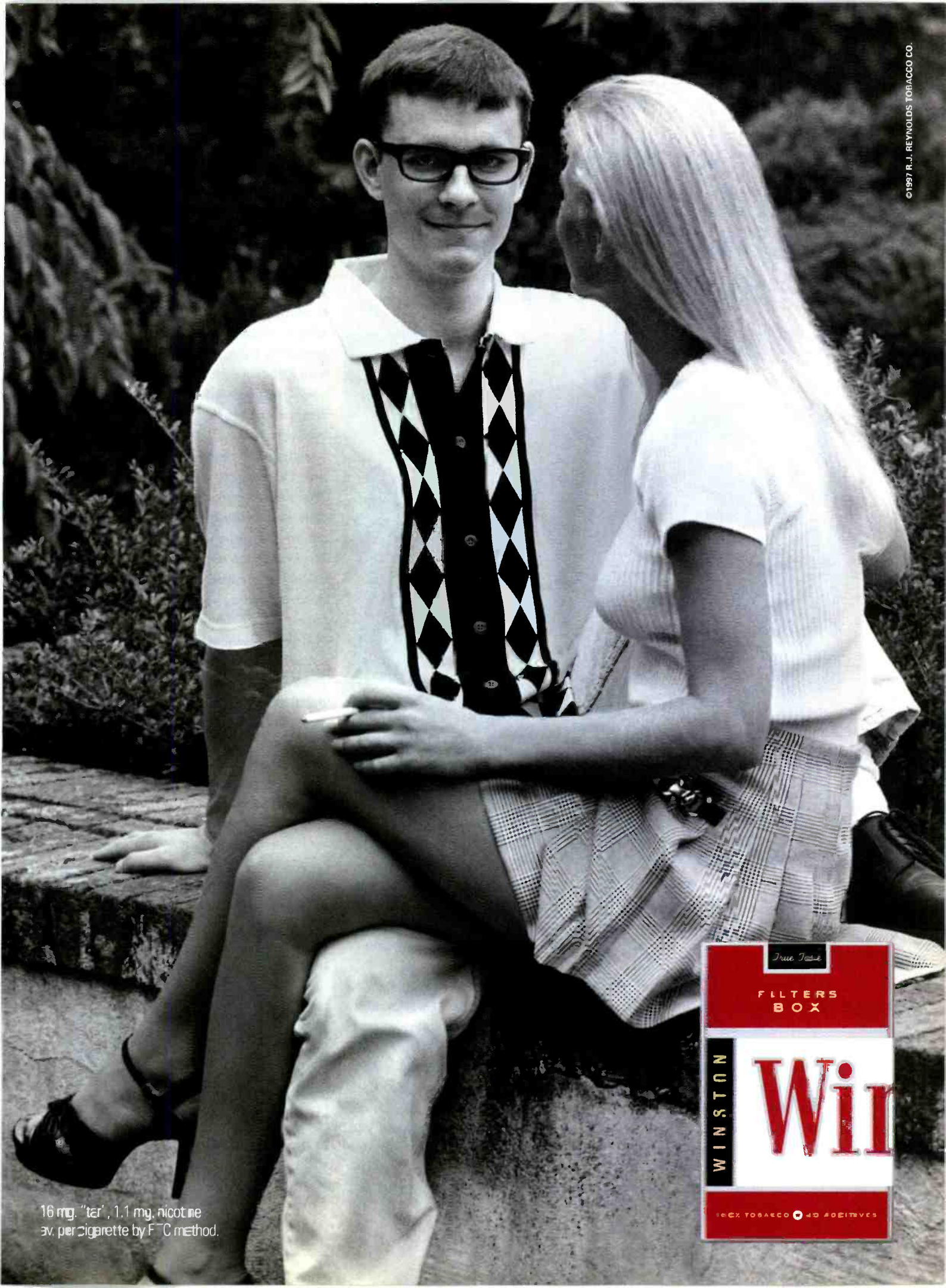
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EQUIPMENT PROFILE

D. B. KEELE, JR.

SUNFIRE TRUE SUBWOOFER MARK II POWERED SUBWOOFER

Photos: Michael Groen

Honey," my wife asked, "is there a big truck in the driveway? Or are you making that rumbling noise?" It was just me, doing ground-plane tests of the Sunfire True Subwoofer Mark II in our driveway, about 20 feet from the room where she was. I was running a sine-wave sweep and had accidentally turned the woofer's gain up to maximum. The Sunfire's limiter was properly protecting the driver against overload, but the speaker was nevertheless generating its designed maximum low-frequency output—which obviously was quite substantial.

The True Subwoofer's rated response goes down to a low 18 Hz. Yet the whole package, including a very efficient, very high-powered, built-in amplifier, fits into an 11-inch cube, which is minuscule for a subwoofer of its output and frequency range.

When I first read Sunfire's spec sheet on this subwoofer, in late 1995, I was immediately excited about the possibility of a super-small subwoofer capable of producing real output down to 20 Hz and below. (I was also quite skeptical about Sunfire's seemingly extravagant performance claims, but I knew that Sunfire's founder, Bob Carver, has a strong track record for making good on his assertions.) I grew even more excited when I first saw and heard a demonstration of the True Subwoofer, at the 1996 Winter Consumer Electronics Show. (The Mark II is an updated version of the 1996 model, with improvements in the woofer and slight changes in the electronics.) A couple of times during the demonstrations, the high air velocities generated by the subwoofer actually sucked the draperies against the system's driver!

Bob is known for his expertise in electronics, not speakers. But he has long been known for devising novel solutions to knotty audio problems. So, coming relatively fresh to speaker design may actually have helped, by letting him look at its problems with a fresh eye. He is to be commended for a very challenging design that a more experienced speaker designer might not have even attempted.

Sunfire's 13-page white paper, written by Bob Carver, goes into great detail on the True Subwoofer's operation, in ways that depart significantly from conventional engineering explanations. He discusses speakers as electric motors (which they are, albeit motors whose loads go back and forth instead of rotating), using an electric-motor concept called the stall ratio (see "The Stall Ratio and Back-EMF").

Sunfire claims that the True Subwoofer is significantly more efficient than conventional subwoofers of comparable performance. Bob cites the difference in power drawn from the AC line by his subwoofer and the draw of a conventional amp driving a much larger, conventional subwoofer to the same sound pressure levels. He says the True Subwoofer's high efficiency results both from its exceptionally efficient ampli-

Rated Frequency Response: 18 to 80 Hz, +0, –3 dB.
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fier and from the design of the subwoofer itself. (However, he does not claim that the subwoofer is more efficient than large conventional woofers, only that it's a lot less inefficient than Thiele-Small parameters say a woofer its size should be.)

At each end of the True Subwoofer's cabinet is a 10-inch diaphragm with a large, protruding surround. However, the system has only one woofer; the other diaphragm is a passive radiator. The woofer and passive radiator have identical frames, cones, surrounds, and spiders and are each said to deliver very long excursions of 2.5 inches, peak to peak. But where the Sunfire's woofer has a voice coil and an extremely large magnet, its passive radiator has a 1.7-pound mass attached. The passive radiator's movement is governed solely by mass, compliance, and the air pressure in the enclosure. In effect, it is coupled to the woofer through the springiness of the air in the enclosure.

THE TRUE SUBWOOFER MANAGES TO GET 18-Hz RESPONSE FROM AN 11-INCH CUBE.

Passive radiators are sometimes referred to as drone cones or vent substitutes. (Bob prefers to call the one in the True Subwoofer a "mass-driven driver.") Essentially, a passive-radiator system is a vented-box enclosure, with the passive radiator replacing the port. The passive radiator enables large amounts of low-frequency acoustic power to be generated from small enclosures. A real vent small enough to fit such an enclosure would not have the same bass effect, nor would it have enough vent area to avoid turbulence. (Turbulence causes not only wind noise but also vent compression, a limiting effect that occurs when the vent's output stops rising as input power is increased.) The area of the Sunfire's passive radiator is quite large, however. And the passive radiator's mass helps tune the Sunfire's enclosure, whose volume is less than 1 cubic foot, to 20 Hz. For an 8-inch vent to have the same effect, it would have to be about 60 feet long—which means the vent tube's volume would be about 21 times that of the enclosure!

In a box this small, two large diaphragms making very large excursions generate extremely high air pressure—about 3 pounds per square inch, according to Sunfire (10 to 20 times the pressure in conventional enclosures)—and a total force of about 150 pounds on each cone. To supply such force requires a high-current woofer with a big voice coil and a strong magnetic field. The True Subwoofer's magnet, about twice the size of any I've seen on a production woofer, weighs 14 pounds. The beefy, four-layer, high-power voice coil is 3 inches in diameter and 2 inches long.

To deal with the large forces involved requires heavy-duty construction of the woofer and passive radiator. The surround and spider must be very stiff and strong, so that they do not deform in normal operation. The True Subwoofer's surround is therefore ⅛ inch thick and is composed of five separate layers of foam, compressed by heat and pressure.

The high current is supplied by one of Sunfire's very efficient Tracking Downconverter amplifiers, rated at an impressive 2,700 watts. The amplifier is operated directly from the AC power line, without an isolating power transformer. There's no shock hazard because the amp is in the same enclosure as the woofer, so you can't touch the amp's output connections, and its inputs are isolated via optocouplers, eliminating any direct connection between the input jacks and the power line. The Tracking Downconverter amplifier is extremely efficient because its power supply tracks the audio signal, thus limiting dissipation in the output transistors. (For further details, see *Audio*'s January 1997 review of the Sunfire Cinema Grand power amp or get Sunfire's white paper describing it.)

All of the True Subwoofer's electronics, controls, and input connections are mounted on an anodized aluminum plate, 0.2 inch thick and 10 inches square, that forms the subwoofer's rear panel. The complete rear-panel assembly (including input connections, controls, preamplifier, power amplifier, and power cord) weighs only 4½ pounds!

The controls on that panel include adjustments for bass level, crossover frequency, and phase, as well as a switch whose positions are labeled "Flat" and "Video Contour." (The latter position raises the cutoff from 20 to 30 Hz, which increases ex-

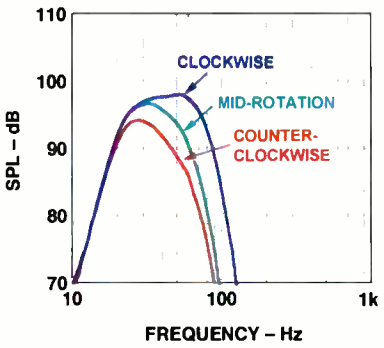

Fig. 1—Frequency response at crossover settings of 33, 55, and 75 Hz.

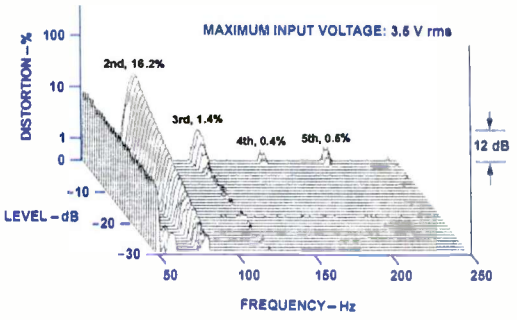

Fig. 2—Harmonic distortion spectrum for E_1 (41.2 Hz); 0 dB equals 3.5 volts rms.

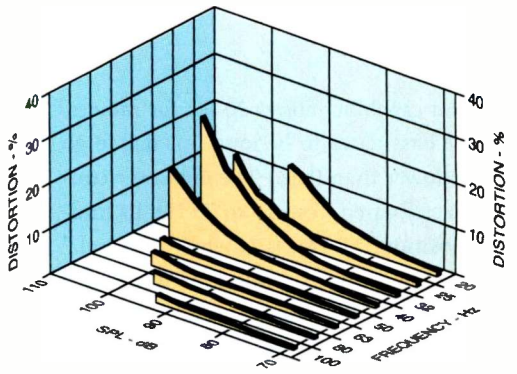

Fig. 3—Harmonic distortion vs. SPL and frequency.

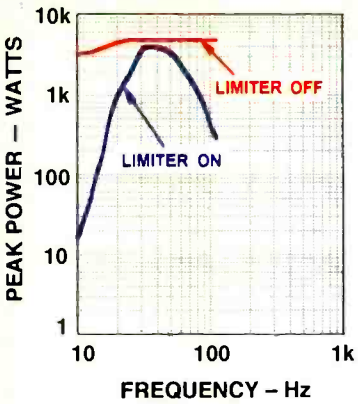

Fig. 4—Amp peak power, 4-ohm load.

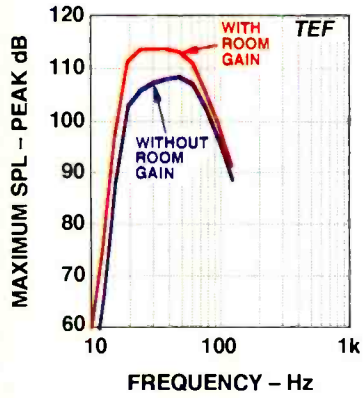

Fig. 5—Maximum peak sound output.

cursion capability above 30 Hz for movies, whose bass tends to be loud but not to go much lower than that.) The crossover control is calibrated from 35 to 75 Hz; its middle position, 55 Hz, is labeled "Normal." The phase control's range runs from 0° to 180°, with its "Normal" setting at the 90° middle position. The stereo inputs include line-level RCA jacks and speaker-level five-way binding posts spaced to accept double banana plugs. Stereo line-level outputs, passively high-passed via capacitors, are also provided.

Most subwoofers have stereo inputs that sum to mono. The True Subwoofer does, too, but instead of mixing the left and right signals equally, it mixes in 7.6 dB more of the left channel than of the right, to preserve some of whatever bass difference signals may be in a recording. This weighted summing takes place on the preamp board, which also holds the crossover and several types of filter and dynamic protection circuits. The filters include the switchable 20/30-Hz cutoff filter and equalization to flatten the woofer's response. To safeguard the amplifier and the woofer from overload and to prevent the system from generating objectionable noises when overdriven, the True Subwoofer has a thermal-protection circuit, a clipping eliminator (limiter), an excursion limiter, and a circuit that detects low back-EMF.

The thermal-protection circuit allows the amplifier to feed full sine-wave power into the woofer for up to about 2 minutes; it then reduces the power to prevent overheating. If the input level is reduced, the circuit resets automatically after a time. Sunfire claims that the circuit will never activate on any rational music or special-effects signal.

The True Subwoofer's maximum output level is set by the clipping eliminator, a limiter placed after the volume control to keep overly loud signals from driving the True Subwoofer to excessive distortion; it operates at all frequencies. The excursion limiter prevents the woofer from being overdriven below 25 Hz, by momentarily attenuating loud signals below that frequency by about 4 dB for several seconds, even if the input level drops during that period. Tied into the excursion limiter is the circuit that detects low back-EMF; it is designed to reduce the drive level at the woofer's vented-box tuning frequency, where the driver's impedance is lowest, in order to protect the internal amplifier.

Measurements

Figure 1 shows the Sunfire True Subwoofer's frequency response for three crossover settings. These are ground-plane measurements, the ones I was making on my driveway. The test microphone was on the concrete, 1 meter in front of the subwoofer (i.e., on the side opposite the rear panel), equidistant from the woofer and the passive radiator. To compensate for ground-plane gain, which doubles the pressure, I subtracted 6 dB from the measurements. The 2.83-volt rms input level used in testing passive speakers was above the Sunfire's excursion-limiting threshold, so I used an input signal of 0.5 volt rms (about 6 dB below that threshold) and raised the curves by 15.1 dB to compensate. The bass level control was set approximately midway, at its indicated 0-dB position. The cutoff switch was in its "Flat" position, and the phase control was set to "Normal/90°," its middle position. With these settings and a 20-Hz, 0.5-volt input signal, the excursion of the passive radiator was about 0.6 inch, peak to peak, and its driver's peak-to-peak excursion was about 0.1 inch.

With the crossover control fully clockwise, at its 75-Hz position, the response curve is fairly flat and covers a range of about 23 to 71 Hz between its –3 dB points. Set fully counterclockwise, at an indicated 35 Hz, the curve peaks at 28 Hz and covers the range of 20 to 42 Hz. The passbands between –6 dB points are roughly 20 to 80 Hz with the control fully clockwise, 19 to 59 Hz with the control at mid-rotation, and 18 to 52 Hz with the control at its lowest position. The highest crossover setting is significantly lower in the Mark II than it was in the first True Subwoofer, whose crossover control was calibrated from 40 to 120 Hz.

I had originally expected that the True Subwoofer would be somewhat delicate and that I'd have to be careful not to feed it a signal that would drive it to damaging excursion levels or overheat it. These concerns were unfounded; the Sunfire is very robust. I couldn't even get it to sound bad. Its limiters efficiently ensured that overload was always graceful, with only lower harmonics evident when the woofer was driven to extremes, no matter the frequency, the level, or how fast I applied the signal. The cabinet is so solid that its walls didn't vibrate at all during my high-level sine-wave sweep. (The cabinet did move a bit, however, about which more later.) And when driven by high-level sine waves, the True Subwoofer's excursion and the forces it produces are downright scary! If you happen to touch the passive radiator's flat center when its excursion is large, you'll get a hard rap on your knuckles.

THE CONE EXCURSIONS, AND THE FORCES THEY PRODUCE, ARE DOWNRIGHT SCARY!

I measured excursions of about 1.4 to 1.5 inches, peak to peak—the greatest of any

driver I've tested. (Sunfire quotes a still larger excursion, 2.5 inches, peak to peak, but says that's for a driver in free air, not in the enclosure.)

The woofer and passive radiator reached their maximum excursions at different frequencies, of course. The woofer's excursion peaked at 31 Hz, a frequency at which the passive radiator's excursion was fairly small. At 25 Hz, both moved equal distances. At 20 Hz, just about the True Subwoofer's resonant frequency, the woofer's excursion reached its minimum, while the passive radiator's extension was very large. Going lower, the excursion of both diaphragms increased again, with the passive radiator's maximum excursion at about 17 Hz and the woofer's at about 15 Hz. Below 15 Hz, the excursion of both elements dropped off rapidly. No dynamic offset was evident in the woofer's excursion (passive radiators don't exhibit offset).

The True Subwoofer's E_1 (41.2-Hz) harmonic distortion is seen in Fig. 2. Signal voltages up to 3.5 volts rms were applied to the left-channel speaker-level input and the volume control set at its midpoint. (At 41 Hz, this input signal and volume setting kept the level just below the threshold of the Sunfire's protection limiters and caused a woofer excursion of about 1.1 inches, peak to peak.) The second harmonic rises to a significant 16.2%, but the third harmonic reaches only a low 1.4% and higher harmonics are 0.5% or less. The Sunfire sounded quite effortless and powerful at this frequency. Total harmonic distortion was somewhat high, but because most of it was the comparatively benign second harmonic, it wasn't bothersome.

Table I shows the Sunfire's 20-Hz harmonic distortion at input levels ranging from 18 dB below the limiter's threshold of 0.25 volt rms to 30 dB above it. When this threshold was reached, the woofer's output was reduced by about 4 dB. At higher levels, the excursion increased somewhat but then reached a limit. Test conditions were the same as for Figs. 1 and 2, except that the volume control was turned up to maximum. The 20-Hz output levels do not include the effects of room gain. The "Total" distortion column lists the sum of the powers in the second through fifth harmonics. The data in the Table is referenced to the level of the fundamental alone, rather than to the total output of fundamental plus harmonics. This change from standard practice enables me to give distortion percentages greater than 100% where the harmonic's level exceeds the fundamental's.

As in Fig. 2, the second and third harmonics predominate in the tabulated measurements, even exceeding the speaker's output of the fundamental at levels 24 dB or more above the limiter's threshold—significantly so, at +30 dB. According to Bob Carver, this is no accident. At levels more than 12 dB above the limiting threshold, the electronic drive to the woofer is deliberately distorted to raise low-order (second- and third-) harmonic distortion; this makes the True Subwoofer sound louder when severely overdriven, although the fundamental does not get louder. At the 20-Hz test frequency, the additional distortion comes from the woofer (whose excursion is quite small) rather than from the passive radiator (whose excursion is very large at this point).

Figure 3 shows distortion for frequencies from 20 to 100 Hz at levels of 70 to 110 dB SPL, room gain included. The distortion percentages are for the sum of the powers of the first 10 harmonics, referenced to the power of the fundamental; this is not quite identical to total harmonic distortion, which includes the power in all harmonics. (Note that the SPL scale reflects the level of the fundamental alone, not counting harmonics.) The end point of each curve marks the level where output of the fundamental stopped increasing as the input level was raised.

As you can see, the Sunfire can generate very impressive levels of low-frequency output, albeit with significant second-harmonic distortion. At all frequencies, the second harmonic predominates. At 20 Hz, the True Subwoofer can generate 97 dB SPL of the fundamental, with 13% second-harmonic distortion. At 32 Hz, it can generate very loud levels (up to 104 dB) but with 25% second harmonic. At 50 Hz and above, the distortion does not exceed 3%.

How audible is this distortion? To check, I compared the True Subwoofer's sound to that of a Velodyne F-1500B subwoofer, whose distortion I've measured as being less than 1.5%, for any harmonic, when delivering its maximum output at 20 Hz ("Thunder in the Listening Room: Subwoofer Shootout," *Audio*, November 1992). Both subwoofers could generate roughly the same maximum levels at 20 Hz and were equally able to rattle the windows and move knickknacks on the wall. Surprisingly, both subwoofers sounded quite similar when played at the same level; the Sunfire's second-harmonic distortion was not very noticeable or objectionable. That's because the human ear is very forgiving of low-frequency distortion (especially of the second harmonic, which is musically harmonious). One reason for this is that the ear's hearing threshold is higher at low frequencies; another is that a tone's fundamental tends to mask its harmonics. Wideband music signals will also mask harmonic distortion components.

My distortion measurements are higher than those reported by Sunfire because of

Table I—*Harmonic distortion at 20 Hz versus input level, in dB re limiting threshold (0.25 volt rms) and in volts rms. Distortion is given as a percentage of the level of the fundamental rather than of the total output, and the output levels do not include room gain.*

Input Level		Output SPL	Harmonics, %				
			2nd	3rd	4th	5th	Total
−18 dB	0.03125 V	76.3 dB	1.6	0.3	0.3	0.3	1.7
−12 dB	0.0625 V	83.1 dB	6.1	2.5	0.3	0.4	6.6
−6 dB	0.125 V	88.9 dB	8.9	1.4	0.4	0.7	9.0
−1 dB	0.225 V	93.3 dB	11.3	3.1	0.7	0.6	11.8
0 dB	0.25 V	91.5 dB	8.9	2.2	0.3	0.4	9.2
+6 dB	0.5 V	95.6 dB	10.7	16.2	5.2	4.8	20.7
+12 dB	1 V	95.4 dB	11.3	18.2	6.6	7.7	23.7
+18 dB	2 V	95.2 dB	11.1	26.6	8.6	9.0	31.4
+24 dB	4 V	95.8 dB	53.7	101.2	12.7	8.7	115.6
+30 dB	8 V	95.9 dB	53.1	124.5	14.5	21.6	137.8

differences in our testing methods. Bob uses a two-microphone near-field technique, with one mike close to the center of the driver and the other near the center of the passive radiator, and then sends the summed signal from the mikes to a distortion analyzer. I made ground-plane measurements, with a single mike, at various distances. I verified that the distortion was indeed lower when the mike was placed close to the cones and that it increased significantly when moved farther away, to positions more representative of normal listening distances. At these distances, you hear not just the output from the cones but all sounds radiated by the system, including side-wall radiation and noises caused by cabinet rocking. When measured by the near-field method, distortion was typically less than half that shown in Fig. 3 and within Sunfire's specification.

Figure 4 shows the results of short-term peak-power measurements on the Sunfire subwoofer's internal amplifier, measured using tone bursts, with the amplifier disconnected from the speaker and connected to a 4-ohm resistive load. The amp was powered by an isolation transformer and an adjustable voltage source set to 120 volts rms. These measurements were made at the Sunfire factory by Bob Carver himself, under my direction and supervision.

With the amp's internal clipping eliminator on, the output curve is shaped like a haystack, peaking at about 4 kilowatts(!) from 30 to nearly 50 Hz, but the limiter reduces the power at higher and lower frequencies. At 20 Hz, for example, the power is limited to a little over 1 kilowatt. With the limiter defeated (by removing an internal connection), the peak power rises into the 5-kilowatt range above 20 Hz, smoothly rolling off below that to a still hefty 3.2 kilowatts at 10 Hz. Since a sine wave's peak-to-average ratio (crest factor) is 3 dB, the subwoofer's built-in amplifier is clearly capable of generating roughly 2.5 kilowatts of continuous sine-wave power, at least for intervals of about 2 minutes.

The Sunfire True Subwoofer's short-term peak sound output versus frequency, measured using the same tone burst as in the previous test, is shown in Fig. 5. The crossover control was set to its highest frequency, 75 Hz. As before, the input to the system was raised until the output was objectionably distorted, as judged by ear and by monitoring the output waveshape with an oscilloscope.

Note the levels in Fig. 5. The Sunfire's low-frequency output equals or surpasses that of most subwoofers and large full-range speakers I have measured. The only systems that can compete with it are much bigger. Only above 30 Hz do a few other speakers deliver more output than the Sunfire, some attaining levels of 120 dB or greater above 40 Hz. Two Sunfires used together could easily outperform any other speaker used singly and still take up much less space.

Use and Listening Tests

I'd seen the Sunfire True Subwoofer at trade shows, but it wasn't until I got it home that I realized how amazingly compact it is. You can actually hold it under one arm (though not for long—it's very heavy for its size).

When I first get a speaker system, I like to feel it with my fingers and see how it reacts when I push its diaphragm. When I tried this on the Sunfire subwoofer, nothing seemed to move. The cone didn't budge, and the surround, very flexible on other speakers, felt like a hard surface. I wondered if a speaker this stiff could actually work. But when I

THE STALL RATIO AND BACK-EMF

Electric motors and generators are essentially the same, coils that can move within magnetic fields. Move the coil, and it's a generator, putting out a voltage, or electromotive force (EMF). Apply a voltage to it, and it moves—a motor. But since a motor's coil is being moved within a field, it also generates back-EMF, a voltage that opposes the one being applied to it.

Back-EMF sounds like a bad thing, but it isn't necessarily. If it becomes too low relative to the applied EMF, the motor stalls, i.e., it runs inefficiently, turning more and more of its electrical input into heat instead of motion. When it gets hot enough, it burns out and stops—or vice versa, depending on its heat resistance.

A motor's back-EMF will vary with its speed. It stalls under load because the load slows it down to the point where it can no longer generate enough back-EMF to properly oppose the incoming voltage. When that happens, current flow through the coil becomes excessive, causing the heat.

Stalling is defined by the ratio:

$$\frac{EMF_b}{V_f - EMF_b},$$

where V_f is the applied voltage and EMF_b is the back-EMF. When this ratio falls below 1 (that is, when the back-EMF is less than half the applied voltage), the motor is "in stall." The further into stall it gets, the more its heat output rises and its efficiency drops. Sunfire's Bob Carver says conventional speakers normally operate in stall, making them dissipate about 95% of their input power as heat and radiate little of that input power as sound.

The stronger the magnetic field and the more the coil is moved within it, the greater the back-EMF. The Sunfire True Subwoofer moves its voice coil vigorously within a very strong magnetic field; according to Sunfire, it generates a back-EMF of 47.3 volts rms when delivering 104 dB SPL at 27 Hz. Under those conditions, its amplifier is delivering 50 volts rms (yielding a generous stall ratio of 17.5), for a nominal output of 625 watts into the driver's rated 4 ohms. Because the driver is well out of stall, it operates efficiently.

What about electrical efficiency? The nominal power sounds high. Sunfire says that because of impedance variations, power factor (the phase relationship between voltage and current), slip angle (the phase relationship between the driving voltage and back-EMF), and the current-limiting effects of back-EMF, the effective power delivered to the True Subwoofer's driver is actually far less than the internal amplifier's rated 2,700 watts. So electrical efficiency, as measured by power draw at your AC wall socket, is high, too. *Ivan Berger*

fired the Sunfire up, everything moved—in spades! As I said earlier, the diaphragm excursion during full-power operation at low frequencies was somewhat scary.

So was the motion of the cabinet. The motions of the woofer and passive radiator generate significant unbalanced forces when high-level signals are played. These forces rock the cabinet and can make it creep along the floor, especially if the floor isn't carpeted. The True Subwoofer comes with small rubber feet attached, and Sunfire provides an extra set, about ½ inch deep, which encourage rocking rather than creeping on most surfaces. When I used the larger feet and put the subwoofer on the carpet, it would rock significantly at high levels but would not creep. The rocking is greatest at about 16 to 17 Hz, where the woofer and passive radiator are essentially 180° out of phase (when one is moving inward, the other is moving out).

Half of the True Subwoofer's manual is devoted to safety issues, placement, connections and controls, crossover frequency adjustment, and troubleshooting. (The manual's other half lists specs and describes how the system works.) You are warned not to remove the rear panel because of potentially lethal voltages in the amplifier circuits behind it, some of which operate directly from the power line without the isolation normally provided by power transformers. As for placement, Sunfire recommends locating the True Subwoofer in a corner, which I did for most of my listening tests.

I added the Sunfire to the music system in my listening room. Ancillary equipment included a pair of KEF Reference Series Model Two speakers, driven by a Crown Macro Reference power amplifier and a Krell KRC preamp. My signal source was an Onkyo Integra DX-7711 CD player. To roll off the lows being fed to the main speakers, I inserted a passive 90-Hz high-pass filter with a 6-dB/octave slope into the preamp's tape loop; I then put a passive shelving network in series with the subwoofer so that its input signal would not be rolled off. The shelving filter provided a 6-dB/octave lift below 90 Hz but bevelled off below 10 Hz. Although I used the Sunfire's line inputs, the signal I fed to it was derived from the amplifier's speaker outputs so that I would not need long runs of unbalanced line-level cables between the preamp and subwoofer.

I COULDN'T OVERLOAD THE SUNFIRE SUB ENOUGH TO MAKE IT SOUND BAD, LET ALONE DAMAGE IT.

The Sunfire was driven through its left line-level input.

I placed the Sunfire diagonally in the corner, so that the woofer and passive radiator were equidistant from the intersecting walls. However, later tests revealed that as long as the True Subwoofer was within 6 inches of the corner, orientation was quite unimportant. The subwoofer's small size encourages you to move it around to see what placement yields the best bass. The crossover control was set to its clockwise, 75-Hz, position and the phase control to its middle position, 90°.

The first selection I listened to was Little Feat's "Hangin' on to the Good Times," on the *Brüel & Kjaer Pro Audio* test CD (Brüel & Kjaer CD-4090). The robust and extended bass on this track gave the music plenty of punch.

With the Sunfire's volume control slightly above its middle, 0-dB, position, I got somewhat more bass than I would from my B&W 801 Matrix Series 3 speakers, which are essentially flat to 20 Hz at my listening position in this room. A subwoofer with its own amp and level controls, operating below 80 Hz, lets you boost the low bass without overemphasizing the upper bass and lower midrange; that additional degree of control over your listening setup's sound is usually very desirable. The Sunfire's rapid, 36-dB/octave rolloff above 70 Hz ensures it won't add energy to frequencies above its passband.

I listened to the True Subwoofer with classical, jazz, country, rock, pipe-organ, and synthesizer music, as well as sound effects and test signals. On all this material, the Sunfire's bass output kept up with or exceeded that of most speakers and subwoofers I have tested.

The Sunfire's bass extension equalled that of any speaker I have tested. Very few speakers (subwoofers included) can reproduce the 18-Hz pedal note in the second movement of Saint-Saëns' Symphony No. 3 in C Minor, the "Organ" Symphony (Philips 412 619, track 2, 9:04 to 9:20). Among those I've tested, the Sunfire, the Velodyne F-1500B, and the Hsu Research HRSW 10V subwoofers all can, but the Sunfire is much smaller than the other two.

The True Subwoofer's excursion limiter and clipping eliminator did a very good job of preventing overload. It was a pleasure not having to worry about overload when listening at high volume levels to recordings with lots of low bass. One such recording, track 1 of *The Digital Domain: A Demonstration* (Electra 9 60303), starts very low, with forest and brook sounds, and then hits you with a jet flyover at full level. Sunfire's trick of increasing the subwoofer's low-order harmonic distortion when the sub is severely overdriven did a good job of making the woofer sound louder, even though the level of the fundamental didn't increase. On other subwoofers with limiters, when the volume of the program material reaches the limiter's threshold, there's no further apparent increase in bass level.

The Sunfire's strength is in the low bass; at 40 Hz and above, many speakers have higher output capability and are often cleaner. This might be one reason to use main speakers that have solid output down to 40 Hz and use the Sunfire to fill in at lower frequencies. Don't get me wrong, as the Sunfire's bass is already *loud* by the point where the limiter kicks in at higher bass frequencies. It's only a limitation with rock, whose bass power is greatest above 40 Hz, and then only if you're listening at true concert levels. But two True Subwoofers, operated close together, would have 6 dB more output and could keep up with virtually anything—and still wouldn't take up more room than one ordinary subwoofer!

For direct comparisons between the Sunfire True Subwoofer and the Velodyne

F-1500B, I placed both in the same room corner. (The Sunfire's edges were parallel to the walls and about 2 inches away from them; the Velodyne was in front of the Sunfire, with its woofer facing toward the rear wall.) On most recordings, it was hard to tell the difference between the two subs. Bass quality and quantity were equally impressive, and both shook the room equally well when reproducing the Saint-Saëns 18-Hz pedal note.

In low bass, the Sunfire had slightly greater maximum output, but the Velodyne could play slightly louder in the upper bass. Slight differences did exist in voicing and frequency balance, but I had no clear preference. The Velodyne reproduced more of the upper bass, in the crossover region, presumably because it rolled off less steeply than the Sunfire above the crossover point.

From my normal listening position, both sounded equally clean on low-frequency sine waves. Only when I walked up to the front wall, near the corner, and listened directly to the two subwoofers' outputs, could I hear a change in the character of the Sunfire's output, which was caused by its higher-level low-order harmonics.

FEW SPEAKERS OR SUBS I'VE TESTED PRODUCED LOUDER BASS THAN THE SUNFIRE, AND NONE WENT DEEPER.

I also found it hard to tell the two subs apart when listening at a high level to Ron Tutt's kick drum on *The Sheffield Track Record/The Sheffield Drum Record* (Sheffield CD/14/20). As with the sine wave, it was only when I listened in the corner that I could hear differences; The Velodyne sounded a little tighter, and the Sunfire went slightly lower and could play a bit louder at those low frequencies. On the helicopter track of the *Digital Domain* CD, the Sunfire reproduced the high-level low-frequency sounds of the helicopter's blade slapping air more realistically and louder than the Velodyne.

On third-octave band-limited pink noise, the Sunfire could deliver slightly more output than the Velodyne at 32 Hz and below, but at 40 Hz and above, the Velodyne's output was greater. The Velodyne sounded somewhat cleaner than the Sunfire at 40 Hz and below at equally loud levels. On alternating-level tone bursts, the Sunfire could play 20- to 32-Hz bands louder than the Velodyne. The Velodyne's limiters made every burst sound the same, whereas the alternate bursts played by the Sunfire were louder but had a slightly higher-pitched quality.

I also compared the Sunfire with a Boston Acoustics VR2000 powered sub. The Sunfire walked all over the Boston below 32 Hz but came in behind the Boston at 40 Hz and above. At 50 Hz and above, the Boston could play significantly louder and cleaner than the Sunfire.

Despite its efficiency, the Sunfire draws a lot of power from the AC line. When I listened at high levels to material with heavy bass, the lights in my listening room fluctuated in sync with the bass. When I listened to the kick drum on the title track of AC/DC's *Highway to Hell* (ATCO 92419), it was like having my own light show!

Does the Sunfire True Subwoofer live up to its name? Yes! A true subwoofer should be able to rattle the walls at 25 Hz and below, which the Sunfire accomplishes easily. Admittedly, the True Subwoofer has somewhat higher distortion than some of its competitors. But the difference between the Sunfire's distortion and the super-low distortion of the Velodyne was not clearly discernible on most program material at normal listening distances. From a psychoacoustic standpoint, it may be better to allow higher maximum output with higher distortion, as Sunfire has.

The Sunfire True Subwoofer is a truly innovative product with a number of unusual characteristics, including extremely small size, high output even below 20 Hz, a very powerful, high-efficiency internal amplifier, and excellent self-protection systems. I doubt that the True Subwoofer would have seen the light of day at any large speaker manufacturer. Even to attempt designing a subwoofer with its very small size, high output, and response to below 20 Hz takes guts that large companies seldom have. The Sunfire True Subwoofer is a groundbreaking design that embodies some very innovative thinking and creative problem-solving. I'm impressed! A

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EQUIPMENT **PROFILE**

EDWARD J. FOSTER

MARANTZ SR-880 A/V RECEIVER

The Marantz SR-880 audio/video receiver accommodates both the future and the past. Looking to the past, the SR-880 not only decodes matrixed Dolby Surround material (as does every other A/V receiver I can think of) but also accepts Dolby Digital (AC-3) information in raw RF form from laserdisc. So, unlike many current Dolby Digital A/V receivers, the Marantz requires no external RF demodulator for this. Looking to the future, it offers both optical (Toslink) and wired (coax) inputs for Dolby Digital signals in bitstream form from today's DVD players and tomorrow's DBS and HDTV equipment. And with an eye toward expansion, the SR-880 has preamp outputs on all six channels and supplies an independent stereo feed for a music system in a second room. With the addition of an infrared sensor (available from Niles, Sonance, Xantech and others), a stereo power amp, and speakers, the SR-880 can afford independent operation in a second room or zone.

For local control, the SR-880's RC2000 programmable remote (supplied) is one of the most universal and well equipped that you're likely to find. The buttons are well spaced, clearly labeled, and light up momentarily at the touch of a side-mounted "Lighting" bar. An LCD panel displays the currently selected source and gives current status information. The RC2000 can not only learn the codes of just about any product you have, but can clone itself by downloading all the commands it has learned to another RC2000, for use in another room or as a safety backup. Furthermore, it supports independent 20-step programmable macro buttons so you can fire up a whole system or execute other multistep processes at a touch. For example, you could use one button to turn on the SR-880 and a TV projector, set the receiver's input and surround mode, and drop a motorized screen. Four of the remote's buttons are dedicated to macros, but macros can also be programmed into nine of its function buttons.

Besides its own AM/FM-stereo tuner, the SR-880 has provisions for three external audio program sources (CD and two tape sources) and five audio/video sources ("TV/DBS," "DVD/LD," "VCR 1," "VCR 2," and "AUX"), with recording outputs for both "Tape" and both "VCR" circuits. All line-level audio and composite-video connections on the rear panel are nickel-plated RCA jacks, but the "AUX" jacks, which are on the front, are gold plated. The "AC-3" input gives you a choice of coaxial, Toslink optical, and RF jacks. S-video jacks are provided for the "DVD/LD" input, one TV monitor output, and the "VCR 1" input and output. (Sad to say, the Marantz SR-880's

USING THE SR-880 RECEIVER IS NOT ONLY EASY BUT A PLEASURE!

Rated Power Output, Stereo Mode: 110 watts/channel into 8 ohms, 20 Hz to 20 kHz.
Rated Power Output, Surround Mode: Main and center channels, 110 watts/channel into 8 ohms, 40 Hz to 20 kHz; surround channels, 75 watts/channel at 1 kHz.
Dimensions: 17¼ in. W x 6¼ in. H x 18 in. D (43.9 cm x 15.8 cm x 45.8 cm).
Weight: 32 lbs. (14.5 kg).
Price: $1,499.99.
Company Address: 440 Medinah Rd., Roselle, Ill. 60172; 630/307-3100; www.MarantzAmerica.com
For literature, circle No. 91

Photos: Michael Groen

accommodations for the future stopped short of giving the "TV/DBS" input an S-video connector.)

Color-coded multiway binding posts are used for each of the five speaker outputs. Each post accepts a single banana plug (as well as bare wire), but the pairs are spaced too widely to handle a dual-banana plug, in accordance with European safety rules. (Some European AC plugs match a dual banana's ¾-inch spacing.) The rear panel also carries one switched and one unswitched convenience outlet, each with a 1-ampere (120-watt) rating, a multiroom output, and jacks for daisy-chaining components for control by the same remote. For the tuner, there are terminals for the AM antenna and a coaxial connector for the FM.

The primary array of buttons below the main panel display selects the program source. To their left are three additional buttons that independently select the digital input ("RF," "Optical," or "Coaxial") and, at the extreme left, a "Night" button that engages Dolby Digital's dynamic-range compressor if the program material supports that feature. Three small, round buttons above these toggle the front-panel display, the "OSD" (on-screen display), and an input attenuator on and off.

THE MARANTZ SR-880'S REMOTE CONTROL IS A PLEASURE TO USE AND UNCOMMONLY VERSATILE.

Along the bottom are a "Power/Standby" bar, a gold-plated headphone jack, and up/down pads that cycle through the processing modes ("Stereo," "AC-3," "Pro Logic," "Movie," "3 Stereo," "Hall," and "Matrix"). The next button, which switches the receiver to its "Multiroom" mode, is followed by three knobs for "Bass," "Treble," and "Balance," each with a center detent. The SR-880's tuner controls consist of down/up pairs of tuning and preset-selection bars, at the right of the main display, and, just below these, buttons to choose the FM reception mode (mono or stereo) and to scan, load, and clear the station-preset memories.

The RC2000 remote has independent selector buttons for each source (a feature that I really like). When you use the remote to select a source, functions appropriate to that source show up on the RC2000's LCD screen next to buttons "D1" through "D8." Two other buttons, below "D4" and "D8," page through four possible sets of labels for that source. Some of these label pages control the source itself, providing such functions as channel selection in TV mode or chapter selection on a laserdisc player; one label page in each set usually controls recording and offers "REC," "Pause," and "Stop" control of either VCR or either audio tape deck, as appropriate.

A tenth button in the remote's source-selection group, "AMP," converts the eight "D" buttons and two page buttons into amplifier controls. The first page enables you to choose the processing mode: Dolby Digital (AC-3), Pro Logic, Matrix, Hall, THX (on THX-certified Marantz products) Movie, Dolby 3 Stereo, or Stereo. The second page accesses setup controls, the third enables you to modify the operating mode, and the fourth controls the characteristics of the Dolby Digital decoder.

Another interesting touch is the presence of separate on and off buttons rather than a single on/off toggle. These are needed because the SR-880 has separate control codes for on and off, which makes it compatible with in-wall keypads and other system controllers. A separate "Source On/Off" pad on the remote controls the operating state of program sources.

System setup is performed from the remote, using on-screen displays. I found these to be more intuitive than usual, though other reasonable people may disagree with my personal reaction to the menu structure and nomenclature that Marantz chose. Menus are navigated and selections made with the usual four directional arrows and center button (in this case, marked "OK"), at the lower right of the RC2000. To the left of the array are transport-control buttons, with the usual graphic symbols for play, pause, stop, skip forward and back, and scan forward and back. Good-sized

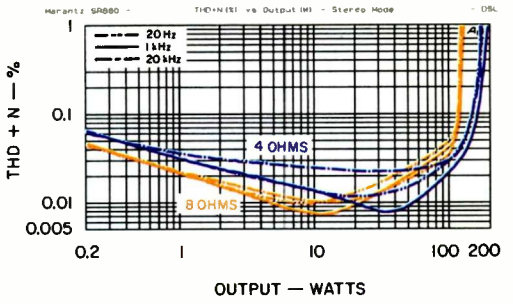
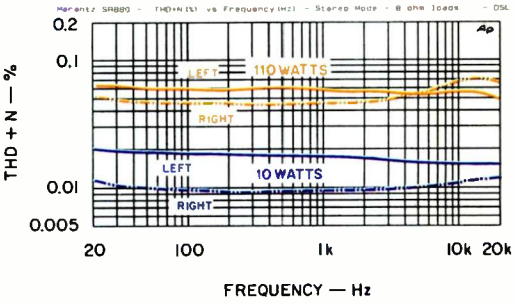


Fig. 1—Stereo mode, THD + N vs. output.



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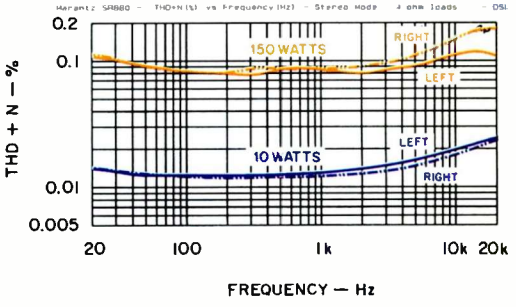

Fig. 2—Stereo mode, THD + N vs. frequency for loads of 8 ohms (A) and 4 ohms (B).

B

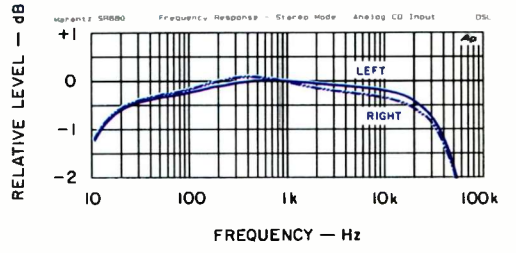

Fig. 3—Frequency response, stereo mode.

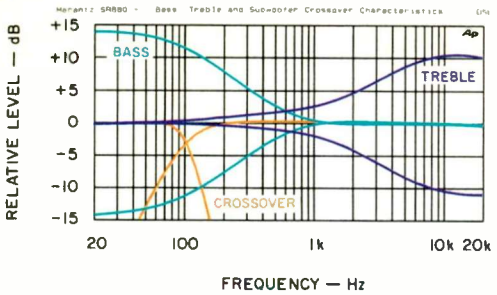

Fig. 4—Tone control and crossover characteristics.

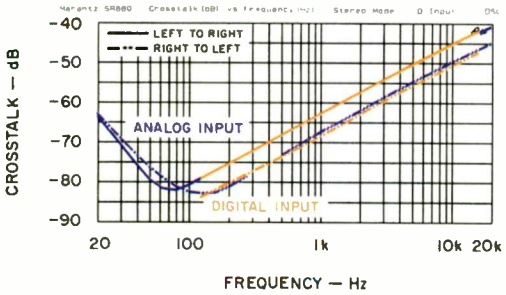

Fig. 5—Crosstalk, via analog and digital inputs.

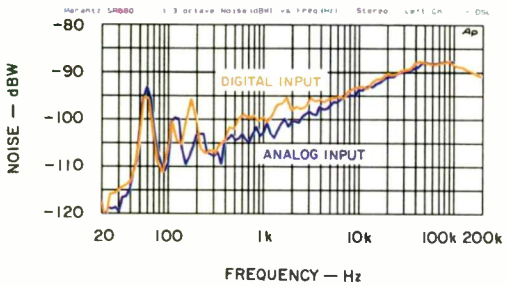

Fig. 6—Residual noise, via analog and digital inputs.

up/down volume pads are above the directional cluster and just to the right of the numeric keypad. You also can mute the sound from the remote.

The RC2000 has other features that distinguish it from ordinary remote controls. There's a "Guide" pad to activate the on-screen programming guides of most DSS receivers and an illumination sensor that monitors ambient light and deactivates the LCD screen's backlighting when there's enough room light, to preserve battery power. The same sensor automatically backlights the remote keys for 5 seconds (a time span you can adjust) whenever the room darkens quickly and whenever you press any of the remote's buttons. A nifty battery-level indicator advises you to replace the batteries before you lose the instructions you've programmed. And the RC2000 maintains its smarts for up to an hour while you replace the cells. Clearly, this is a very well-conceived remote!

Measurements

As far back as I can remember, Marantz has assigned less power to the surround channels of its A/V receivers than to the main front pair. It also used to give the center channel less power than the main fronts, on the presumption that most people would use small center speakers and redirect center bass energy to the main fronts or to a subwoofer. Marantz may have been correct in that assumption, but I've never been convinced it's a good idea to scrimp on center power, because that's where so much of a soundtrack is focused, arguably raising the power requirement at least as much as bass redirection lowers it.

I'm pleased to say that Marantz has had a change of heart: The SR-880 delivers 110 watts per channel into 8 ohms from all three front channels. The surround channels still carry a reduced rating (75 watts/channel), but that 1.66-dB difference should be barely discernible—and then only if you demand maximum output from your surrounds (very uncommon). I measured clipping points of 130 watts (21.1 dBW) per channel in the main front pair with 8-ohm loads and 80 watts (19.0 dBW) in the surrounds. As usual with receivers having equal power across the front, the center measured a bit higher on the bench than the left/right pair (140 watts or 21.5 dBW in this case) because the power supply sags less with only one channel driven.

These power ratings are based on my measurements of THD + N versus output. I'm not showing the curves for all the channels, but the curves for the main front channels, driving 8- and 4-ohm loads, can be seen in Fig. 1. The smooth shapes of these curves suggest that the SR-880 uses a traditional Class-AB output stage but, I suspect, with rather little overall feedback. Instead of breaking sharply upwards from a minimum just below the clipping point—the usual case when a lot of global feedback is used—these distortion curves climb slowly as the amplifier's output rises above 10 watts per channel into 8 ohms or 30 to 40 watts per channel into 4 ohms.

My supposition of relatively little global feedback is reinforced by the output impedance's uniformity across the audio-frequency band. Many amps' output impedances rise several-fold from 50 Hz to 20 kHz, but the SR-880's rises by only 20%! Other things being equal, I've come to associate constant output impedance with especially good sound.

I'VE LEARNED TO ASSOCIATE UNIFORM OUTPUT IMPEDANCE LIKE THE SR-880'S WITH GOOD SOUND.

The flip side of the feedback coin is distortion. An amplifier that uses relatively little global feedback is likely to generate more distortion than amps that use a lot of feedback; that's the case with the SR-880. As you can see in the THD + N versus frequency curves for 8-ohm loads (Fig. 2A), the SR-880 meets its 0.05% THD specification over most of the audio band on the right channel but not on the left. Worst case, THD + N at the rated output of 110 watts per channel reaches 0.073%; that's not quite spec but not really bad either. Since Marantz doesn't specify the output power of the SR-880 into 4-ohm loads, I gave it a 4-ohm rating of 150 watts per channel, based on the 4-ohm curves of Fig. 1. At 10 watts and 150 watts per channel, THD + N reaches 0.183%, worst case (Fig. 2B).

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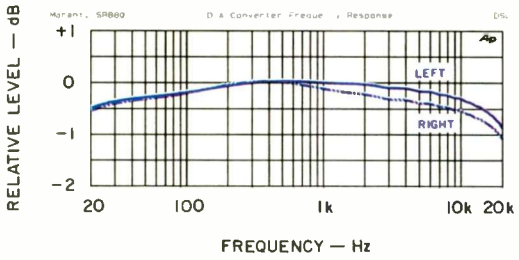


Fig. 7—D/A converter frequency response.

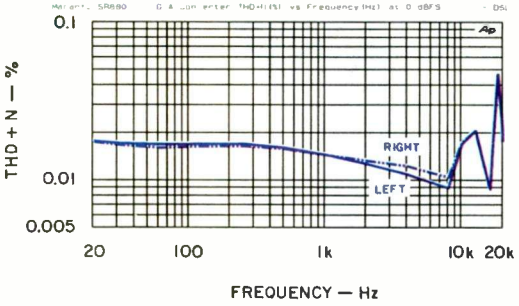


Fig. 8—D/A converter THD + N vs. frequency.

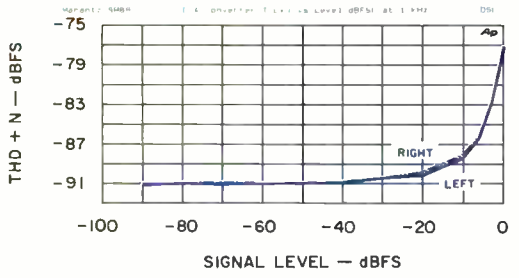


Fig. 9—D/A converter THD + N vs. level.

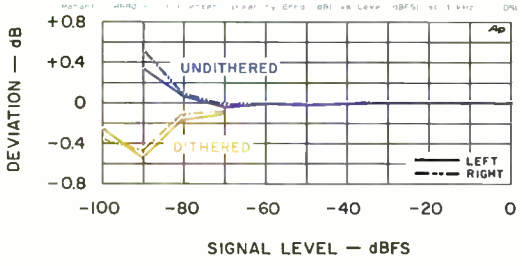


Fig. 10—Deviation from linearity.

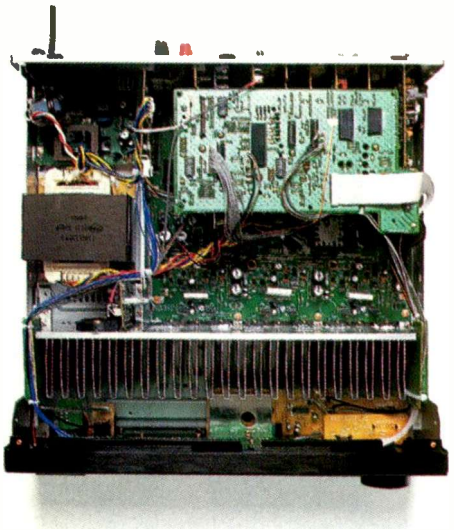
With 8-ohm loads, dynamic power and continuous power proved pretty much the same: Only 0.4 dB more power was available when using the IHF toneburst. That still amounts to a dynamic headroom rating of +0.7 dB, since the amplifier's continuous power was 0.3 dB greater than specified. With 4-ohm loads, I clocked a dynamic power of 230 watts, or 23.6 dBW, at clipping. With 2-ohm loads, the output stage didn't so much clip as sag, so the dynamic power figure is difficult to determine precisely.

The SR-880 offers no way to bypass its tone-control circuitry, so the best you can do to ensure flat response is to set the knobs at the detents. On my sample, the overall response (this usually varies from sample to sample) came out at +0.12, –0.55 dB from 20 Hz to 20 kHz; you can't see them because of the expanded dB scale I used in Fig. 3, but the –3 dB points were below 10 Hz and at 67.9 kHz. Figure 4 shows the maximum effect of the bass and treble controls and the subwoofer-crossover characteristics with the "Small" speaker settings. Both tone controls have shelving characteristics with ranges that are quite well balanced, although there is more ultimate boost and cut in the bass (about ±14 dB) than in the treble (about ±10 dB). The subwoofer crossover frequency is appropriate for home theaters (–3 dB at just over 100 Hz, –6 dB at 80 Hz and 116 Hz), and the filters have the usual 12-dB/octave high-pass and 24-dB/octave low-pass slopes.

Line input sensitivity (21.5 mV for 0 dBW into 8 ohms) and impedance (46.2 kilohms) were appropriate, and the input overload point was more than adequate even with the attenuator switched off. Furthermore, left/right stereo balance was perfect with the balance knob at its detent. Output at the tape-recording jacks was fine, and the source impedance was reasonably low.

When I turned my attention from the analog to the digital input to check D/A converter performance, some of my measurements were quite comparable. For example, left/right channel separation was so similar over the range covered by my test CD that I overlaid the results taken via the analog and digital inputs (Fig. 5). The third-octave noise analyses are quite similar, too, when the data taken via the digital input is referred to 0 dBW rather than to 0 dBFS, so I've overlaid these curves as Fig. 6. And, although I didn't overlay the converter's response curves with the analog response curves (because of the substantial difference in frequency axes), you'll find the same low-end rolloff (and a very similar treble rolloff) in the converter's response (Fig. 7) that you saw in Fig. 5 for response via the analog input.

The conclusion to be drawn is that the majority of the response error, as well as most of the noise and crosstalk, occurs in the analog stages following the converter. In fact, if one were to mentally subtract the



THE AMPS IN THE SR-880 SEEM TO EMPLOY RELATIVELY LITTLE GLOBAL FEEDBACK.

SR-880's frequency response via the analog input from its digital-input response, you'd find that the D/A converter's response is near perfect except for a slight rolloff in the high treble. That, and the relative absence of response ripples, suggests excellent digital filtering.

The converter's THD + N versus frequency (Fig. 8) confirms that suggestion. Although I have measured CD players and self-standing converters with a cross-modulation spike of less than the SR-880's 0.048%, it's better than I've measured on

the DACs of many other A/V receivers; compared to its competition, the Marantz SR-880 acquits itself very well in this regard. Distortion in the bass and midrange may be somewhat greater than on the DACs in, say, good CD players; however, these data include the noise and distortion of the preamp and power amp as well as that of the converter. That's probably why THD + N versus level (Fig. 9) starts out at –77.0 dBFS (with a 0-dBFS input). Distortion drops rapidly, however, and is less than –90 dBFS from –30 dBFS on down.

THE D/A CONVERTER'S NEAR-PERFECT, RIPPLE-FREE RESPONSE SUGGESTS EXCELLENT FILTERING.

Analog-circuit noise also placed a floor under the S/N ratio (93.6 dB, A-weighted, 85.1 dB CCIR-weighted) and quantization noise (–81.2 dBFS). The quantization-noise test is designed to measure converter noise in the presence of a signal (which S/N does not) and to exclude converter distortion, but analog noise in subsequent circuitry is included in the tally. Dynamic range is measured with a low-level stimulus, so, although the data include analog circuit noise and distortion, the distortion contribution of the analog circuitry is likely to be less. Converter linearity error—shown for 1-kHz dithered and undithered signals in Fig. 10 and for a 500-Hz dithered fade in Fig. 11—pretty much ignores subsequent noise and distortion and exercises the converter by itself. With a half-decibel error, worst case, in the 1-kHz test, I'd say the results are admirable!

Turning now to surround-sound operation, the same frequency-response anomalies exist in main-front-channel response (but not in center- or surround-channel response) with Dolby Pro Logic and Dolby Digital operation as with stereo operation. Clearly, these originate in the tone-control circuits, which are in the signal path of the main channels but not the others. In the treble, response fell abruptly above 23.18 kHz because of the anti-aliasing and reconstruction filters in the digital chain. That's quite normal with today's DSP-based Dolby processing.

The response of the "best" and "worst" channels in Dolby Digital Surround mode are overlaid with the response of the LFE channel in Fig. 12; Fig. 13 shows the response of the various channels in Dolby Pro Logic mode. Although the right surround channel proved "best" with Dolby Digital, there really wasn't a substantial difference between its response and the responses of the left surround or center channels—only a couple of tenths of a decibel at 20 kHz. The tone controls' effects aren't so apparent in the Pro Logic curves of Fig. 13 because of the coarse vertical scale needed to show the treble rolloff in the surround channels (–3 dB at an unusually high 8.5 kHz) and the low-end rolloff in the center when "Normal" (small-speaker) operation is selected (–3 dB at 104 Hz).

Figure 14 shows THD + N versus frequency at rated power in Dolby Pro Logic mode for the center, left front, and left surround channels (the curves for the respective right channels were essentially the same). The front-channel THD + N is excellent (actually better than with stereo operation, possibly because a restricted analyzer bandwidth is used for the Pro Logic measurement); the surround channel's THD + N, less than 0.75%, is about par for the course.

In Pro Logic mode, the A-weighted noise could have been better, especially in the center channel (whose residual noise measured –72.8 dBW). Steady-state channel separation at 1 kHz ranged from a low of 38.6 dB (between surround and right front) to a high of about 80 dB where it's really important, between the center and surround. For the most part, separation ranged between 41 and 46 dB.

Figure 15 shows the substantial separation possible with AC-3 signals. The two curves represent the overall best and worst cases, best being between right front and left surround and worst being between center and left front. For the most part, separation ranged between 57 and 71 dB. With Dolby Digital decoding, all channels were balanced within a total spread of ±0.42 dB, which wasn't terrible but could be improved upon. Distortion at

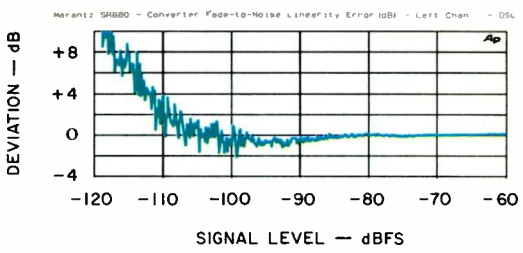


Fig. 11—Fade-to-noise test.

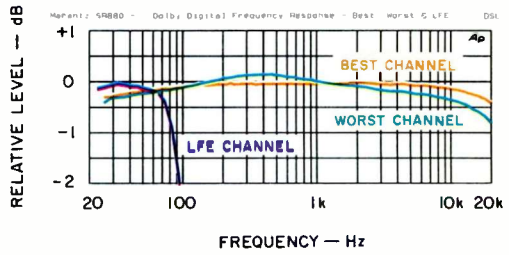


Fig. 12—Dolby Digital frequency response.

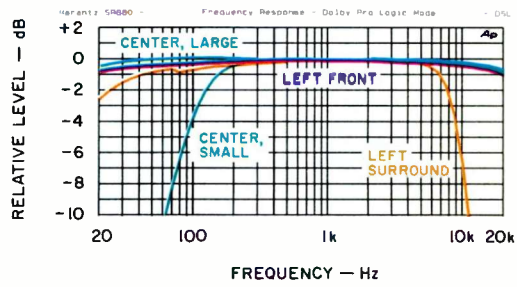


Fig. 13—Dolby Pro Logic frequency response.

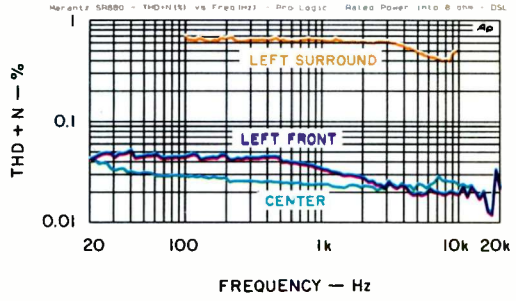


Fig. 14—Dolby Pro Logic mode THD + N vs. frequency at rated power.

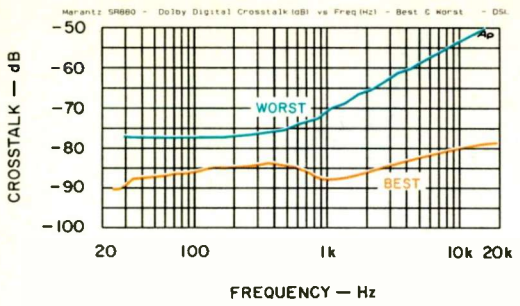


Fig. 15—Dolby Digital crosstalk.

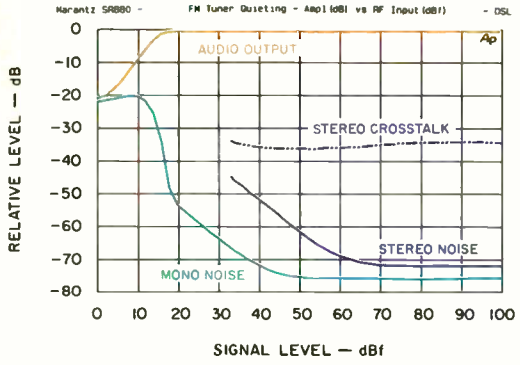


Fig. 16—FM tuner quieting.

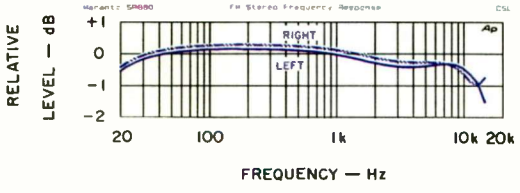


Fig. 17—FM stereo frequency response.

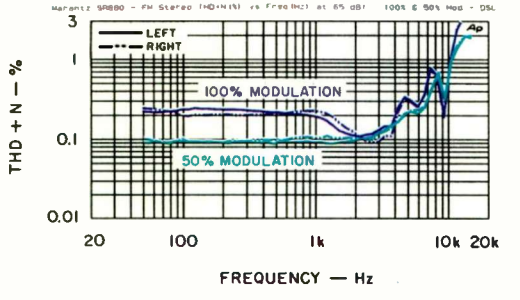


Fig. 18—FM stereo THD + N vs. frequency.

1 kHz and 0 dBFS (measured at 10 watts) was 0.025%, worst case, in the primary channels and 0.051% at 30 Hz in the LFE.

Although I've left it to last, the SR-880's FM tuner deserves special accolades; it's one of the best I've found in recent A/V receivers. It's unusually sensitive, achieving 50-dB quieting at 18.8 dBf with a mono broadcast and at 38.7 dBf with stereo and excellent ultimate quieting (75.3 dB in mono, 70.3 dB in stereo), as shown in Fig. 16. Except for a little more treble rolloff at 15 kHz (–1.52 dB) than I'd hope for, stereo frequency response (Fig. 17) is quite good, too, and channel balance is very good (within ±0.11 dB). Channel separation was a reasonably decent 27.4 dB or better from 100 Hz to 10 kHz.

The tuner generates only about half as much THD + N below 1 kHz with 50%-modulated as with 100% modulation, but there isn't as substantial a difference above 2 or 3 kHz (Fig. 18). Capture ratio was 1.5 dB at 45 dBf; adjacent-channel selectivity came in at almost 8 dB and alternate-channel selectivity at over 66 dB. Taken individually, none of these readings is "best of class," but they are interrelated and, taken as a whole, impress me as being an astute compromise between low distortion, high selectivity, and decent performance under multipath reception conditions. Image rejection and AM rejection were both better than 50 dB, and the stereo pilot and subcarrier signals were adequately rejected at the tape-recording output. All in all, a very fine tuner!

Use and Listening Tests

There's a lot to like about the Marantz SR-880. It's an easy receiver to set up, and the remote is outstanding—really in a class by itself! Once you have the system up and balanced, and the remote programmed, control over just about everything in the system lies under your fingertips.

Using the Marantz SR-880 is not only easy but a pleasure! No fumbling with multiple remotes. No turning up the room lights to see what you're doing—just give a tap to the lighting bar when needed. And no plowing through level upon level of nested menus or cycling through endless alternatives to get to the one you want; almost everything is directly accessible. Sure, there are four pages of possible alternatives for the "D1" through "D8" buttons, but each page is organized logically, so you're likely to stay on it for what needs tending to and, even if the desired control is not on the current page, to learn quickly where you need to go to find it. With the complexity of today's home-theater electronics, Marantz' superb human engineering is a tremendous virtue and I award the SR-880 high marks in this area.

The SR-880 provided plenty of sound level with the relatively efficient Paradigm speakers I have in my home theater. With

THE SR-880'S FM TUNER DESERVES ACCOLADES AS ONE OF THE BEST IN A/V RECEIVERS.

material from DVDs and AC-3 laserdiscs, the Dolby Digital decoder proved its mettle by providing crisp reproduction, subtlety when called for, and excellent inner detail. On music CDs played in stereo, the sound was a trifle warm (which I attribute to the lower midrange response bump introduced by the tone controls) but more detailed than I've heard from some other A/V receivers. I think that's attributable partly to the better-than-average D/A converters Marantz chose for the SR-880 and partly to a power amp design that recognizes the sonic benefits that result from constant output impedance.

I'm sure I would have been even happier with the sound had Marantz allowed me to bypass the tone-control circuitry. And I could give the SR-880 a more rousing accolade had the designers been more generous with its S-video facilities. If you can accommodate these oversights, I think you'll find this receiver worthy of careful consideration. That's especially true if you live in the boonies (as I do) and listen to FM; its tuner is far above average. Buying always comes down to balancing strengths and weaknesses, and that's a personal decision. I find so much to like about the Marantz SR880—its accommodating stance to past and present Dolby Digital sources, its great remote, and fine sound—that I'm willing to accept a limitation here and there. A

MEASURED DATA

AMP SECTION, STEREO MODE

Output Power at Clipping (1% THD at 1 kHz): 8-ohm loads, 130 watts/channel (21.1 dBW); 4-ohm loads, 190 watts/channel (22.8 dBW).

Dynamic Output Power: 8-ohm loads, 140 watts/channel (21.5 dBW); 4-ohm loads, 230 watts/channel (23.6 dBW); 2-ohm loads (see text), 270 watts/channel (24.3 dBW).

Dynamic Headroom re 8-Ohm Rating: +0.7 dB.

THD + N, 20 Hz to 20 kHz: 8-ohm loads, less than 0.073% at rated output and less than 0.021% at 10 watts/channel; 4-ohm loads, less than 0.183% at 150 watts/channel and less than 0.025% at 10 watts out.

Damping Factor re 8-Ohm Loads: 110.

Output Impedance: 76 milliohms at 1 kHz, 76 milliohms at 5 kHz, 83 milliohms at 10 kHz, and 92 milliohms at 20 kHz.

Frequency Response with Tone Controls at Detents: 20 Hz to 20 kHz +0.12, –0.55 dB (–3 dB below 10 Hz and at 67.9 kHz).

Tone-Control Range: Bass, ±11.3 dB at 100 Hz; treble, ±10.4 dB at 10 kHz.

Subwoofer Crossover: High-pass –3 dB at 105 Hz and –6 dB at 80 Hz, 12 dB/octave; low-pass, –3 dB at 101 Hz and –6 dB at 116 Hz, 24 dB/octave.

Sensitivity for 0-dBW (1-Watt) Output: 21.5 mV.

A-Weighted Noise: –85.9 dBW.

Input Impedance: 46.2 kilohms.

Input Overload (1% THD at 1 kHz): 8 V with attenuator off, 9.7 V with attenuator on.

Channel Separation, 100 Hz to 10 kHz: Greater than 45.3 dB.

Channel Balance: ±0.00 dB.

Recording Output Level: 475 mV for 500-mV signal at CD input; 730 mV for 100%-modulated FM signal at 1 kHz.

Recording Output Impedance: 1.5 kilohms.

FM TUNER SECTION

Sensitivity: For 50-dB quieting, 18.8 dBf in mono and 38.7 dBf in stereo.

S/N Ratio, 65-dBf Signal Input: Mono, 75.3 dB; stereo, 70.3 dB.

Frequency Response, Stereo: 20 Hz to 15 kHz, +0.17, –1.52 dB.

Channel Balance: ±0.11 dB.

Channel Separation, 100 Hz to 10 kHz: Greater than 27.4 dB.

THD + N at 65 dBf, 100% Modulation: Mono, 0.26% at 100 Hz, 0.23% at 1 kHz, and 0.21% at 6 kHz; stereo, 0.24% at 100 Hz, 0.2% at 1 kHz, and 0.27% at 6 kHz.

Capture Ratio at 45 dBf: 1.5 dB.

Selectivity: Adjacent-channel, 7.9 dB; alternate-channel, 66.3 dB.

Image Rejection: 55.5 dB.

AM Rejection: 51.5 dB.

Stereo Pilot Rejection: 75.3 dB.

Stereo Subcarrier Rejection: 60.5 dB.

AMP SECTION, DOLBY PRO LOGIC MODE

Output Power at Clipping, 8-Ohm Loads: Main channels, 130 watts/channel (21.1 dBW); center channel, 140 watts/channel (21.5 dBW); surround channels, 80 watts/channel (19.0 dBW).

THD + N at Rated Output, 8-Ohm Loads: Main, less than 0.054%, 20 Hz to 20 kHz; center, less than 0.042%, 10 Hz to 20 kHz; surround, less than 0.75%, 100 Hz to 10 kHz.

Frequency Response: Main Channels, 20 Hz to 20 kHz, +0.12, –0.98 dB and –3 dB below 10 Hz and at 23.18 kHz; center, "Wide" mode, 20 Hz to 20 kHz +0.04, –0.72 dB and –3 dB below 10 Hz and at 23.18 kHz; center, "Normal" mode, +0.02, –3.0 dB at 104 Hz and 23.18 kHz; surround, +0.02, –3.0 dB, 18 Hz to 8.5 kHz.

A-Weighted Noise: Main, –75.7 dBW; center, "Wide" mode, –72.8 dBW; surround, –76.0 dBW.

Channel Separation at 1 kHz: 38.6 dB or greater.

DOLBY DIGITAL (AC-3) MODE

Channel Balance: 0.83 dB or better.

Frequency Response: Main channels, 25 Hz to 20 kHz, +0.14, –0.83 dB; center channel, 25 Hz to 20 kHz, +0.05, –0.63 dB; surround channel, 25 Hz to 20 kHz, +0.02, –0.43 dB; LFE channel, 22 Hz to 100 Hz, +0, –3 dB.

THD + N at 1 kHz for 0-dBFS Signal: Main, 0.022%; center, 0.015%; surround, 0.025%; LFE (at 30 Hz), 0.051%.

Channel Separation, 100 Hz to 10 kHz: 53.3 dB or greater.

D/A CONVERTER SECTION

Frequency Response: 20 Hz to 20 kHz, +0.14, –0.96 dB.

THD + N at 0 dBFS: Less than 0.048%, 20 Hz to 20 kHz.

THD + N at 1 kHz: Below –77.0 dBFS from 0 to –90 dBFS and below –90.3 dBFS from –30 to –90 dBFS.

Maximum Linearity Error: Undithered signal, 0.51 dB to –90 dBFS; dithered signal, 0.52 dB to –100 dBFS.

S/N: A-weighted, 93.6 dB; CCIR-weighted, 85.1 dB.

Quantization Noise: –81.2 dBFS.

Dynamic Range: Unweighted, 90.8 dB; A-Weighted, 93.1 dB; CCIR-Weighted, 84.1 dB.

Channel Separation: Greater than 41.6 dB, 125 Hz to 16 kHz.

EQUIPMENT **PROFILE**

BASCOM H. KING

THRESHOLD T800D AMPLIFIER

The T800D is the latest, largest, and best of the Threshold power amplifiers. Unlike the lower-powered T400, T200, and T100, the T800D is a full-bridge design utilizing what Threshold terms a fully balanced differential topology. Further, the amplifier is said to operate in Class A up to 200 watts with 8-ohm loads. It's a formidable beast of an amp, weighing in at 126 pounds and using 14 pairs of matched, insulated-gate bipolar transistors (IGBTs) per channel, a 1,250-volt-ampere toroidal power transformer, and 335,000 microfarads of filter capacitance. It's also a damned attractive beast, though my wife (who helps me carry equipment out to the lab and back) tells me there ought to be a law against amps being so heavy.

The obvious center of attraction on the T800D's front panel is a pair of output level meters, continuing the visual tradition from past Threshold amplifiers. (It's also available without the front-panel meters, as the T800.) A large on/off rocker switch with an indicating LED above it is located below the right-channel meter. On the rear panel are two sets of gold-plated five-way binding posts for each channel's speaker connections. Each channel also has a high-quality RCA phono jack for unbalanced inputs, an XLR connector for balanced inputs, and a three-position input mode switch (see "Technical Highlights"); a green LED shows when this switch is set correctly for the type of input signal being received. An IEC line-cord connector and a line fuse are at the lower center of the panel.

When I looked inside the T800D, the first thing that caught my eye was its formidable power transformer, which is 7 inches in diameter and 7¼ inches high; it occupies about 40% of the amp's interior. Behind it are four 78,000-microfarad, 63-volt filter capacitors, interconnected by a large p.c. board that also carries some supporting circuitry. Another board, just inside the rear panel, carries the input connectors, the input mode switches, and the circuitry for the LED signal-type indicator. A p.c. board behind the front panel bears the meter circuitry, including jumpers for setting the meter lights to two brightness levels and for setting the meters' sensitivity to read 0 dB at either full power or one-tenth power (a 10-dB difference).

Like the smaller Threshold amplifiers, the T800D's enclosure is made up of several equal-sized heat sinks—five per side in this model. A long, U-shaped extrusion running fore and aft on the inside of the heat sinks supports all of the output and driver devices; it also couples the heat sink sections together, thermally and mechanically. The circuit board carrying the front-end circuitry is mounted flush with the outside surface of these extrusions, for a very striking visual effect. Parts and construction quality are first-rate.

Rated Output: 200 watts per channel into 8 ohms, 400 watts per channel into 4 ohms, and 700 watts per channel into 2 ohms.
Rated Distortion: Typically less than 0.1%.
Dimensions: 18¼ in. W x 9¼ in. H x 25½ in. D (46.4 cm x 23.6 cm x 64.6 cm).
Weight: 126 lbs. (57.2 kg).
Price: $8,490 in black, $100 additional in platinum gray; without meters, Model T800, $7,890 in black, $100 additional in platinum gray.
Company Address: 310 Cortez Circle, Camarillo, Cal. 93012; 805/383-2788.
For literature, circle No. 92

Photos: Michael Groen

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TECHNICAL HIGHLIGHTS

Threshold's fully balanced differential topology provides two identical signal paths for each input signal phase (assuming that the input signal is balanced). Following is a description for one of these identical circuits.

The input stage is a complementary dual-differential circuit using low-noise J-FETs. Each of the four input J-FETs is connected in cascode with a bipolar transistor of the same polarity (NPN transistors for the N-channel J-FETs and PNP transistors for the P-channel J-FETS). In a cascode connection, the drains of the J-FETs are connected to the emitters of the transistors. Two of the collector outputs of these four transistors, one each from the positive and negative sides, are connected to the emitters of opposite-polarity bipolar transistors, in what is called a folded-cascode connection. The collectors of this last pair of transistors are tied together through the output stage's bias-spreading regulator and constitute the last voltage amplifier. A complementary pair of MOS-FETs, connected as source followers, comes next; these MOS-FETs function as a driver for the output stage.

The output stage is a complementary arrangement of seven pairs of insulated-gate bipolar transistors (IGBTs), operating as source followers. All of these devices are closely matched to have the same gate-to-source voltage at a given current level; the matching is done at their normal operating temperature. An overall negative feedback loop runs from the output back to the non-inverting side of the input's complementary differential amplifier.

Since there are no input or shunt feedback-network capacitors in the signal path, the DC and AC gains are the same. To minimize output DC offset, the amplifiers are adjusted and burned in at the factory for 40 to 80 hours.

The T800D has balanced and unbalanced inputs but has three input modes: "Unbalanced," "Balanced 1," and "Balanced 2." "Balanced 1" is for true balanced signals, with two signal paths driven in opposite phase. "Balanced 2" is for quasi-balanced signals from preamps with only unbalanced circuitry that nevertheless have XLR outputs. The T800D will actually amplify such signals even in "Balanced 1" mode. However, because its meters read the negative signal phase, which is not present in unbalanced signals, the "Balanced 2" (and "Unbalanced") positions provide some phase-inverting cross coupling between the amp's two, otherwise separate, signal paths. When set to either "Balanced 2" or "Unbalanced" mode, the output of the positive-phase circuit is fed through an appropriate-size resistor to the negative-phase input differential amp's inverting input and the positive (or normal) input terminal of this differential amp is grounded. In the "Balanced 1" and "Balanced 2" modes, a 1-kilohm resistor between each signal input line and ground provides a balanced input impedance of 2 kilohms. In the "Unbalanced" mode, the 1-kilohm resistor in the positive input line is lifted from ground, leaving a permanently connected 48-kilohm resistor to set the unbalanced input impedance.

In the power supply, separate rectifier bridges and main filter capacitors develop the main positive and negative supplies for each channel's output and driver stages. Each of the main filter capacitors is bypassed by film capacitors. A set of high-voltage taps on the power-transformer secondary feeds another set of bridge rectifiers, one for each channel. The filter capacitors for these rectifiers are located on each channel's amplifier p.c. board and are arranged in two groups of twelve 470-microfarad, 63-volt units per board. From these capacitor banks, discrete voltage regulators feed positive and negative regulated voltage to the front-end circuitry.

The positive and negative supply lines to each channel's output stage are fused, and sensing circuits detect if any of these fuses blow. The protection circuitry will mute the outputs by shorting the signal input lines and shutting off the output stage bias if a fuse blows, if either channel overheats, or if the incoming AC line voltage drops below a set level. (Only an inordinate fluctuation in line voltage will trigger the protection circuitry.) *B.H.K.*

Measurements

The T800D's frequency response was virtually the same with open-circuit, 8-ohm, and 4-ohm loading, indicating very low and uniform output impedance in and beyond the audio range. Therefore, only the 8-ohm curve is presented in Fig. 1. It is for the balanced input (in "Balanced 1" mode); with an unbalanced input, response was down about 1.7 dB more at 200 kHz. Corresponding rise times measured 1.8 microseconds in balanced mode and 2.2 microseconds with unbalanced input. Square-wave response at high frequencies with an 8-ohm resistive load was essentially exponential (normal) in shape. When the 8-ohm load was paralleled by a 2-microfarad capacitor, the resultant ringing had about 28% overshoot and was essentially damped out within one half cycle of the 10-kHz square wave. This is a bit more ringing than I usually see but still typical of many power amplifiers. Low-frequency square waves had no tilt at all: The T800D is truly DC-coupled.

THE T800D IS THE LATEST, LARGEST, AND BEST OF THE THRESHOLD POWER AMPS.

The two channels' common-mode rejection ratios (CMRR) matched, at –58 dB each, from 20 Hz to about 2 kHz. Above 2 kHz, the left channel's CMRR decreased, ending up at –53 dB at 20 kHz, while the right channel's got better, ending up at –67 dB at 20 kHz.

Distortion, not unexpectedly, was better in the balanced input mode. Figure 2 shows how the left channel's total harmonic distortion plus noise (THD + N) at 1 kHz and SMPTE IM distortion change with power

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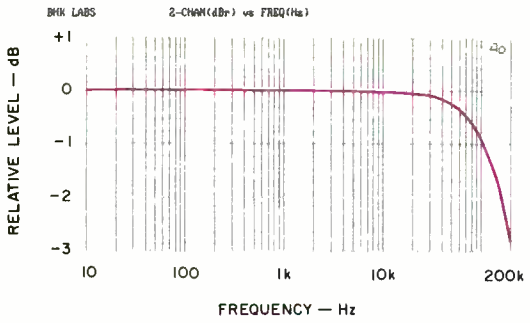
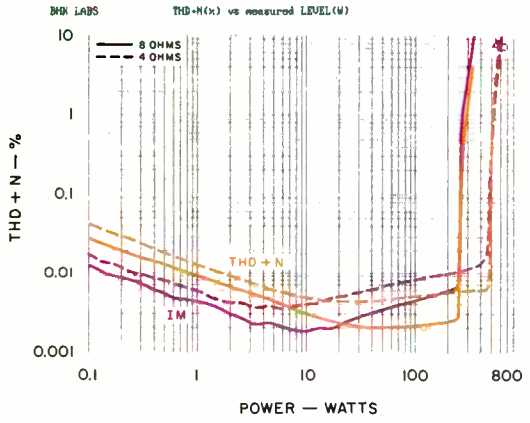


Fig. 1—Frequency response with balanced input and 8-ohm loads.



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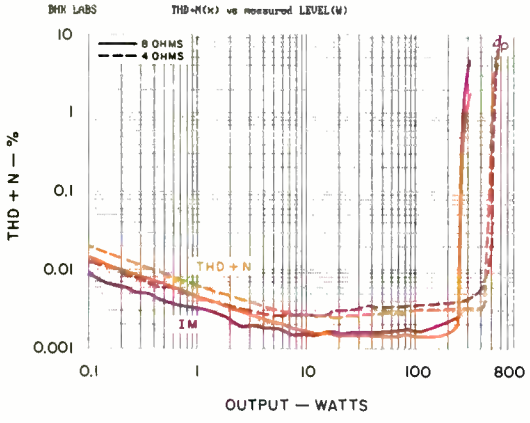

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Fig. 2—THD + N and SMPTE IM distortion vs. power output, for unbalanced input (A) and balanced input (B).

(for unbalanced input in Fig. 2A and balanced input in Fig. 2B). For THD + N versus frequency, see Fig. 3A (unbalanced input) and Fig. 3B (balanced input). The harmonic-distortion residue from a 1-kHz signal at 10 watts into 8 ohms (Fig. 4) reveals an admirable absence of high-order distortion products.

One not-so-desirable characteristic of the T800D is its tendency, when pushed into clipping by high-frequency test signals, to stay clipped a bit too long after the input signal passes its peak. (The T400, which I reviewed in the August 1995 issue, also did this.) When this is happening, substantial common-mode current passes through the output stage from the positive to the negative power-supply rails. This drags down the supply voltages, reduces power output, and heats up the output stage. Music, however, is unlikely to have enough high-frequency energy to trigger the effect.

Damping factor is plotted in Fig. 5 for the left channel in balanced input mode (damping was slightly higher in the right channel and slightly lower with unbalanced input). With such a high damping factor, there should be no excuse for anything but tight, powerful bass from speakers driven by the T800D.

Interchannel crosstalk was down by more than 100 dB over the whole audio range, in either direction for balanced input and for unbalanced input when measured from the right to the left channel. However, left-to-right crosstalk with unbalanced input rose above –100 dB at 7 kHz, ending up at –92 dB by 20 kHz.

The Threshold T800D's worse-case noise was in the right channel. At the output of the amplifier it measured 269 microvolts, wideband, and 87 microvolts, A-weighted; with unbalanced input, the respective figures were 251 and 81 microvolts. Left-channel noise was about 25% lower with balanced input but only about 5% lower with unbalanced. IHF signal-to-noise ratios for the two channels and input modes ranged from about 90 to 92 dB.

Gain was very closely matched in the two channels, 27 dB in unbalanced mode and 33 dB in balanced. Corresponding input sensitivities for 1 watt into 8 ohms were 125.5 and 63 millivolts.

Dynamic power into 8-ohm loads was 342 watts, with no appreciable power sag during the 20-millisecond IHF tone burst. Into 4-ohm loads, dynamic power was 666 watts at the beginning of the burst and 595 watts at its end. Based on the power ratings of 200 and 400 watts into these loads, dynamic headroom works out to be 2.3 dB into 8 ohms and 2.2 dB into 4 ohms. Clipping power was 294 and 510 watts, respectively, yielding clipping headroom of 1.7 and 1.1 dB.

The AC line-current draw changed considerably as the amplifier came up to operating temperature. The T800D drew about 9 amperes when turned on from cold but

ASSOCIATED EQUIPMENT USED

Equipment used in the listening tests for this review consisted of:

CD Transports: Sonic Frontiers SFT-1 and PS Audio Lambda Two Special

CD Electronics: Genesis Technologies Digital Lens anti-jitter device and Threshold DAC 2, Sonic Frontiers SFD-2 MkII, and Classé Audio DAC-1 D/A converters

Phono Equipment: Oracle turntable, Well Tempered Arm, Accuphase AC-2 moving-coil cartridge, Vendetta Research SCP-2C phono preamp, and phono stage of the Anthem Pre 1 preamp

Additional Signal Sources: Nakamichi ST-7 FM tuner, Nakamichi 250 cassette deck, and Technics 1500 open-reel recorder

Preamplifiers: Threshold T2, Sonic Frontiers Line-3, Ayre K-1, and Forssell balanced tube line driver (or no analog preamp at all)

Power Amplifiers: Sonic Frontiers Power-3 mono tube amplifiers, Houston GSP-02 tube amp, an Ayre V-3, and Quicksilver M135 mono tube amps

Speakers: Genesis Technologies Genesis Vs and B&W 801 Matrix Series 3s

Cables: Digital interconnects, Illuminati DX-50 (AES/EBU balanced); analog interconnects, Transparent Cable MusicLink Reference (balanced) and Tara Labs Master and Music and Sound (unbalanced); speaker cables, Transparent Cable MusicWave Reference and Tara Labs RSC Master Generation 2

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EQUIPMENT PROFILE

CELESTION A3 SPEAKER

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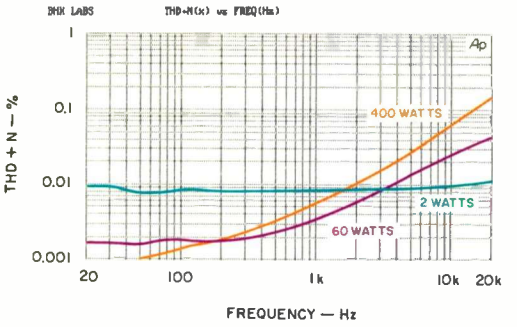

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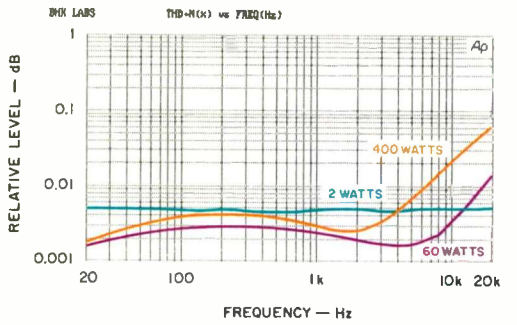

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Fig. 3—THD + N vs. frequency into 4-ohm loads with unbalanced input (A) and balanced input (B).

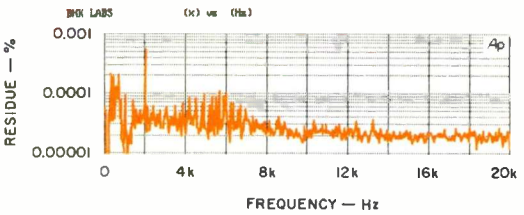


Fig. 4—Spectrum of harmonic-distortion residue for a 1-kHz signal at 10 watts out into 8 ohms.

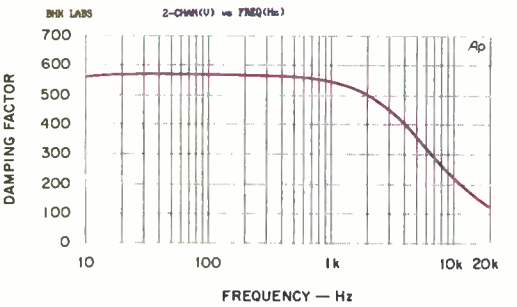


Fig. 5—Damping factor.

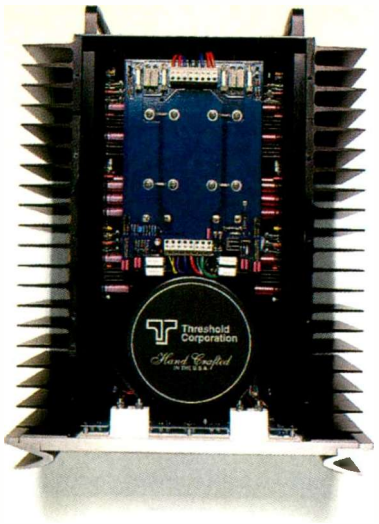
came down to about 4 amperes when fully warmed up. (Talk about overcompensated bias regulators! On the other hand, this helps the amp come up to temperature and attain its best sound more quickly, so it may well have been a deliberate design choice.) And in one test, conducted before the amp had fully warmed up, the AC line-current draw was 5.2 amperes at idle and at low power levels but started to increase between 10 and 15 watts per channel, reaching 8.5 amperes at 230 watts per channel.

These results indicate that the T800D does not quite fit the classic definition of a Class-A amplifier, which should, when feeding its rated load, dissipate about twice its rated power at any point from idle up to full rated output. (With lower-impedance loads, Class-A amps will operate in Class A at low power levels but will shift into Class-AB operation at some point well below rated output.) By that definition, the T800D's current draw at idle should be more like 10 or 12 amperes and should not change as output increases.

The power-dissipation characteristics associated with Class A stem from the fact that the current to the output devices of a Class-A amp never cuts off; the current in each push-pull half of a Class-A amp should be continuous over the full signal cycle, and the current wave shape in each output device will be mostly sinusoidal for a sine-wave signal. Threshold, among others, has devised means of reducing the quiescent idling power dissipation below the classic requirement. In such arrangements, the current's wave shape more closely resembles that of a Class-AB amplifier except that it drops only to a minimum value during those portions of the cycle instead of cutting off completely, as it would in a Class-AB design.

Use and Listening Tests

Before I listened to the T800D, I had been using Threshold's T2 preamp and DAC 2 D/A converter and had been generally impressed with their sound. Then I hooked up the T800D, using balanced interconnects. With the T800D warmed up and feeding my B&W 801 Matrix Series 3s, the sound was simply wonderful, among the very best I've heard with the 801s in my system! This amplifier has explosive dynamics, great definition, very



AT 126 POUNDS, THE THRESHOLD T800D IS A BEAST OF AN AMP BUT A DAMNED ATTRACTIVE ONE.

realistic tonal balance, tight and powerful bass, and a smooth, spacious, and musically believable sound. This is one of very few amplifiers that I find myself enjoying at higher than usual levels (with appropriate material, of course). For me, the undue irritation that all too frequently accompanies high resolution is a prime consideration; happily, very low irritation is among the T800D's positive attributes.

Changing over to Genesis V speakers, I used balanced interconnects from the preamp to the Genesis woofer amplifier and to the T800D. With the Genesis Vs, the sound was very compelling, dynamic, and musical. Space and definition were superb. The T800D was a touch more forward and dynamic than the Sonic Frontiers Power-3 mono tube amps; the Power-3s sounded more laid back and lush. Which amp I preferred depended on the recording I played. After switching the T800D's input mode between balanced and unbalanced a few times, I got a fleeting impression that the sound was slightly better in balanced mode than in unbalanced.

The T800D performed without a hitch, both in the lab and in my system. It sounded superb, and I absolutely enjoyed using it. Needless to say, I appreciated the sound of the Threshold preamp and DAC as well. I give a thumbs-up to the T800D. A

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EQUIPMENT PROFILE

EDWARD J. FOSTER

DENON DVD-2000 DVD PLAYER

Some DVD players have enough D/A converters to enable their internal Dolby Digital (AC-3) decoders to supply full 5.1-channel analog audio; others rely on downstream decoding to do the job. The Denon DVD-2000 is the latter type, but I find that of little consequence. Relatively few audio/video products can handle a 5.1-channel analog input properly, and new, upscale integrated amps and receivers are likely to include their own 5.1-channel Dolby Digital decoders, which can be used not only with DVD players but with digital satellite receivers, AC-3-ready laserdisc players, and whatever else turns up. True, the DVD-2000 provides a Dolby Digital bitstream only via a Toslink optical socket, so it can be used only with a downstream converter that has a matching input; most decoders do, however, so that's also of little consequence.

If you don't yet have a Dolby Digital Surround decoder, the DVD-2000's nickel-plated analog output jacks will supply your Pro Logic decoder with a Dolby Surround signal that includes the information from the Dolby Digital bitstream. In fact, the "Basic Connection" section of Denon's manual treats the analog mix as the standard condition and external Dolby Digital processing as an "Optional Connection."

The DVD-2000 is also said to support 96-kHz, 24-bit linear PCM (as well as the more mundane 44.1/48-kHz, 16-bit fare) via its AC-3/PCM Toslink output. Video is available in NTSC composite form on a nickel-plated RCA jack and, in S-video form, on an adjacent base-metal connector. Power is supplied via a removable two-wire IEC line cord.

The front panel couldn't be simpler: a central disc tray that's flanked on the far left by a power switch, headphone level control, and gold-plated headphone jack and, on the right, by six buttons that control operation ("Open/Close," "Skip/Search" forward and back, "Stop," "Still/Pause," and "Play"). I guess I could be a curmudgeon and chide Denon for gold-plating the visible but infrequently used headphone jack while using base metal for the invisible but always used rear connectors, but what's the point? Everyone does it, and I had no problems with these base-metal connectors for as long as I used the player, which is more than I can say for some other players I've tested.

THE DVD-2000'S SOUND IS REALLY ENJOYABLE: CLEAN, SHARP, EXQUISITELY DETAILED.

For the most part, you'll operate the DVD-2000 from its simple, sensible, 38-button remote. As you'd expect from that button count, it offers many functions not found on the front panel. These include slow-motion video in both directions, repeat (by chapter or title or by start and end points you select), and mark points to be returned to later.

Directional buttons arranged at the four points of the compass surround a central "SEL." key; this array, in conjunction with other buttons, can be used to navigate through on-screen menus, call up the title, chapter, and time, and move to a new title, chapter, or time (which you can also select from the 10-key numeric pad). The north and south buttons are also used to cycle through the available soundtrack and sub-

Dimensions: 16¾ in. W x 3½ in. H x 11¼ in. D (43.4 cm x 8.7 cm x 28.8 cm).
Weight: 7½ lbs. (3.4 kg).
Price: $799.
Company Address: 222 New Rd., Parsippany, N.J. 07054; 973/575-7810.
For literature, circle No. 93

Photos: Michael Groen

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KEF RDM *one* SPEAKER

As reviewed in

AUDIO

September 1997

Some notable quotes from Edward M. Long in *Audio's* September issue:

"...KEF has gained an enviable reputation for producing excellent loudspeakers."

"...clear, precise imaging."

"The RDM *one* reminds me of the classic BBC LS3/5a, but with deeper bass and higher output."

"...the KEF RDM *ones* are an excellent value—and very good looking, too."

Designed by the same engineers as our legendary Reference Series, the RDM *one* features KEF's patented Uni-Q® technology. Uni-Q places the tweeter at the exact acoustic center of the woofer cone to create a single point source for the entire frequency range—the ideal to which all speakers aspire—producing a flawless soundstage over a much wider listening area. Whether on a bookshelf or stand, the RDM *one* no longer confines you to sitting in a central sweet spot to enjoy exceptional performance. Audition them for yourself by contacting us for the name of the authorized KEF dealer nearest you. Ask for a full reprint of the RDM *one* review when you call.

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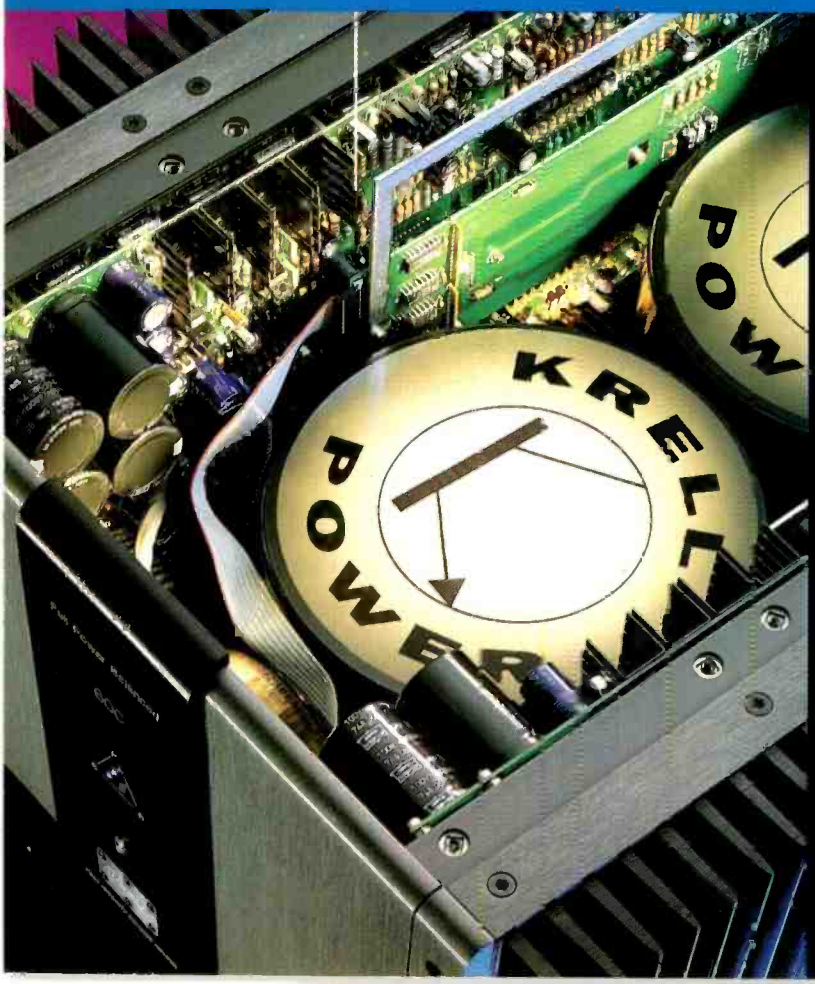

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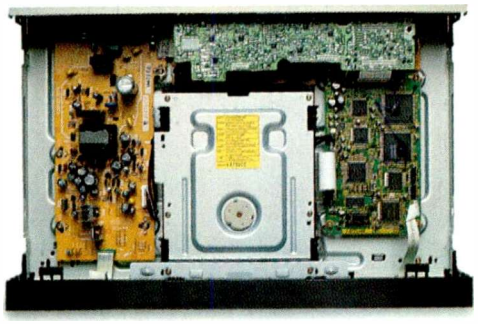
title languages and to select camera angles on discs encoded with these features.

On audio and video CDs, up to 18 tracks can be programmed for playback in any order using the "Play Mode" key, an on-screen display of the available tracks, the directional arrows, and the "SEL." button. On karaoke Video CDs, the "Audio" and up/down buttons choose the preferred audio channel or turn it on or off.

Of course, the primary reason for buying the DVD-2000 is to play DVDs. DVD default playback conditions are determined with the "Setup" menus elicited by pressing the key of the same name. The first menu offers three choices of program rating: "Kids' Titles Only," "Forbid Adult Titles," and "Play All Titles" (the default); to make a change, you must enter a four-digit password via the keypad. The second and third menus are used for setting the default audio and subtitle preferences: English, French, Spanish, Original, and Other for the audio;



ON THE BENCH, DENON'S DVD-2000 PROVED TO BE A VERY NICE PLAYER INDEED.

Automatic, English, French, Spanish, and Other for the subtitles. In each case, "Other" permits you to enter a standardized four-digit code for other languages; the codes are listed in the manual. (In DVD lingo, "Automatic" subtitling means that the subtitle is in the same language as that selected for audio reproduction. Why one would want that, I have no idea, except to help learn the language, but that's how DVDs go. Fortunately, you can kill the subtitles from the remote.) The fourth setup menu is for telling the player the aspect ratio of your TV screen: 4:3, the factory setting, which displays letterbox video with black bands on the top and bottom of the screen; 4:3 pan/scan, which fills a standard TV screen with a portion of the widescreen image; and 16:9 for displaying widescreen images "full screen" on a 16:9 set. The fifth menu lets you toggle the on-screen display on and off, and the final level lets you choose the on-screen display language: English, Français, Español, and the ubiquitous Other.

Measurements

On the bench, the Denon DVD-2000 proved to be a very nice player indeed. Using the new Sony test DVD, I found the Denon's video performance to be right on the money as far as the luminance channel was concerned. Response was down a mere 0.5 dB at the highest multiburst frequency on the disc (4.2 MHz), a discrepancy so trivial that it's well to ignore it; in any event, it's pretty difficult to document video response more accurately than that by using a waveform monitor. Luminance level was on target, too, at –0.4 dB re the standard, and I could find no measurable gray-scale inaccuracy whatsoever over the full 10-step brightness range.

Chrominance level was high, by 2 dB, but that seems to be endemic with DVD players; it's interesting only in that the VCRs I've measured usually exhibit low chroma level while DVD players register high. In any case, the monitor will compensate for these differences. The Denon's other chroma measurements—phase (tint or hue) accuracy and differential gain and phase (shifts in chroma intensity and tint with changes in scene brightness)—were as perfect as they come.

Because the DVD-2000's analog audio output is two-channel, I used the CBS CD-1 test disc rather than the Dolby Laboratories AC-3 disc for evaluating the performance of the Denon's internal D/A converters.

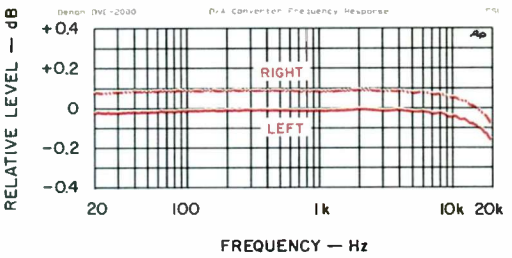


Fig. 1—Frequency response.

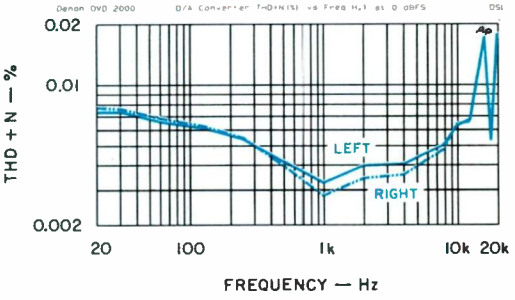


Fig. 2—THD + N vs. frequency.

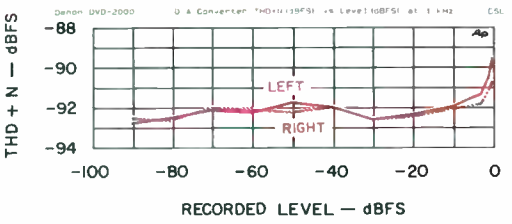


Fig. 3—THD + N vs. recorded level.

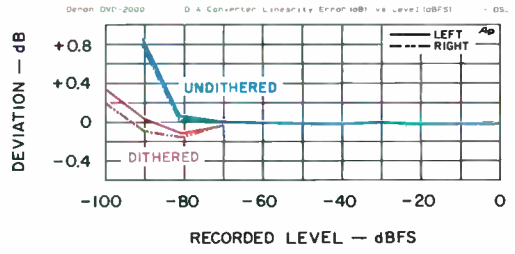


Fig. 4—Deviation from linearity.

They proved to be among the best I've found in a DVD player. Take a look at the frequency response curves in Fig. 1. I've expanded the vertical axis to ±0.4 dB, to ferret out filter ripple and response errors, because they were extremely small. But even on this scale, it's hard to see the filter ripple since it measures on the order of hundredths of a decibel! Furthermore, response is dead flat in the bass and down a mere

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0.17 dB, worst case, at 20 kHz. That's really first-class!

The channels were balanced within ±0.05 dB, and output from a 0-dBFS recording just exceeded 2 volts, the unofficial standard. Output impedance was reasonably low (1,000 ohms), so interfacing with other gear should be easy. And the DVD-2000 delivered adequate signal level into either high- or low-impedance headphones.

Figure 2 shows THD + N versus frequency at the 0-dBFS level. I've used an expanded vertical scale for this graph, too, so interpret the intermodulation "peaks" at 16 and 20 kHz accordingly. Although the cross-products do reach 0.0183% at 20 kHz, distortion and noise sum to less than half that over most of the audio range, which, among the D/A converters being used in current DVD players, is very respectable.

Figure 3 shows THD + N versus recorded level when I used a 1-kHz (actually 997-Hz) test frequency. I've expanded the vertical scale yet again, to cover a total spread of only 6 dB, because the DVD-2000's THD + N was so uniform: no more than –89.4 dBFS over the full dynamic range and –91.6 dBFS maximum at levels from –30 dBFS on down.

These measurements suggest excellent converter linearity, and Fig. 4, which directly plots linearity error as a function of level, confirms it. Even on this (once again, expanded) vertical scale, there's no trace of nonlinearity between 0 and –70 dBFS and almost none at –80 dBFS. With a dithered recording, the nonlinearity amounts to only 0.35 dB at –100 dBFS.

Figure 5 depicts nonlinearity in a different manner, using the fade-to-noise track on the CBS CD-1. This computer-generated recording simulates a fade from –60 to –120 dBFS using a dithered signal. I've shown only the data taken on the DVD-2000's left channel, but the right channel performed about the same. As you can see, the error at –110 dB amounts to 2 dB or less, which is very good.

THE DVD-2000'S D/A CONVERTERS RANK AMONG THE BEST I'VE FOUND IN A DVD PLAYER.

In the spectrum analyses of residual noise from an infinity-zero signal and of output for a 1-kHz signal at –60 dBFS (Fig. 6), note that there are no power-line-related components of significance. The worst line-related component is below –120 dBFS, and its 60-Hz frequency suggests that it may have been caused by magnetic hum pickup in the interconnecting cables rather than a hum source within the player itself. In the infinity-zero plot, you can see just traces of energy at 88.2 and 176.4 kHz, equivalent to twice and four times the sampling rate. However, the 88.2-kHz component rises significantly in the presence of actual signal, as you can see in the –60 dBFS/1-kHz curve. You can't hear 88.2 kHz, of course, but the presence of this component does suggest possible converter imbalance in this player that could give rise to intermodulation; I'd have preferred that it not be there. Interestingly, dynamic range (which is tested with the same –60 dBFS/1-kHz track of the CD-1) was excellent, almost 97 dB, unweighted, and nearly 100 dB on an A-weighted basis. With CCIR weighting, the DVD-2000's dynamic range still cleared 90 dB, which is quite impressive and suggests that my concern may be ill-founded.

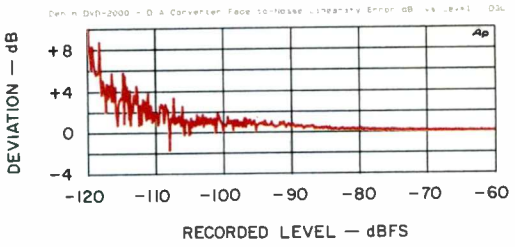

Fig. 5—Fade-to-noise test.

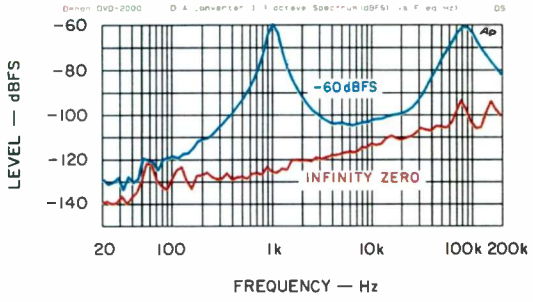

Fig. 6—Noise spectra.

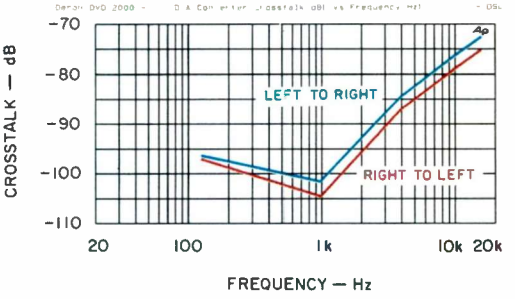

Fig. 7—Crosstalk vs. frequency.

The spectra in Fig. 6 will suggest to the knowledgeable reader that the DVD-2000's S/N should be excellent, and it was, with both CCIR and A-weighting. Quantization noise, which I consider a more meaningful measurement than S/N in a digital system, was also very good, at –89.1 dBFS.

Channel separation (Fig. 7) exceeds 100 dB at 1 kHz and is pretty much the same measured from the left to the right channel or vice versa. Even over the full test range (125 Hz to 16 kHz), separation exceeds 72 dB, which testifies to excellent circuit layout as well as to care in manufacturing.

Use and Listening Tests

The Denon DVD-2000 is simple to install and relatively simple to use. The buttons on the remote aren't illuminated, and most are rather small and closely spaced. Many have the same feel, too, so it's easy to push the wrong one in a darkened room. On the other hand, this remote is smaller than many and easier for the small-handed person to manipulate.

I played a number of commercial discs on the DVD-2000, with great results. On well-recorded DVDs, full-motion picture quality was visually excellent. The contrast was first-rate, the resolution excellent, and the colors very clean. As usual with DVD,

MEASURED DATA

PCM AUDIO

Line Output Level: 2.16 V at 0 dBFS.

Channel Balance: ±0.05 dB.

Line Output Impedance: 1 kilohm.

Headphone Output Level: Maximum voltage, 3.37 V; maximum power, 16 mW into 600 ohms or 22 mW into 50 ohms.

Headphone Output Impedance: 95 ohms.

Frequency Response: 20 Hz to 20 kHz, +0, –0.17 dB.

THD + N at 0 dBFS: Less than 0.0183%, 20 Hz to 20 kHz.

THD + N at 1 kHz: Below –89.4 dBFS from 0 dBFS to –90 dBFS and below –91.6 dBFS from –30 dBFS to –90 dBFS.

Maximum Linearity Error: Undithered recording, 0.89 dB to –90 dBFS; dithered recording, 0.35 dB to –100 dBFS.

S/N Ratio: A-weighted, 106.5 dB; CCIR-weighted, 97.5 dB.

Quantization Noise: –89.1 dBFS.

Dynamic Range: Unweighted, 96.8 dB; A-weighted, 99.1 dB; CCIR-weighted, 90.4 dB.

Channel Separation: Greater than 72.9 dB, 125 Hz to 16 kHz.

DVD VIDEO

Luminance Frequency Response: +0, –0.5 dB, 0.5 to 4.2 MHz.

Luminance Level: –0.4 dB.

Chroma Level: +2 dB.

Gray-Scale Linearity: No measurable error.

Chroma Phase Accuracy: Within 1°.

Chroma Differential Gain: No measurable error.

Chroma Differential Phase: No measurable error.

still-frame and slow-motion picture quality depended as much upon the disc as anything else. Suffice it to say that the DVD-2000 had trouble with still-frame and slow motion on scenes that most players find difficult and produced clean, relatively blur-free pictures on scenes where other players also performed well. As far as DVD's special features go—multiple viewing angles, subtitles, multiple soundtracks, and so on—the DVD-2000 supported whatever the disc had to offer.

I HAVE TO GIVE THE DENON DVD-2000 HIGH MARKS OVERALL FOR PICTURE QUALITY.

When reproducing the Snell & Wilcox D-1 test pattern recorded on the new Sony test disc, the DVD-2000 cleanly resolved all wedges. Although full contrast wasn't maintained on the 5.75-MHz block, there was no difficulty discerning the pattern. I therefore give the Denon DVD-2000 high marks overall for picture quality.

I doubt that anyone would buy the Denon just to listen to CDs, but the quality of the DACs in the DVD-2000 is most clearly apparent when reproducing music. And though I seldom listen to music CDs in my home theater, I found myself really enjoying the experience with this player. The sound was clean, sharp, and exquisitely detailed. Those with different taste may find the sound a bit too etched, but I think it will appeal to the majority of people. For the record, however, the DVD-2000 is one of those DVD players that is unable to recognize the signals on home-recorded CDs (CD-Rs).

Decoded by my reference Citation 7.0 processor and played through my Adcom five-channel power amp and Paradigm speakers, the Pro Logic mixdowns of the Dolby Digital soundtracks on DVDs were eminently satisfying—so much so that I'd not hold back buying this Denon DVD-2000 before purchasing a Dolby Digital decoder. You can derive a lot of enjoyment from the DVD-2000 (and start to accumulate a library of DVDs) in a conventional Pro Logic-based home theater. Discrete Dolby Digital Surround sound can always be added later—one step at a time. A

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AURICLE

DANIEL KUMIN

SNELL ACOUSTICS RCS 1000 ROOM-CORRECTION SYSTEM

At one time or another, almost every audio buff has wrestled with listening-room acoustics. Many of us resign ourselves to living with whatever room modes and reflections fate slings our way. Others spend untold hours and, sometimes, thousands of dollars on acoustical analyses and room treatments (from simple curtains or soft furniture to specialized bass traps and diffraction/diffusion panels), all in the effort to coax our listening spaces into more benign acoustical behavior.

Company Address: 143 Essex St., Haverhill, Mass. 01832; 508/373-6114.
For literature, circle No. 94

Room acoustics are often the most profound influence on what we ultimately hear, dwarfing the audible significance of speakers, amps, and source components (to say nothing of AC line filters or vibration damping devices). The hapless speaker designer has no way to predict what acoustical mayhem lies in wait for his laboriously balanced, meticulously engineered creations. But digital technology is beginning to provide ways of fighting back.

Snell Acoustics, the high-end speaker company founded by the late Peter Snell some 20 years ago, is among the first to release a fully formed room-correction system. Now in production, it's gone through nearly five years of development and at least three distinct stages of existence. Among those participating in its gestation have been Kevin Voecks (Snell's chief designer at the time, who is now at Revel), the R&D department of Audio Alchemy, and BNK Electronics, Inc. (the corporate identity of internationally known audio-DSP expert Radomir Bozovic, who is responsible for much of the system's ultimate design). Finally, under Snell's current ownership, Boston Acoustics, the design was completed and put into production under chief engineer Dave Smith (formerly of McIntosh and KEF).

The result of this epic development saga is the Snell RCS 1000, a relatively unassuming black box that deploys six channels of time-derived digital equalization to correct the frequency- and time-domain anomalies that room acoustics impose on loudspeaker and listener. The system gives the user—or, more precisely, the installer—the ability to hit virtually any system-response target within the limits of your amps and speakers; you could even generate wrinkly-looking curves with hundreds of data points, if you wanted, though I'd hardly call those sensible. To accomplish all this, the RCS 1000's installation routine requires a Windows PC as the controller; however, once setup and tuning are complete, the Snell system runs without the PC, controlled by a simple remote handset. The system's price, including the initial installation by the dealer, is $15,000.

The RCS 1000 is housed in an elegantly formed chassis comprising a very heavy-gauge, complexly shaped front panel and a finely finished, all-steel pan and top cover, with a top-grade, anodized black finish. Set into the faceplate is a window for a dis-

Photo: Michael Groen

Like a few others in this business, we've successfully avoided becoming a household word.

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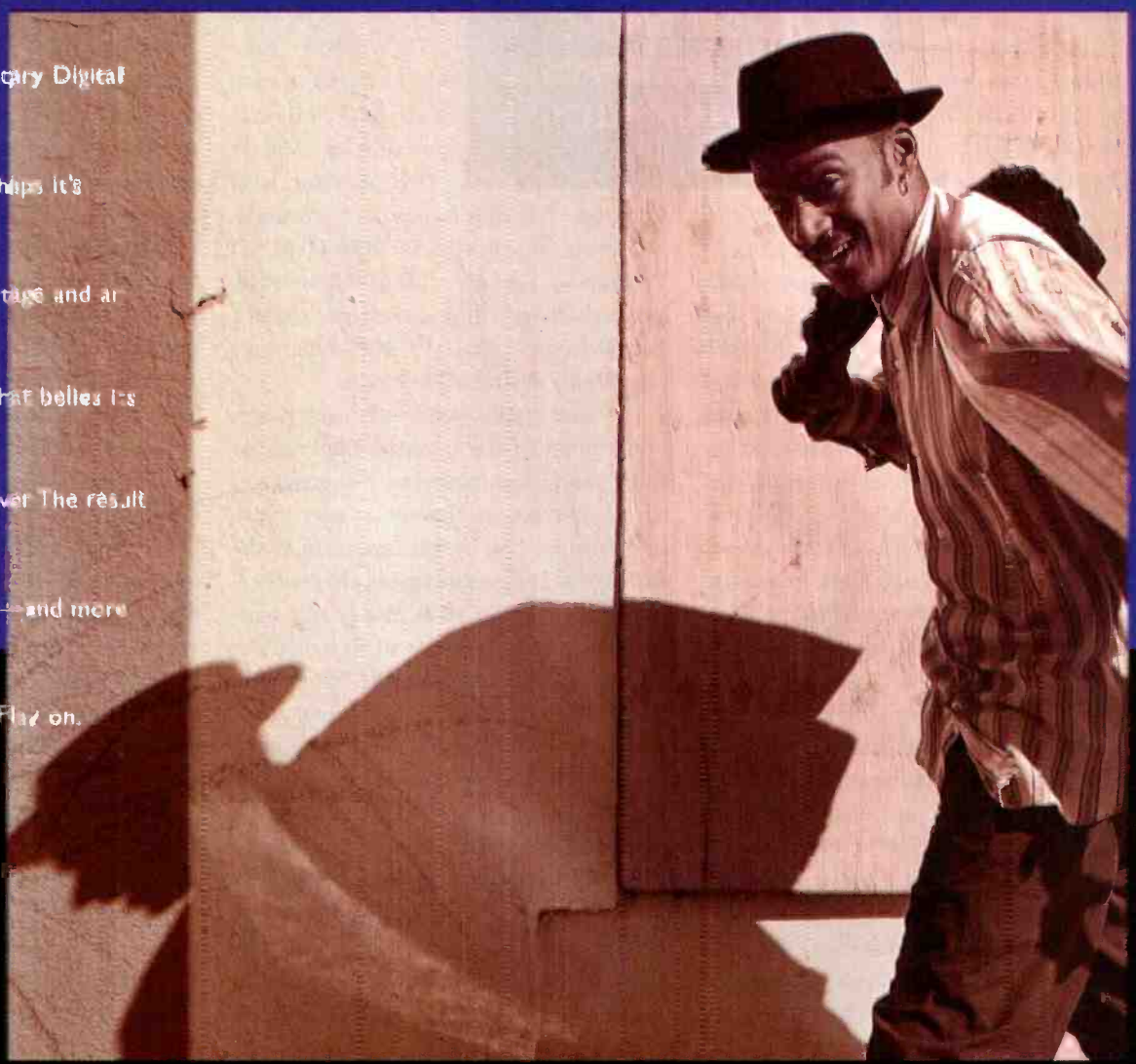

Marcus Miller, Santa Monica
photo by William Claxton

play (two lines of 20 characters) and a small round cutout for the infrared eye. The supplied remote is elegantly finished to match, with only 17 small round buttons: 11 presets, "Bypass," "Preview," "Select," muting, and volume up/down.

On the rear panel, each of the six channels (left, center, and right front, left and right surround, and subwoofer) has four jacks: two RCAs for unbalanced input and output, two XLRs for balanced in and out. A thirteenth female XLR accepts the measurement microphone required for setup. There's also a nine-pin RS-232 serial port for interconnection with the PC, an IEC removable power-cord socket with adjacent AC switch, and a computer-style (DB-25 female) 25-pin jack that can accept six-channel balanced audio via a single cable (an increasingly popular type of home theater connection); however, there's no corresponding DB-25 output connector. All audio connectors are of the highest quality.

THE SOUND BECAME BETTER INTEGRATED YET MORE DISTINCT, AND IMAGING IMPROVED DRAMATICALLY.

Inside, the RCS 1000 runs no fewer than six 24-bit Motorola DSP56002 40-MHz signal-processing chips, with A/D and D/A conversion via Burr-Brown 20-bit devices; 24-bit digital filtering is performed at the output side. Construction is modular and very tidy, with boards on six different planes and three two-channel modules each for the A/D and D/A functions. Analog audio is buffered in and out via Philips ICs.

Snell's original room-correction concept was purely time-domain, cancelling individual reflections. However, according to chief engineer Dave Smith, this turned out to be impractical, yielding audible artifacts ". . .as bad as, or worse than, the original problems you were trying to solve." Instead, the RCS 1000 equalizes in the frequency domain (based on the time-domain measurements made during installation), using six minimum-phase FIR (finite impulse response) filters that perform two-pass calculations. This enables the system's filter resolution to be higher in the bass region and somewhat lower in the less critical upper octaves. In the five main channels, Snell employs a proprietary algorithm that it calls "progressive filtering," which smoothly adjusts filter precision from a few hertz at 20 Hz to about half an octave at 20 kHz; the subwoofer channel gets the highest filter resolution of all, with 1.3-Hz precision.

Hookup is very straightforward: The Snell is inserted between a preamp or surround processor's multichannel line outputs and the inputs of the power amps. In my system this placed it just upstream of Parasound HCA-2003 and HCA-1000 amps (which drive my front and surround speakers) and a B&W 800 ASW active subwoofer. Speakers were B&W 803 Series 2s flanking a Matrix HTM up front, with Citation 7.3 dipole/bipole surrounds. Sources included JVC's XV-1000 DVD/CD deck and a Pioneer CLD-D702 laserdisc player (both used only as transports) and a B & K Components AVP-4090 tuner/preamp/Dolby Digital/DTS decoder.

A typical installation, which involves several hours of fairly intensive fiddling, has four stages: measurement, frequency-response correction, time-delay correction, and downloading of the correction to the RCS 1000. The measurement phase is performed by the RCS 1000, mostly automatically, acquiring a series of Fast Fourier Transform data sets from the usual "tick-plop" FFT impulse signal. The operator's only real jobs are to move the mike between measurements and—rather more demanding—to determine where the mikes should be placed for data acquisition and how to group the positions for spatial averaging so that the resulting equalizations will give proper results at the main listening locations. As many as nine different measurements may be taken per speaker for each "project" (which is how the system groups data). You can create as many projects as you want and store them on a PC, but the RCS 1000 can hold equalization curves for only one project at a time. Its 12 presets hold 11 curves downloaded from the setup PC; the twelfth preset, "Bypass," is fixed.

The correction phase consists mostly of designing target curves, overall contours for the RCS 1000 to realize when it applies its FFT smarts to actual playback equalization. (You could, of course, choose a perfectly horizontal line as your target. But anechoic "flat" response, which FFT equalization can more or less deliver, sounds awful. Because it does not factor in the contributions of room reflections and modes, it almost always sounds harsh, bright, honky, bass-shy, and generally unmusical.) You can set up as many as six different targets, one for each speaker, which might tempt you to experiment with real-world, in-place timbre-matching.

It goes without saying that selecting measurement locations, determining spatial-averaging groups, and designing target curves is precisely where the art of the thing comes in. And, in large part, it explains why Snell does not offer the RCS 1000, unchaperoned, to do-it-yourselfers, even to such earnest and indisputably well-intentioned ones as me.

Snell's Dave Smith set up the system in my studio, running a somewhat more modest FFT series than might typically be applied for a (well-heeled) paying customer. We collected three measurements at my primary listening position, one at my head position and the others about 8 inches to either side; in the name of science, we also ran a similar group of FFTs at my desk chair, which is fully 45° off the main speakers' axis and faces away from the usual soundstage. Each measurement location was mapped six consecutive times, and FFTs were performed for each speaker, including the subwoofer. With fewer speakers (as in a standard stereo system), fewer measurements and FFTs would have been made.

In keeping with this shorthand setup, we designed only two initial target curves. The "music" curve had a modest (3-dB) upward slope over the range from 80 to 20 Hz, to enrich the bass, and a similarly mild 3-dB "downtilt" over the top three octaves; the "home theater" curve had 6 dB of bass en-

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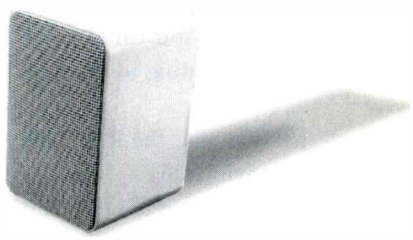

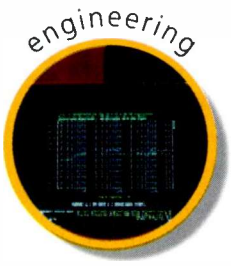

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richment and an elbow like that of the Home THX re-equalization curve in those same upper octaves. These were pretty generic, acceptably all-purpose targets, applied to all channels. In a permanent installation the dealer would spend far more time and effort in these adjustments, and Smith relates that installers often schedule a tune-up a month or two after the initial visit.

THIS DIDN'T SOUND LIKE EQ BUT, RATHER, LIKE I'D UPGRADED MY SPEAKERS OR MY ROOM.

We then created four presets: two-channel stereo using only the main, head-position left/right/subwoofer data and the music curve; the same utilizing a spatial average of all three measurements; a movies preset employing the home theater target curve and head-position measurements for all six channels; and an experimental work-desk position, in stereo, averaging two measurements about a foot apart. (I subsequently repeated the entire process on my own, finding it very interesting and worthwhile to experiment with different mike setups and spatial averages. You could easily spend several days just getting to the next level.)

So, after all that, how did the RCS 1000 sound? In a word, remarkable.

Snell's room-correction system did not sound like equalization at all. Rather, it sounded as if I had suddenly upgraded loudspeakers. Or, more precisely, as though I had instantly transported my familiar speakers (and myself) to their maker's carefully constructed and acoustically treated listening room, where they were now able to do their very best.

In my room, with preset 1 (the centered, two-channel setting), the effect is best described as a threefold unveiling. The bottom two octaves immediately sounded clearer, "faster," less woolly, and obviously more extended in the region below 40 Hz. Treble above, perhaps, 3 kHz sounded cleaner, more three-dimensional (cymbals in particular), and, well, less "recorded." A corollary to this was an almost startling change in hall sound and reverb decays, which became noticeably more distinct. And last, but not least, the lower midrange (the male vocal region) opened dramatically, with a clearly more detailed, transparent texture and none of the megaphone-like quality often heard in this range. All this occurred on a system that, most listeners agree, sounded pretty damned good to begin with—maybe not precisely what many audiophiles would consider "reference grade," but delivering definitely high-end sound.

Several specific notes. A favorite disc of the Alban Berg String Quartet's late Beethoven quartets (EMI Classics CDC 47134) displayed an impressive improvement in cello sound, losing its upper-bass emphasis and gaining crisp timbral distinctness. Stereo imaging both tightened and opened, on this and many other discs. For example, with the RCS 1000 bypassed, the first violin seemed to wander about a foot to either side, depending on pitch and dynamics. With the Snell system at work this effect almost disappeared. At the same time, an extra dimension of stage depth and "air" appeared.

On *Earwitness*, the fascinating Steinway Recording Piano historical recordings by D. W. Fostle (Isophone 90681), the piano's elemental hammer thuds and string clangs became both more discernible and better integrated, contradictory as that sounds. Modifications of overall timbre were far less noticeable than on instruments whose notes were more sustained, but the change in soundstage was more dramatic: The RCS 1000 just about eliminated the slight side-to-side image shifts that plague so many systems (mine included) when playing high-resolution piano recordings—I think this is so universal that most of us don't even hear it anymore—and instead placed the piano firmly and naturally in recorded space.

On concert-hall orchestral recordings, such as a CD of selections from Carl Nielsen's *Saul and David* (Sony Classical SK 53276), the RCS 1000's net impact on hall sound and spatial depth was even more distinct—bigger and deeper yet, somehow, subtler and more organic. One result of this was a remarkable and very concrete improvement in clarity and discrimination among inner voices, especially the passages of dense, brass-choir counterpoint typical in Nielsen. Tympani passages could now "roll through" the hall without the accompanying muddiness or confusion I frequently hear from even the best recordings.

Very clean pop and jazz produced still more obvious changes, mostly because these recordings almost always have something happening from 40 to 160 Hz, where the RCS 1000's precise equalization was most significant. Playing *Arista Nashville* (a Boston Acoustics demo compilation), I heard some truly dramatic changes, especially in the Nashville-cliché chest tones of singers like Radney Foster and Brooks & Dunn. The result was more natural sounding good-ole-boy vocals—less hooty and obviously clearer. Bass guitar was transformed even more radically, losing marked amounts of bloat and overhang. On just about any track on this disc (or any similar recording), I'd switch the RCS 1000 from "Bypass" to my stereo preset and immediately think, "Oh, yeah—*that's* what bass really sounds like." The RCS 1000 also illuminated studio reverb: You could almost identify which studio-reverb preset was used on each of these "new country" hits.

Full 5.1-channel surround listening revealed equally substantial benefits. I did quite a bit of playback with 5.1-channel DTS CDs, via the B & K AVP-4090's optional DTS decoder, and found that the Snell's virtues were apparent at least as much in multichannel sound as in stereo. The most natural DTS music recording I've found so far is Chick Corea's *Remembering Bud Powell*, a straight studio session of, mostly, bebop quintets. Despite its rather overblown soundstaging of the drums, this disc already sounded impressive, but the RCS 1000 made it sound even more like a live performance in my room. When the Snell system was engaged, this 5.1-channel recording became noticeably more cohesive, with significantly less localization of the five main speakers,

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placing me much more convincingly into the space. The improvements in string-bass realism and timbre were equally striking.

Movie soundtracks gained markedly, too. Running the train/bus crash from *The Fugitive* laserdisc (Warner Home Video) via Dolby Pro Logic—a scene I've auditioned maybe 10,000 times—I heard distinctly more detail. The sound was less screechy and less boomy but had more decipherable high-frequency content, and there was a very distinct extension of sub-bass impact. The *Fly Away Home* DVD's soundtrack, gorgeously produced in Dolby Digital Surround, was still more impressive; I noted again the improvement in envelopment and cohesiveness the RCS 1000 delivered.

In use, the RCS 1000 was generally unobtrusive, though I was constantly bothered by the 6- or 7-second silence while it changed presets (the unit loads coefficients from flash ROM for each channel). Since the "Bypass" preset does not bypass the RCS 1000's circuitry but, rather, inserts a zero-correction filter curve, it takes as long to load as the 11 others. And since there are no output relays, powering down with the power amps still on is a mistake you'll make only once. (I did, even though I'd been warned—now *that's* a turn-off transient!) The Snell's display is too small to read at any distance, which is annoying. And the supplied remote, though beautifully crafted from an aluminum billet, is not exactly ergonomic: Its tiny gold-on-black lettering might as well not exist in a dim room; this is one you'll have to learn to operate by feel.

SWITCHING IN THE SNELL RCS 1000 MADE ME THINK "OH, YEAH, *THAT'S* WHAT BASS SOUNDS LIKE!"

Obviously, I was mightily impressed by the Snell system's potential. Did the RCS 1000 sound perfectly transparent? This is a tough one. An obvious answer is that, by definition, no equalizer is transparent. But the Snell's case is a bit different. I'm not ready to swear that the RCS 1000 had net-zero impact on audio passing through it in "Bypass" mode, which leaves all the Snell's circuitry in the signal path; after repeated plugging and unplugging; I debated whether or not the RCS 1000, even in this mode, induced some ephemeral change in the upper midrange. But whatever this was—if it even existed—it paled in light of the improvements the RCS 1000 made, with correction engaged, on just about everything I played thorough it.

And I felt that I had only scratched the surface of the thing. I would like to spend a month or so learning my way around the RCS 1000's software and studying measurements of my room, then choosing better-informed mike placements and designing more considered correction presets. I believe that the Snell RCS 1000 has the potential to extract considerably more from my relatively modest audio system. What I've heard so far advanced the system about halfway from where it was to the standard of the best multichannel sound I've ever heard. I'm pretty sure that, given enough time and study, I could halve the remaining distance again. A

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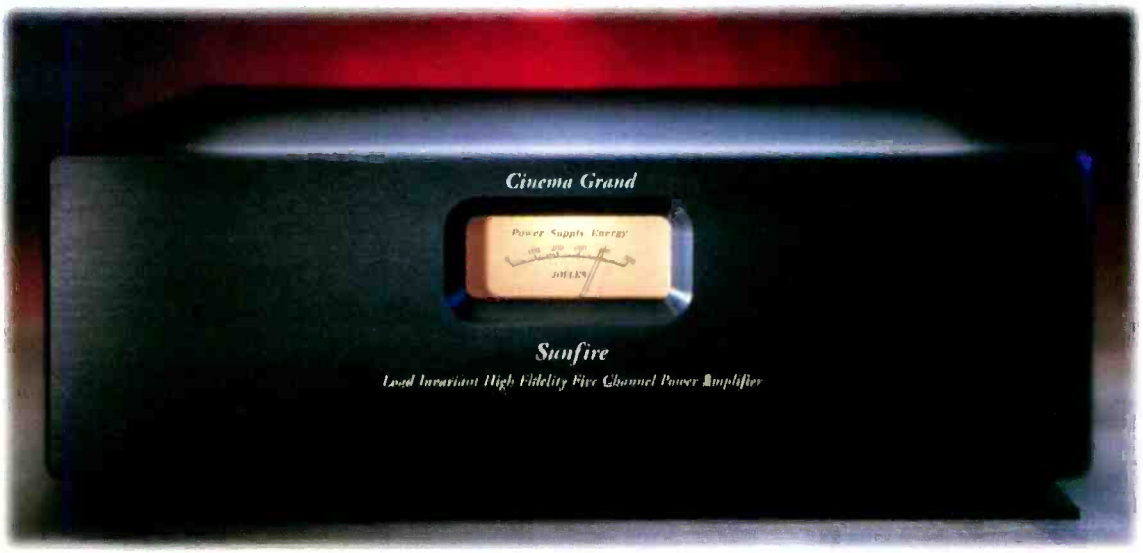

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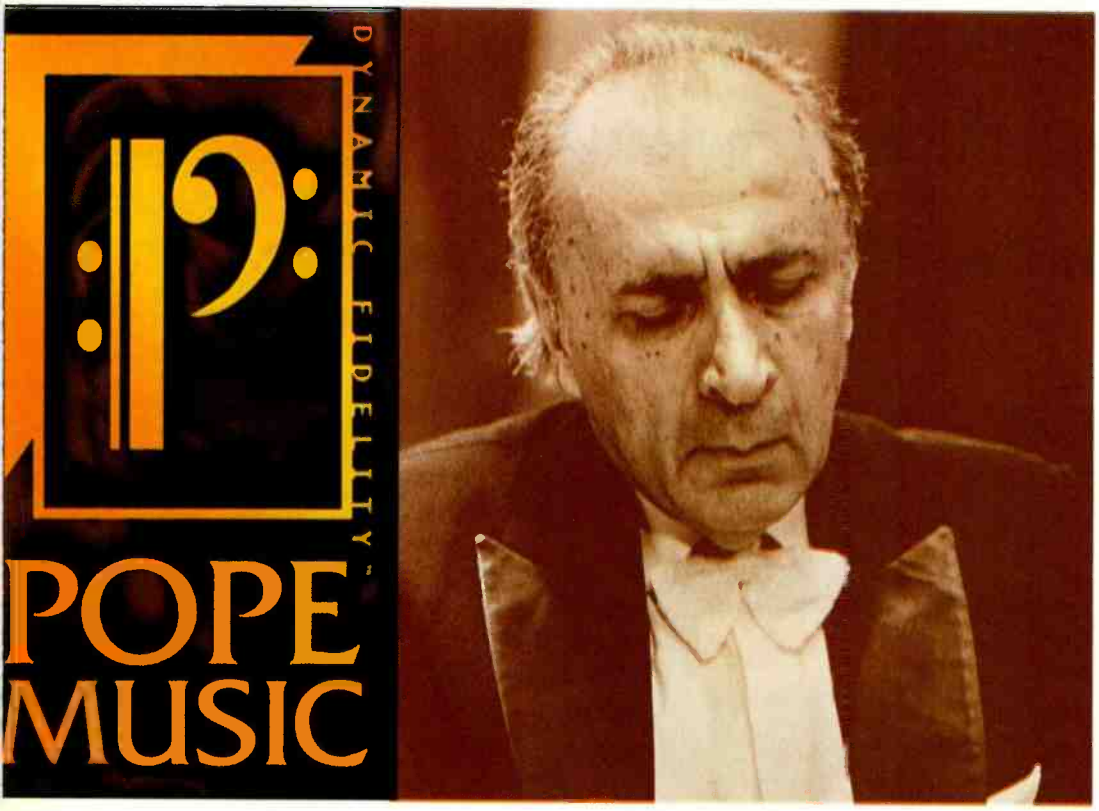


Photo: PopeMusic

Chopin: Works for solo piano
Naum Starkman, piano
POPEMUSIC PMG2010
DDD; 67:53
Sound: A+, Performance: A

Sometimes, you appreciate a recording only after repeated listenings. When I first heard pianist Naum Starkman's Chopin CD, I wasn't sure if I liked it or not. The recorded sound that engineer and producer Gene Pope obtained is so crystal clear that it seemed I was listening from inside the piano rather than from the audience's point of view. But the more I listened and compared the sound with other piano recordings, I came to the inevitable conclusion: Gene Pope knows how to record a solo piano.

The CD booklet contains a great deal of material concerning the recording details. One cannot help but be impressed with the painstaking care Pope took in finding the perfect location for this recording. He vividly describes the many acoustical features of the Christ Church in Bronxville, New York, and how these add to the ambience. The piano was a Bösendorfer Imperial Grand with an enormous sound, especially in the lower register. To capture the performance, Pope used just two Brüel & Kjaer omni microphones and a Nagra D four-track digital open-reel recorder. The result is a clear, natural sound with a huge dynamic range.

Of course, all this care would have been in vain without a great pianist, but Naum Starkman easily rises to the occasion. One of Russia's finest musicians, he is also known internationally as a master teacher. His performance style is sensitive and elegant, without the bravado that often obscures Chopin performances.

Chopin is unusual among the great masters in that his compositions are almost exclusively for one instrument, the solo piano. Even in his other works, the few songs and chamber pieces, as well as his two concertos for piano, the keyboard is always utilized. No other composer in history has made such a rich contribution to piano literature.

Although his music is played and appreciated throughout the world, it always retains the nationalistic flavor of his native Poland. Even when abroad, Chopin always identified with the sufferings of his country. While in Vienna, he heard of Russia's capture of Warsaw and in protest composed his "Revolutionary" Étude. After the disasters in Poland, he wrote his famous "Funeral" March.

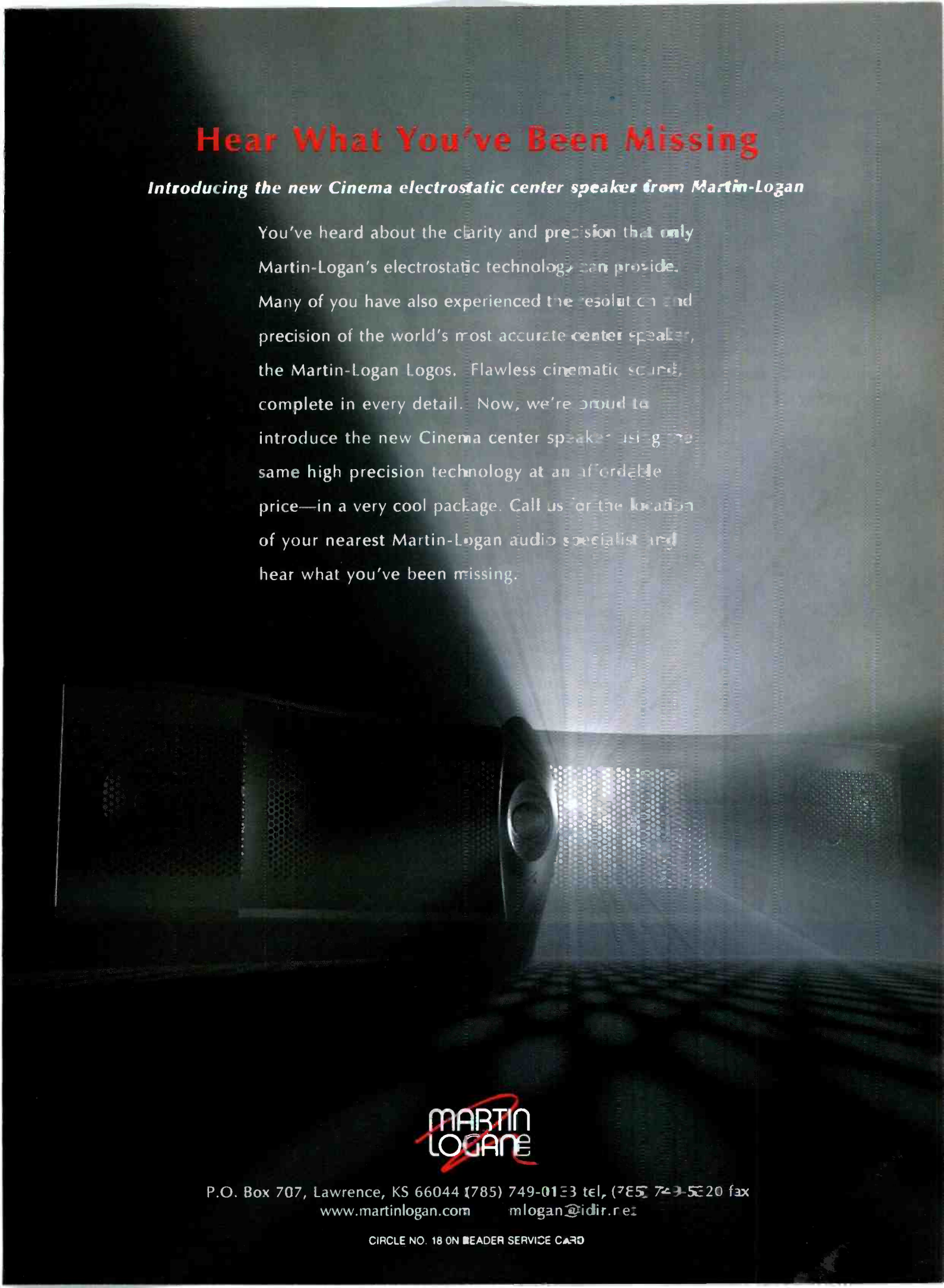
In the 20th century, with the Nazi invasion of 1939, Chopin's music

Mozart

Symphonies No. 38 in D, "Prague," and No. 39 in E Flat
Orchestra di Padova e del Veneto, Peter Maag
ARTS 47364; DDD; 61:36
Sound: A, Performance: A–

Almost four decades after leading an outstanding series of Mendelssohn and Mozart recordings with the London Symphony for Decca/London, Swiss maestro Peter Maag has formed his own Italian-based orchestra and still clocks in as a superb Mozartian. His approach allows the woodwinds to be heard as equal partners with strings; when brass and timpani are added in tuttis, one hears a real "wind band" presence.

Ardent and spirited, the readings of these two symphonies, Nos. 38 and 39, might best be described as having robust lyricism and unbridled passion, always sounding fresh and spirited. Only a quirky mannerism in the last movement of Symphony No. 39 mars the joyous music making on this CD, but even that might seem fresh insight compared to the antiseptic, joyless, neat and boring, so-called correct approach to Mozart that has served as a pallid standard over the last couple of decades. The sound is close up and focused, with great attention given to woodwinds, brass, and timpani. *Rad Bennett*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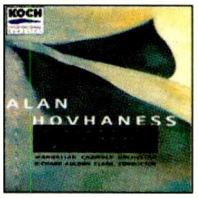
became a national symbol. The last music heard on Warsaw radio before the city's surrender to Germany was Chopin's Polonaise in A Major. When Chopin left Poland in 1830 to seek his fortune in the world, his mother whispered to him, "Frederic, thou wilt be a great musician. Thy Poland will be proud of thee."

Starkman was once asked, "How do you play Chopin?" He replied that he "didn't know how to play Chopin, but I was certain how not to play Chopin; not too masterly and not too sentimentally." Starkman's wisdom—which should be given to all young pianists—and Pope's careful attention to production details have yielded a CD of lyric grace and beauty. *Patrick Kavanaugh*

Hovhaness: Symphony for Metal Orchestra; Khrimian Hairig; The Holy City; Psalm and Fugue, and Kohar

Manhattan Chamber Orchestra, Richard Auldon Clark
KOCH INTERNATIONAL CLASSICS
3-7289-2H1; DDD; 52:41
Sound: A, Performance: A

For many years, fans of the distinctive music of Alan Hovhaness had to search for out-of-print LPs from MGM or poorly distributed recordings from the composer's own label, Poseidon. While major labels are now scrambling left and right to record his works, this is Koch's fifth album.



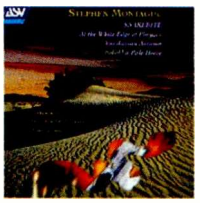
There seems to be strong public interest in music that is spiritual yet has an attractive, unannoying simplicity. (Henryk Górecki and Arvo Pärt are other composers in this category.)

Eastern music, specifically Armenian, and early Western polyphony are major influences on Hovhaness, a Seattle-based composer, who is one of this century's most prolific. He often writes for unusual combinations of instruments; he has, for example, created a number of works for trumpet and orchestra, two of which are in this collection. A mood of haunted desolation is often felt in these pieces. The Psalm and Fugue, Opus 40A, is one of his modal, spiritual works for strings. "Kohar" is based on Armenian folk-music style and has a hypnotic feeling; it is scored for flute, English horn, strings, and timpani. The main work here, Symphony for Metal Orchestra (Symphony No. 17), is for an unusual aggregation of six flutes, three trombones, and metallic percussion instruments. Traditional Japanese court music (gagaku) and the sounds of the folk reed instrument, the Shó, were Hovhaness's primary stimuli for this fascinating and highly rhythmic composition. Try it as an audio demo antidote to bang, baroom, and harp! *John Sunier*

Montague: Snakebite, At The White Edge of Phrygia, Varshavian Autumn, and Behold A Pale Horse

Choir of the Orchestra of St. John's, Smith Square; Christopher Bowers-Broadbent, organ; Orchestra of St. John's, Smith Square, John Lubbock
ASV DCA 991; DDD; 62:15
Sound: B– Performance: A

Contemporary composer Stephen Montague writes fascinating music that is quite accessible, reasonably easy on the ear in a tonal sense, yet rhythmically exciting. He manages to use bits and pieces of minimalist technique to create larger forms that hold one's interest far longer than the often irritating repetitive fragments of most minimalist compositions. Toccatas seem to be his forte, exemplified here by the brass and organ piece, "Behold a Pale Horse," and the longer "At the White Edge of Phrygia" for full orchestra, both rhythmically driven, with lots of attention given to virtuoso writing. "Snakebite," a more programmatic tone poem, finds the orchestra working up a grand partner-swinging version of the folk reel "Dusty Miller," only to be "poisoned" by an alien "snakebite" tune that brings the ensemble's heartbeat to an alarming halt. The orchestra resuscitates itself, and "Dusty Miller" triumphs. The recorded sound is detailed, but the apparent multimike system flattens everything out to the proscenium, allowing little aural depth. The music is rewarding enough that it deserves to be heard, albeit with regrets that it wasn't afforded a more natural hall sound. *Rad Bennett*



Made in the USA (American violin encores)

Andrés Cárdenes, violin; Luz Manríquez, piano
OCEAN RECORDS OR103
DDD; 52:01
Sound: A, Performance: A

Winsome, sometimes rather glib fiddling in confections by Aaron Copland, Cecil Burleigh, Samuel Barber, Victor Herbert, William Bolcom, André Previn, and others. These pieces are encore material, every one, and cleverly done—but perhaps too much of a nice thing for some tastes. The pickup is very close, even intimate, but clean. *Robert Long*

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ROCK~POP RECORDINGS

Photo: Jill Furmanovsky

Be Here Now

Oasis

EPIC EK-68530, 66:16

Sound: A, Performance: A–

On "Rock 'n' roll Star," the opening track of Oasis' debut album (1994's *Definitely Maybe*), the band brazenly stated its career goals. With its follow-up album, 1995's *(What's The Story) Morning Glory*, the band made good on its boasting and proceeded to give us two years of entertaining headlines about fights, feuds, and assorted scandals. *Be Here Now* is where Oasis gets to prove its staying power, and it does—musically, at least—with another batch of Noel Gallagher's skillfully crafted songs and a heaping dose of brother Liam's cocky attitude. "I'll put on my shoes while I'm walking slowly down the Hall of Fame," Liam sings in "My Big Mouth." And you better believe he will—as long as Noel doesn't trip him up enroute.

Beatles, Beatles, Beatles. It's impossible to write about Oasis without using that word. And so I will, noting that Noel's Fab Four fixation is as strong as ever with lifted lines, "borrowed" riffs, and a George Martin-styled production. Authenticity? Noel doesn't need no stinkin' authenticity. He offers his comment on the most tired argument in rock criticism on the album's opening track. "Fuck me," a backwards voice intones at the start of "D'You Know What I Mean?" And then the band leaps into an epic rocker that uses the exact same chords as its blockbuster 1996 hit "Wonderwall," and incorporates drum loops sampled from N.W.A.'s classic 1988 rap masterpiace *Straight Outta Compton*. No one can ever accuse this thieving British group of lacking a sense of humor.

Noel Gallagher knows that the only thing that matters in rock today is whether or not a song moves you emotionally, and his indelible tunes carry a visceral kick. "My Big Mouth," "It's Getting Better (Man!!)," and the title track recall the quicker tempos and angrier vibes of *Definitely Maybe*, with effective arena rock bombast thrown in.

PAUL WELLER

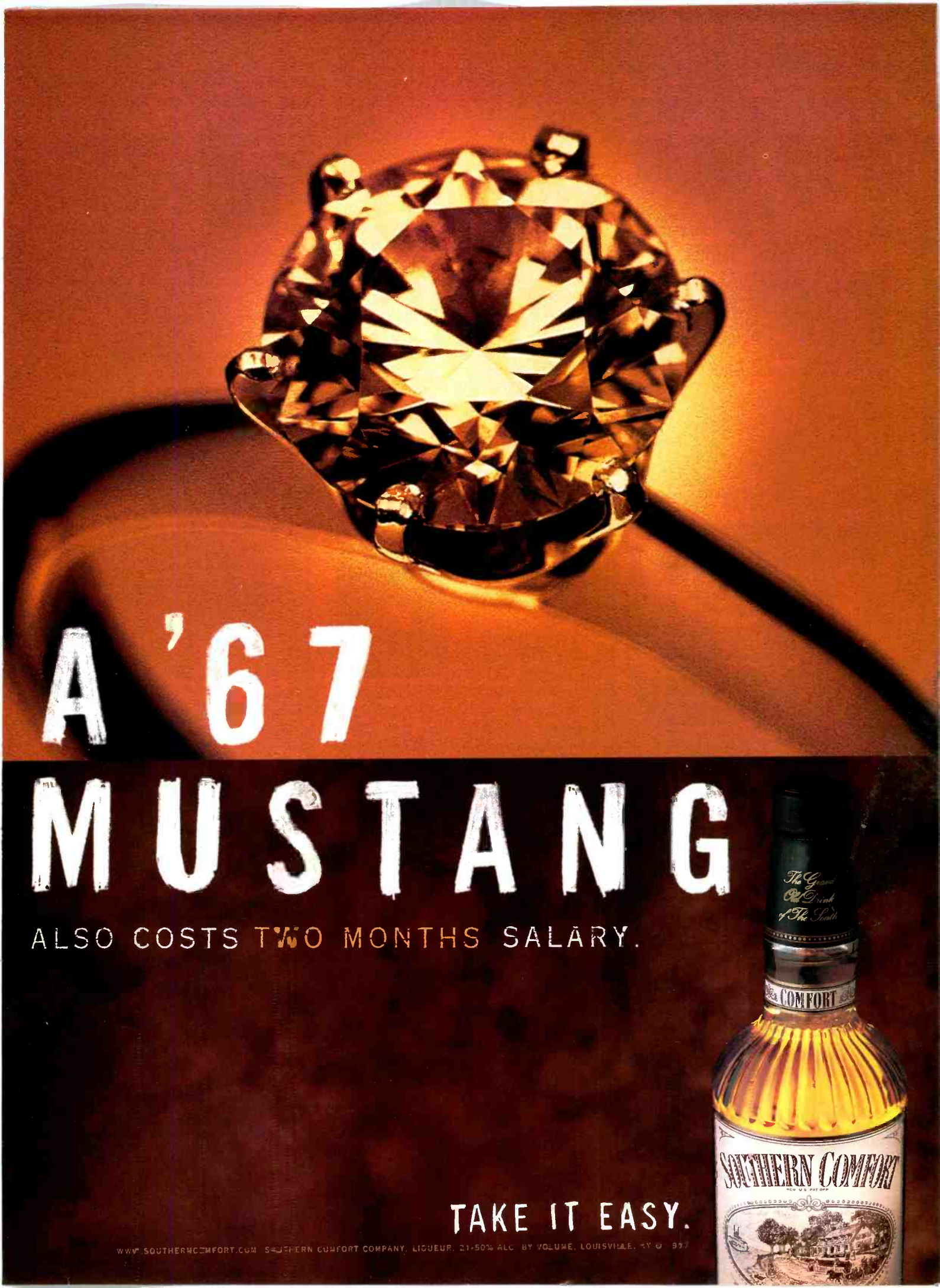
HEAVY SOUL

ISLAND 314 524 277, 40:56

Sound: B, Performance: B+

When Paul Weller sings, "It's a joy to know/I've got a heavy soul" on the title track of his new album, he may be shaking off the mundane world's maddening flux in favor of the spiritual realm's peaceful infinity. But it's more likely that he's alluding to the source of his musical obsessions.

Heavy Soul, as with past solo efforts, has Weller immersing himself in the restorative waters of classic R&B. Much of the album's impact is derived from producer Brendan Lynch, who re-creates the studio ambience of a '60s soul album while attempting to keep the music live, using as few overdubs as possible. The core band is more than up to the task. It's evident on the retro strut of "Peacock Suit," the jazzy daydream of "Up in Suze's Room," the hornets'-nest psychedelia of "Brushed," the Motown ecstasy of "Golden Sands," and the bubblegum bop of "Mermaids." Heavy soul, indeed. *Greg Siegel*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Still, Oasis doesn't skimp on the big ballads. Lush orchestrations and headphone-friendly layers of sound decorate prettier numbers, such as the 11-minutes-plus "All Around the World," "Don't Go Away," and "Magic Pie." The last is the only tune that Noel sings, and he's said it's one of the best he's ever written. "You see me, I got my magic pie," goes the massive singalong chorus. What does it mean? Not a damn thing, far as I can tell, but I'm willing to waive that demand when the hooks are this good. Sometimes we ask too much of our rock 'n' roll stars, when darn good entertainment ought to be enough. *Jim DeRogatis*

Surfacing

Sarah McLachlan
ARISTA 18970-2, 41:19
Sound: A–, Performance: B+

Sarah McLachlan's music has always been about attaining some kind of ecstacy. With *Surfacing*, however, she seeks redemption from pain, working with themes of spirituality and love. It seems as though McLachlan has had a full-fledged conversion experience. Like the hymns of 12th-century mystic Abbess Hildegard von Bingen, her lyrics read like love songs and entreaties to a higher power.

The result is an intensely personal mood that's wonderfully complemented by a mix that's subtler and earthier than on McLachlan's previous albums. The textures are more spare, with violins and synths breathing as if through a translucent scrim on "I Love You." Acoustic guitars and piano pick out details, and drums tap out a distant pulse. On "Witness," Yves Desrosiers gets an eerie yet strangely nostalgic feel with a lap steel guitar filtered as if it were heard through an old phone line from beyond. In sum, it's an intimate, often sad, and with the exception of the propulsive groove of "Sweet Surrender," almost cloistered album. *John Diliberto*

Music for Pleasure

Monaco
A&M 31453 7629, 56:23
Sound: A, Performance: B

Peter Hook (last name says it all) played bass in '80s pop darlings New Order. Or, as the debut album from his new band reveals, Hook was perhaps the man behind New Order's curtain—pulling levers, strings, and pulleys while merely staying in the background and attending to low frequencies to keep up appearances.

For better or worse, Monaco appropriates everything entirely endearing and quirky about New Order. There's the trademark twangy guitar, the discofied rhythms, the infectious, sing-along choruses and hook-driven melodicism, all mixed within a program that abruptly changes channels between chiming, guitar pop (the Oasis-like "Buzz Gum"), the house rhythm and Casio calliope of "Sweet Lips," and the catchiness of "What Do You Want from Me." Cohesion indeed exists here in the form of Hook's superb, seductive songwriting (not unlike classic New Order). But, as well-crafted and enjoyable as it is, *Music for Pleasure*'s stab at diversity makes for a slightly bumpy ride. *Mike Bieber*

THE EL CAMINOS

Reverb Explosion!
DEL-FI 71289, 37:41
Sound: A, Performance: A

Surf-music purists are among the most uptight pain-in-the-asses you'll ever encounter, as they lie in wait for an unsuspecting critic to mistakenly refer to an instrumental group (e.g., The Ventures) as a surf band. Then they issue stinging missives from on high, cursing the critic for erring and damning him to a life of one-foot waves and sand in his pants. But in the case of The El Caminos' *Reverb Explosion!*, there is no denying that it is a surf guitar album through and through, and anyone who would deny it is an idiot. Here's why: Beyond some strictly musical criteria, there's the fact that The El Caminos use only Fender, Danelectro, and Vox guitars and reverb-drenched (hence the album title) Fender amps. Also, the songs—which run the gamut of surf standards like "Exodus" and Dick Dale's "The Wedge"—don't have any lyrics except for a few shouts of joy here and there.

The El Caminos are a Japanese band fronted by rhythm guitarist Eddie Ugata; they were discovered by Bob Keane of the legendary and recently retooled Del-Fi label—and if anyone knows the difference between plain ol' instro rock and surf, it's Del-Fi. *Reverb Explosion!* is a finely-crafted gem (recorded 16-track analog for a close-to-authentic sound), and you'd be advised to let it come crashing down on your poor head, Mr. Hodad. *Tom Gogola*

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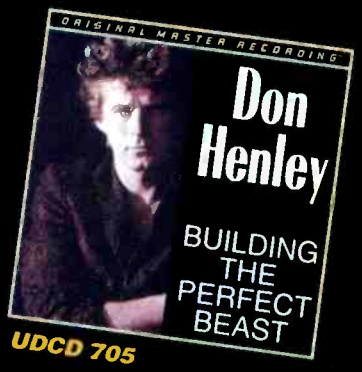

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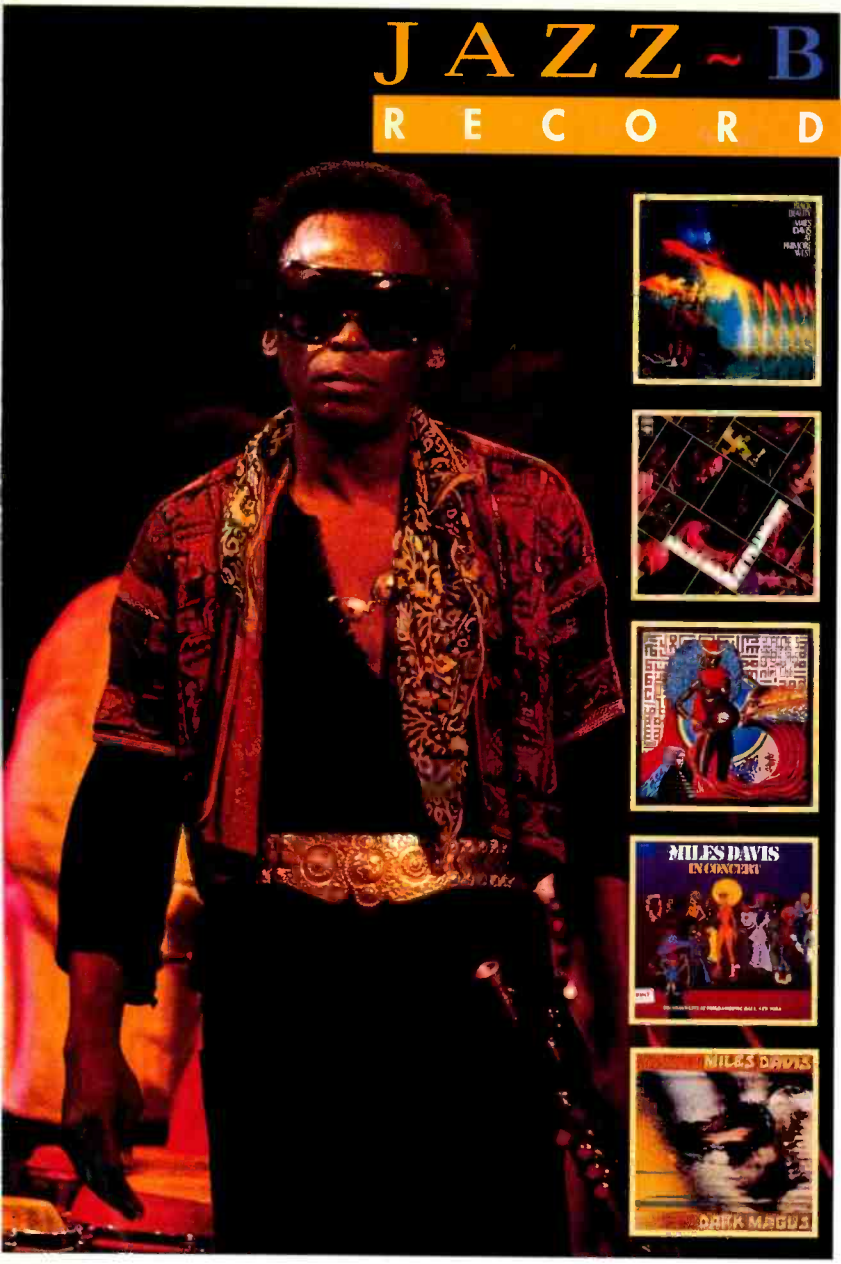

Photo: © David Gahr

Black Beauty: Miles Davis at Fillmore West
Miles Davis
COLUMBIA/LEGACY C2K 65138, two CDs, 1:20:04
Sound: B–, Performance: B

At Fillmore: Live at the Fillmore East
Miles Davis
COLUMBIA/LEGACY C2K 65139, two CDs, 1:40:16
Sound: B–, Performance: A–

Live-Evil
Miles Davis
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Sound: B, Performance: B+

In Concert: Live at Philharmonic Hall
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COLUMBIA/LEGACY C2K 65140, two CDs, 1:24:31
Sound: B, Performance: B

Dark Magus: Live at Carnegie Hall
Miles Davis
COLUMBIA/LEGACY C2K 65137, two CDs, 1:41:05
Sound: B, Performance: B–

During the first half of the 1970s, Miles Davis was so prolific that he released a succession of double LPs, one after the other. The trumpeter's evolution, viewed in these micro-steps, seemed almost static. But in these five re-released double CDs, two released for the first time in the U.S., you can hear Miles moving from the 1969/1970 *Bitches Brew/Jack Johnson* era into the nervous grooves of 1972's *On the Corner* and then beyond, towards a brilliantly creative period that was short-circuited by Miles's illness and six-year hiatus, beginning in 1975.

How does one approach these recordings 27 years down the line? You could talk about the extraordinary groups Miles assembled, with such musicians as John McLaughlin, Gary Bartz, Joe Zawinul, Jack DeJohnette, Dave Holland, and Airto Moreira. (Who else could have Keith Jarrett, Chick Corea, and Herbie Hancock all playing electric keyboards on the same track?)

Nevertheless, it's not the musicians he used, but rather how he used them that's key. Ironically (at least for detractors of Miles' "electric" music), these albums share a kinship with *The Complete Live at the Plugged Nickel* series, which documents his classic '60s quintet during a weeklong, 1965 stint in Chicago. As he did with that acoustic group, Miles was exploring a collective improvisation, an interactive conversation that would start with familiar themes and then tack out towards the unknown. This collective sensibility exists in the jangly energy of *In Concert* and *Live-Evil*, the Heavy Metal tone painters of 1974's *Dark Magus*, and the psychedelic mutations of the *Bitches Brew* band heard on the two Fillmore sets.

Here, a burst from Miles' trumpet creates a melodic motif, while a rhythmic interaction between Holland and DeJohnette (often sounding like a hellbound charge through a *Blade Runner* landscape) alters the tune's direction with equal weight. The Fillmore concerts, specifically, find Miles working more with colors and textures than with rhythms and distinctive melodies. Jarrett and Corea follow suit, creating a haze of overdriven keyboard washes that recall Sun Ra. DeJohnette and Holland turn the snakey, sensual vamp of "Bitches Brew" into a menacing stalker's groove, while Moreira abandons his rhythmatist's role, adding pointilistic accents and asides.

In every situation, even when blasting through a wah-wah pedal, Miles remains Miles. He was always sculpting melodic contours and terse declarations that immediately centered even the most woebegone improvisation. And there are a few of them, to be sure, especially on *Dark Magus*, a poor, concert recording response to the superior *Agharta* and *Pangaea* studio albums from the same (early '75) period. As Miles pushed improvisation and electric frontiers, he also pushed the limits of recording; balances aren't quite what they should be, some distortion is clearly not intended, and producer Teo Macero's tape edits were, frankly, crude. But none of these problems gets in the way of music that was born in the moment and sounds braver today than it did 27 years ago. *John Diliberto*

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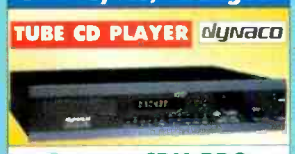

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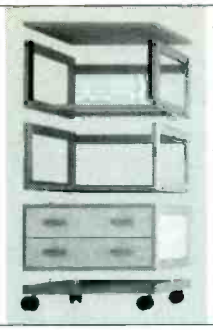

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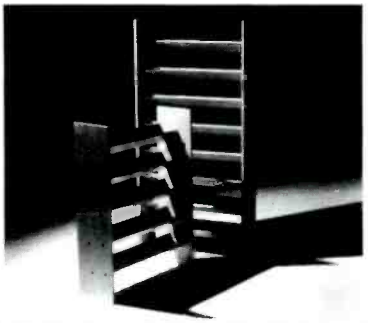

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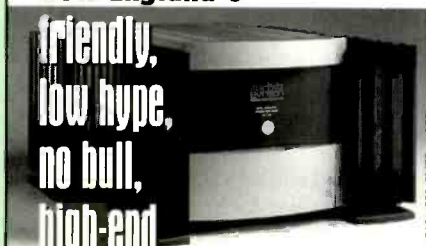

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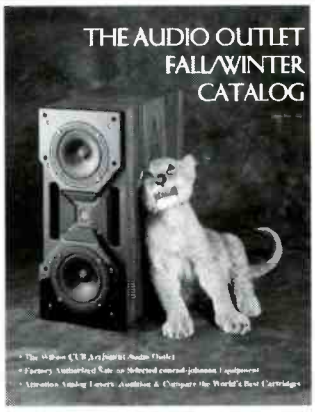

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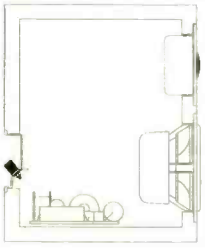

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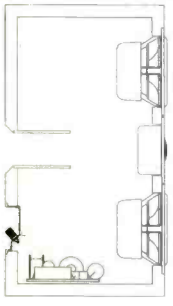

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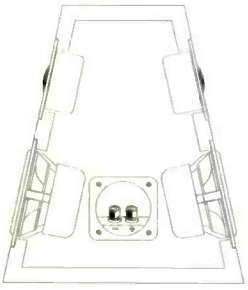

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AD INDEX

*Regional Ad

AUDIO, November 1997, Volume 81, Number 11. AUDIO (ISSN 0004-752X, Dewey Decimal Number 621.381 or 778.5) is published monthly by Hachette Filipacchi Magazines, Inc., a wholly owned subsidiary of Hachette Filipacchi USA, Inc., at 1633 Broadway, New York, N.Y. 10019. Printed in U.S.A. at Dyersburg, Tenn. Distributed by Warner Publisher Services Inc. Periodicals postage paid at New York, N.Y. 10019 and additional mailing offices. One-year subscription rates (12 issues) for U.S. and possessions, $24.00; Canada, $33.68 (Canadian Business Number 126018209 RT, IPN Sales Agreement Number 929344); and foreign, $32.00.

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PlayBack

AudioControl SA-3052 Portable Real-Time Analyzer

How do I know a product I'm reviewing has, say, reasonably flat response from 90 Hz to 17 kHz? Because I measure it, with AudioControl's SA-3052 ($1,359). It displays response in third octaves from 25 Hz to 20 kHz, uses fourth-order filters for precision, and can display 9 dB of signal at a time for a detailed view or 36 dB at a time to capture bumpy curves (really mountainous ones can be scrolled up and down for viewing). It runs 3 or 4 hours per battery charge, so I can use it in cars; a light warns when I'm down to a half hour's juice. It has 'scope-probe and balanced and unbalanced audio inputs, but I mostly use the calibrated mike. For greater accuracy, I can store as many as six curves, from different mike positions, then compare or average them. A printer port lets me run off response curves on any standard computer printer, either with a log sheet that leaves space for my comments or as a half sheet of the curve alone. For $100, I could have had my name and address included on the printout (impressive—and handy, if the unit's stolen); for another $899, I could buy a VGA output for a computer monitor. And the manual is one of the best I've seen, for any product whatsoever. I wish the SA-3052 weighed less than 11½ pounds and were a bit less bulky, that the A-weighting filter were not a $44 option, and that it came with a pink-noise CD as well as a pink-noise generator. But hey! It does the job, and I already have CDs with pink-noise tracks. You can also get a version of this analyzer without printer ports and battery, the SA-3051 ($995), and with special features for car-stereo judging as the SA-3055 ($1,599). (AudioControl Industrial: 2410 70th Ave. West, Mountlake Terrace, Wash. 98043; 425/775-8461; fax 425/778-3166; www.audiocontrol.com.)

GRADE: A–

Ivan Berger

For literature, circle No. 120

LEGACY AUDIO HIGH CURRENT PREAMPLIFIER

Legacy Audio produces audiophile-quality electronics and speakers at very reasonable prices. Legacy's High Current preamplifier ($1,495) performs admirably. It has an FET input stage and bipolar transistor output, is directly coupled without servo circuitry, and, according to Legacy engineers, requires no feedback correction. This design is said to preserve transient response and yield transparent, smooth sound without being affected by source load or cables.

One of the preamp's main features is an optical-relay volume control that's said to be immune to the "scratchy" noise that can eventually plague conventional potentiometer controls. The inputs and outputs include a pair of balanced XLR input and XLR output jacks, a pair of unbalanced RCA output jacks, RCA input jacks for tuner, video, and CD, and a processor and tape loop. The pushbutton source selector incorporates a handy mono function. Its supplied remote duplicates the front panel's source selection, volume, balance, and muting functions but not its on/off switch.

GRADE: A–

The Legacy High Current preamp performed well with a variety of amps, including my own Legacy High Current amp, a pair of Pass Aleph 2s, and a Hafler 9505. The more I used it, the more it grew on me. As advertised, it sounded transparent; it also had plenty of treble detail, an excellent soundstage, and tight, deep bass. I liked its stepped attenuation display for each channel and the solid feel of its selector switches, but I subtracted a couple of points for its lack of a phono preamp and the remote's omission of on/off switching. These quibbles, however, are offset by its more than reasonable price and the inclusion of balanced connections. (**Legacy Audio**: 3023 Sangamon Ave., Springfield, Ill. 62702; 800/283-4644.)

John Gatski

For literature, circle No. 121

Musical Fidelity X-CANS Headphone Amplifier

A number of dedicated headphone amplifiers have reached the market recently, for several reasons. There's increased interest in high-quality headphone listening, and many of today's best 'phones are dynamic models that don't require the added electronics that electrostatics often do. Yet, fewer audio and A/V components have headphone jacks, and if you find them, they rarely bring out all the musical enjoyment available from top-notch 'phones.

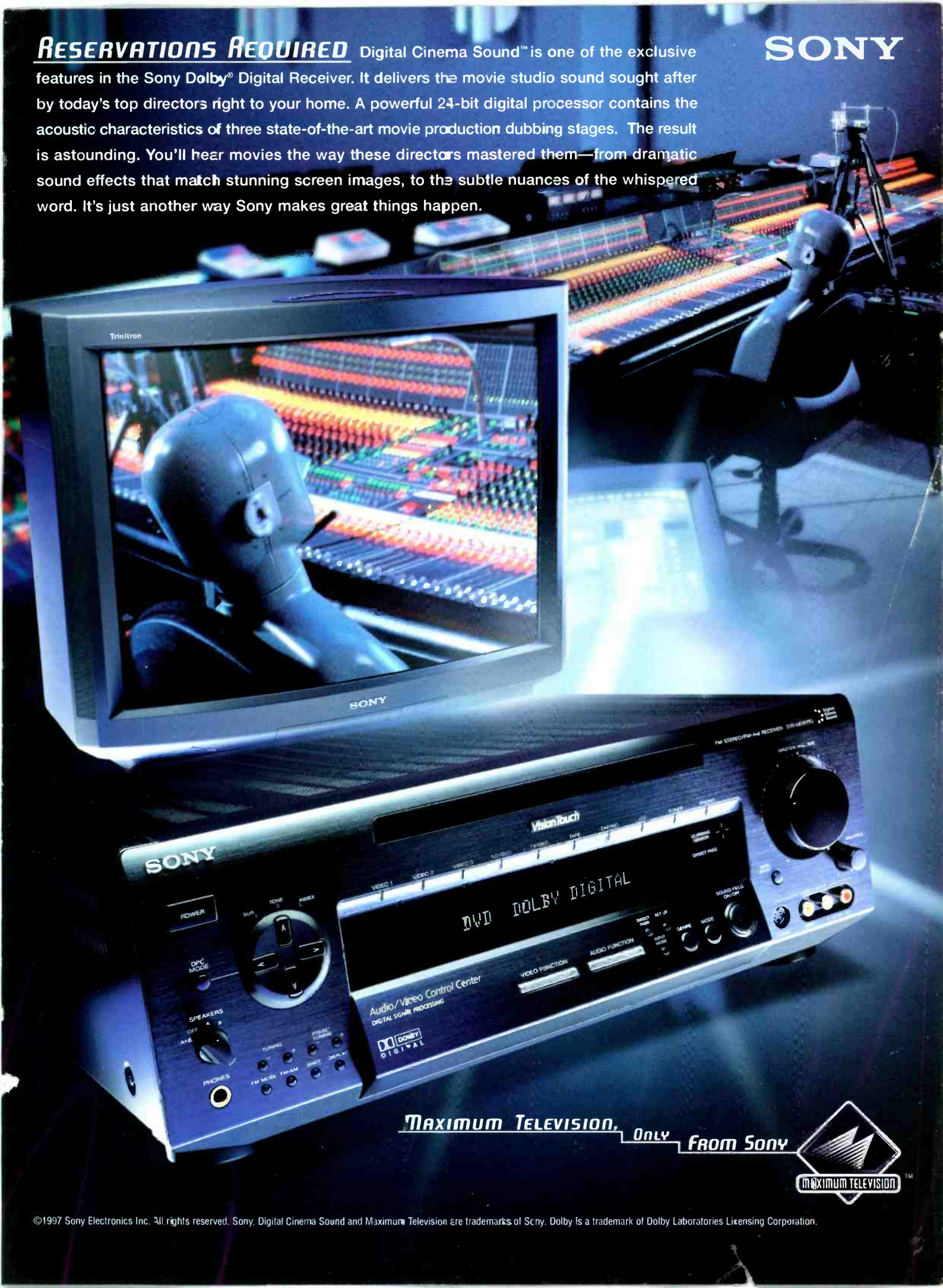
GRADE: A

One of the latest headphone amps is this $250 British entry. Like the other eight components in Musical Fidelity's X series, it's encased in an extruded aluminum cylinder 8.6 inches long, with connections at one end and LEDs and controls at the other. Considering the X-CANS' modest cost and its lack of ventilation slots, I was surprised to be told that it's a Class-A, single-ended triode design!

Its maximum rated output power is 100 milliwatts into 40 ohms, and the rated S/N ratio is 86 dB, A-weighted. The X-CANS delivered sufficient level from every set of dynamic 'phones I plugged into it, and the sound proved rich, balanced, and clean. It was only in the area of a subtle "oomph factor" that the X-CANS were bested by my reference headphone amp—which costs more than five times as much. That oomph is the sort of improvement that beefier power supplies can often deliver; though I didn't try it, the X-series does include just such an upgrade power supply, the X-PSU ($200). (**Audio Advisor**: 4649 Danvers Dr. SE, Kentwood, Mich. 49512; 800/942-0220.

John Sunier

For literature, circle No. 122



S O L U T I O N S

Every "Bit" of Every Signal to Everywhere

Today, your sound and pictures start as "bits". The information stored on a CD, LaserDisc, DVD, or transmitted to a DSS receiver...it's all bits of digital data.

AudioQuest offers a complete range of cables optimized to transfer all four digital standards with an absolute minimum of interference: S/PDIF (75Ω coax), AES/EBU (110Ω balanced), TosLink (EIA-J fiber optic), and ST (AT&T type fiber optic).

Even though pictures and sound may begin as digital signals, they must be converted back into the world we live in, the world of analog. Most of your components and most of your cables are handling analog signals, whether audio or video.

Under the VideoQuest name we make high performance cables for all the different video signal systems. We also make several different grades of cable for each system. The cable in one system is not better than the cable in another, only the number of channels of information is different. The same type of wideband 75Ω coax is needed for every channel, no matter how many.

• Coaxial RF (radio frequency, also called RG for radio guide) cable carries the combined audio and video signal from an antenna or a DSS dish, or a cable TV box.

• Composite Video cable carries the entire picture signal between most VCRs and LaserDisc players to the monitor.

• S-Video (Y/C), carries the same information, but in two pieces. The "Y" signal carries the b/w picture and the "C" signal carries the color information. When color TV became available it had to be compatible with existing b/w TV sets, so the extra information for color was kept separate. S-VHS machines, video cameras, DSS receivers, LaserDisc and DVD players are among the equipment often featuring S-Video outputs.

• Component Video (YIQ): Even the "C" in Y/C is a combination signal. Since there are three colors (red/green/blue), there must be two color difference signals. Y-I is the red signal, Y-Q is the blue, and Y minus red and blue is green. DVD players are the first to feature YIQ outputs.

• RGB: Red, Green and Blue are the real components of a video signal. RGB cables carry the three color signals, plus the vertical and horizontal marker information that allows the monitor to draw a picture and not just a continuous line of changing colors. RGB is most common for feeding separate video projectors.

Audio: As important as it is to get the video right, it's the audio that carries the drama, the power, the emotion...whether it's a system with or without a picture.

Unfortunately, it's late in this ad and we've run out of room to "talk" about AudioQuest double balanced and triple balanced audio interconnect, Hyperlitz speaker cables, UL CL/3 in-wall cables, on wall cables, AC power cables, high purity long-grain metals, exotic insulating materials and patented constructions. We'll just have to hope that you ask an AudioQuest/ VideoQuest dealer to demonstrate for you how very important all these things are. We'll also be pleased to send you the "long" version (our literature). Please use any of the communication media listed below to let us know where you want it sent.

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