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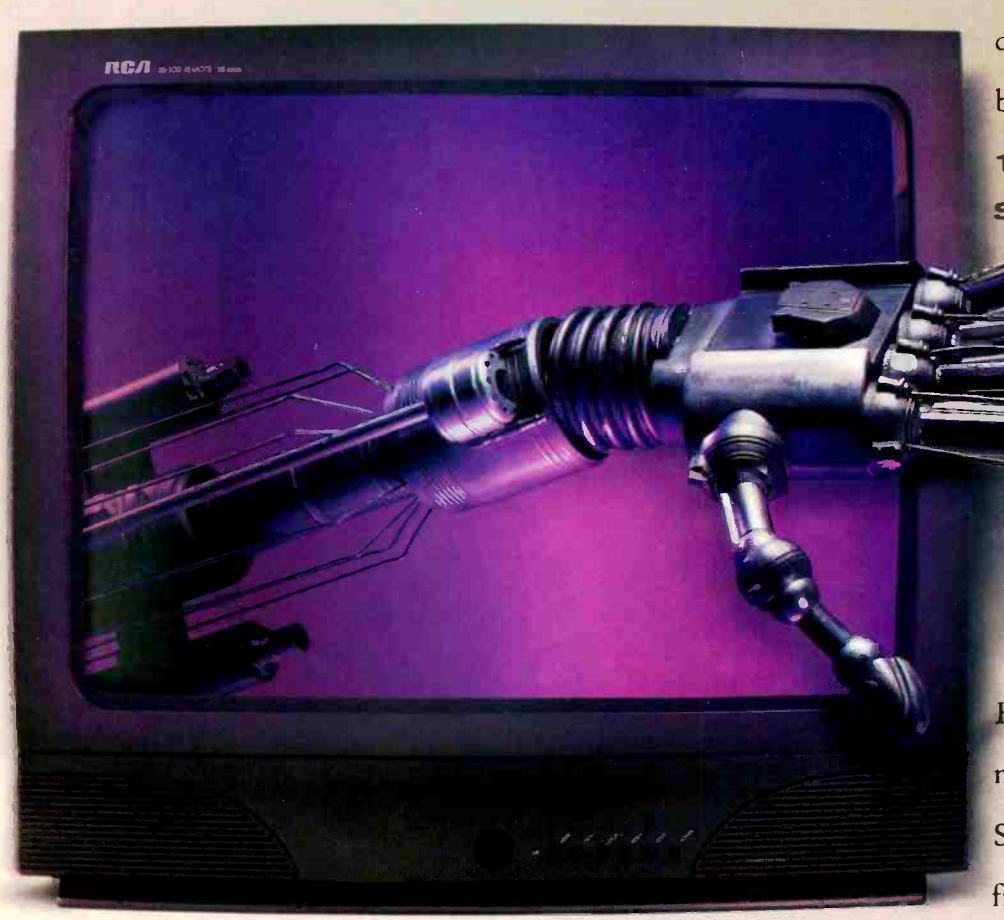

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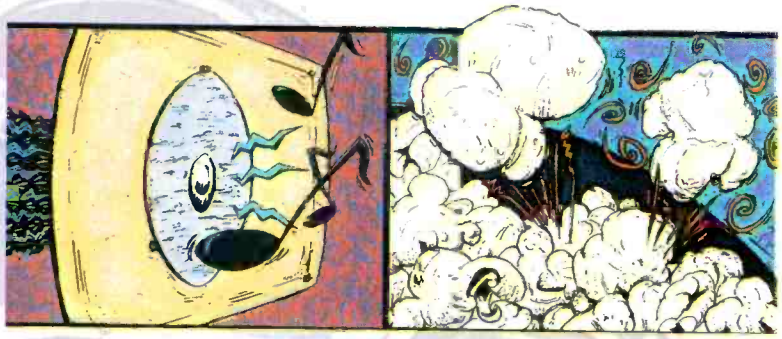

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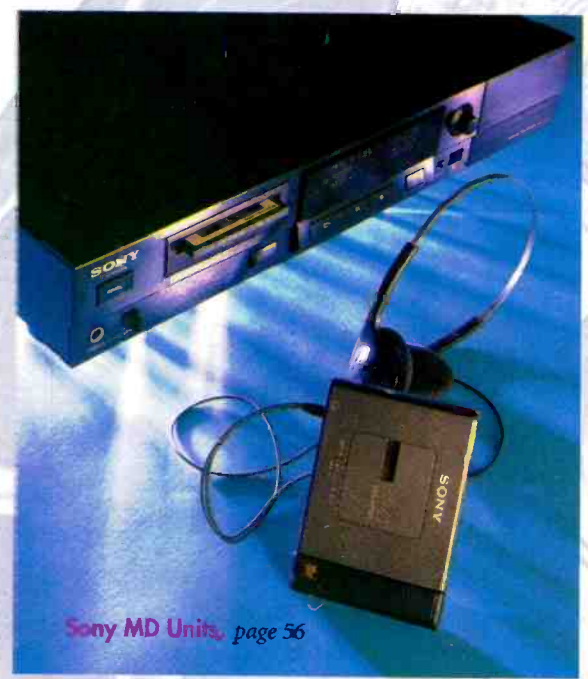

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The Cover Photographer: Robert Lewis
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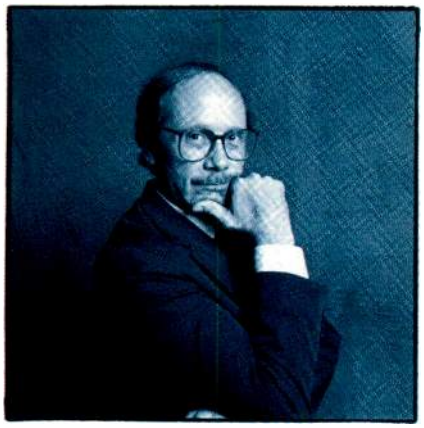

Potpourri time. Let me call your attention to a new column, "PlayBack," which will always be located just under the back cover of the magazine. We intend to have three to five short equipment reports on each "PlayBack" page. Even though "PlayBack" may look like a new products column, it is the result of hands-on reviewing from hard-nosed reviewers. Let us know how you like it.

An updated edition of *New Ears: The Audio Career & Education Handbook* was released by Mark Drews, the compiler and editor, about a year ago. This is the best single source I know of for information on courses in sound engineering, music recording, and music technology. Ken Pohlmann reviewed the original edition in our January 1992 issue, saying that it could save hours of personal research. More than 100 programs are covered in detail, including university, trade school, and home study plans, while a master directory lists over 400 audio programs worldwide. Aside from updating the basic information, this edition includes profiles of several audio-related careers. One section lists names and addresses of magazines and journals, broken down into pro, trade, and consumer titles. *New Ears* is available for $24.95, postage paid, from New Ears Publishing, 1033 Euclid Ave., Syracuse, N.Y. 13210-2661; phone, (315) 425-0048.

I'm not usually much interested in dictionaries, though I'm glad to have in my working library well-used copies of the *IEEE Standard Dictionary* from Wiley and Glenn White's *The Audio Dictionary* from the University of Washington Press. Cheaper and more appropriate for "the man in the hi-fi store" is the *Consumer Electronics Product Terminology Dictionary* from the Consumer Electronics Group of the Electronic Industries Association. The definitions are arranged by topic, covering accessories, home audio, camcorders, computers, FAX, mobile electronics, telecommunications, television, and videocassette recorders with LaserDisc players. My basic quibbles are some wrong definitions and too many too-technical terms lumped in with the ones no one needs to have defined. I think both could have been solved with some more back-and-forths between the editor(s) and the people who actually generated the words and definitions. The book doesn't pretend to be exhaustive, with only a few dozen words covered in each section, but the $4.50 price is right. It's also available on computer diskette. The CEG/EIA is located at 2001 Pennsylvania Ave., N.W., Washington, D.C. 20006-1813; phone, (202) 457-8700; FAX, (202) 457-4901.

Hotcake bills itself as the "Handbook of a Thousand Common Acronyms to Know in Electronics" and covers communications, IC design, signal processing, computer architecture, video, graphics, networking, and software. Also included are acronyms for worldwide standards, standards organizations, industry societies, consortiums, and many government agencies and programs, as well as some terms from electronic engineering and business. Costing $9.75 an issue or $29 for four issues, this 24-page soft-cover pamphlet is published twice a year by Rothschild & Associates, 175 Knibloe Hill Rd., Sharon, Conn. 06069-2215; phone, (203) 364-1915; FAX, (203) 364-1917.

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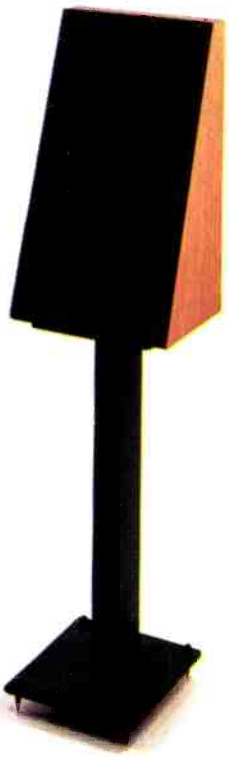
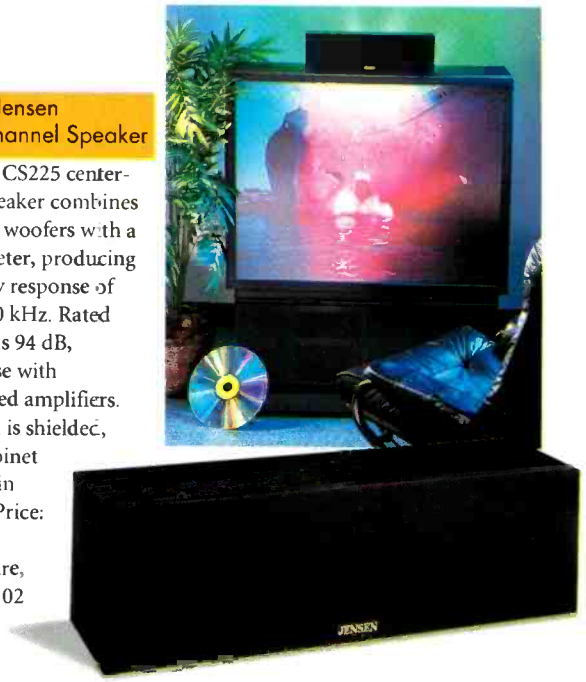
WHAT'S NEW



Spica Speaker

The "TC" in the Spica TC-60 stands for "Time-Coherent," a property the company says is derived from the speaker's distinctive sloping baffle, an acoustical blanket that helps control dispersion in the lower treble and reduce cabinet resonances, careful driver matching, and a crossover said to eliminate time-delay errors. The speaker is available in oak, black lacquer, and dark cherry. The optional Gravity Stands shown weigh 30 pounds apiece and can be sand-filled; they have tilt and height adjustments. Prices: TC-60, $795 to $895 per pair, depending on finish; Gravity Stands, $250 per pair. For literature, circle No. 100

Jensen Center-Channel Speaker



Jensen's CS225 center-channel speaker combines two 5-inch woofers with a 2-inch tweeter, producing a frequency response of 70 Hz to 20 kHz. Rated sensitivity is 94 dB, allowing use with low-powered amplifiers. The system is shielded, and the cabinet is finished in black ash. Price: $99 each. For literature, circle No. 102

Duntech Speaker

Known for its large speakers, Duntech now has a compact model, the PCL25, which is just over 2 feet tall and a foot square. Like all Duntechs, the PCL25 uses a vertically symmetrical driver array, here using twin 6.3-inch woofers flanking a 1-inch dome tweeter. Array dimensions are calculated to produce coincident sound at a 12-foot listening distance. Frequency response is 55 Hz to 20 kHz, ±3 dB, with less than ±30° phase variation between 150 Hz and 15 kHz. Sensitivity is 89 dB, and impedance is 4 ohms. Rosewood as well as several other exotic wood finishes are available. Prices: $1,995 per pair; stands, $295 per pair. For literature, circle No. 101

Parasound Powered Subwoofer

The model designation of the GMAS-18 stands for "Great Mother of All Subwoofers" and for its 18-inch driver, which has a 2½-inch excursion. Its specifications include 103 dB maximum SPL (with 3% THD) at 10 Hz and 131 dB maximum SPL at 40 Hz; THD at more typical levels is rated at 0.05% or less from 20 to 80 Hz. A modified, bridged-mono version of Parasound's THX-certified HCA-1200II amplifier, designed by John Curl, is included; the amp delivers more than 650 watts continuous, with a 75-ampere peak. The subwoofer cabinet is finished in gloss black with rosewood accents. Price: $3,850 each. For literature, circle No. 103

Boston Acoustics Center-Channel Speaker

Stacking the tweeter above the midrange in the Boston Acoustics Lynnfield VR12 promotes the wide horizontal and limited vertical dispersion a center-channel speaker should have. Its three-way design, with dual 6½-inch woofers, brings the bass cutoff point (±3 dB) down to 58 Hz. The vertical bar in front of the tweeter is Boston's Amplitude Modification device, to counteract resonant peaks. Price: $400 each. For literature, circle No. 104

WHAT'S NEW

Newpoint Surge Protector

Designed to protect audio and video equipment against line-voltage surges, the AV100C, from Newpoint, has seven outlets plus a surge-protected TV-cable passthrough. The company says it will repair or replace any A/V products damaged by surges while plugged into the unit, to a value of $10,000. The AV100C can handle a 15-ampere load and is rated at 330 V and 360 joules. Other features include a recessed power switch to prevent accidental turn-off, a right-angle plug that does not protrude far from the wall, and an audible alarm that warns of lapses in protection.
Price: $49.99.
For literature, circle No. 105

Pioneer CD/LaserDisc Player

For convenient CD play, Pioneer's CLD-D503 combi player has a separate sub-drawer set into its LaserDisc drawer; for convenient LaserDisc play, it automatically reverses from side A to side B, within 8 seconds. A one-bit D/A converter is used. Digital video processing boosts picture S/N to 50 dB, and a digital time-base corrector reduces picture jitter. A system remote control is included.
Price: $650.
For literature, circle No. 106

Polyfusion Amplifier

The Polyfusion Model 860 is rated at 100 continuous watts per channel, at less than 0.01% THD, into 8 ohms. Both balanced and unbalanced inputs are provided. The design uses MOS-FET technology, d.c. coupling, servo control, and a fault-protection system that mutes both input and output if temperature, output d.c., supply current, or line voltage gets too high. A manual muting switch is also provided. Price: $2,850.
For literature, circle No. 107

SOTA Turntable

A 24-pole, synchronous motor and belt drive spin the SOTA Moonbeam's high-density polymer platter. A medium-mass, straight-tube tonearm with fixed headshell is included, as is a tension-hinged dust cover.
Price: $379.
For literature, circle No. 108

Enlightened Audio Designs D/A and Surround Decoder

The TheaterMaster, by Enlightened Audio Designs, combines a D/A converter with a surround decoder—and can even double as a preamp, thanks to its remote volume control, six sets of analog line and digital inputs, analog and digital tape inputs and outputs, and front-panel microphone input. A Zoran 38001 decoding computer is also built in, making this perhaps the first home component that can decode 5.1-channel Dolby AC-3 signals; a plug-in decoder for Digital Theater Systems' Zeta-Digital 5.1-channel audio format is planned. The TheaterMaster also provides HDCD audio decoding. Price: $5,950.
For literature, circle No. 109

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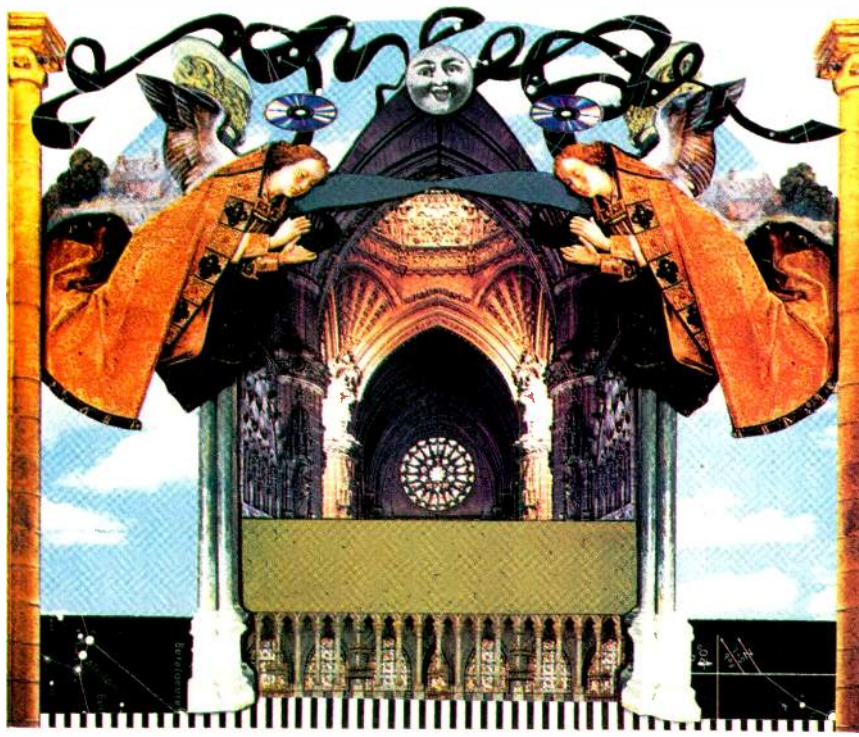
TAPELESS RECORDING



The Age of Magnetic Tape, 1950 to 1995: Are we at the end of an era? It most certainly looks that way.

Recently I attended a classical recording session in New York, the first I'd been to for quite some time, a whole evening on location in a large Catholic church. It turned out to be state of the art and much, much more—and, at least for me, full of astonishing surprises. How things are changing! In the "remote" control room, an office in this big, opulent church, I looked at thousands of dollars of recording and monitoring equipment, all of it the very latest, ready for a long evening of recording. But there was no tape.

NO TAPE?? Almost none. To the best of my knowledge, one small smidgeon of the stuff, enough for, at a guess, a few minutes or so of the old-style recording, was inside a modest DAT unit, two-thirds rack size, not even the primary medium out of no fewer than three systems recording simultaneously. This in contrast to the great cartons of tape reels, 10 inches and up, at past sessions, the hundreds of miles of obscenely wide ribbon running at obscenely fast speeds—15 ips, 30 ips—which fed the big, old recording machines of umpteen million sessions in the past! No tape. How soon will this be the standard setup? Any day.

THE BIGGIES MAY CHURN AND TOSS TO KEEP UP, BUT BIGNESS BOGS; SMALLNESS IS INNOVATIVE.

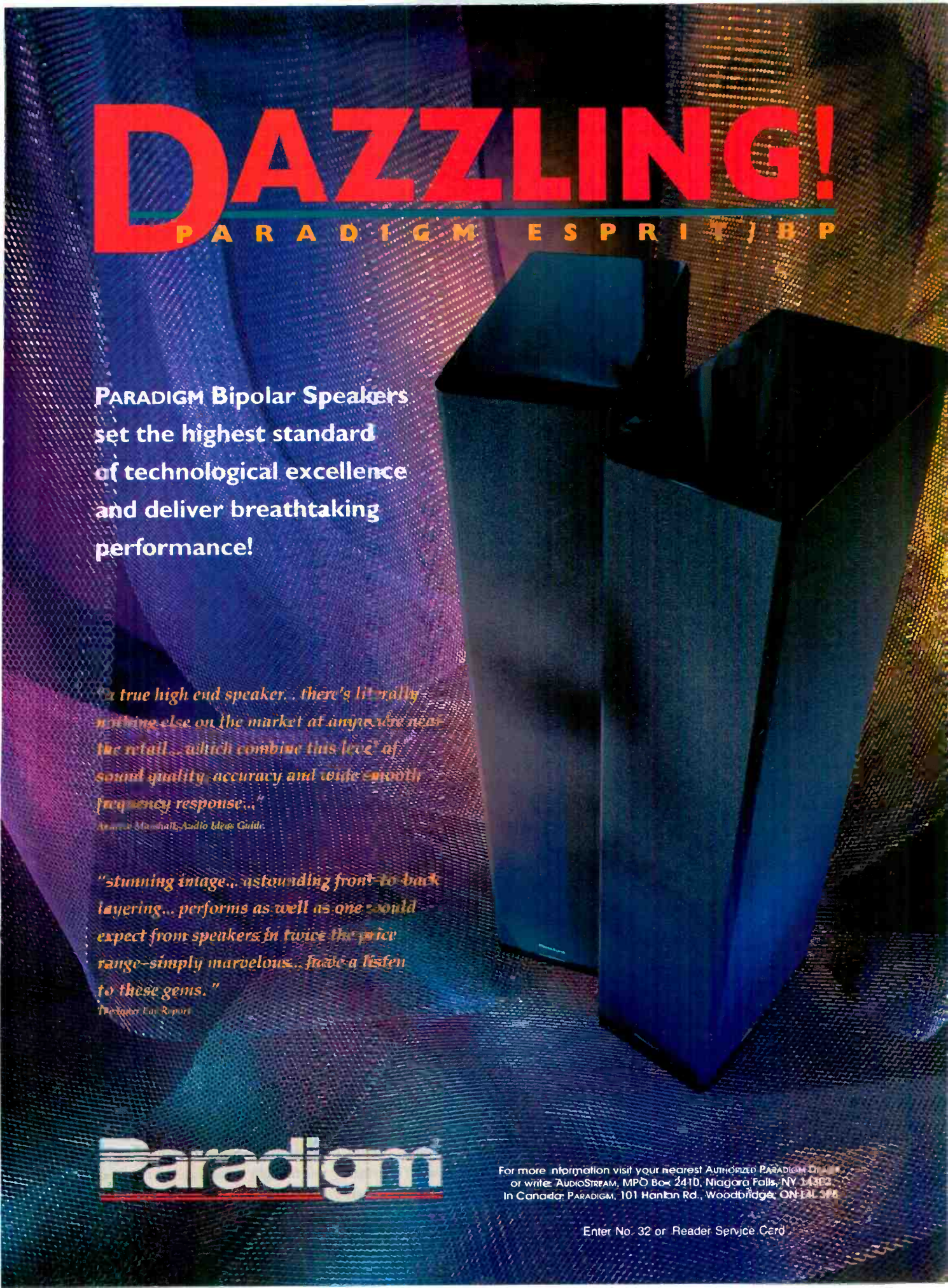
Paradoxically, the new record company, Epiphany Recordings, is tiny compared to many a giant. As far as I could figure, it boasted a huge catalog, at the time of my visit, of exactly one available CD, and several more listed but as yet unreleased including the music being recorded that very evening. Normal advance publicity. Yet don't our audio innovations often begin with technically super outfits, which are small in terms of production and sales? In this day and age of overweening bigness, yes! It's obvious, no matter how the biggies may churn and toss to keep up. Smallness is innovative. Bigness bogs.

The absence of recording tape was just the beginning. There were also, for me, fascinating musical connotations in this session and the same for numerous earlier audio innovations and procedures out of the past, suddenly updated. Start with the music.

Epiphany is the brainchild of two men named Kipnis, the second and third generations in a distinguished musical family that many will know from the recent and more remote past; I have been familiar with the work of all three. Kipnis I, Alexander Kipnis, was one of the finest basso singers in the early part of this century, born in the Ukraine, educated mainly in the German areas before World War I, picked up at a relatively late age (like Kirsten Flagstad from Norway) by the ever-zealous Metropolitan Opera in New York, where he became a household name. Kipnis I would now be 103, though I remember his marvelously resonant voice well enough; he was not at our recording session.

Kipnis II, Igor Kipnis, has long been well known in the musical world as a harpsichordist and fortepianist, very much alive today, the son of Alexander and an equally pure musician, though both can be heard on records. Igor made his

Illustration: Mary Schuck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debut and reputation as a harpsichordist, somewhat to my amusement at the time, because until he came along, all extant harpsichordists were little people, beginning with the minuscule but dramatic Wanda Landowska, the Mother Superior of the harpsichord movement, who was perhaps 4½ feet tall. The succeeding well-known players weren't much bigger, including a number I knew: Ralph Kirkpatrick, Putnam Aldrich in Boston, Edith Weiss-Mann of Hamburg and New York. All were mousy. Igor Kipnis was a giant in comparison. He made the harpsichord (or fortepiano) look small and probably feel small as well. Kipnis II, like his father, was a pure musician and artist (he is Epiphany's Artist & Repertoire man and prime performer as well). Kipnis II even sports the Jeffersonian side curls in his hair that are now a musician's trademark. I gather he is not the least interested in audio engineering except for practical purposes. Throughout our recording session he stayed mainly in the "live" musical area, down in the church nave, with some musical friends, paying occasional brief visits to Engineering headquarters. Entirely pleasant to all on hand, including me, but distant from all that equipment. Without Kipnis III, where would he be? Lucky he, to have, in turn, a Kipnis son who lives in our world and with obvious pleasure.

Kipnis III, son of Igor, grandson of Alexander, is Jeremy Kipnis. Not a name that comes from the Ukraine. When I first heard about this joining of Ks and found that it was Igor, not Jeremy, who approached *Audio* with a request to send someone to the recording session, I thought it sounded all too much like a dominating papa financing a doting, but maybe not so talented, son for his own recording company. Two minutes with Jeremy Kipnis, and that idea flew out the window in a hurry. Kipnis III is a born audio man well on his way to genius (my personal opinion). Whatever papa, Kipnis II, might do to help Jeremy would be just fine, but Kipnis III is clearly able not only to assemble fabulous audio equipment on his own but also to modify it, even in cooperation with top equipment company engineers and other audio men of his generation. So with Igor and Jeremy, we have a real symbiosis, a pure musician and an equally pure audio man, and all in the family. Interesting.

Jeremy has an engineering partner, Karim Ibish, who is at the company offices in Amherst, Massachusetts, but was at the recording session. Kipnis II and III currently live in Connecticut, with both recording and editing at that location, as well as in New York. A decidedly peripatetic outfit (see Gilbert & Sullivan).

To make a beginning on the equipment, the primary medium used by Epiphany,

WITH IGOR AND JEREMY KIPNIS, WE HAVE A REAL SYMBIOSIS, A PURE MUSICIAN AND AN EQUALLY PURE AUDIO MAN.

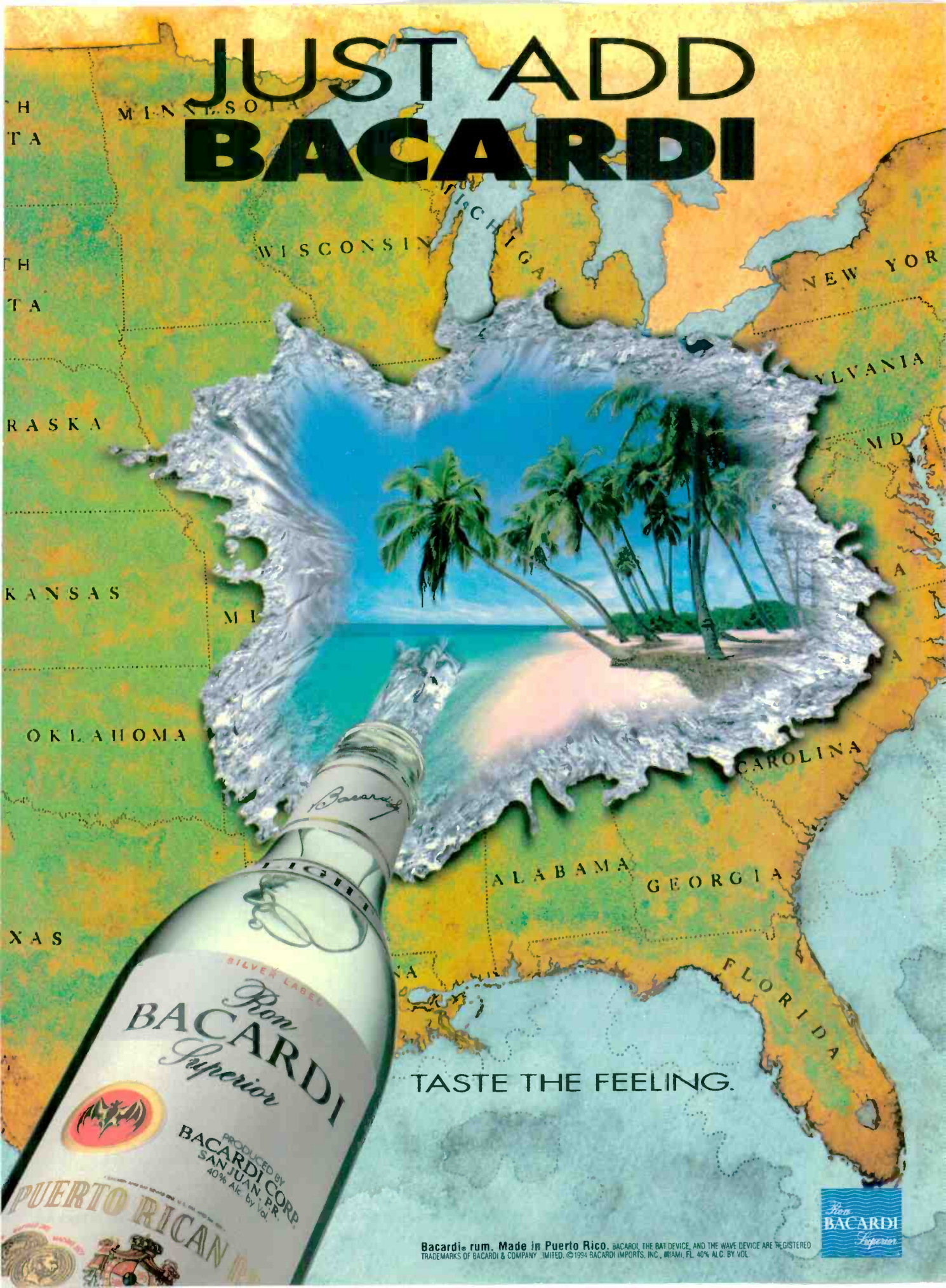
the ultimate master, is not DAT but a system I had yet to hear about (though our engineering people surely know it): Glass optical discs, ODMs. Each disc, about the size of a CD, holds some 30 minutes of recording—there were quick changes of disc every so often, with a spoken ID put down on each. I have all the specs (much too much to pass on to you), but clearly the quality of this optical digital system is remarkable—24 bit, lowest jitter of any digital medium, and so on. Also note this: "Professional archive performance." Aha—glass lasts and lasts, assuming you don't break it. Glass is good for hundreds of years, right? Even Roman glass, which is mostly darkened by now, still might be read into viable audio after 2,000-odd years if we had a few Roman recordings on hand.

So, can you imagine a recorder that not only uses no tape but is also, at least in part, removed from electronics, tied to light circuitry, made on glass? The other two systems were far more conventional, though the latest thing on the market. DAT and, if you will believe it, MD, the Sony digital disc with lots of controversial compression, generally distrusted by both purist engineers and far-out consumers. All of these were operated, the whole triple recording chain, via battery power. Even the mikes. Not a plug in the wall anywhere. How many recording sessions do you know that were all-battery?

Well, I know of two, both my own and both a long time ago. For once, I anticipated Kipnis III, and by some 19 years. With the help of the Swiss, my Canby Singers and I borrowed the very first portable stereo Nagra and, in a New Jersey wooden church, did an entire recording session on batteries, even the rewind. The Nagra has been largely a film-biz machine, but its Swiss makers nevertheless contrived to switch their marvelous foot-square baby (running 15 ips with professional quality) to the stereo mode. Not exactly as small as today's handful of stereo DAT, but *very* small for the day. I even carried it home in the New York subway. The little beast, of course, ate D-cells like crazy. I forget how many at a time. But we used batteries for precisely the same reason then as Jeremy Kipnis does now. The next year we did it again, with add-on arms to take 10-inch reels. Unlike the earlier Magnecord extensions (which I tried), these actually worked, giving us double the recording time....

And so it went, something unusual at every turn. Special cabling—Cardas Litz, Golden Five, Hexlink Five (I'm just reading the specs)—even the a.c. was super-special, for the monitor playback—a big battery-powered d.c. inverter for a "pure a.c. 117-volt sine wave." Wow! Con Edison, dip your head in shame.

I end, before I am editorially amputated, with what struck me as a lovely controversy-generator. Jeremy Kipnis says he prefers (and so do friends, musical and otherwise) the Sony MD much-compressed system to the professional DAT, also Sony. There they were, together, as second and third simultaneous recording media. Like ice cream, MD is smoother, richer, more inviting in musical reproduction, says Jeremy. Or words to that effect. Than DAT? Swallow this thought if you can, friends, and come back for more in another installment. A



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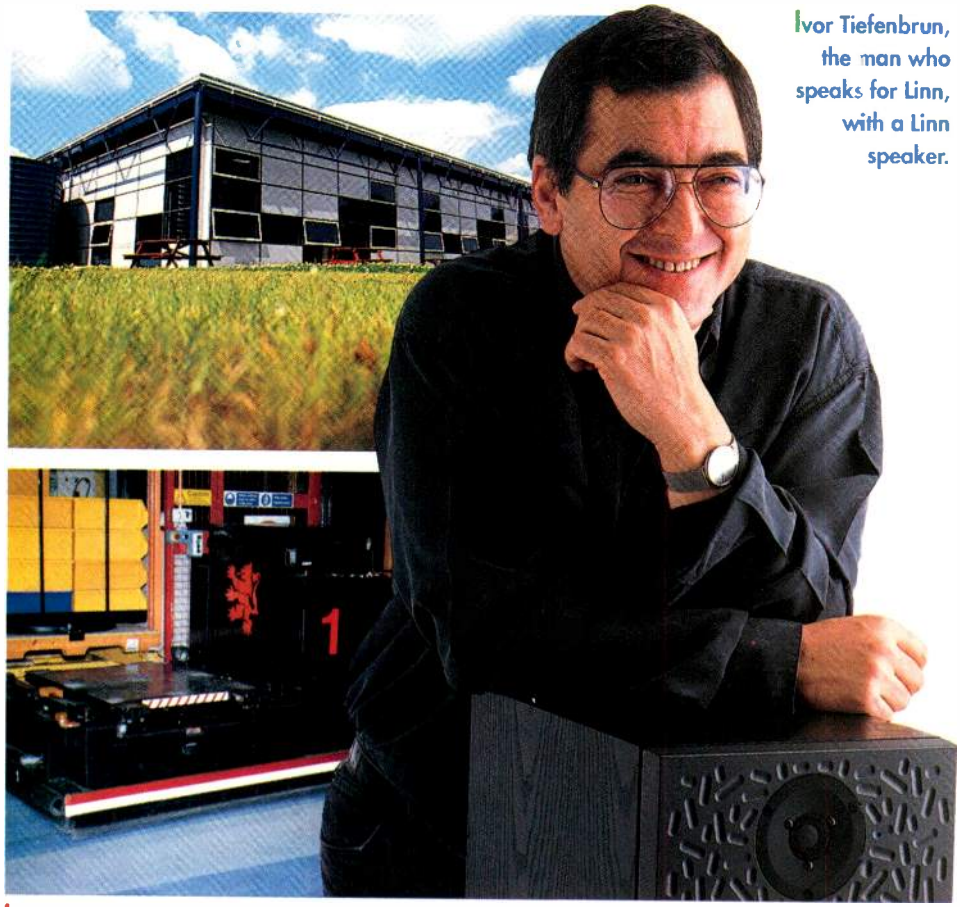
LINN'S IVOR TIEFENBRUN



Ivor Tiefenbrun, the man who speaks for Linn, with a Linn speaker.

Linn's ultramodern factory is full of highly automated equipment, much of it built by or for Linn.

For more than two decades, Linn Products Ltd. of Scotland has dominated the audio scene in the United Kingdom. The firm's success is due in no small part to the enthusiasm and notoriety of founder Ivor Tiefenbrun. Truly the P. T. Barnum of hi-fi, Tiefenbrun has badgered, seduced, cajoled, finessed, and intimidated his way across hundreds of column inches in magazines around the world. [It won't hurt for us to add a few more.—*E.P.*]

During the course of Linn's history, Tiefenbrun has championed dealer installations, home demonstrations, single-speaker demo rooms, and other practices which, in the U.K. at least, transformed the way hi-fi is purchased. More controversially, Tiefenbrun and Linn also helped to alter the way hi-fi is used, having called attention to the integrity of speaker stands, spikes, cable quality, and other aspects of what is now regarded by many as normal hi-fi "housekeeping."

Linn has moved from being a turntable-only manufacturer to the producer of entire hi-fi systems, in a robotized factory judged to be one of the most modern and sophisticated in Europe, let alone Scotland. But the change from specialist to broad-based manufacturer means that Linn can no longer be regarded as a fringe operation able to indulge in the sort of infantile pursuits that made high-end audio both fun and frustrating a decade ago. Additionally, Linn has produced products and embraced technologies that would have been regarded as heretical in the heyday of their LP12 turntable: Full remote-control preamps, multi-room installations, a range of CD players and D/A converters.

Synchronicity and irony played their parts when I called to make an appointment with Tiefenbrun for this interview. The mutually agreed site was London, after an event that shows just how respectable Linn has become. Now one of the product lines carried by Harrods, the most upscale department store in the known galaxy, Linn was chosen by that company and Warner Bros. (U.K.) to supply the sound system for the press launch of the digitally remastered Led Zeppelin catalog. Was I the only guest present to note the incongruity of Linn—once the last bastion of analog—helping to promote the digitizing of analog masterpieces? . . .

What do you see as the differences between Linn circa 1994 and Linn at the height of its notoriety in the late 1970s? I would describe the old Linn as targeting products purely at hobbyists. . . .

[*Laughs.*] I got into hi-fi as an engineer who was interested in music. My goal, my aim, was to build a full range of quality hi-fi equipment. And it took us a long time to do that. Our notoriety came from the proposition that what we offered was outrageous, was unbelievable—basically a turntable that could influence the sound. So the initial reaction to that was incredulity. That made us notorious (A) because the claim seemed outrageous, and (B) because we had to be very vociferous to convince people. People often wouldn't listen. They said that turntables just went 'round and 'round. I used to say, "And loudspeakers just go in and out." [*Laughs.*] But you remember those days.

From the beginning, to me the thing was access to the music. So there was this kind of threshold, and if you got above it, a system could seduce you into listening to it even if you didn't know the music. It's that ability to learn, to discover, and to explore that excites my interest in hi-fi. It's not the joy of tinkering. I got over that as a kid, with my "boy racer" days, with my motorcars that I used to take apart. That was my main outlet. One of the things about Linn is that the people who started it at the beginning are still there, and we're still trying to achieve what we set out to achieve.

So a full system was always part of the game plan?

Always. The first product that we made was the LP12 [turntable]. And at the bottom of the leaflet it said, "Sondek Division." People laughed; they said, "But you only make one product." And I said, "Yes, but we want to make a complete system." We wanted to be specialists in music systems, rather than a turntable specialist, an arm specialist, and so on.

That was considered an awfully ambitious goal. But if you don't have a goal, a dream, you have no future. So within a year, we had another leaflet with "Isobarik Division" on it. It was less than a year after the LP12. And over the years we ended up with three loudspeakers—we had the Kan, the Sara, and the Isobarik. Then we went into tonearms and cartridges. And the last stage was when we did our own preamp and power amp.

At what point do you think that Linn graduated, in the perception of the public, from specialist status—when all your customers seemed to be hi-fi magazine readers—to broad-based?

Well, the way people find out about Linn now might be slightly different. I think that the public perception of us probably hasn't changed because people either know about us or they don't.

Despite of all your efforts to reach a wider audience?

In spite of all our efforts. We might be one of the best-known specialist hi-fi companies but we're still not . . .

. . . a Sony?

Of course not. Those companies are thousands and thousands of times bigger than us, enormously successful, global companies. But in our small part of the market, we have a great deal of brand recognition and probably a lot of respect. It might seem funny to you to use the word "respect," but I think the perception of us changed when we led the way to being the first specialist full-range kind of company. Because that was another Linn "first."

Whenever we've made these moves, we were far from being welcomed. There's a kind of natural reluctance to welcome new kinds of competition or a change. People have a natural inertia. It mitigates against change. So people saw our development into a full-range hi-fi company as a threat to the notion of the component business. We still make components; all of our products can be used independently, in a broad context, with open standard interfaces. We are part of the big industry; we welcome [such use]. There's no fun dancing alone at the discothèque even if you own the discothèque.

THERE'S NO POINT IN MAKING BETTER HI-FI IF NO ONE HEARS IT'S BETTER OR IF IT DOESN'T PERFORM BETTER.

But I think that the industry's perception of us changed. And I don't really think that reflects the public's perception. In a sense, we've also been seen to have started out as tweaky and way-out—though the two aren't necessarily synonymous—too successful and therefore a target. If you're in the pole position, everybody's trying to pass you and knock you off. Rolls-Royce and Ferrari will get reviews that tear their products to shreds; it'll never happen to Skoda or Isuzu. So there's a price for being an innovator or a leader.

Do you think that it's possible for any company that had its roots in the specialist or audiophile sector to make the transition to a broad-based market, to appeal to non-enthusiasts, so to speak? To put it another way, is it possible to be more commercial and still be tweaky?

We don't want to be tweaky, and we've always had to be commercially viable. Otherwise the company wouldn't be here. And we couldn't support our existing customer base or do justice to the people who have built our business: The distributors, the retailers, the rest of it. So we've always had to be serious. And the LP12 was always a serious product.

But there was always a tweaky element to it. Maybe "tweaky" is a bad word, but it was Linn who pioneered the whole notion of a progressive series of upgrade steps based not just around upgrading whole components but around fine-tuning. It was Linn who talked about things that had nothing to do with buying new equipment: Tightening up the screws that hold your drivers to the baffle, polishing a stylus with a matchbook striker, and cables. What Linn did was act like a manufacturer voicing the same sentiments that had less respect or less credibility when they came from an audio writer. The same thing only in a different context.

[*Laughs.*] The irony is, we spawned a vast industry in cables and clamps and connectors and so on. We said these things were important and no one believed us, but probably it produced this sub-industry.

You didn't cash in at all, aside from a few cables and stands?

No, we didn't. We've never managed to benefit from all that. You know that pioneers get scalped, and settlers take the profits. That's the way it works. The reason for being a leader, a pioneer, is that you want to be. At Linn we've got people who are enthusiastic about engineering, about quality, about music, and we don't see it as an enthusiasm for hi-fi; we see it as a way of getting at music. It's a key.

But if we were true to ourselves as music lovers, we wouldn't give a damn about the equipment we played it on. Sure, we'd rather hear music on a good hi-fi system than a boombox, but if music is all we're after, we could be happy with less.

No, because you're not going to broaden your taste in music unless you get a system that's good enough to take you in there and allow that music to communicate with you. And that, to me, is the rationale for hi-fi. It's not just to have better quality per se. It's because the advantage is that you can start to appreciate things you never thought you would. Your taste develops, broadens, deepens. And then you can bring your family up with music. That, to me, is the justification for the hi-fi industry. And

that's why the quest is endless. One day you will enjoy opera, with our help.

Never!

It is possible. We're famous for demonstrating the differences. We're famous for initiating spikes to keep speakers from wobbling. People see that as tweaky. On the other hand, when the market discovered that, the retailers found a way they could contribute to the sound the customer had in the home. And we emphasized that. But there was always an element that perhaps, without fully understanding everything—and no one does—made more of the adjustments than of the fundamentals.

The retailer's main way of contributing became mixing and matching components, telling the customer what to do. And that disenfranchised the customer and emasculated the retailer. Then, when CD came along, people felt, well, there's nothing you can do here. The fun's gone out of the business. You're not going to be able to make a sound that will astonish people. And maybe the retailers and the manufacturers felt that we can no longer surprise and astonish the customers in the way that an LP12 could.

What we're saying is that you still can. You just need a higher level of expertise. You can do it with the quality of your installation. And when you're talking about an in-wall, multiroom system, you only have one chance to pick the point where you're going to put the speakers in the wall. You can't go knocking holes all over the guy's walls. So the paradox is that you need a higher level of expertise.

Is that what led you to the global restructuring of the Linn dealer network?

There are two things which caused that. One was the imperative of 1992 [the lifting of trade restrictions between members of the European Economic Community], which made it clear to us that companies that didn't have a strategy for quality distribution would not be able to make a quality product. The choice in this world is to be the cheapest or the best. We wanted to be the best. That meant we needed retailers who were committed to a quality approach. Otherwise, what could they do that a mail-order catalog couldn't do?

They might understand their town. They know how to make good sound in the home; they know where the music is, the record shops, the universities—they know the community. They can demonstrate, they can communicate with their customers, they can service and install. It's *that* which our retailers can do and address that the mail-order house can't do.

We said, "Look, guys, we can only maintain the quality if we have a contract that embeds these standards. These are the standards that we think we should be applying. You tell us." And we asked on our questionnaire, "How good do you want to be?" and we'll abide by the majority view. And they pitched it at a certain level.

But it wasn't above the level at which we started. It wasn't below it either. The irony is that the people who talked the most about quality and standards didn't want to do it, and the people who were most concerned did. Because the people who took it seriously had their doubts. Would they be able to compete against discount competition selling product in boxes? Well, we know the answer: The people with the balls to remember why they got into the business in the first place went for it. The others bad-mouthed us, rubbished us, hoped we would fail—in the mistaken belief that that would make them more successful. That produced the controversy.

IF I COULD MAKE PEOPLE LISTEN TO MUSIC ALL DAY, I THOUGHT, IT WOULD BE A GREAT WAY TO MAKE A LIVING.

What is the downside of having a restricted dealership?

The downside is that people think it's restrictive. It isn't. It's open; it's competitive. And anyone who meets the standard can participate. There's no point in making better hi-fi equipment if no one hears it's better or if it doesn't perform better in the customer's home.

The two things I wanted to do when I started the business were to treat other people the way I'd like to be treated and to make stuff that was better than what I could buy. It seemed pointless to me to make something if I could walk down the street and buy a better one. I thought if I could do this, make people happy and listen to music all day, what a great way to make a living.

And I think that's what got a lot of people into the business in the first place.

How do you now see Linn's initial resistance to and final acceptance of CD?

[*Laughs.*]

Because you did say . . .

. . . there was blood coming out of the record player.

Aside from the legendary—possibly apocryphal—remarks, you did say, when you brought out your first CD player, that you'd always maintained Linn wouldn't bring out a CD player until the sound was of a standard with the turntable.

With CD, we felt that the claims made were exaggerated. We felt that it didn't do the industry a service. We felt that it was counterproductive. And events proved that what we said was correct. In retrospect, I was wrong. I probably should have been more positive about it. The perception was that we were negative about it. People who know the company know that we were working on it from the beginning, that we had digital recording systems years and years before.

And then our customers were terrified that we would walk away and abandon their precious record collections. The question I'm asked most often, though, is, "Are you going to keep on improving the LP12?" Now, in the last few years, the rate of product enhancement and improvement to the LP12 has exceeded anything we've done prior to launching our own CD players, yet people are still nervous and neurotic. That's because we all know that there will come a time when it will be very difficult, if not impossible, to access the music that exists in vinyl.

But no one is more interested in that music than we are or values it more highly than we do. But we do know it's conceivable, probably inevitable, that although we will make record-playing equipment for as long as people want to buy it, in the future, vinyl will be the preserve of people who know and understand what is uniquely available on vinyl and who are prepared to invest at the LP12/Ekos/Arkiv level. The bottom of that market is going. The days of being able to get reasonable quality, cheap access to vinyl . . . it's just not there. A

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JOHN EARGLE

VIDEO DATA REDUCTION

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Just a few months ago, I attended a day-long seminar jointly sponsored by the University of Southern California and the Society of Motion Picture and Television Engineers on the subject of data reduction in video transmission. Video data reduction is important as we look forward to digital transmission of video and the coming of the Compact Disc as a video carrier. The small-dish satellite transmission systems that are now available to consumers already make use of video data-reduction techniques.

Readers of *Audio* have been exposed to data reduction as it applies to audio signals through articles on the PASC and ATRAC algorithms that are used in the Digital Compact Cassette and MiniDisc. You will recall that these systems make use primarily of masking effects in which a loud signal in one frequency band masks softer signals in adjacent bands, making it possible to encode them with fewer bits—or in some cases to ignore them altogether. The net result in DCC and MD is a 4- or 5-to-1 data-reduction ratio.

Video has its own requirements and opportunities for data reduction, and these are driven by the high rate of signal redundancy in normal video transmission. As explained by Charles Poynton, of Sun Microsystems, there are techniques for reducing the data required to transmit a single frame (spatial techniques) as well as techniques for reducing the data that is common to several consecutive frames (temporal techniques). Let us first consider the temporal aspect.

Video is transmitted in the U.S. at 30 frames per second, and on the average, the difference between consecutive frames is quite small. So here is the first opportunity for data reduction: Transmit only the actual differences between the frames, not each new frame.

VIDEO DATA REDUCTION IS IMPORTANT AS WE LOOK FORWARD TO DIGITAL TRANSMISSION OF VIDEO.

This technique can be expanded to allow for relatively slow panning of the scene. Here, motion vectors can be determined by analyzing consecutive frames, and only the *new data* entering the scene at the leading edges of the picture needs to be encoded.

In a fast-moving program, the technique is modified so that every 15 frames, for example, the complete frame is updated. And every time a scene changes, the entire frame must be updated as well.

The spatial aspects of data reduction have much to do with psychological aspects of vision: What we are most likely to be unaware of and what we are most likely to see. Studies have been conducted to determine the number of levels, or shades, of a given color that are necessary to provide the eye with a continuum of response. In most cases, a nonlinear representation of these levels will offer a better overall effect, enabling fewer bits to be used to encode the entire range. It is useless to provide more information than this.

Studies have also been made of just how much sharpness in the picture is necessary. At the seminar, the work of William Glenn was cited to show that the eye is most sensitive to contrast in the range of 2 to 5 cycles (or lines) per degree; above and below this range, the number of bits assigned to luminance transmission can be reduced accordingly.

As Poynton stated, the best part of data reduction is "representing the image in the most efficient way to begin with." We normally think of video as a time-varying signal. However, if we think of it as a frequency-based signal—and analyze it that way—we can more easily carry out some of the visually optimized data-reduction tricks.

The key here is to represent the video signal by means of the *discrete cosine transform.* In applying this, a


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keep the emphasis on buddies.
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frame is broken down into many regions, or blocks, each made up of an eight-by-eight set of pixels (a pixel, or picture element, is the smallest element that can be addressed). The transform then makes use of "spatial redundancy, which is the statistical similarity of neighboring samples." Typically, a small number of transform coefficients can be used to describe the block sufficiently.

I hope you've by now seen that video data reduction is a collection of techniques operating on different levels and in different domains. In fact, some of the standard systems in use today are open-ended and can operate at several basic levels of data reduction, depending on application. Reduction ratios can run anywhere from 10 to 1 upwards to over 100 to 1.

Surprisingly, these systems do very well, and it is rare to see an artifact that is really bad. At the SMPTE/USC seminar, I saw a number of different systems, all operating at different data rates. In rapidly changing scenes at low data rates, there was some evidence of "blocking," the tendency of individual data blocks in the scene to become obvious as such, due to the fact that the system was simply being taxed beyond its limits. This does not happen often, and it does not happen for long.

As a fitting close to the seminar, a group of producers and engineers who work in the creative sides of film and video discussed the pros and cons of data reduction. As we have seen in the audio arts, there is a good bit of reluctance to throw out past gains in old technology simply because there is something new. As with analog audio, the art and technology of film and video have co-evolved over many years, and technical limitations were more than once shaped into aesthetic advantages. Digital processing and perceptual encoding are still rather uncomfortable topics for many creative people, primarily because there is a history of standards hastily arrived at and not easily undone. There is also the analog-based conviction that there is something inherently substantial about their medium (film, tape, or vinyl) that shapes the message.

All of this is about to change as the economic demands of information and video transmission double or quadruple in the near future. A

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DMX: Info, Pros, Cons

Dear Editor:

In one of his last "Behind the Scenes" columns for *Audio*, entitled "Classical Derailed" (May), the late Bert Whyte sang the praises of a listening source for classical music called Digital Music Express (DMX), owned by International Cablecasting Technologies (ICT). Could you please give me a mailing address or phone number for ICT so that I can learn more about this system and its availability in my area?

Rossney E. Smyth
Chester, N.J.

The Editor-in-Chief's Reply: Contact ICT at 11400 West Olympic Blvd., Suite 1100, Los Angeles, Cal. 90064. You can call ICT at (310) 444-1744.—*E.P.*

Dear Editor:

I read Bert Whyte's "Classical Derailed" with great interest. Readers may be interested to know that DMX is offering a new service this year. The problem with the standard DMX system is that it is tied to cable. The new service is available via DBS as well as cable. DMX for Business, as its name implies, is initially being offered to businesses needing background music, but it is my understanding that it will eventually be available to audio buffs.

The system broadcasts 61 stereo pairs of audio channels (90 by early 1995, and 120 by year's end) via a single transponder on the new Telstar 402 satellite, on its Ku-Band side. Required to receive the DBS broadcasts are a satellite dish (2 to 3 feet in diameter), an LNB, and a satellite receiver (made by ComStream). The method used for encoding the broadcasts is the two-channel version of Dolby AC-3. The receiver uses a "smart card" for system security. Telstar 402 was a good choice for the satellite, as customers may use the same dish and LNB (with a standard receiver) to receive all four PBS networks.

The prospect is an exciting one for audiophiles, but I would miss hearing the added fare that only an *excellent* radio station can offer (news, interviews with artists, etc.). I hope, as systems like DMX and its descendants mature, programmers for the same will add the human element again—minus the commercials.

Bard-Alan Finlan
San Marcos, Cal.

Dear Editor:

I enjoyed Bert Whyte's column about the joys of DMX, as well as John Gatski's article on "Digital Radio" (September). I'm one of the lucky ones who has DMX available through a cable system. However, in spite of its superb quality, freedom from commercials, and very reasonable price, I have elected to pass over DMX and continue to listen to the local classical music station. KING-FM has a big advantage that DMX lacks—a schedule.

With DMX, you have no idea of what's coming up (or, for that matter, what you just missed), and the company has no intention of ever telling you. What you get from DMX, for all practical purposes, is sonic wallpaper. Although it would be duck soup, technically, to allow you to scroll through coming attractions, the company has assured me that this will never happen.

Do you think I'm being overly critical? Ask yourself how much television would be worth if you had no way of knowing what was to be broadcast or when, if all you knew was that the program would be a drama, a sports event, whatever. How much would you pay for a concert ticket if you knew only that it would be for chamber music? The concert could start at any time, there would be no program, and the group would not be known in advance.

I think I know why DMX has this policy. The company doesn't want anyone recording the broadcast. Unfortunately, this doesn't help the listeners. I have to choose how I will spend my time; listening to unknown music is not going to be one of the ways.

Norm Strong
Seattle, Wash.

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The Editor-in-Chief's Reply: I agree with you to some extent, though I find my own music listening via radio to be of the background music type. However, it seems to me that the concert is constantly going, as opposed to one that starts at a certain time, a time that always seems to be inconvenient to me. While I don't have a printed program, there is one, being played by a first-rate pick-up group, as it were. As far as I can see, the "no-recording" policy isn't really DMX's but rather that of the record industry, which might well have crushed the fledgling effort otherwise. In the end, then, isn't the quality of this service enough reason to buy it? While you must make your own decision, it appears to me that the service will be commercially viable.—*E.P.*

Pesky Power Lines

Dear Editor:

I sincerely enjoyed Edward M. Long's article "That Mysterious Source: The A.C. Power Line" (June). It was very informative and did spur my interest in how power affects the quality of my audio system.

However, I was wondering if you are considering a follow-up article giving specific suggestions for those who wish to improve the power supplied to their audio system. Or if you are considering a "round-up" article, similar to the home/car directories, itemizing the various types and pieces of equipment available to handle the a.c. power problem (with specifications, manufacturers' addresses, etc.) and exploring the differences between power-line "conditioners" (equipment that maintains an a.c. voltage) and power-line "filters" (equipment that merely filters r.f.i./e.m.i.). Are home computer conditioners good enough for high-end audio equipment?

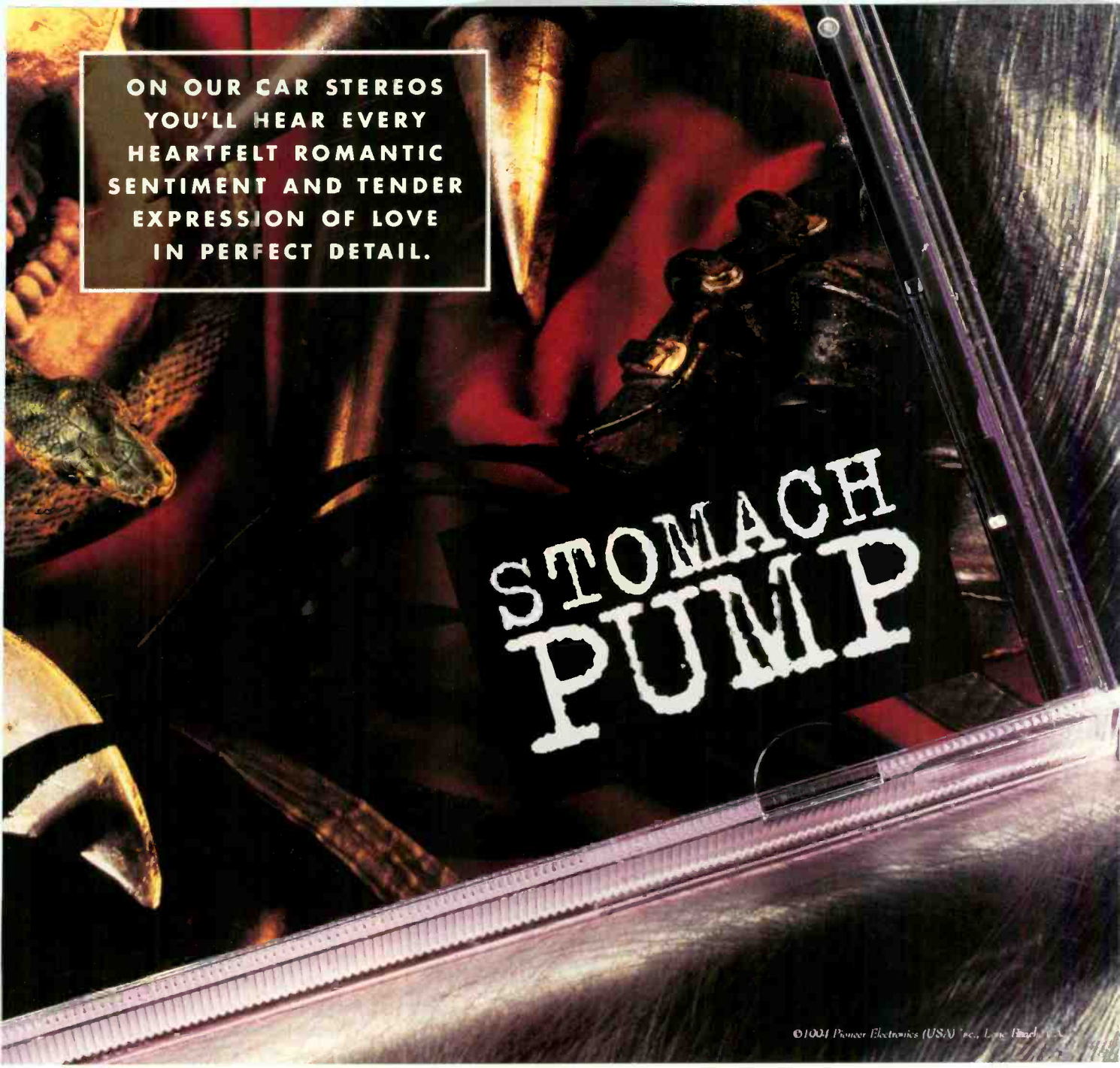
I do have one specific question. I have received information from one manufacturer of power-line filters, and test results show that their filters begin to attenuate r.f.i./e.m.i. at 10 kHz at 15 dB, whereas other power-line filters begin to attenuate at 60 kHz at 3 dB. Can you elaborate on the relationship between frequency and the amount of attenuation?

Bryan X. Sherrod
Pleasant Hill, Cal.

Author's Reply: Thanks for your kind words about my article. I appreciate it greatly when readers write and tell me that I have stimulated their interest.

I'll answer your specific question first: It would appear that the manufacturer you mention is serious enough about suppressing r.f.i./e.m.i. that they use more expensive, larger value components (chokes and/or capacitors) to do a better-than-average job. If their power-line filter attenuates 15 dB at 10 kHz, then it certainly will do a good job at higher frequencies. A filter that attenuates only 3 dB at 60 kHz will have a very steep slope to suppress r.f. energy one octave higher at 600 kHz, which is near the low end of the AM radio band. My guess would be that a power-line filter will not have this kind of steep slope filter.

It would be interesting to look at the wide range of a.c. power-line interface devices that are available and list their attributes. There are many such devices, from simple, inexpensive surge suppressors to complex, expensive a.c. line conditioners. The simplest device does offer some advantage over just plugging your system into



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an a.c. wall outlet. An a.c. power-line conditioner that offers a truly isolated interface, large power capability, and uninterrupted power can be very expensive. For a life-support system, this is an absolute necessity; for an audio system, it might be fun to play soothing music during a local disaster that knocks out everyone's a.c. power. A good compromise, for audio systems that don't need uninterrupted a.c. power, is a device like the Panamax Max 1000 surge protector and line conditioner, which I reported on in the June 1993 issue.

If there seems to be enough interest, I am sure that our esteemed editor will consider a round-up article.—*E.M.L.*

Dear Editor:

I read with much interest Edward M. Long's article in which he discussed the effect of a.c. power lines on audio equipment performance.

I would greatly appreciate it if he would recommend to me any articles that deal with methods to insure proper PC quality, beyond what he mentioned in his article. I am interested not only in how I can improve my existing installation but also what specs I can give my electrical contractor for new construction.

Alex Wallau
Vice-President, ABC TV Network Group
New York, N.Y.

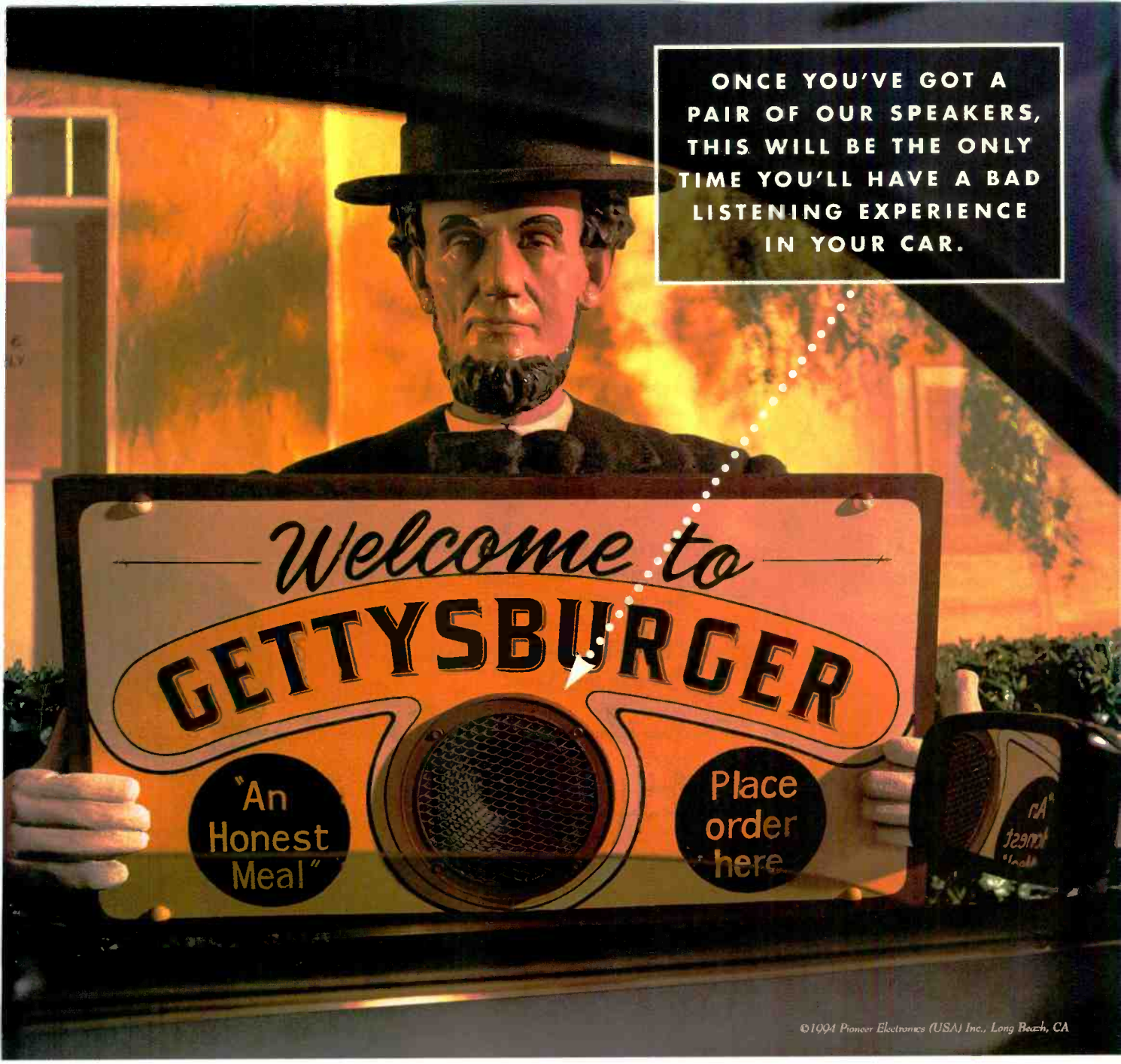
Author's Reply: The best information about a.c. power-line problems is the *Handbook of Power Signatures* by Alexander McEachern, published by Basic Measuring Instruments, 335 Lakeside Dr., Foster City, Cal. 94404. The phone number is (415) 570-5355, and the FAX number is (415) 574-2176. This handbook is very technical and shows many problem waveforms along with possible reasons for them. I hope you will find it helpful.—*E.M.L.*

Praise for Sony's Portable DAT

Dear Editor:

I have owned a Sony TCD-D7 portable DAT recorder ("Equipment Profile," June) for about three months now, and I am very impressed with its performance. The unit is tough! I connected it to my old truck's stereo system via a cassette adaptor (same type as used for portable CD players), and it sits on the seat beside me. Several times when I made fast stops, the TCD-D7 slid off the seat and bounced on the floor, without stopping or even muting! One time I made a fast left turn; the unit fell on the floor, skidded across, and slammed into the right door—and didn't skip a note!

Another extremely useful feature is the switchable "AVLS." Sony touts it as keeping volume at safe levels when listening with earphones, but its real use is to reduce dynamic range for listening in a car or noisy truck. I have found, to my dismay, that I usually can't listen to uncompressed music in the truck with the windows down; the music is either too soft or blasting me out! This happens with pop hits from 45-rpm records! I'd hate to think what classical music would do if not compressed. The TCD-D7 has output volumes from 1 to 20; the compressor kicks in at about level 6. The higher you set the volume, the more compression there is. By the time you get up to 14, the music has no dynamic range at all. Any higher, and the bass tends to modulate the treble. At about 9, the music sounds like that from a typical FM station.



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The unit has a switchable auto level control for recording music and for recording from the mike input. I don't use the feature, since I want to get full dynamic range on the tape, but I guess it would be useful for recording conferences (if you wanted to use such a good recorder for that).

Another useful feature is the removable battery holder. It's possible to take the holder out, change the batteries, and replace it while driving on country roads, although you do have to slow down some.

The only gripe I have is that the unit does not have a standard optical or digital input. [Special cables, at $60 to $80, are required.—*I.B.*]

Finally, I don't see why anyone would buy a digital recording medium that uses data compression. Any failure in the recording medium over time could cause the loss of too much data for reconstruction by the logic system. DAT uses the most data to record the music and thus should be most able to compensate for dropouts or other problems. I once creased and crumpled the tape in a DAT cassette (by mistake), and the machine still played it! I would recommend the Sony unit to anyone who wants digital quality sound on the road. The tapes are cheap, and they play for a long time.

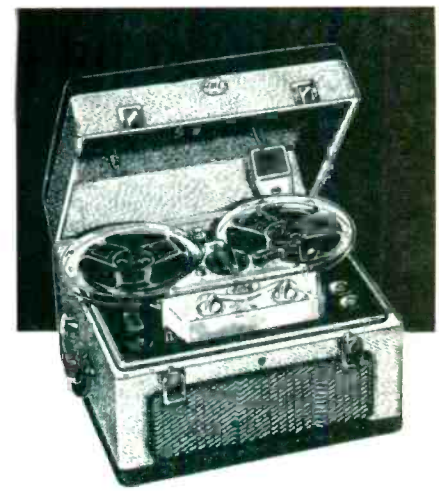
P. V. Brown
Woodbine, Md.

Equipment Help Wanted

Dear Editor:

I've owned an FME open-reel tape recorder, Model 47A (see illustration), since 1969. I'm trying to find parts and/or another unit, whether it's working or not. I would appreciate hearing from any individual or organization that collects these 1950s recorders.

Kevin Wheeler
3907 Sunbeam Ave.
Chattanooga, Tenn. 37411



Dear Editor:

My SAE amplifier, Model 2400L, only functions on one channel. Local repair shops have tested the amp but are unable to repair it because I no longer have a schematic, nor a parts list. Since SAE is out of business, the shops are unable to get any further information. Also, my SAE tuner, the Mark VIII, has non-operational LEDs, making it very difficult to determine the stations.

This is excellent equipment that I have enjoyed for many years. I am disappointed that I have not been able to repair the units and would appreciate any suggestions.

Bruce Raiffe
P.O. Box 821
Edison, N.J. 08818

AUDIO CLINIC

JOSEPH GIOVANELLI

Recording Bells Successfully

Q *I have had little success in making clean recordings of certain bells and gongs that accompany our monastic choir. I have used high-quality cassette decks. When I used Dolby B or C NR, the recordings were even worse than without noise reduction. I tried a Hi-Fi VCR and still could not make acceptable recordings.*

I was successful with a DAT recorder and would like to get a second digital recorder so that I can edit. I am hesitant to do this because, given all the problems I have had with other formats, I'm not convinced that the MiniDisc or the DCC system will be usable. What should I do?—Richard Young, Mt. Shasta, Cal.

A I have had no experience with recording bells on either DCC or MD, so I cannot comment as to how well they will work for you. I have successfully recorded bells on open-reel tape, VHS Hi-Fi, cassette, and even phonograph discs.

Bells are very rich in high-frequency harmonics, not to mention the transient produced as the clapper strikes the bell. Even without asking, I am sure that most of your troubles result from your recording at too high a signal level. Never mind that the recording level meters don't indicate overmodulation. When you consider the huge amount of treble boost required when making cassette recordings, what appears to be a good recording level will surely saturate the tape when recording bells. I had problems recording bells on a VHS Hi-Fi machine at first; reducing the recording level cured the problems.

You may have also closely miked the bells. The mike preamplifier, or perhaps the mike itself, may have been overdriven. (Yes, this is possible with capacitor mikes!)

I have found that, in most circumstances, a good sonic balance between the bells and voices and other instruments will be achieved when the level of the bells is well below that of other instruments or voices. In terms of absolute sound level, bells are perceived as quite loud even when they are really not.

Although a DAT recorder will work well, you will still overload it if you push your levels. Because these machines work so well, use a second DAT machine for your edits if your budget allows it.

If your recordings are to be sold, keep in mind that the vast majority of buyers will likely not own DAT machines. Thus, you must come to terms with copying onto analog cassettes. By keeping the signal level produced by the bells relatively low, you will be able to make usable cassettes, even when noise reduction is used.

Apportioning Surround Amps

Q *I use two stereo power amplifiers in my surround setup, one to drive the satellite speakers while the other drives the center-channel speaker and subwoofer. Would I be better off using one amplifier in its bridged mode to feed more power to the subwoofer, or should I use that stereo amp to drive a pair of subwoofers, one per channel? Of course, these subwoofers won't have the power that can be supplied to one subwoofer if I use the bridged mode. What would you suggest that I do?*—Wes Sterling, Omaha, Nebr.

A I would definitely opt for the two subwoofers. Depending on your amp, you could get more power with the bridged amp feeding one subwoofer, but I think that the acoustical efficiency and better bass support from the dual subwoofers would offset this. (Either way, of course, you'll need an additional power amp for your center channel.)

If you have a sufficient power reserve, you could keep the amplifiers wired as you now have them but drive two subwoofers from the appropriate amplifier, assuming that their combined impedance would not be too low for the amp. This would improve acoustical efficiency and increase some amplifiers' power output. If the two subwoofers' paralleled impedance was too low, you could connect them in series, but you would gain no power and would lose some damping. The bass will be less controlled as damping is reduced.

Trouble in Treble City

Q *I have three tape decks. I've tried to set proper azimuth on all of them, and have checked their frequency response and found it excellent. Nevertheless, tapes made on one machine either lack highs or are too bright when played on the other decks. What can I do about it?*—Dia-Chan Tran, Aurora, Ill.

A Did you check azimuth with a calibrated test tape? It would enable you to adjust azimuth and set up the playback frequency response in accordance with the standards used in modern cassette recorders. You may need two such tapes, one to match Type I tape EQ to the response of ferric oxide tapes and the other to do the same for chrome (Type II) and metal (Type IV) tapes.

Even if you aligned your three decks with a misaligned tape, they should then be aligned (or, rather, misaligned) alike, so alignment would not be the cause of your problem. Let us assume for this piece that your test tape is flawless. If your machines employ separate play and record heads, use the tape to align the playback heads, and then align the record heads to get maximum high-frequency output through the playback heads as you record. The next step is to adjust the record equalization of each machine for the flattest response with the brand and type of tape you plan to use.

Now see if recordings made on each of your decks will play back properly on the other decks. Make the first tests using no noise reduction. When there are few or no problems of high-frequency compatibility among your decks, make similar tests with each deck's noise-reduction circuitry turned on. If you achieved compatibility without noise reduction but continue to have problems with it, you must look into the calibration of your decks' NR systems. This will require the aid of your decks' service manuals.

When you have adjusted each machine, try the compatibility tests again. All should be well.

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

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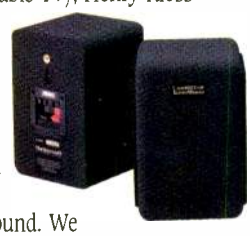


Because we sell carefully matched and tested home theater speaker systems factory-direct, with no expensive middlemen, you can save hundreds of dollars. We believe the products on these pages represent the country's best values in high performance home theater components. Audio critics, and thousands of satisfied customers, agree. *Stereo Review* said "Cambridge SoundWorks manufactures loudspeakers that provide exceptional sound quality at affordable prices." *Audio* suggested that we "may have the best value in the world."

Center Channel Speakers

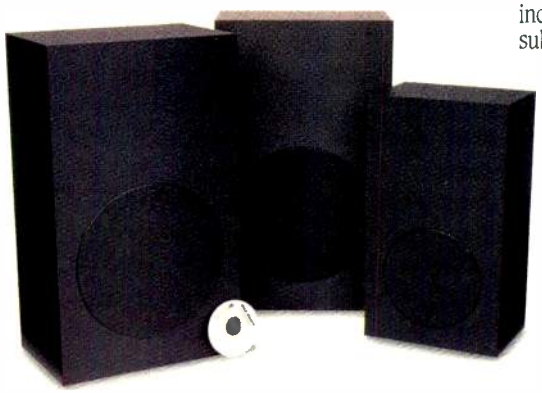
Cambridge SoundWorks manufactures three speakers for use as center channel speakers in Dolby Pro Logic home theater systems. All three are magnetically shielded so they can be placed near a TV or computer monitor. *Model Ten-A* is a small, affordable two-way speaker. **$80**. *Center Channel* is identical to a Cambridge SoundWorks *Ensemble* satellite (but with magnetic shielding). **$149**. *Center Channel Plus* uses an ultra-low, ultra-wide design that is ideal for placement above (or, with optional support stand, below) a TV monitor. **$219**.

Surround Speakers

Cambridge SoundWorks makes two "dipole radiator" surround sound speakers. Dolby Laboratories recommends dipole radiator speakers for use as surround speakers. *The Surround* has a very high power handling capacity and is often selected for "high end" surround sound systems. *Audio*, describing a system that included *The Surround* said, "In many ways the surround sensation was every bit as good as far more expensive installations." **$399 pr**. The smaller *The Surround II* is arguably the country's best value in a dipole radiator speaker. **$249 pr**.

Powered Subwoofers

The original *Powered Subwoofer* by Cambridge SoundWorks consists of a heavy-duty 12" woofer housed in an accustic suspension cabinet with a 140-watt amplifier and a built-in electronic crossover. *Stereo Review* said it provides "deep powerful bass...31.5 Hz bass output was obtainable at a room-shaking level... they open the way to having a 'killer' system for an affordable price." **$699**. Our *Slave Subwoofer* uses the same woofer driver and cabinet, but does not include the amplifier or crossover. It can only be used in conjunction with the *Powered Subwoofer*. **$299**. The new *Powered Subwoofer II* uses a 120-watt amplifier with an 8" woofer. **$399**.



Our *EXO-1* electronic crossover can be used with either of our powered subwoofer systems, or with powered subwoofers made by other companies. Its high pass filters keep strong, low bass signals out of the main stereo speakers, and directs them to the powered subwoofer. **$299**.

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Tape Deck Oscillation

Q *My cassette deck operates normally in play mode. However, when I press the record button, the VU meter's left- and right-channel needles swing over to the extreme right and oscillate in that area. The sound system (connected to the deck) emits a repeating, rapid-fire sound that resembles an operating machine gun. What is causing this problem, and how can I fix it?*—Alex F. Soave, Plainview, N.Y.

A The problem may be in your deck or in the way you have it hooked up to your system. If your system connections and switch settings are feeding the tape deck's output signal back to its input, you'll get exactly these results. Otherwise, several circuit defects in your deck can cause the oscillation you described. The most common one is defective bypass capacitors, especially (but not exclusively) those capacitors only active in the record circuitry. (If you plan to attempt your own repairs, get a service manual for your machine to help you identify circuit components and their purposes.) My first suggestion is to obtain a large capacitor, perhaps 2,000 µF, with a 50-V or higher rating. Place the machine in "record." Jump this capacitor across the connections to various bypass capacitors; if the oscillation ceases, you've just bypassed the defective capacitor.

Other things can also account for this oscillation. Be sure that all the screws that hold the circuit board in place are tight; sometimes these mounting screws also ground some components. Where such a ground is missing, the signal may still find its way to ground, but through a high-impedance path; this can lead to common coupling and a tendency toward oscillation. Dirty switch contacts, poorly soldered connections, a cracked circuit foil, etc. can also cause oscillation.

Making an Omni Indoor FM Antenna

Q *I understand that the "T-type" antennas supplied with most receivers have an uneven dipole pickup pattern. Would it be possible to obtain more of an omnidirectional pattern by arranging two of these antennas so that they meet in the middle and are perpendicular to each other? Will this increase multipath interference or cause other drawbacks?*—Steve Hirsch, Windsor Locks, Conn.

A Yes, more omnidirectional reception can be obtained by arranging two folded dipole antennas as you have described. But although it's a simple matter to mount one such antenna on a wall, mounting the crossed dipoles is another matter. If you were to mount them on a wall in such a way that one dipole ran horizontally and the other vertically, you would only add multipath problems and not obtain quite the omnidirectional results you would like. You will have to mount your two dipoles on a wooden frame and find a way to suspend it in the clear.

The antennas will combine into one feed line. This arrangement will cause a slight mismatch of impedance between the antenna and the tuner, but it should be of no consequence.

If space is a problem, you might try mounting one of these antennas vertically. Because FM stations are both vertically and horizontally polarized, this mounting arrangement should permit the antenna to operate with a more or less omnidirectional pickup pattern.

However, if multipath is a problem, an omnidirectional antenna will just make it worse. The best way to deal with multipath is to use as directional an antenna as possible, aiming it at the clearest signal of the many bouncing around in the air. The signal you want may not be the strongest signal; sometimes the direct signal from a transmitter will be accompanied by many multipath reflections from the same direction, while a single, clean reflection can be found by aiming the antenna more or less away from the station.

Maintaining Head Azimuth

Q *How can I keep my tape heads from going out of alignment? I have a three-head cassette deck whose record and play heads are in a single block.*—Danny Tse, San Lorenzo, Cal.

A This is most often a problem in decks whose head assemblies move and stop rapidly. The only remedy that I know of is to put a small dot of glue, nail polish, or Loctite on the azimuth adjusting screw, to hold it in place. Be sure to use something that you can remove when necessary. Nothing is really permanent, and when your heads wear down and need replacement, applying a tiny dot of "glue"

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Audio magazine once said our *Ensemble*® speaker system may be "the best value in the world." Since then, numerous critics have applauded our *Ensemble* and *Ensemble II* systems. Designed by Henry Kloss (founder of AR, KLH and Advent), they became best sellers by offering quality construction and accurate, wide-range music reproduction — at factory-direct prices.

We're pleased to introduce new versions of our *Ensemble* and *Ensemble II* systems, as well as our new, ultra-compact *Ensemble III*.

The *New Ensemble*

New Ensemble is an improved version of our original dual-subwoofer/satellite speaker system. *New Ensemble* maintains the dual subwoofer design, which allows for maximum room placement flexibility. Placement of bass and high-frequency speakers in a room (and how those speakers interact with the room) has more influence on the sound quality of a music system than just about anything. *New Ensemble's* ultra-slim (4 1/2") subwoofers give you more placement flexibility than any system we know of.

So What's New?

New Ensemble maintains the tonal balance, frequency range and quality of construction of the original. There are two basic differences.

1. *New Ensemble* uses a new 8" woofer with a very long "throw" for linear cone excursion and more accurate bass. An integral heat sink provides improved power handling.

2. *New Ensemble's* satellite speakers use the same speaker drivers and crossover as the original, but with new midrange and high frequency balance controls.

The midrange control lets you choose the same output in the key 800-1600 Hz octave as in the original, or you can emphasize that octave by 2 dB. *Ensemble* satellites have relatively less output in this range to avoid the "boxy" sound typical of many speakers. This results in an "open" sound on large-scale symphonic works. For small-scaled music, the higher output position proves a "warmer" sound.

A high frequency control has three positions: A) The same balance as original *Ensemble*. B) A 2 dB high frequency increase. C) A 2 dB high frequency decrease. The switch can subtly increase the system's "airiness" (Increase) or it can reduce any tendency towards "edginess" (Decrease).

In terms of "real life" performance, we believe our *New Ensemble* system competes head-on with speakers selling for hundreds more. Available with black-laminate subwoofers for **$629**, or with vinyl-clad subwoofers for **$549**.

The *New Ensemble II*

New Ensemble II is an improved version of our best-selling speaker system. It's more affordable than *New Ensemble* because it uses one cabinet to house both subwoofer speakers. *New Ensemble II* maintains the tonal balance, frequency range, power handling and construction quality of the original *Ensemble II*. But its satellite speakers use the same tonal balance controls as *New Ensemble's*.

New Ensemble II also uses a new flared subwoofer port. The subwoofer cabinet encloses two 6 1/2" long throw woofers mounted in a sealed "acoustic suspension" chamber. They project into a second chamber fitted with the flared port, which provides smoother air flow, eliminating extraneous noise on strong bass notes.

Stereo Review said the original *Ensemble II* "performs so far beyond its price and size it can be compared only with much larger speakers at substantially higher prices." *New Ensemble II* carries on this tradition, outperforming other speakers in its category, including well-known models for about twice the price. Factory-direct price, **$439**.

The *Ensemble III*

Now you can bring the clear, balanced wide-range sound of *Ensemble* speakers to a small, crowded room. Our new *Ensemble III's* satellite speakers are only 4 1/2" x 6 1/2" x 3" and its subwoofer is 8" x 8" x 15".

Compared to *New Ensemble II*, *Ensemble III* gives up a little in power handling, low bass range, and efficiency. Unlike the "cube" satellite speakers you'll find in most similarly priced systems, *Ensemble III's* satellites are two-way speakers. *Ensemble III's* 6 1/2" woofer uses two voice coils in a cabinet with a flared port for smooth air flow.

With most recordings *Ensemble III* will sound virtually identical to *New Ensemble II*. It simply won't play as loud. Its construction quality is normally found only in much more expensive speakers.

Factory-direct price, including connecting wire, cutter/stripper and Hook-Up Guide, is only **$329**.

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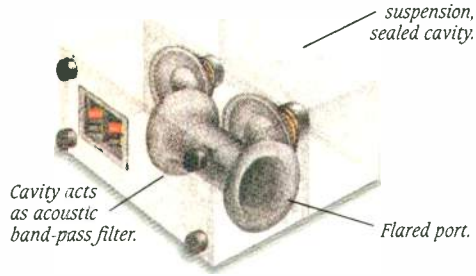

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will let you turn that azimuth screw to set up the new heads.

Playing Mono Phonograph Records

Q *How do I obtain a mono signal from a stereo turntable? I plan to record some noisy discs and understand that setting my player to mono will help in this regard. Do I wire the phono outputs in series, with this series combination connected to the phono inputs on my receiver?*—John Comer, Cincinnati. Ohio

A I have found that, in most instances, rewiring a turntable for mono has little audible effect on background noise even though theory says otherwise. You will, however, notice a slight decrease in tracing distortion on some highly modulated discs, and the huge output pulses caused by warped discs will be reduced. This is especially true of 78s. (*Editor's Note:* Switching your preamp to mono will give you most of the noise improvement but will help less with the tracing distortion and output pulses.—*I.B.*)

You actually want to wire your outputs in parallel, not series, but it's simple. Plug both phono outputs into an ordinary Y-connector, and feed its third terminal to one of your phono inputs. If you wish to feed both, you need a second Y to fan out from the first.

If you'll often switch between stereo and mono, you can mount four phono jacks and a single-pole, single-throw switch in a metal project box. One pair of jacks will accept the cables from your turntable; the other will accept a cable to your preamp's phono input. Wire each pair of jacks to the opposite pair, and wire the switch's two contacts to the "hot" terminals of either jack pair, so that closing the switch ties the two channels together. This will give you monophonic playback, even with stereo discs.

You will discover that there is very little change in frequency response between the mono and stereo arrangements.

Old House Wiring

Q *I am putting a new stereo system together—just a straightforward system, with no home theater use in mind. But I'm concerned that the only available listening room in my small apartment has just one electrical outlet, which accepts two two-prong, ungrounded plugs. The wiring is very old; it is covered in fabric rather than plastic. Will this outlet suffice for my setup? Also, is there a potential hazard to stereo components when they are connected to an ungrounded electrical outlet?*—Gregory Smith, Toronto, Ont., Canada

A Most stereo systems require more plugs than the two in your listening room. But many devices include convenience outlets that can be used to supplement the two that are available.

I'm not nearly as concerned about the lack of grounding as I am about the old wiring. Old wiring implies that the circuits are poorly segregated. This means that several other outlets will share the same fuse or circuit breaker. This, plus the fact that the wire gauge is probably lighter than would be used in modern house wiring, will lead to voltage variations, depending on how many appliances are operating at any given time. When the operating voltage falls, the maximum available power output from your amplifier will decrease, possibly with an increase in distortion; this may or may not be audible. Most other components have regulated power supplies and so are less likely to be affected.

As you know, many audio components employ three-wire line cords whose plugs have a third terminal that automatically grounds them. These grounds often cause more audio problems than they solve; they can lead to ground loops, which cause hum and noise. Common adaptors let you plug three-prong cords into two-prong outlets. To restore grounding, place the adaptor's grounding lug or pigtail under the screw that holds the cover to the outlet. If the box was properly wired, this screw will serve to ground the equipment. This setup also lets you disconnect grounds if you have hum problems: Disconnect all but one, then restore the grounds, one at a time, skipping any components whose grounding causes hum.

If you should discover that the outlet box is not grounded, ground one piece of your equipment to the nearest radiator or water pipe. Because of the arrangement of interconnecting cables, this will ground all other equipment. Choose the preamplifier or integrated amplifier as that one piece to be grounded. A

Denon's lifelong philosophy of "Design Integrity" has led us to constantly improve audio quality in all phases of the reproduction chain—including circuitry for Home Theater. As a result, off-the-shelf IC components like those used by our competitors, are no longer good enough for Denon's AVR-2500 Audio/Video Receiver. The new Denon AVR-2500 features Dynamic Discrete Surround Circuitry, D·D·S·C which employs discrete surround circuitry plus an 18-bit digital converter in the DSP stage. (Most competitors use lower bit converters.)

Just as discrete components allow an audio system to be optimized for better sound, Denon's DDSC produces more accurate, more realistic surround sound by reducing Total Harmonic Distortion, by increasing Signal-to-Noise and minimizing DSP quantization noise.


AVR-1500

Naturally, the Denon AVR-2500 also features the latest audio and FM circuitry, such as multi-zone capability for playing different programs in different parts of your home and personal memory fields for one-button recall of your favorite, custom tailored surround sound stages. The AVR-2500 and AVR-1500 also feature the RDS *Smart Radio System*, which lets broadcasters offer you additional, invaluable information, services and conveniences, either on the front panel or via On-Screen Display on the AVR-2500. Denon AV Receivers: DSP surround sound, advanced features *and* uncompromised High Fidelity.

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Our lives as audio enthusiasts would have been very different without Tom Stockham. Audio buffs and electrical engineers know Stockham as the man who introduced digital recording and tapeless editing to the world, as well as for his associations with Soundstream Technologies. Then there was his patent on the homomorphic compander, a forerunner to dbx and Dolby noise-reduction systems.

Stockham received his bachelor's, master's, and doctoral degrees from M.I.T. He has received numerous awards for his contributions to audio technology: The Poniatoff Gold Medal from SMPTE, a Gold Medal from the AES, an Emmy, and many others. Most recently, NARAS awarded him the first-ever Technical Grammy Award in 1993 for his "pioneering role in the development and advancement of digital recording."

Currently a professor of electrical engineering at the University of Utah, Stockham also runs his own consulting firm, Stockham Technologies, the focus of which is applications in vision and genetics. In this interview, reprinted from the Winter/Spring 1994 issue of *NARAS Journal*, published by The National Academy of Recording Arts & Sciences, Dr. Stockham discusses the development of digital recording, his views on the digital/analog debate, and other audio matters. *D.L.*

PHOTOGRAPH: BUSATH PHOTOGRAPHY

TOM STOCKHAM

fidelity VS familiarity

Daniel Levitin

What was your role in the development of the technology we now know as digital audio?

Let me go back a little ways. The first time I ever saw digital audio actually working was in 1962. I'd been a student at M.I.T. in the '50s, and then I went into the Air Force. When I came back to M.I.T., as a new assistant professor, I went around visiting the labs and I found people doing interesting work. Some of the students were using a computer called the TX-0, and they had connected a tape drive to the machine and a microphone and speaker to an A/D and D/A converter. What you could do was talk into the microphone, and the tape would record all of that in binary. It was probably using 6 to 11 bits, with a sampling rate around 10,000 samples per second. After you had finished recording, the thing would rewind and play it back.

Daniel Levitin holds degrees from Stanford University and the University of Oregon in Cognitive Science. He has written extensively on professional audio applications, taught music technology at Stanford University, and worked as a staff engineer/producer for 415/Columbia Records. He currently performs research in visual and auditory psychophysics at the University of Oregon.

We're talking about a machine that took up the better part of a large room, right?

Right. Then the TX-2 was developed, which was an even larger computer. It had 65K memory with 36-bit words. This was the first really large magnetic core memory computer. It was back in the days before the byte, with seven-track tape and all of that.

Where did the converters come from at that time?

A company named EPSCO created an A/D-D/A converter you could buy. It was capable of 11 bits, I think, and was pretty high up there in sampling rate, maybe 22k. It's possible I saw some demonstrations of these in the late '50s, around 1959. Bernie Gordon, who was the CEO at EPSCO, was playing with digital audio back then.

What did you do next?

Well, we used the TX-2 and digital audio quite a bit. I worked on a project with Amar Bose, who was at M.I.T., and we used it to design the first Bose speakers.

Were the first Bose speakers built around the same principles as his later ones?

Yes, it was his idea that the loudspeakers were limited by the room acoustics, not so much what was put in a well-designed loudspeaker; that the problem was mostly outside, not inside the speaker. Of course, one could build a terrible loudspeaker to claim otherwise. But his idea was that if you built a loudspeaker properly, most of the distortion was put forth by the room.

Why would room acoustics be so singularly important in a home listening environment? If I have musicians actually play in my living room, it sounds great. Why do room acoustics play such a critical role if I merely put speakers—point sources, essentially—in the room at the same locations where the live musicians were?

Because your living room then becomes a second venue. If musicians are recorded in a concert hall and you try to play back the sound of that hall in your living room, the second-venue problem is created.

So you've got one set of acoustics stacked on top of another, competing.

Yes, that's right. That's why live performances sound so much better than anything you have ever heard. And the second-venue problem hasn't been solved, even today.

It seems like one solution would be what contemporary recording engineers have done, at least for popular music. If you record everything in a controlled studio environment, close-miked, you would avoid this competition of acoustics.

That is a partial solution to the second-venue problem, but it's not a total solution.

Because of the inherent artificiality of studio recordings?

Suppose we let the listening venue be the one that we want. Let's try to change the original venue somehow, such that when you combine a typical listening room venue with the changed original venue, the whole thing turns out more like a single venue when it's played back. As far as I know, nobody's ever shown conclusively that such trials work well, or even better. It's somewhat better, but it's not the solution we really want.

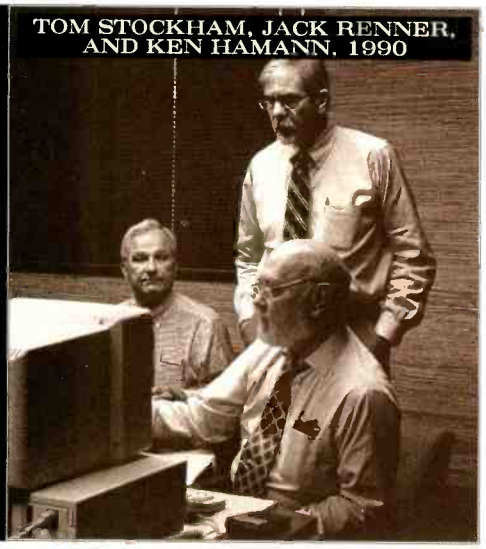
Bose found a living room that he felt was

reasonable, and he put a loudspeaker in the corner. It was a prototype of the first one his company sold, the 2201. You may remember that it was an eighth of a sphere and fit in a corner. We set up a microphone and recorded some music produced by the speaker in this "ideal" listening room.

The next step was to find the impulse response of the room. By setting off a spark in the corner where the speaker had been, and recording it over and over again, the spark permitted us to determine the noise-free impulse response of the room. In this way, we had the impulse response of the ideal speaker as a reference.

Next we took the music we had used earlier and convolved it with the spark recordings we had made. The whole idea was to see how much poorer the loudspeaker was than the spark (the ideal speaker). We found that by using a filter, properly designed, the two were very close.

Before digital systems for home could be built, professional equipment was needed to create the recordings.


TOM STOCKHAM, JACK RENNER, AND KEN HAMANN, 1990

It seemed to us that all but a very few of the speaker problems had been removed. Now, I'm going from memory here; if Bose was sitting here he might be yelling that that isn't the major point. As exciting as these results were, the point is we used digital audio for this experiment back in 1963 and 1964.

What was your next encounter with digital recording?

We knew how expensive digital audio was back then, and I just didn't pursue it much more for a while. Starting in 1966, I spent 2½ years at M.I.T.'s Lincoln Labs, working on digital signal processing.

What got you interested again?

One day, two very well-known M.I.T. professors came into my office because I had been asked to write a problem for the doctorate exam that year. They said, "We want to ask you a question about this problem you put in here on the exam: What is this *about*?" Now, I had created a digital version of an RC circuit in the problem, and I told them that. I figured, since digital signal processing was going to be an important part of the future, that the students were being taught all about this. And these two professors just said, "*Oh.* Okay," and they walked away. But this told me that the people who were really in the know didn't understand this; they weren't aware of what it meant.

You left M.I.T. in 1968 and joined the Computer Science faculty at the University of Utah. What prompted your formation of Soundstream in 1975?

Malcolm Low (the L in KLH) was here at Utah and helped set up Evans and Sutherland Computer Corporation; they pioneered "3-D" computer graphics. One day in 1974, Malcolm came over to my house and said, "You know, it's time to start a digital audio company." I told him he was crazy, but one thing led to another, and we were in business a year later.

Our purpose in starting Soundstream was to develop a system for the home that would play back digital recordings. We knew there was a chicken-and-egg problem, so we started out by creating the professional equipment that would be needed to create the recordings themselves.

We developed some 16-bit, A/D-D/A systems, and we put together a machine that could record and play back. It had an instrumentation tape recorder—a recorder that's used for technical experiments and such—and a large box of electronics that went with it.

And storage was all on magnetic tape?

Right. As far as I know there was no one using anything but magnetic tape in this

arena. However, the Japanese had built a number of different digital audio recorders and playback systems in their labs and they'd bring them around occasionally at AES Conventions. But that was growing very slowly and very internally there. I don't think they thought there was a market for it! I think they thought they needed to be up to date with the technology, but they weren't really anxious about commercializing it; you couldn't find anybody at Japanese companies who was talking about selling it. It was more for demonstration—"Here, have a look at the future." Denon was doing the most; they were going out in the field with 14-bit recorders and making LPs with them. Then they would use their digital recordings to show how good their analog audio equipment was. They were not trying to interest the recording companies in any way I could detect. However, I was. We worked for three years before we made a paid commercial recording.

You are credited with making the first commercial digital recording. . . .

Right. We took our machine and did a digital recording in Santa Fe of an opera in 1976. Of course, by then we'd made a lot of digital recordings, and so had many others, but only in laboratories. Santa Fe was the first real-world recording we made. Everything worked perfectly. Then we demonstrated the recordings at the AES Convention in the fall of 1976.

Did you then try to get record companies and recording engineers interested?

Doug Sax was doing a lot of direct-to-disc recordings, but he wasn't interested in our digital machine. So we went to Crystal Clear records and did a recording of Virgil Fox, and those recordings were stunning—very, very interesting. That started our cash flow going. We also recorded Arthur Fiedler and the Boston Pops. These weren't released right away, though. The first commercially released digital recording was for Telarc, of Frederick Fennell and the Cleveland Symphonic Winds, recorded in spring 1978. The thing became afire then; people who had never talked to me before started calling me on the phone and saying,"Why didn't you tell us it could be this good?" That was when people really understood what we were doing and what it meant. By 1981, we had at least 500 digital masters in our vaults that came from various sources.

Telarc and Soundstream brought digital recording to the world. Other people had it, but they were just using it internally. Then, in 1982, Jack Renner [CEO and chief engineer of Telarc] put out the first CD. The role I played, along with my people, of course, was to commercialize digital audio and to have it used by the recording companies, not just by the technical people. There's been a lot of talk about who made digital audio first. We had the first commercial digital recorders; 3M was second in developing theirs.

You also were a pioneer in digital editing.

Yes. The funny thing is, even today people are using editing systems that are very primitive, and our editing system was up and running back when we were in Santa Fe. We had a totally computerized editing system. This meant you didn't have to have tape swishing back and forth; you could start at the back of the recording and do your editing backwards if you wanted. We invented hard-disk editing, and we were using it back in 1975.

In a sense, we not only pioneered tapeless editing, but we were the only people who were in it. My involvement with Soundstream stopped in 1980, but the technology found its way to other companies.

What was the sampling rate of these first digital recorders?

At different times we had three different sampling rates. When we first put the converters together, we thought that our market would be radio, that people at radio stations would want this. So we were working with a 15-kHz bandwidth then, because FM has a 15k bandwidth. We made some recordings with that bandwidth, but not many, not more than three or four. I'm pretty sure that the one at Santa Fe used that.

So, you are talking about a sampling rate of 32k or so?

It would have to have been larger than 32k; that's cutting it a little close. We used

ENRICO CARUSO

37,500. After that we had a converter that was something like 47 kHz—I don't know where that came from, it was some fraction of something—but it was above 44.1. Then all the rest were 50 kHz, and anybody that's got one of our machines right now is at 50.

How many Soundstream machines were sold?

Between 15 and 20. I have no idea how many are still in use. My guess is essentially none. We sold most of our inventory to Bertelsmann. They loved our editor, and worked one of them constantly for eight years. They just put it away in April of this year. I think that editor worked on thousands of CD masters.

Did all of the machines use the original Honeywell transport?

Yes.

Did you have to modify it?

Yes. Basically, what we did was put in a head for 16-track work plus two side channels for SMPTE. We usually didn't use that; we didn't have too many jobs where we had to sync with anybody.

How did you handle error correction?

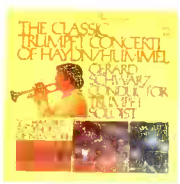
We recorded a given track on two tape tracks and separated them as far as possible from each other. So, for example, we might record on tape track numbers 1 and 8, and the signals were identical. This correction and detection system was very, very good. The only one I can think of that was better was the one that comes with CD. We had no problems with this scheme of writing everything twice. The logic of determining if there was an error was very simple and very reliable.

So the way it worked is that you just compared one track to the other?

Yes, we'd see if the two codes were identical. If they weren't identical, we knew which one was bad, because if there was a dropout, the energy on the tape was too low. Incidentally, none of our clients ever found a digital error in any of the tapes we made. And I'm sure there was a terabit of stuff by the time we quit.

What did early digital sound like?

It sounded great to me, but don't ask me.

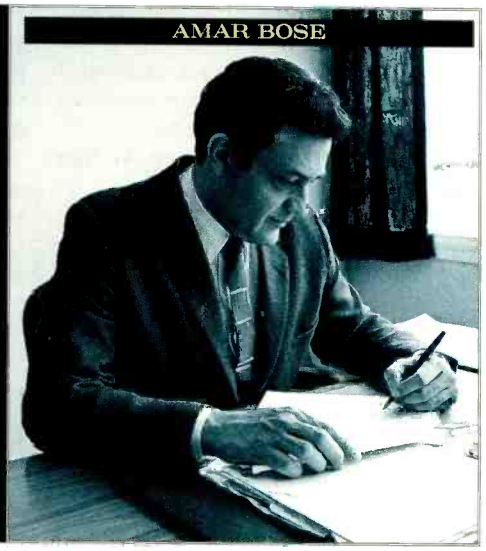


You know what a golden ear is. Well, I have a *lead* ear. Jack Renner always tells me I have a good ear, but I never would say that's the case. I enjoyed the music, and it was definitely superior to anything I had heard before. Our tape recorders were made not just by listening, of course, but by a group of people listening and a very, very careful study of whether the thing was theoretically correct.

Did Soundstream ever get around to looking at digital audio for the home? Something like CDs?

That was the idea from the beginning. Malcolm Low brought the idea up in our very first discussions in 1974. In 1980, we merged with Digital Recording Corporation, and the name became DRC/Soundstream, a public company. I did not play a heavy role in the development of the digital player they were trying to put together, but we were trying to develop something like the CD.

Amar Bose and I used digital audio for experiments on the second-venue problems back in 1963 and 1964.



When you say it was like the CD, do you mean it was optically based?

Yes, it was. I was running the recording part, so I wasn't in charge of the design there. They wanted to create a "record" that would be the size of a 3 x 5 card that you could put in your shirt pocket and carry around with you. In this mode, it wouldn't be the card that moved, it would be the reader that moved. A unit was built, and it did work. But it was abandoned when the CD emerged, and the design race was over.

There are still a great many people who say that analog sounds better than digital. The battle has been playing out in some of the high-end audio journals as well as in pro audio and musician magazines....

Are the people who are saying this in control of a company or a business? Because, of course, companies have to make money or they die. And you know, just before people are going to be killed or murdered, they will say *anything*.

Well, there are musicians and artists, respected recording engineers...

Well, that could be, but that's not the question. The question is, does the digital recording sound like the original source? Now, because it sounds different from the analog recording, it might be more pleasing to some listeners and less pleasing to others. As far as I can tell, there isn't any defect hanging around in digital.

Have you seen that book about recording by Gaisberg? It's an old book from the '40s. [*The Music Goes Round*, by Frederick William Gaisberg, Macmillan, 1942.] He recorded Caruso way back, and he talks about the transformation between acoustic and electric recording as it occurred in 1925. He points out that most of the recording engineers had to give up their trade when that happened because they didn't know what to do with the new recording technology. Now, I can imagine that more than a few people were upset about that—they lost their jobs. I wouldn't be a bit surprised if some of them said, "Gee, this electric recording doesn't sound as good, does it?"

Well, I always figured that when people say they like analog recordings, what they like is actually the harmonic distortion. The terms they use—like "warmer," "softer," and "less harsh"—suggest that this is what they like about analog. Distortion can sound warm because it muddies up things. Digital has no distortion, so they don't like it; they're not accustomed to hearing recorded music that way. Do you think this is part of it?

Oh, absolutely. In fact, I think that's almost the *whole* thing. It is that smearing that they like. After I restored the Caruso recordings, we played them back for some collectors and compared it with the originals. [In the '70s, Stockham processed old Caruso recordings; his restorations were later issued by RCA.] Now, the originals had lots of surface noise, lots of energy above 8k or so, and the restorations didn't, because there was no [music] energy in that part of the spectrum in the original recording. And you know what? Many of the collectors liked the sound of the [unrestored] originals *better*, and the only reasonable explanation is because their ears needed to hear energy in this range. I find this very interesting. I should think you would know something about this from your own laboratory work.

Just to exhaust all the possibilities in this digital/analog debate, is it possible people are hearing artifacts in digital? Bad anti-aliasing, dithering, and so on?

I don't think so. If things have been done right by the people who build the equipment, that's not going to happen. Unbelievable amounts of diligence have been put in to make sure that's not a problem.

Some of the really cheap converters that are built into budget equipment do sound awful, though. . . .

Well, that's a different issue. Obviously, you can make something bad if you want to—and if you want to make it cheaper. I feel kind of funny about all this, because, like you, I want to find "the answer." But every time I went to find the answer, I haven't gotten cooperation, or had the facilities, and so on.

Do you know Stan Lipshitz's work? He has done more than anyone to put this out in the open. He writes in the AES journal. He's tried to make the role of dithering understood by people who haven't understood it. He was president of the AES a couple of years ago. As an academic, I think he is the one person in the world who most knows what can go wrong, the unbelievable things that can go wrong in research studies when people try to do them honestly—and dishonestly. Lipshitz talks about the whole notion of telling whether things are different, whether you can hear the difference between A and B. He points out that if you wanted to try and determine if two things are identical or not with 99% confidence, you have to get things right every time in seven consecutive trials.

You're talking about the statistics of certainty; the binomial probabilities.

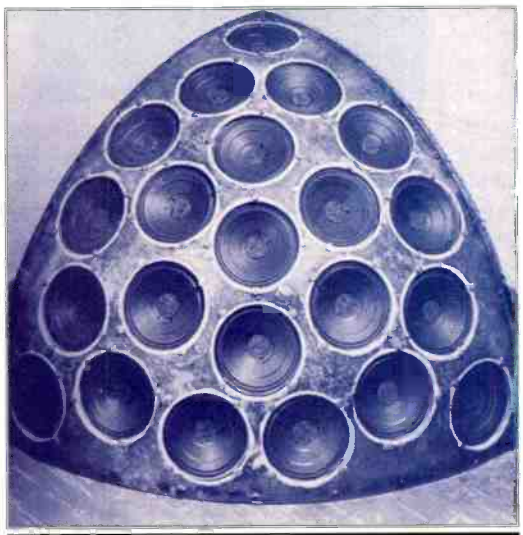
Right. So for example, if you listen to three recordings and start pontificating on the differences, and someone comes along who knows whether this is accident or talent, you're not even on first base with this sample of three. If someone is going to come in and listen and A/B some recordings, you can't believe they know what they're talking about—or that the difference exists—unless they are able to get it right seven times in a row.

You were part of the expert panel that examined the Watergate tapes. What was the assignment of the Watergate panel?

It was just a few days before Rosemary Woods came up with the existence of the 18½-minute gap. And so any plans that were being made at that time were cleared up quite quickly, right then and there. Our team then spent essentially six months writing a report about the gap.

Did you get hold of the tape and try to recover the portion that was erased?

Oh, yes. We did a *very* thorough job trying to recover it. Unfortunately, it was erased by a stenographer's recorder that had a double erase head, and absolutely no human voice sounds were there except in a couple of places where the instrument used was stopped and then started again. But it was obvious, in the final analysis, that the gaps were created by the pushing of a manual button on the recorder. Also obvious was the way in which it was done; without a doubt, it had to have been done by a finger pushing this manual button.



A HONEYCOMB SPEAKER ENGINEERED WITH AMAR BOSE.

Do you see something replacing the CD soon, as new technological breakthroughs are made?

I haven't been following this, but the concept that some people have had—namely that you could have a "CD" on a chip—is still pretty far off. You have to take into account the "25-year syndrome." The syndrome is that you cannot change recording media faster than once every 25 years. In particular, there was the Edison [cylinder] era, which was about 1877 to 1900. Then the disc reigned as a primary medium, and, of course, it wasn't electric for 25 years. Then the electrically recorded 78 survived until 1947, when the LP came out. (I'm going to put the medium of tape aside here.) It was a longer stretch that time, before the CD came out in 1982, maybe because of the two media being around, the cassette and the LP. And, of course, another retardant [for the 25-year rule] was the advent of stereo in the middle there. But the industry isn't going to put up with another major change for another 15 years or so. You have to realize that everything before the CD was needle and groove, so it might even be more robust this time because the technology is so different now. But I'm sure there will be a change, counting when it started in 1982 and then adding 30 years.

That long? What if technology allows for a dramatic change in format or type? What if you could get the playing time up to 10 hours, or the size down to 2 inches, or if the indexing gets better?

I don't think that size or any of those other things is going to have the weight that a new change in sound quality would. The things you mention are just conveniences, in my world. I don't think they would have the thrust to create a major change.

You think that change is driven by sound quality?

I do, I really do. When you look back historically, it was sound quality that drove the changes; the first records were so much quieter than the Edison cylinders, which were very, very noisy. And the advent of vinyl was a huge quality improvement.

You were first author on a famous IEEE paper in 1975, "Blind Deconvolution Through Digital Signal Processing." The article describes your work in restoring those old Caruso recordings, but it also

talks about work you've done in enhancing blurred visual images. What is the connection between your work in audio and in vision? Have they cross-pollinated?

Yes, because, in fact, the whole technology is blind deconvolution. In both modalities [sound and vision], our work was based on the ideas put out in an earlier paper, "Nonlinear Filtering of Multiplied and Convolved Signals" [Oppenheim, Schafer, and Stockham, published in the IEEE journal in 1968]. That was a very large bomb on the EE plateaus. The notion that you could do linear filtering for nonlinear systems wasn't universally well received. The whole thing stood on Al Oppenheim's doctoral thesis—and you see, it is really very simple. Mathematicians have known for years that you could make a transformation from multiplication to addition; even children learn this in school: It's just the logarithm. There's a theorem in modern algebra that says that if you have a vector space (and this is a modern algebraic vector space, not what you would talk about if you were doing electrical engineering with electricity and things like that), then if the rule for combining vectors is not type A, you can make it be type A by a unique one-to-one transformation, creating another vector space with a different rule for combining things. What that says, of course, is that if you have something that doesn't combine using addition, but using some other transform, you can force it to use addition.

That's the key to the deconvolution problem, then. In the particular case of the Caruso recordings, you have two convolved signals; the signal from Caruso is convolved with the response characteristics of the old mechanical-horn recording mechanism.

If I understand you now, you're saying that you can take this convolution, apply an FFT to create a multiplicative function, and turn it into an additive function. Once you have the latter, it is trivial to separate the two functions, allowing you to restore the sound of Caruso's voice.

That's right. As you know, if you apply an FFT to a convolution, the convolved signals are then no longer convolved—they are multiplied. Because you've gone from the time domain to the frequency domain. And when you do that, as everyone knows, you go from convolution to a product. Then you just take the log and you've got a sum, and you can you apply regular linear theory.

There are two arenas for making an interesting practice for using these things. One is taking multiplied things and making them additive; the other is taking convolved things and making them additive.

In the paper you talk about deblurring photographs as being the same problem conceptually as the dereverberation you did in sound. Ideally, you would have several recordings of Caruso with the same horn impulse response, and analyzing these would allow you to extract out the horn response—because it would be common to all of the recordings. But in this case, you only have one example, so you sliced up the image into a bunch of smaller frames, assuming that whatever it is that created the blur will exist commonly in each frame. Is this how NASA deblurs Mars pictures?

Well, I haven't had much contact with them, so I don't really know how they do it. But, yeah, I imagine that it must be very similar.

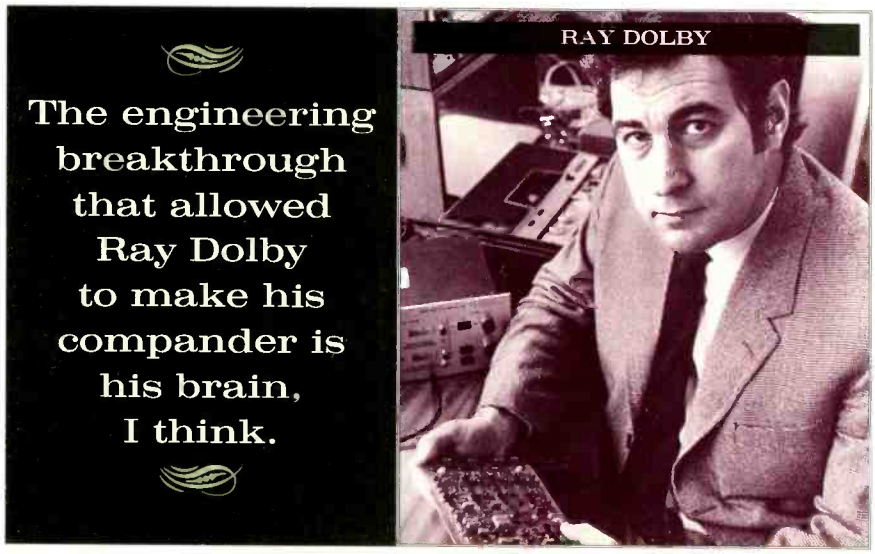
Presumably, NASA has thousands of pictures of Mars all taken with the same camera from a similar angle, so the problem should be easier for them.

Yes, you're right. And this is fundamentally a deconvolution problem of the type we've been talking about. But they don't need to chop up the individual image, so they can get much better resolution than if they only had one picture.

In audio, is surface noise an example of an additive function?

Yes. And there are analogies in vision as well. In black-and-white photography with film, how much silver do you have to put in the film so that when you examine it on a light table it appears to be the same as the original scene? The answer is, the log of the exposure. So photography is multiplicative. But you can transform it into being additive by taking the log.

In audio, an automatic gain control is multiplicative. The 1968 paper discusses this and describes four of our experiments. The first one was an automatic gain control where you'd take the log of the signal, process it linearly, and come back out again and exponentiate the result. That gives you an automatic gain control.



This sounds like a compander.

Right, that's indeed what I did; I made a compander.

Well, in fact, didn't you make the first compander?

Yes, I did, but only the first *homomorphic* compander. Other companders were developed, starting in the early part of the century. The telephone company used them, for instance, to reduce line noise.

How did the commercial companders, the dbx units, for instance, differ from yours?

I think the dbx units had a great similarity to the original compander I built.

Maybe you could describe, for the readers who don't know, what a compander does and how it works.

If you have a dynamic range of X dB, you can make it have a dynamic range of X/2 dB, or any other dynamic range you want to have. I patented a way to make a compander that would do that kind of thing. It takes the complex log of the signal, and then it puts the real part of that through

either a linear or nonlinear filter. Next it exponentiates the filtered signal, and then restores the sign by multiplying the exponentiated filtered signal by the imaginary part of the complex log.

The filter is designed to be a low-frequency attenuator if the compander is in the compression mode, and a low-frequency amplifier if the compander is in the expansion mode. It makes a very nice compander. But not good enough for ultra hi-fi. That's what made me do what I did in developing digital recording.

How is this different from compressors and expanders, such as those recording studios use?

Well, those are designed to alter the signal for particular purposes. A compander should allow you to take a signal, compress it [in recording], expand it [in playback], and have it be intact so that it's just like the original.

You said it was clear to you it would be impossible to make one with high enough fidelity, but then Ray Dolby did make one.

The compander that Dolby made was very, very good work. You know how that works: When you have tape noise, you make the dynamic range of the signal less, so everything's louder—the loudest things are now just as loud as they were, but the softest things are 50 dB louder. That means that when you go and expand, the noise has been pushed through a floor that you didn't have before. Unfortunately, because the signal is bipolar, it's very hard to control. Because the signal is positive, then negative, and so on, you have to have a very quiet switch. I'll tell you, making digital recording work is a lot easier than making this work. Dolby made this work, because his things aren't that decontrolling. He doesn't try to do too much compression.

What was the engineering breakthrough that allowed him to make this?

His brain, I think. He's a very creative guy, very creative. He was a star, you know, in the TV era. He was one of the people who put together TV recording in the '50s, so that you could have delayed television broadcasts; he was part of the Ampex group that did that.

Have you heard Dolby SR?

It's not bad. But it won't do what digital will do.

Some people say that Dolby SR is better than digital, that it's "smoother," " silkier," "warmer"...

Well, we're back to what we were talking about and the dichotomy between fidelity and what you like. Also, I haven't had a chance to look very deeply inside the machines it's competing against, the Sony and Mitsubishi digital recorders. I don't know what's in them; I haven't had a chance to see for myself whether they work right or wrong, so I can't comment.

Do you think this is a case similar to the Caruso restorations, where your collectors liked the noisier recordings better?

There is definitely a relation. When we first were using the dbx, we did some experiments where we recorded one tape with dbx and the other without. We had it set up so you could switch between them for playback. When you turned on the normal one, everyone would be happy. But when you got rid of all that noise and the hiss went away, it was dull and uninteresting. Then, when I said, "Let's compare the companded one with the *original*," and I threw the switch, they couldn't tell the difference!

This is a matter of "fidelity" versus "what you like." I want to be sure that you understand I have no feelings of any type that people shouldn't like what they like. But I do get upset when people don't understand that what you like might not be exactly like the original you were trying to put back together in the recording process. There's nothing wrong with not putting it back together the same as it was; it might even be a lot more fun. But if you're talking about fidelity, you shouldn't say that you don't have it when you do. It is important to distinguish between whether what you're talking about is coherent or not. A

Stockham receiving the first NARAS Technical Grammy Award from NARAS Presicent and CEO Mike Greene at the 95th AES Convention, 1993.

Stockham accepting Gold Medal from Bart Locanthi as Albert B. Grundy looks on at the 83rd AES Convention, 1987.

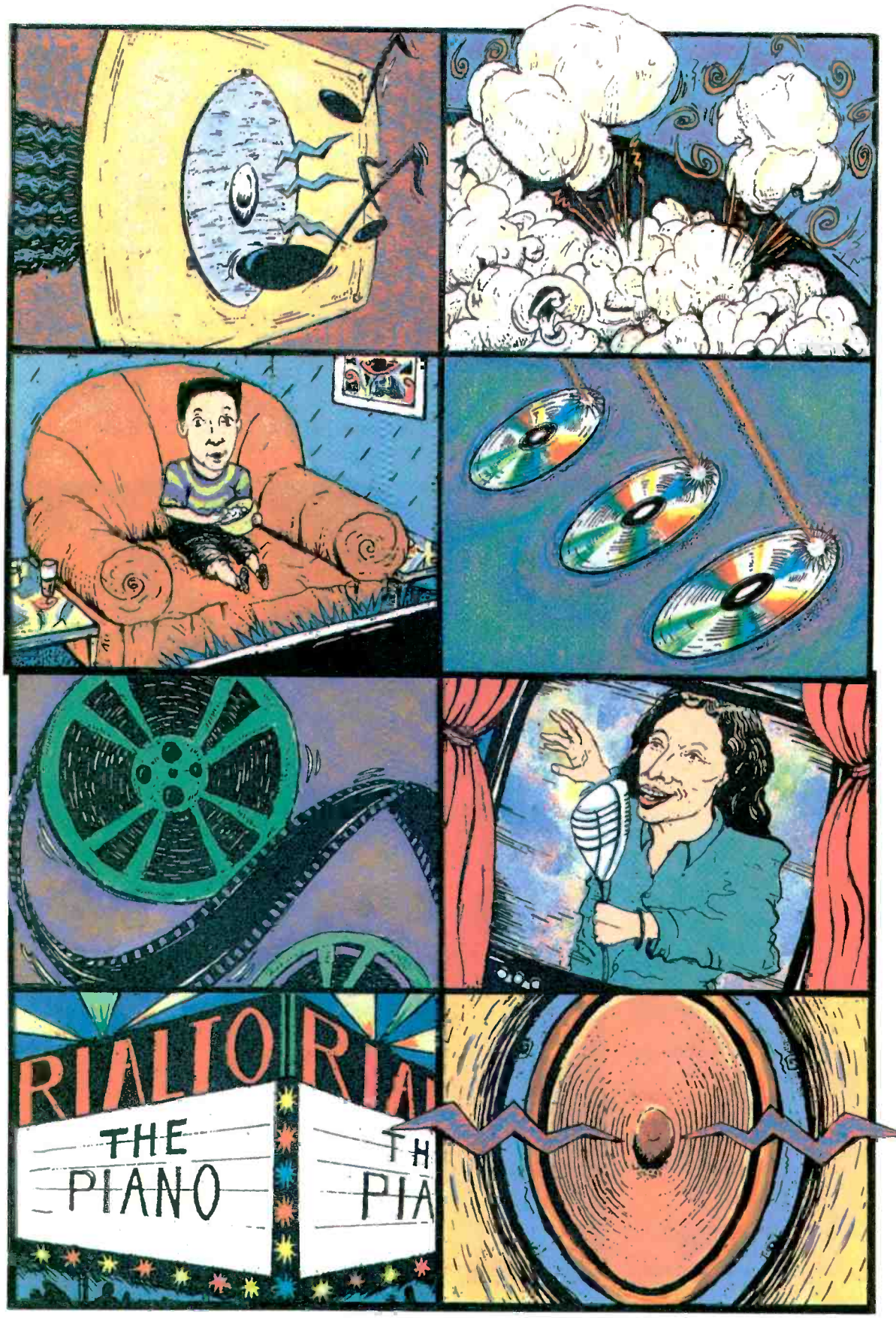


illustration: david rolfe

WHERE DO YOU BEGIN?

PLANNING a HOME THEATER SYSTEM

william r. hoffman

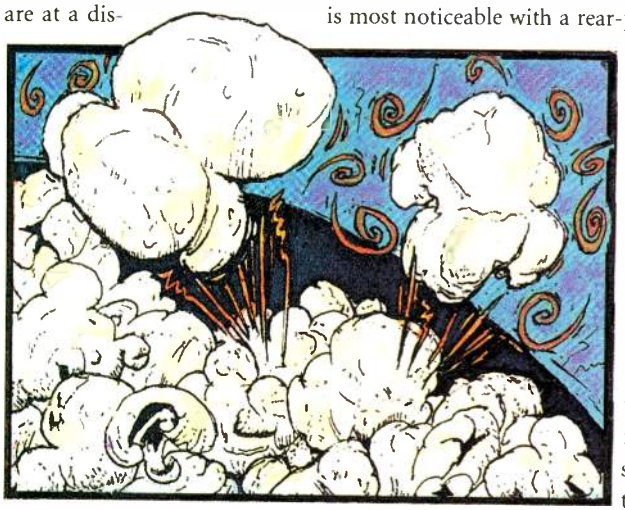
Home theater is the fastest growing segment of the home entertainment industry, as video rental/sale shops are as plentiful as pizza parlors. Movies with surround soundtracks on tape and LaserDisc are as common as hot, buttered popcorn. The variety of entertainment and spectacular sounds previously found only at the local Bijou can now be brought home for a few dollars in rental fees. Indeed, the theater's quality of sound can often be bettered.

For those new to this entertainment experience, here are some guidelines on video equipment, screen sizes, seating arrangements, and (naturally) sound—plus some tips on avoiding the more common problems.

THE VIDEO SIDE

A well-equipped home theater might look like the one in Fig. 1, with its large video screen, multiple speaker systems, and a cabinet to house the many electronic components involved.

The video receiver may be either the direct-view (picture-tube) type, television's mainstay since the 1940s, or a projection system. Direct-view screens are at a disadvantage for home theater use, however, because they're usually limited to a maximum screen size of about 35 inches (measured diagonally, as TV screens always are). A 35-inch set will be very large and heavy, and require a well-built cabinet to contain it.



Screen sizes larger than 35 inches generally require projection systems. These usually use three small picture tubes, similar to those in the direct-view receiver but with much greater light output. Each tube—through a system of filters, lens, and (often) mirrors—reproduces one primary color (red, green, or blue), which is focused on a large screen where the three images are combined into a single, full-color picture. Both front- and rear-projection systems are available.

THE BIGGER YOUR HOME THEATER'S SCREEN, THE MORE IMPORTANT GOOD VIDEO SOURCES WILL BE.

The rear-projection system is a single unit containing the projection tubes, optics, and screen. In this system, the picture is focused on the back side of a translucent screen, and viewed from the screen's front. Most rear-projection sets have screens in the 40- to 50-inch range, though sets as large as 73 inches are available. While many have the 4:3 (width-to-height) screen proportion long familiar to TV viewers, a growing number have wider proportions, such as 16:9, to accommodate "letterboxed" widescreen movie tapes or discs.

But what if we want a true theater-size screen? The front-projection system, with separate projector and screen like the arrangement in a real movie theater, is our answer. These systems typically provide images 10 feet or more in diagonal measure.

The images on projection systems' larger screens tend to be less sharp and less bright, and also tend to be lower in contrast than those on direct-view sets. These problems usually increase as screen size does, in part because larger screens make it easier to see defects in the original picture. High-end video systems often include add-on devices, such as line doublers, to enhance the projected picture, and most critics feel they are well worth their high price. Maintaining a sharp, well-focused picture usually takes more frequent adjustment with projection systems than with direct-view sets, especially with front-projection systems having floor-mounted projectors or screens that can be knocked out of position.

Systems with bigger screens take up more floor space too. This is most noticeable with a rear-projection set, whose single cabinet must be high enough to position the screen properly, wider than the screen itself, and deep enough to hold all the optics. With a front-projection system, the projector cabinet tends to take up several square feet of floor space but can often be mounted on or in the ceiling, if there's enough headroom. And while the screen is often mounted in a cabinet for aesthetic reasons, you can save space by wall-mounting it, letting it stand free on short legs, or even making it electrically retract into the ceiling.

The bigger the screen, the more important it is to have good sources for your video pictures. LaserVision discs are the best source medium for home video, followed by high-band videotape (Super-VHS and Hi8), then by broadcast or cable TV (depending on the station, reception, and your local cable company), and then, dead last, regular VHS or 8-mm videotape. However, availability is also a factor: LaserVision discs, which are not as widely sold as movie tapes, are even less widely available for rent. In addition, high-band tape recordings are virtually impossible to buy or rent, which limits their home theater use mainly to showing movies recorded off the air or cable.

THE AUDIO SIDE

While Fig. 1 shows a total of nine speaker systems in our home theater (commercial movie theaters usually have more), this doesn't mean that the typical movie soundtrack has nine channels encoded in it. It also doesn't mean that you'll necessarily have nine speakers in your installation. Most current movie soundtracks have four channels—two main front stereo channels (screen left and screen right), a front center channel (the dialog track), and a single surround channel. Prints produced for major first-run theaters may have discrete tracks for these channels; prints made

for neighborhood theaters (and home video releases) currently have only two discrete channels of audio information. A matrix decoder (such as Dolby Surround, Dolby Pro Logic, Ultra Stereo, or THX) must be used to extract the additional channels' content. In addition, most decoders also provide a bass-only signal, which may be in stereo (the bass from each of the incoming channels' signals) or a summed mono signal (the bass from both incoming channels summed together).

We can start our home theater with just the two front main speakers and add other channels later. Even after we build up to a complete surround system, most of each film's sound will often be coming from them, so they, more than anything else in our system, will determine the ultimate quality of the sound we hear.

This means that the first step toward good home theater is usually to stop using the speakers built into the video receiver. These speakers usually use small, inexpensive drivers whose frequency response, distortion, and output levels don't qualify as high fidelity. In addition, the width of the receiver cabinet limits how far apart the speakers can be, which means that the channel separation they offer is often marginal for movies and inadequate for stereo music listening. If your video receiver has external speaker outputs and reasonably powerful amplifiers (5 or 10 watts a channel), as a first step you can add decent external speakers, add a more powerful amplifier later, and later still expand to full surround.

For video, unlike stereo music, the center speaker is very important: It reproduces the sound accompanying the action at the center of the screen. Usually this is an actor speaking, so the center speaker is sometimes called the dialog system. The larger the screen and the more spread there is in the seating area, the more important this speaker is. Without it, people sitting off to the side will tend to hear a voice come from the location of the nearest speaker instead of from the actor's location on the screen, which can be very annoying. Nonetheless, most surround decoders have "phantom" settings that deliver center-channel signals to the left and right speakers for home theater systems that don't have a center speaker.

Ideally, all three front speakers would deliver the same sound to you and everyone else in your home theater. This ideal is hard for engineers to realize, because the center speaker, usually placed just above or below the screen, has a different design and size than the other two speakers. Many surround decoders therefore also have a choice of "normal" surround for systems with limited center-channel bass and "wide" surround for systems with better matched speakers.

For home theater, all three front speakers, and especially the center one, should have horizontal dispersion broad

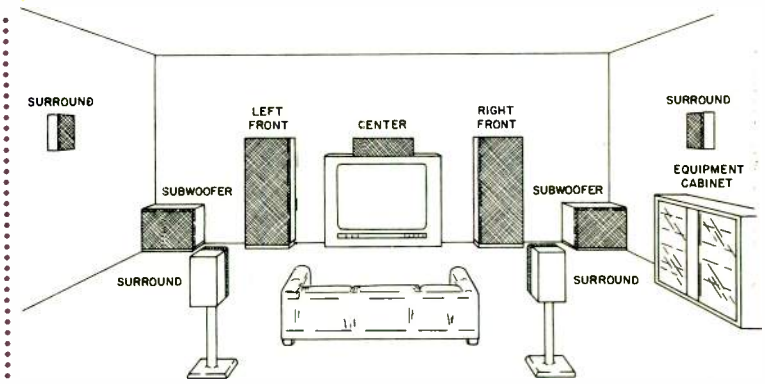


FIG. 1— **HOME THEATER LAYOUT AND COMPONENTS; SEE TEXT.**

FIG. 2— **VIEWING DISTANCES IN A HOME THEATER.**

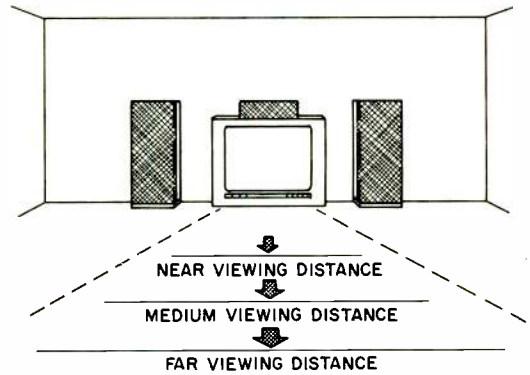


FIG. 3— **CURVE FOR DETERMINING POWER RATIO.**

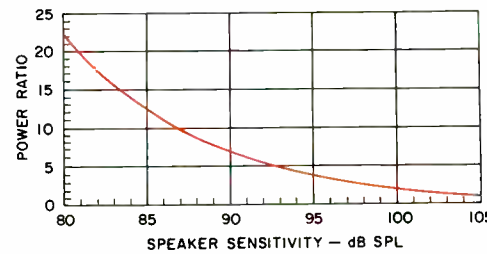
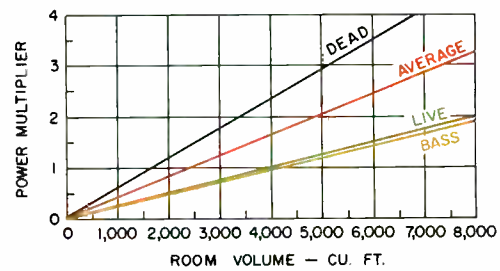


FIG. 4— **CURVES FOR DETERMINING POWER MULTIPLIER FOR ROOM VOLUME AND ACOUSTICS.**



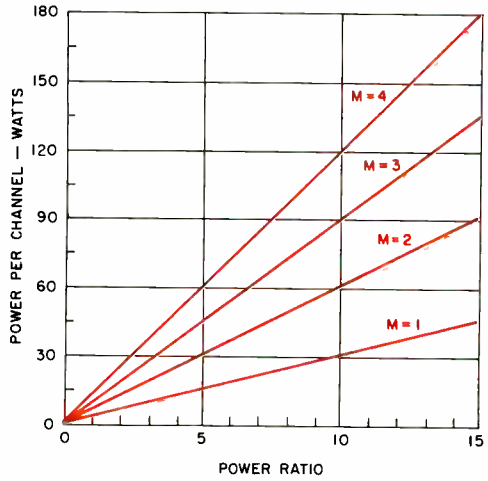


FIG. 5— **CURVES FOR DETERMINING AMPLIFIER POWER REQUIREMENTS.**

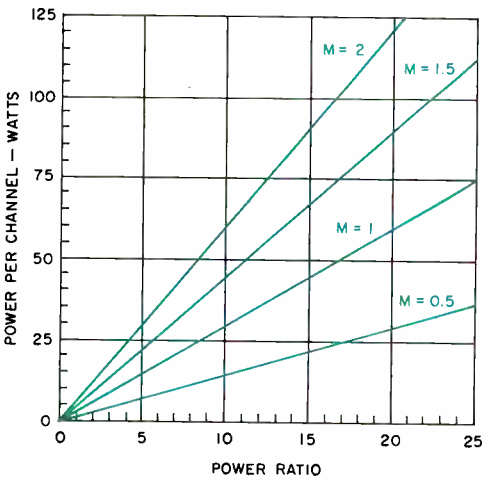


FIG. 6— **CURVES FOR DETERMINING BASS POWER REQUIREMENTS.**

enough to cover the whole audience. This, too, is hard to accomplish in a center-channel speaker because it usually must be wide but not tall, to fit near the screen—exactly the wrong shape for wide dispersion.

The left and right surround speakers bring the viewer into the action. Distant gunfire, planes flying overhead, and other very dramatic effects come to life through them. But since the main action is up front, on the screen, surround speakers should not call attention to themselves. To ensure this, surround speakers are best mounted above the viewers' heads—on or in the wall, or hung by brackets from the ceiling. Speakers designed for surround are also usually designed to diffuse the sound image and make it hard to localize, so the listener will be conscious of the surround sound field but not of the surround speakers' locations. Some speakers use cross-firing drivers; others use bipolar radiation (firing from front and rear with the same polarity) or dipolar radiation (firing from front and rear in opposite polarity).

Dipole surrounds are almost always placed at the room's sides, with their drivers aimed along the room's walls and their dead sides toward the listener (THX Standards specifically call for this); this makes them very difficult to localize. Other surround speaker types, however, can be placed either at the sides or at the rear of the room. While Fig. 1 shows surround speakers in both locations, home systems almost always have just a single pair of surround speakers, in one location or the other.

Surround speakers are generally smaller than the front speakers, to be inconspicuous and because today's surround signals typically include little or no sound below 50 or 100 Hz (or above 7 kHz or so).

Bass is an important part of today's movie soundtracks; commercial theaters require flat response down to about 50 Hz or so, with usable output below 30 Hz. But speakers designed for a home theater's front channels are often relatively small, so subwoofers are, sooner or later, a part of most good home theater systems. (Even if your left and right front speakers have adequate bass for music, you might find subwoofers worth adding for their extra punch.) Subwoofers take over where the front main speakers and surround systems fall off, in the lowest bass. This is where you get the sense of power and energy in the more spectacular film sound effects. Although it's common to use only one subwoofer, for reasons of cost and space, the effect of two, with their added power and enhanced sense of surrounding the audience, is generally worthwhile. (A pair is shown in Fig. 1.)

HOUSING THE ELECTRONICS

The electronics of a home theater system can be as simple as a VCR or LaserDisc player and an audio/video receiver with built-in surround decoding circuitry. But an A/V system can also be complex. An elaborate system typically includes a VCR, a LaserDisc combi player (which can also play audio CDs), a preamplifier that permits both audio and video source selection, a stand-alone surround decoder, and at least six channels of amplification (left, right, center, two surrounds, and subwoofer). This equipment can sit out on shelves or other furniture or be placed in a cabinet or cupboard.

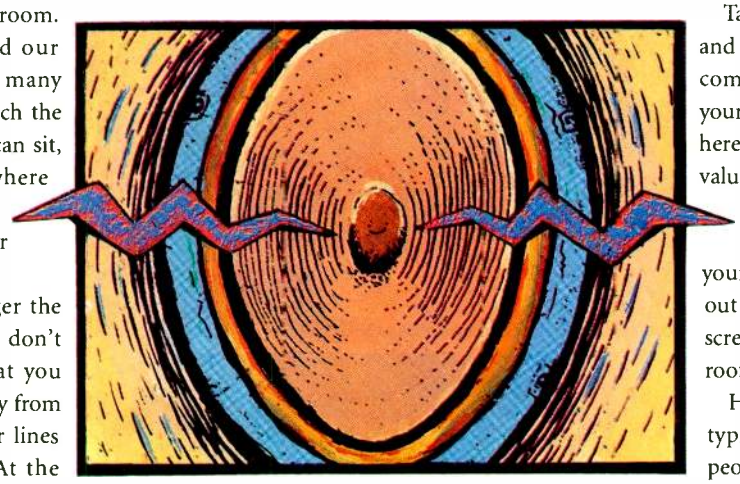
Reaching the cable jacks at the rear of your components can be difficult. If you use open shelves, they should be deep enough to let you turn the components sideways for cable access. Cabinets should also leave room for turning the equipment or have access slots in back through which you can reach it. If the cabinet is too heavy to move out when you need to reach through the back, set it out a few inches from the wall before you load it up. And consider a cabinet with casters.

Since you will probably want to use a remote control even when the cabinet doors are shut, make certain that the doors are of glass or fabric that will pass an infrared beam. Also, make sure

that the components (especially the A/V receiver or the amplifiers) get enough cooling air; if you need to add fans to your cabinet for forced-air cooling, make sure the fans are quiet.

SCREEN SIZE AND SEATING

Another thing we will want to do in planning our home theater is to establish the maximum screen size that can be comfortably viewed and housed in our room. Maximum screen size and our room size determine how many people can comfortably watch the system, how far away they can sit, where furniture can be, where speakers will be placed, and how much amplifier power will be needed.



YOU CAN START YOUR HOME THEATER WITH JUST TWO GOOD SPEAKERS AND BUILD UP FROM THERE.

For screen size, the bigger the better—up to a point. You don't want a screen so large that you cannot back far enough away from it to merge the video raster lines into a coherent picture. At the same time, you don't want to sit too far back, or you'll lose the impact of the picture. These distances depend on the type of screen you have, but there are established industry guidelines to help you determine them. The easy way, however, is simply to use your eyes and think about these two ideas.

Video screen sizes are defined by their diagonal measurements. Standard TV screens are four units wide by three units high (4:3 aspect ratio), and their height is about 3/5 of their diagonal size. For these screens, the optimum viewing distance many industry experts recommend is at least four times to a maximum of six times the picture's height, a range of 2.4 to 3.6 times the diagonal.

For newer, wide-screen sets with a 16:9 aspect ratio, things are more complex. A 16:9 screen's height is a little under half its diagonal size, which would make a viewing distance of four times the height work out to about twice the diagonal. However, most wide-screen sets now use line doublers to smooth the effect of raster lines. This theoretically allows you to sit twice as close as you could otherwise—in other words, between 40 and 60 inches from a 40-inch screen.

Let's define three seating distances from the screen: "Near," "Medium," and "Far" (Fig. 2). Admittedly, these are highly subjective terms, but they can give us at least some idea of what our system space requirements are.

Let's also further define each of these seating distances by who might find them most comfortable. The person who might find the "Near" position best is likely to be someone young; children or even teenagers are generally the ones who like to get the most impact from the presentation. A typical adult might find the "Medium" distance about right. And finally, the "Far" position is for someone who usually prefers sitting toward the back of a real movie theater or perhaps up in a balcony seat.

Table I gives "Near," "Medium," and "Far" viewing distances for all common sizes of 4:3 screens. (If your exact screen size is not listed here, you can simply estimate the value from those given or from the ratios given above.) Comparing these distances to your room's dimensions and layout will tell you how big a video screen would be too large for that room.

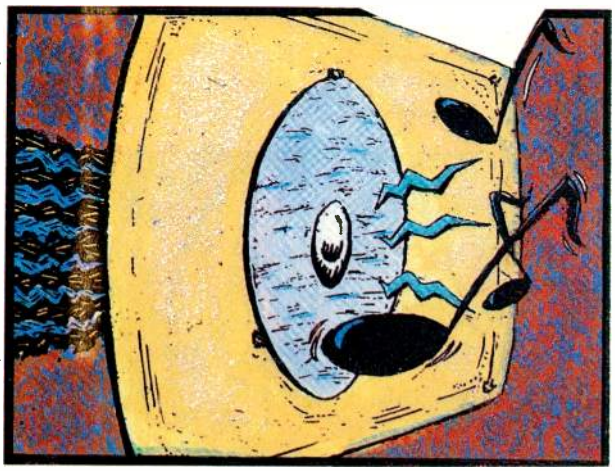
Home theater audiences are typically small, often one to three people. But if your home theater is to be a family affair or you have a great many friends who regularly come to visit, you will probably find Tables II and III helpful in determining your seating capacity. The data is based on the assumption that it is comfortable to sit as much as 15° off the screen's axis. This will certainly be the case with direct-view screens, which provide a very even screen illumination from almost any viewable angle. However, many projection systems do not. Their translucent or reflective screens tend to concentrate the light directly forward, making it important that we sit nearly on axis. Final seating arrangements should therefore be based on the video system you already have or plan to buy.

Table I—Viewing distances, in feet, versus screen diagonal sizes for conventional 4:3 aspect-ratio screens.

	Screen Diagonal											
	25"	27"	30"	32"	35"	40"	45"	50"	5'	6'	8'	10'
Viewing Distance												
Near	4	4	5	5	6	6	6	6	7	8	11	14
Medium	7	7	7	7	8	8	8	9	9	11	16	22
Far	9	9	9	9	9	11	11	11	13	18	24	30

MATCHING THE THEATER EXPERIENCE

If our goal is to match (or surpass) the theater experience when viewing films at home, we must pay careful attention to sound, especially to sound levels. To begin with, how loud should our system be able to play? A target goal of many commercial theaters is 107 dB sound pressure level at any seating location (105 dB is specified as part of the THX requirements for home theater systems). Fortunately, most home loudspeakers and amplifiers can quite readily attain this level in typical domestic surroundings. But how much power will it take to achieve it? This depends on our speakers' sensitivity and our room's size and acoustics.



THE USUAL FIRST STEP TOWARD GOOD HOME THEATER IS TO STOP USING YOUR TV SET'S SPEAKERS.

Loudspeaker sensitivity is almost universally expressed in terms of sound pressure level (dB SPL) produced at a distance of 1 meter with a 2.83-V input signal from the amplifier (2.83 V is equal to 1 watt across 8 ohms). To determine the sensitivity figure for your main front speakers, check the specifications in the owner's manual, look up the figure in *Audio*'s Annual Equipment Directory (October issue), or ask the dealer or manufacturer. (If you can't find out the information or haven't picked your speaker systems yet, use a value of 88 dB; it's a common value, and on the low side of average for cone-type bookshelf or floor-standing speakers.)

Find your speaker's sensitivity figure on the horizontal scale of Fig. 3, move up from there to the curve, and then go directly to the left-hand scale of the graph. This will give us our speaker power ratio (PR). Make a note of this value.

The bigger the room, the more power we need to fill it with sound, so we need the interior volume of our room (height x width x length, in feet). If you don't know the exact dimensions of your home theater room, this is no problem as long as you can estimate them within about 20%.

Our power requirements also depend on the room's acoustics. Whether our theater room is very "live" (acoustically very reflective, with few furnishings or acoustical treatment), "dead" (stuffed with bookcases and upholstered furniture, carpeted, with an acoustic ceiling, etc.), or average will determine how hard our speaker systems will have to work, for a given room size, to get the sound level we want.

Figure 4 has curves for "Dead," "Average," and "Live" rooms. Read up from your calculated room volume to the appropriate curve, and then read across to the left to get the figure that I call the power multiplier (M). Make a note of it. (The "Bass" curve will be discussed shortly.)

Now, using Fig. 5, read up from the power ratio obtained in Fig. 3 to the curve for your room's power multiplier, and then read across to the left to find recommended amplifier power per channel for the main stereo speaker systems. A "crest factor" is included in this power figure, to account for short peaks. The factor is +5 dB (in other words, a multiplier of x3), and brings the system's output up to about 112 dB.

If your center speaker reproduces roughly as much bass as your main front speakers, it should receive as much power as they do, adjusted for any differences in sensitivity between them. (You can use Figs. 3 through 5 for this.) If you use your surround decoder in normal mode, which feeds center-channel bass to the left and right speakers, you can get by with about half the calculated wattage, but not less; this channel may carry quite a bit of information.

The requirements for the surround channels' output levels are usually much lower than those for the front main speakers, since they reproduce mostly incidental

Table II—Seating width, in feet.

	Screen Diagonal											
	25"	27"	30"	32"	35"	40"	45"	50"	5'	6'	8'	10'
	Seating Width											
Near	5	5	6	6	7	8	8	9	10	12	16	20
Medium	8	8	8	8	9	9	10	11	12	14	20	27
Far	10	10	10	10	10	12	12	13	15	20	27	34

Table III—Seating capacity.

Row Width, Ft.	5-6	6-7	7-9	10-12	13-15	16-20	21-25	26-35
Seat Capacity	1-4	4-5	5-6	6-8	8-10	10-13	13-16	16-25

sounds. While there is no fixed relationship here, their output is usually at least 10 dB less, requiring about 10% as much power as the main speakers if sensitivity levels are equal. (If they differ, use Figs. 3 through 5 again.) However, I'd recommend giving the surround speakers at least 20% to 30% of the power fed to the main speakers—and some authorities favor 100%.

The method of determining the required power for subwoofers is a little different than for the other system speakers. In the low bass, most rooms are very reflective, or "live," because most of the things we think of as being sound absorbers (such as carpeting and furniture) actually absorb very little sound at frequencies much below about 100 Hz. (However, some things can have a very dramatic effect. For example, large expanses of window glass freely pass low frequencies right through to the outside, as if the room had no walls! Under such circumstances, the following does not apply. See a professional for advice.)

Now, to calculate requirements for bass power, once again ascertain the power ratio (PR) from Fig. 3 and the power multiplier (M) from Fig. 4, this time using the "Bass" curve. Figure 6 will give us the power per channel, based on these PR and M factors.

If you're considering a subwoofer with its own amplifier, you can determine its suitability to your room by using its amp power and sensitivity rating (if both are given, which is rare) or its spec for maximum output level.

ARE WE DONE?

A home theater system is, unlike most other entertainment devices, extremely complex. What we have just done is some basic planning, in that it only offered us a quick look at what we will be needing in terms of the equipment and the room. A true home theater involves not only sight, but sound, and both must be combined in a way that will be pleasing to the audience. Putting together such an expensive and necessarily complex system is sometimes best done by someone who has a good technical background as well as generous experience. And no book or article could possibly hope to offer both these qualities in any complete sense. Simply, there is no substitute for someone with knowledge and experience to guide us. With that said, I hope I have started you on your way to many years of fine home entertainment.

References

For those with a technical background, and who are also interested in further information on this subject, the following books are strongly recommended:

Davis, Don and Carolyn, *Sound System Engineering*, Howard W. Sams, 1975, 1987.

Everest, F. Alton, *The Master Handbook of Acoustics, Third Edition*, TAB Books, 1994.

HCA-2200" Stereophile *calls our HCA-2200", "...a benchmark product against which other amplifiers can be measured." And why not? John Curl incorporated everything the most musically obsessed person could ever want.*

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This approach to music has attracted its share of fanatics. People like our principal audio designer, John Curl. (Talk about passion — he was so possessed with making music come alive that he practically invented high-end audio in the '70s.)

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D/AC-1500 and C/DP-1000 *The D/AC-1500 is our premier digital to analog converter. The C/DP-1000 is our high resolution CD player. With the simple addition of our Advanced Digital Adaptor Module (an ST optical link), it's transformed into a high performance CD transport.*

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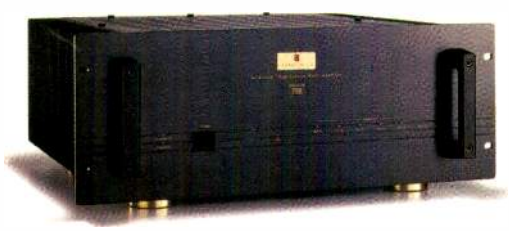

HCA-1206 *With a total of 720 watts on six channels, our HCA-1206 is the most powerful THX-certified home cinema amp made. Sensitive enough to move your soul, but powerful enough to move your foundation.*

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EQUIPMENT PROFILE

SONY MDS-501 MINIDISC DECK

I guess it's a matter of marketing—a witches' brew of guesswork and self-deception when last I studied it. Philips initially launched DCC in the home market and touted its CD-quality sound. Sony launched MD in the portable market and pushed convenience over sound, which was simply described as "approaching" CD quality. Well, the Philips camp now has portable DCC players and, with the MDS-501 deck, Sony catapults MD into the "high-fidelity home market."

Having lived with the MDS-501 for a while now, I must say that I'm impressed with how simple and intuitive it is to operate and by the seemingly amazing things it can do. When you get right down to it, some of these features are not really that amazing to computer buffs, who have been "erasing" entire files (read, "programs") with a single command for years. It is novel, however, to have this facility right at your fingertips in a music recorder. Until recently, not even professionals could instantly wipe a bad take, move tracks around, or combine tracks at the press of a button! As a storage medium, MiniDisc really does bridge the gap between the computer and audio worlds.

Control Layout and Editing Functions

As the first Sony home product of a new format, the MDS-501 follows what appears to be Sony's standard philosophy, i.e., load the first product with features and functions and see which ones consumers actually use. For example, the MDS-501 has a built-in clock that automatically time- and date-stamps each recording as it is made. (However, setting the MDS-501 for unattended recording or playback requires an accessory timer.) For private listening, there's a headphone jack at the lower left of the panel and, next to it, a level control dedicated solely to headphone operation. Headphone output power is generous, the impedance should match most headsets reasonably well, and the independent level control makes the headphone jack useful rather than a mere afterthought.

The MDS-501 has both analog and digital inputs and outputs, the former via conventional gold-plated pin ("RCA") jacks, the latter exclusively via optical Toslink connectors. And needless to say, the MDS-501 includes SCMS to prevent more than one generation of digital-to-digital dubbing. (One might question the degree to which SCMS is needed on an MD deck, since multiple passes through the perceptual encoder/decoder will eventually "unmask" hidden noise components.) The MDS-501 accommodates only digital sources that use a 44.1-kHz sampling rate, i.e., CDs and prerecorded DATs. Digital broadcasts (which operate at 32 kHz) and DATs recorded at 32 or 48 kHz (the default rate) cannot be digitally dubbed onto the MDS-501; you must therefore use the analog inputs.

Control operation is intuitive. The disc slips into a slot, its presence indicated by an orange lamp. An "Eject" button lies below the right of the slot. To its right, under the display, are play, pause, stop, and record buttons. Pressing "Rec" puts the

SPECS

Frequency Response: 5 Hz to 20 kHz, ±0.5 dB.
Playback S/N: Greater than 98 dB.
Wow & Flutter: Below measurable limits.
Line Input Level: Nominal, 500 mV rms; minimum, 158 mV rms.
Line Input Impedance: More than 47 kilohms.
Rated Output: Line, 2 V rms into 50-kilohm load; headphone, 28 mW into 32-ohm load.
Dimensions: 17 in. W x 3⅜ in. H x 14 in. D (43 cm x 8.5 cm x 35.5 cm).
Weight: 11 lbs., 7 oz. (5.2 kg).
Price: $999.95.
Company Address: Sony Dr., Park Ridge, N.J. 07656.
For literature, circle No. 90

Photos: Michael Groen

AS A STORAGE MEDIUM, MINIDISC REALLY DOES BRIDGE THE GAP BETWEEN THE COMPUTER AND AUDIO WORLDS.

deck into record/pause mode; pressing the play or pause control then starts the recording. The track number goes up, with the new track number stored in a temporary table of contents (TOC), each time "Rec" is pressed. If you forget to hit "Rec" when you want to change track numbers, don't worry; the MDS-501 has extensive editing facilities, which I'll get to presently.

Analog recording level is set with a tightly clutched, dual-concentric control that lies at the upper far right, behind a hinged door. Recording level is displayed by a better-than-average LED meter whose range is –40 to 0 dB. An "Over" indicator warns when you've pushed matters too far. When dubbing a digital source, the original level is duplicated automatically, with no need for manual level adjustment.

The "Display" button, adjacent to the remote sensor, toggles the display between the title of the current track and the remaining playing time of the disc. Above these buttons is a multifunction "AMS" dial that's used to cue to the beginning of specific tracks, set the clock, specify the playing order of programmed tracks, enter text data, and control the editing functions.

The MDS-501's editing facilities are both extensive, as I said above, and unfamiliar. All editing is accomplished with controls behind the front-panel door. The most important of these are two editing buttons, "Edit/No" and "Yes," which—often in conjunction with the other editing controls—are involved in virtually all edit operations.

Pressing the "Edit/No" pad cycles through all currently available options; when you get to the one you want, you press "Yes." Some of the options are "toggles," i.e., if you have Level Sync on and you want to turn it off, you press "Edit/No" until "Level Sync ON" appears in the display and then press "Yes" to toggle it off. Whether Level Sync is on or off, pressing the "Rec" button will raise the track number.

If you press "Edit/No" while in the record/pause mode, "Level Sync ?" will appear in the display. If you then press "Yes" twice, the display indicates "Level Sync ON," and a new track number is recorded each time the input level drops below a specific level (–80 dB when digitally dubbing a CD) for 2 seconds or more. (During recording, pressing "Edit/No" displays "Name in ?"; a second tap is needed to advance to the "Level Sync ?" option.)

You can erase, divide, combine, and move tracks after they've been recorded. To erase a track, advance to it with the "AMS" knob, press "Edit/No" consecutively until "Erase?" appears in the display, and then press "Yes." When the track has been deleted and the TOC updated, the display indicates "Complete." You can erase an entire disc by tapping "Edit/No" until "All Erase ?" appears and then pressing "Yes" twice. You can even erase portions of a track by dividing the track into segments (each of which will be individually numbered), erasing the segment you want to remove, and combining the remainder. (Just like a 3½-inch floppy, an MD can be protected from erasure by sliding a tab on its shell.)

To divide a track, pause the disc at the appropriate point, press "Edit/No" until "Divide ?" appears in the display, and then press "Yes." "Rehearsal" flashes in the display, and the starting point of the new track plays back repeatedly with a "Position ok?" legend. If it's okay, press "Yes"; the display will show "Complete." If the dividing point is inappropriate, press "Edit/No" and adjust the "AMS" dial to get to the desired point. In this mode, "AMS" has 256 steps, covering the range from –7.68 to +7.62 seconds in 60-mS increments.

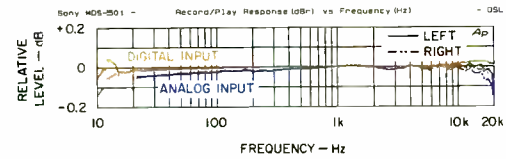

Fig. 1—Record/play frequency response.

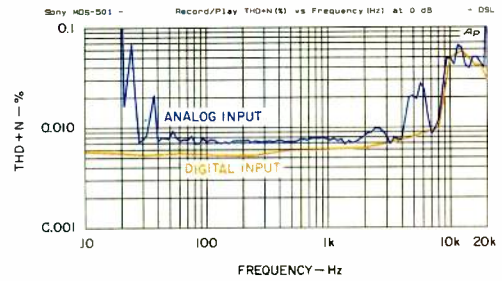

Fig. 2—Record/play THD + N vs. frequency.

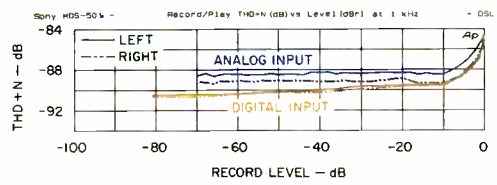

Fig. 3—Record/play THD + N vs. record level.

Combining tracks is similar to dividing them. Turn the "AMS" knob until the track you wish to append is shown in the display, press "Edit/No" until "Combine ?" appears, press "Yes" to enter the "Rehearsal" mode, and—if all is as desired—press "Yes" in response to "Track ok?" Although only consecutive tracks can be combined, you can move tracks so that the ones you wish to combine become consecutive. Select the track you wish to move with the "AMS" knob, press "Edit/No" until "Move ?" is displayed, press "Yes," adjust the "AMS" knob to specify the new track position, and press "Yes" (or the "AMS" knob).

Once you get the hang of the "Edit/No" and "Yes" buttons, the display guides you through each procedure; the system is easy to use and remarkably flexible. The flexibility comes from MD's random-access recording, essentially similar to that of a computer hard or floppy disk. When you "erase," "move," or "combine" tracks, no data is actually erased, moved, or combined. Instead, the table of contents is

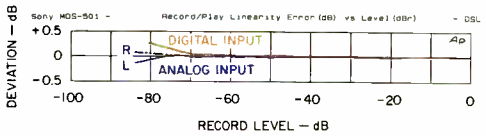

Fig. 4—Deviation from record/play linearity.

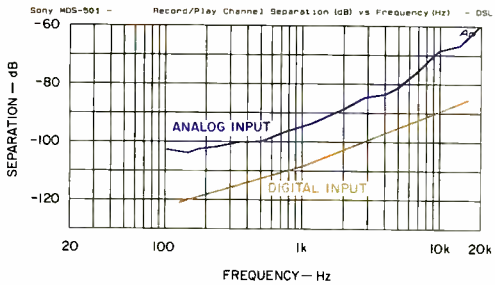

Fig. 5—Record/play channel separation.

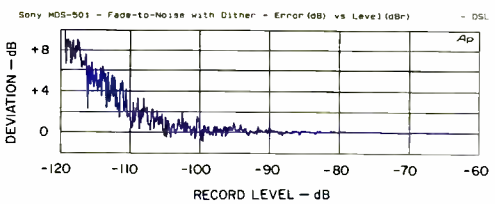

Fig. 6—Fade-to-noise test (dither applied).

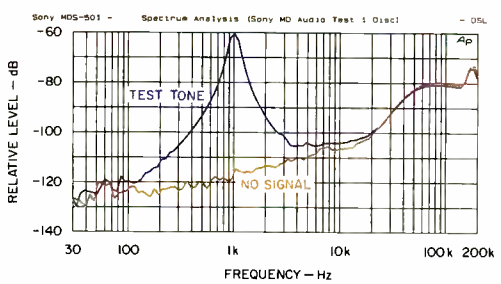

Fig. 7—Spectrum analysis of test-tone and "no-signal" tracks.

changed to indicate where the data lies on the disc and which portions of the disc are available for overwriting because they have been "erased." Bear in mind, however, that all edits exist only in a temporary TOC until you stop the deck and eject the disc. That action records the TOC on the disc. If you switch off power before doing so, the edits are lost. You're limited to 255 track marks on any one disc, but it should be enough to keep you busy!

The remaining controls behind the front-panel door are "Play Mode" (which selects among normal, "Shuffle," and "Program" play), forward and reverse search, "Repeat" play, "Timer" (for unattended recording or playback), and "Input" (to choose between the analog inputs and the digital inputs for recording).

The remote control provides direct access to any track via 25 numeric keys and a ">25" button that permits access to higher numbered tracks. (Press ">25" followed by number-by-number entry of the track you wish.) "Date/Recorded" and "Date/Present" buttons display the recording date of the selection or the current time and date. "Repeat" replicates the function of the corresponding panel button. With the remote's "A-B" button, you can also mark the start and end points of a segment you wish to repeat. A button for auto spacing inserts 3-second blank spaces between tracks during play (helpful when making a tape dub of an MD for use in a tape player that searches for blank spaces) and, when pressed twice, automatically pauses after each track. A music scan feature plays the beginning of each track, in succession.

All operating-mode controls (play, pause, stop, record, and search) are available on the remote; a pair of buttons with the standard skip marking duplicates the action of the front panel's "AMS" knob. The remote also has "CD-Sync." and "CD Player" buttons, which work with Sony CD players. The three "CD-Sync." buttons ("Standby," "Start," and "Stop") facilitate dubbing from the player. The "CD Player" pause and skip buttons temporarily stop and start playback and find desired tracks.

The MiniDisc format supports alphanumeric titling of the disc and each program. With prerecorded MDs, the album title pops up when the disc is loaded, and titles change with each track. A "Scroll" button on the remote moves the display through titles longer than the display's 12-character maximum and then redisplays the initial 12 characters.

You can label your own recordings, but the procedure is not very convenient. You enter the data during playback, letter by letter, using either the "AMS" dial on the front panel or buttons on the remote. As long as you don't care to use certain special characters available only via "AMS," the latter approach is definitely preferable. On the remote, the three "Play Mode" buttons, the two "Date" buttons, the "Repeat" and "A-B" buttons, the 25 numeric keys, and the ">25" pad individually access each letter of the alphabet and a few common punctuation marks.

If you do use the "AMS" dial to label a track, access the "Name in ?" function with "Edit/No," press "Yes," and start punching in letters. By using the search buttons, you can move a flashing cursor under any incorrect character and then either enter the correct one or press "Edit/No" to erase it. When you've finished (which you must do before the end of the track), press "Yes." Again, you must stop and eject the MD to record any titling on the disc. (Whenever you've made a temporary change in the table of contents, a "TOC" indication appears in the display to remind you not to turn off power until you've stopped and ejected the disc.)

THE EXTENSIVE EDITING FACILITIES LET YOU DIVIDE, COMBINE, AND EVEN MOVE TRACKS AFTER RECORDING.

You have two setup options before recording. These determine whether new recordings will be appended to those already on the disc or whether the disc will be erased entirely and recorded from the beginning. Here's the only place where I found Sony's nomenclature slightly confusing. The "append" mode is designated "All REC OFF" and is the factory-default setting. The "erasing" mode is designated "All REC ON" and must be selected before inserting the MiniDisc using (you guessed it) the "Edit/No" and "Yes" buttons.

For dubbing from a digital source, the MDS-501 has a non-defeatable "Auto Cut" feature that stops recording if the level drops below –80 dB for 20 seconds. When this occurs, the display flashes "Auto Cut,"

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and the last 18 seconds of "silence" are automatically "erased." This is probably a good feature in the real world, since you can copy a CD unattended and not waste space recording silence even if the CD runs out before the MiniDisc does. However, if you want to record "silence" (as I did for certain lab tests), the MDS-501 thwarts your attempts. You can get around this by pausing the recording before the 20 seconds are up, restarting it, and "combining" the tracks afterward. I got lots of practice at that!

Measurements

The only test MiniDisc that I know of is Sony's *MD Audio Test 1 for Signal Performance* (TGYS 1). This disc was made by converting the master tape of Sony's *Test CD Type 3* (YEDS-7) to MiniDisc, with the input levels reduced by 0.05 dB. While a good disc in its day, the YEDS-7 has been pretty much supplanted by the CBS CD-1, which is the EIA-recommended test CD and has a number of useful tests that are available on no other disc. I ran the MDS-501 through its paces using the TGYS 1 and then made a digital copy of the CBS CD-1 onto MD. I used this disc for my digital record/play data. Finally, I made recordings from the analog inputs to another MD for my analog record/play data.

Frankly, I flipped out when I found that, within the limits of experimental error, the digital dub of the CD-1 matched the performance data of the professionally encoded TGYS 1 in frequency response, distortion, and A-weighted signal-to-noise ratio! Even in quantization noise and dynamic range, the digitally dubbed disc was no more than 1 dB worse than the professionally encoded TGYS 1.

To be specific: The A-weighted S/N was 98.3 dB at 0-dB recording level for either playback of the TGYS 1 or record/play from the CD-1, the record/play dynamic range was 93.9 dB from the CD-1 versus 94.9 dB from the TGYS 1, and the figures for quantization noise were even closer (88.3 dB for record/play versus 89.1 dB for playback of the Sony test MD). Response and distortion data taken from the TGYS 1 were identical with those from the CD-1 dub, so I have not presented them.

You may ask, "What's so surprising about a perfect dub? Aren't digital dubs supposed to be perfect?" Well, perhaps so when recording from one 16-bit linear system to another, e.g., from CD to DAT. But that's not the case with MD. When digital data enters the MDS-501, it is ATRAC-encoded using Sony's perceptual algorithm before recording. It's not at all apparent that the encoder in a consumer MiniDisc recorder would match the professional system used to make the TGYS 1. I find it quite impressive that the MDS-501 encoder is as close to professional standards as it is!

Equally impressive, if not more so, is the recording performance from the analog inputs. Frequency response (Fig. 1) is within ±0.05 dB from 21 Hz to 19.4 kHz for recording via the analog inputs compared with ±0.03 dB from 20 Hz to 20 kHz on the digital dub. I'm not sure what caused the rise to +0.18 dB at 20 Hz in the recording made from the analog inputs, but the droop to –0.64 dB at 20 kHz is undoubtedly due to the anti-aliasing filter.

ON MOST MATERIAL, YOU'LL DISCERN NO DIFFERENCE BETWEEN CD AND SECOND-GENERATION MD.

Record/play THD + N at 0 dB versus frequency (Fig. 2) is negligibly worse from the analog inputs than from the digital. (Here and in other plots where the curves for the left and right channels were close to identical, I have omitted the right-channel curve for clarity.) It's interesting to note that the peaks in the analog distortion curve occur at frequencies where there was no digital data on the CD-1 I dubbed from. (The digital data points on the CD-1 disc occur at rather widely spaced intervals, and my test gear smooths the response curve between them; I make the analog sweep in much finer increments.) And THD + N versus level (Fig. 3) again is only a few dB worse on recordings made from the analog inputs than on those from the digital.

Linearity error (Fig. 4) is virtually identical (and negligible) whether the analog or digital inputs are used. (In the case of the analog inputs, the results include linearity error of the A/D converter.) Only in channel separation (Fig. 5) is the digital option measurably superior. And since we're speaking of separation in excess of 70 dB, even when using the analog inputs, it's hard to believe that the difference will be audible.

Only the CBS CD-1 disc provides a fade-to-noise track. The results (Fig. 6) testify to excellent low-level linearity in the MDS-501's D/A converter. The spectrum analyses (Fig. 7), which I measured using the Sony TGYS 1 disc (results were the same for the CD-1 copy), exhibit remarkably low hum contamination and good noise shaping.

Just to round out my tests: Record/play channel balance was perfect when recording from the digital inputs and was within ±0.045 dB with the analog inputs. Analog-input sensitivity for 0-dB recording level was 0.594 V rms, and output at 0 dB was 2.1 V rms.

Use and Listening Tests

Failure to deliver adequate performance on the type of bench tests described above will preclude the possibility of good sound. But getting high marks on these tests (which the MDS-501 certainly did!) does not guarantee good sound, especially when we're dealing with a system that uses perceptual encoding to economize on data rate. Ultimately, sound quality is established in the listening room.

So, the $64,000 question: Does the MDS-501 deliver CD-quality sound? Let me answer it this way: If you did not have a CD version of the same program to compare with, and you did not know you were listening to a MiniDisc, I'm quite confident that you'd believe you were listening to a CD. The sound of this second-generation Sony MiniDisc recorder is that close to what we now consider the standard, i.e., the CD. Furthermore, I've heard many CDs that sound far worse than the commercial MD software I auditioned on the MDS-501. On most material, even if you did have a CD version of the same program for comparison, I doubt very much whether you'd discern a difference.

But is the sound identical on all material under all circumstances? Not quite. I've

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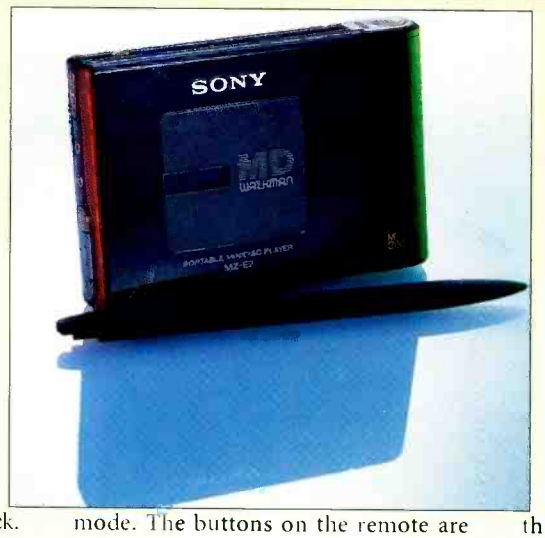
accumulated a number of discs that are particularly hard on perceptual encoders. Some of the signals were used by the Motion Picture Experts Group (MPEG) in evaluating audio compression systems, to separate the men from the boys. When I digitally transferred certain tracks to MD and made A/B comparisons, I could hear a difference. Although the test was not double-blind and thus is suspect, I convinced myself I could reliably tell the original from the copy—just barely, but different nonetheless.

The differences occurred in three areas: A slight suppression of low-level high-frequency content when the algorithm needed most of the available bitstream to handle strong bass and midrange content, a slight dulling of the attack of percussion instruments (piano, harpsichord, glockenspiel, etc.) probably caused by imperfect masking of "pre-echo," and a slight "post-echo" (noise puff) at the cessation of a sharp sound (such as claves struck in an acoustically dead environment). The second and third of these anomalies were most readily discernible on single instruments played one note at a time in a quiet environment, and were taken from a recording specifically made to evaluate perceptual encoders. With regular music recordings, pre- and post-echoes seem to be reasonably well masked by the natural reverberance of the recording, although a slight thickening could be noted when listening to digital dubs of harpsichord and, less frequently, piano recordings.

I realized long ago not to trust my sonic memory, but it's difficult not to make some comparison with the past. I've heard MiniDisc in prototype form; I've heard first-generation players. They were adequate but sonically no match for CD. Obviously, things have changed with the Sony MDS-501. Call it second-generation, call it what you will, the MDS-501 sets a new standard for MD sound quality and is an absolute delight to use. *Edward J. Foster*

Portable Companion: Sony's MZ-E2



Sony sent an early sample of its second-generation portable player, the MZ-E2 ($549.95). Even with its rechargeable lithium-ion battery, it's amazingly small (3 inches deep, ¾ inch thick, and 4¼ inches wide) and light (7.2 ounces). The lithium battery provides two-hour operation; it recharges in five hours (three hours for 80% charge) through the supplied a.c. adaptor. It's also possible to operate the MZ-E2 from the adaptor and charge the battery simultaneously. The cell is removable, so you can switch to a fresh spare. A battery case (supplied), holding three AA cells, attaches to the back of the player; its cable plugs into the external power jack. This battery case about doubles the thickness of the player. Alkaline batteries provide four-hour operation when used alone and 7½-hour operation when used with the lithium cell.

Slide switches on the back of the player activate the Automatic Volume Limiter System (AVLS), to limit output to safe levels and choose either of two levels of bass boost (or none). A spring-loaded slide opens the disc slot. Nearby is a stereo mini-jack and a four-pin connector for the headset and remote controller. This controller, a small round pack with clothing clip, lies partway up the headphone cable.

You can control the MZ-E2 from built-in pads or from controls on the remote. "Hold" controls on both player and remote lock the current operating mode. The buttons on the remote are small, but adequate if you're not thick-fingered. The controller carries two additional buttons not on the main unit. One selects the play mode (normal, track or disc repeat, and random); the other cycles the LCD panel from indicating elapsed time on the current track, to a scrolling display of the track name, and to a scrolling display of the disc title. The track number appears in the first two cases; the total number of tracks on the disc comes up in the last case. The disc name and total number of tracks appear when a new disc is loaded. A battery-condition indicator and play-mode symbols also appear in the display, as do indicators for volume changes. The display is reasonably legible for its size.

In the U.S., the MZ-E2 comes with an over-ear headset that I find infinitely more comfortable (and better sounding!) than the "button" earpieces supplied in Japan. It also comes with a soft carrying pouch. The most interesting optional accessory is the CPM-MZE2K car mount kit, which (if I correctly interpret the manual) includes an umbilical cord, to power the unit from the cigarette lighter, and a connecting pack that couples the output of the MZ-E2 to the cassette heads of a car head unit. An external a.c. power adaptor and battery charger (ACP-MZ60A) and additional lithium-ion batteries (LIP-10) also are available.

I didn't run bench tests on the MZ-E2, but I did give it a go around the block. Pretty impressive. Even in rough use, the deck didn't skip a beat. (Presumably, the laser head mistracked on occasion but recovered before the 4-second buffer ran dry.) Sound quality was easily up to the best Walkman standard and was far and away superior to garden-variety portables. I didn't find the headset particularly comfortable (but neither was it uncomfortable), and I wasn't blown away by its deep bass response. There was enough upper bass to give the impression of a solid low end, however, and headphone comfort is inherently personal. I heartily approve of the AVLS concept, but I think Sony has been overly cautious. The sound level with AVLS on is just louder than good background-music level, and people who need AVLS protection the most are likely to turn it off! *E.J.F.*

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(D.) Some people like two doors better than four doors.

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EQUIPMENT PROFILE

ALPINE 7982 CAR CD CHANGER AND TUNER

The Alpine 7982 is an update of the Alpine 7980, a head unit with a three-disc changer built right into its DIN-sized, dashboard-mount chassis (see February 1993). Both models use a handy, three-disc magazine that loads as easily as a cassette.

Instead of the earlier model's pull-out chassis, the 7982 has a detachable faceplate. When the car's ignition is turned off (and during disc changes), a warning LED blinks, and if the unit is stolen, it will be unusable to anyone who doesn't know its secret code.

The earlier model's tuner section was in a separate chassis that could be hidden under the dashboard. Alpine's second-generation three-disc changer, the Model 7982, actually manages to cram all the electronics into the same chassis as the CD changer mechanism, for a simpler, one-box installation. The Model 7982 can also control an Alpine six-CD changer mounted in the trunk of your car, if three-CD capacity isn't enough for you.

Most of the 7982's convenience features were carried over from the older model. The tuner section has Intelligent Auto Memory, which automatically stores the frequencies of the six strongest stations on the current band into preset memory. In addition to the usual one AM and two FM bands, a Direct Access Preset ("D.A.P.") band stores any desired mix of AM and FM stations. Intelligent Preset Scan stops only at those presets whose signals are strong enough for reasonable listening. There is seek tuning in either direction, with adjustable local/distant sensitivity.

The CD player allows random play of tracks on the current disc ("M.I.X.") and repeat of the current track or disc. The 7982 has lost the 7980's six-track programming, but it's gained direct keypad access to any desired disc in the built-in changer (or the trunk-mounted changer, if one is connected); on the earlier model, you could only cycle one way through the discs.

On both the old and new versions, a feature called Source Tone Memory automatically memorizes the bass and treble control settings separately for each program source. And connections are provided to automatically mute the audio when an Alpine cellular phone is in use. The current model does not have a wireless remote control, as the old one did, but it has gained a digital clock and the ability to select green or amber illumination.

The CD circuit features include Alpine's I-DAC, a 20-bit hybrid interpolative D/A

SPECS

CD SECTION

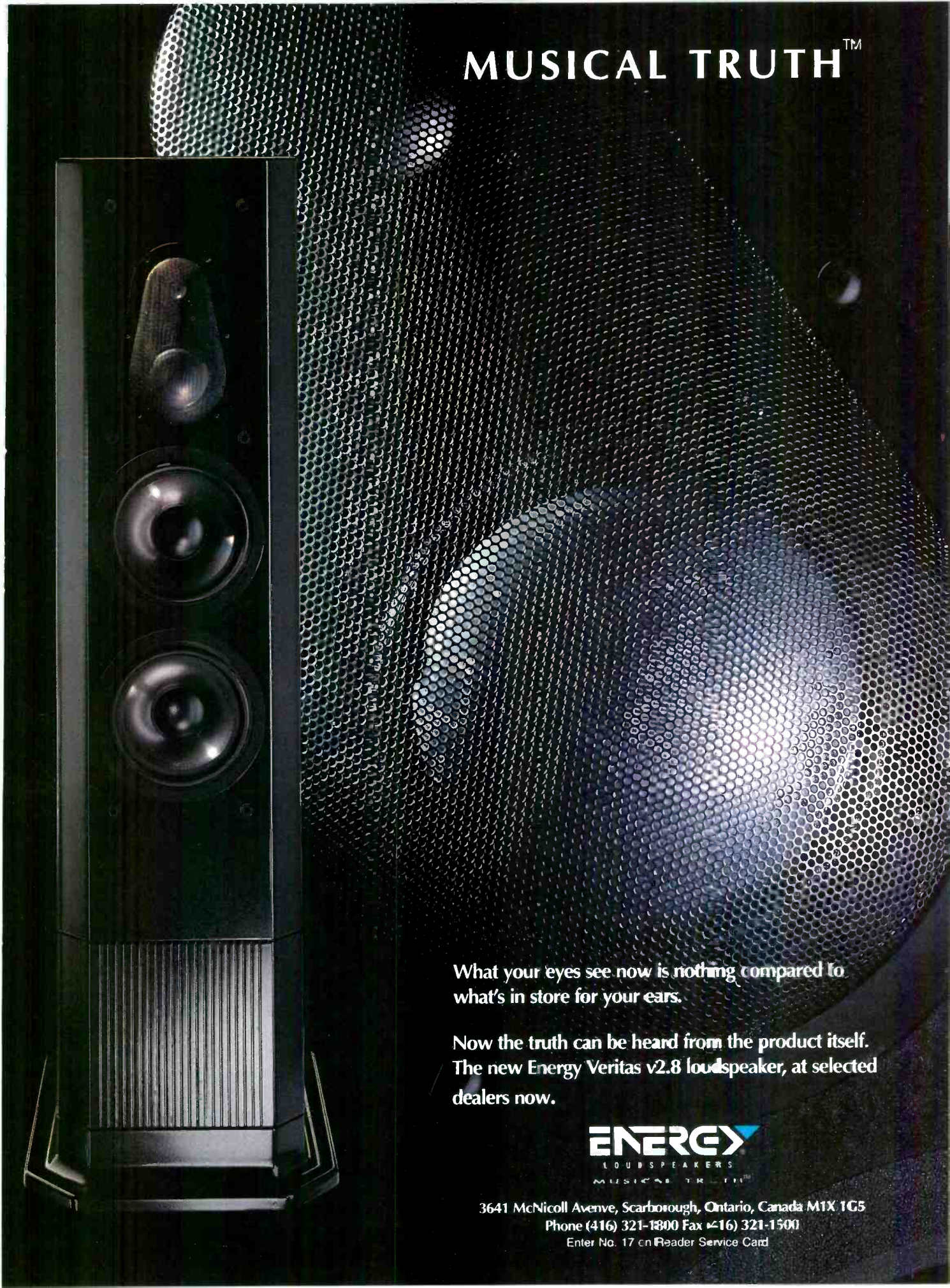
Frequency Response: 5 Hz to 20 kHz, +0, –1 dB.
THD: 0.01% at 1 kHz.
Dynamic Range: 95 dB.
S/N: 100 dB, A-weighted.
Channel Separation: 90 dB at 1 kHz.

AM/FM TUNER SECTION

FM Mono Usable Sensitivity: 9.3 dBf.
FM 50-dB Quieting Sensitivity: 13.5 dBf.
FM S/N: 65 dB.
Channel Separation: 35 dB.
Alternate-Channel Selectivity: 80 dB.
Capture Ratio: 2.0 dB.
AM Sensitivity: 22.5 μV.

GENERAL SPECIFICATIONS

Bass Control Range: ±18 dB at 30 Hz.
Treble Control Range: ±12 dB at 10 kHz.
Power Requirements: 14.4 V d.c. (11 to 16 V allowable).
Output Voltage: 2.1 V, unclipped.
Dimensions: Chassis, 7 in. W x 2 in. H x 6¼ in. D (17.8 cm x 5.0 cm x 15.8 cm); nose-piece, 6⅞ in. W x 2⅛ in. H x 1⅛ in. D (17.2 cm x 5.2 cm x 2.7 cm).
Weight: 4¾ lbs. (2.15 kg).
Price: $780.
Company Address: 19145 Gramercy Pl., Torrance, Cal. 90501.
For literature, circle No. 91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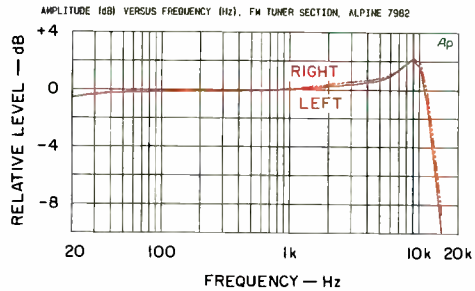

Fig. 1—FM frequency response.

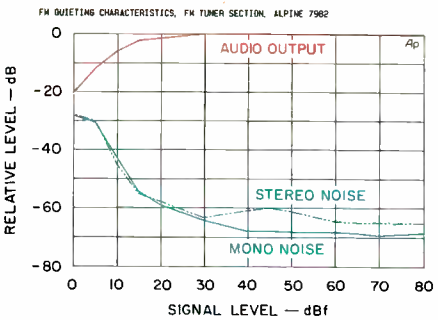

Fig. 2—FM quieting characteristics.

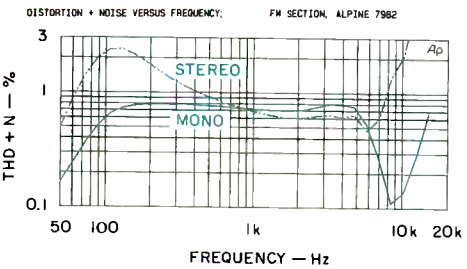

Fig. 3—THD + N vs. frequency, FM tuner section

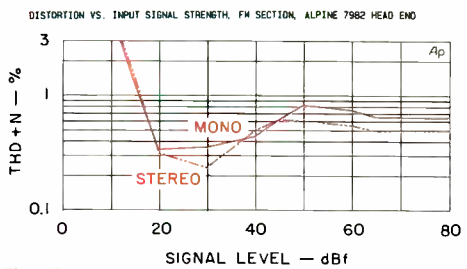

Fig. 4—THD + N vs. FM signal strength.

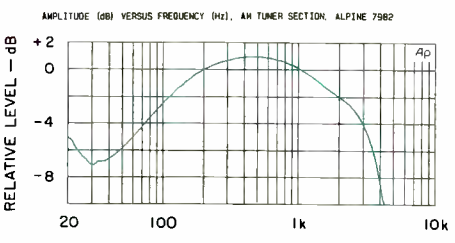

Fig. 5—AM frequency response.

converter combined with one-bit D/A conversion technology for excellent low-level linearity. Eight-times oversampling is employed in the unit's digital filter. Besides normal CD playing (complete playback of each of the three discs mounted in the disc magazine), you may select a specific disc and track, or you can have the unit play the first 10 seconds of each track until you hear a track you like. Fast forward and fast backward scanning work while in the play mode, should you want to reach a specific portion of a track.

Control Layout

The 7982 can be turned on by pressing the "Pwr" button at the top left of the panel or by pressing any button. The first time the unit is powered up, the factory four-digit code must be entered before the 7982 will operate. After that, you need not reenter the code (which you can change to one of your own choosing) unless the unit is disconnected from the battery. A CD eject button and the clock display/adjust button are also situated in the top left corner of the panel. Just below are "Dn" and "Up" buttons used for radio tuning, fast CD scanning, and track advance or retard. The rest of the panel's upper section houses the magazine loading slot.

A bulging panel section at the lower left contains audio up and down buttons flanking a "Mode" button, plus three buttons used for source selection. Normally, the audio buttons control volume, but pressing the "Mode" switch repeatedly cycles their functions through treble, bass, balance, and fader adjustment. The three source selectors also perform dual functions: The "Tuner/Band" button cycles through the AM and two FM bands, while the "3Disc" and "6Disc" buttons double as pause and play controls for the internal three-disc and optional six-disc changers, respectively.

IF THREE CDs IN THE DASH ARE NOT ENOUGH, THE 7982 CAN CONTROL ANOTHER SIX IN YOUR CAR'S TRUNK.

The lower right corner of the front panel contains six numbered buttons that are used to set and access tuner presets, and to select discs. When the "Func" button just to their left is pressed, they perform such additional functions as FM mono/stereo switching, distant/local switching, auto memory station preset, preset and CD scanning, CD repeat, and accessing the "D.A.P." band. A small button nearby, labelled "DSP ILLUM," switches the display's color.

The display, below the magazine loading slot, offers complete status information, such as band indication, preset channel or disc indication, digital frequency display, distant/local indication, stereo/mono indication, loudness level (calibrated from 0 to 35), CD repeat status, and activation of "M.I.X." or "D.A.P."

Tuner Measurements

Figure 1 shows the frequency response of the Alpine 7982 in the FM tuner mode. Although a slight rise in response, about 2.0 dB, is observed at 10 kHz, response is down some 5.0 dB at 13 kHz.

Figure 2 shows the mono and stereo FM quieting characteristics. Mono 50-dB quieting requires a signal input of only 12.5 dBf. There's no comparable stereo figure, as S/N ratio reaches 60 dB by the time signal strength is sufficient to switch the tuner into stereo mode. Maximum S/N with strong signals measures 68.5 dB for mono and 64.8 dB for stereo. These figures are all quite similar to those for the prior model.

Figure 3 is a plot of THD + N versus modulating frequency. At 1 kHz, THD + N measures 0.69% for mono and 0.65% for stereo. (I suspect that the sample I tested was slightly out of alignment, since the model I tested last year exhibited far lower FM distortion, and I don't think the FM circuitry has changed much.) Figure 4 shows how THD + N varies with input signal level for mono and stereo. From this plot, I determined that mono usable sensitivity was approximately 11.5 dBf.

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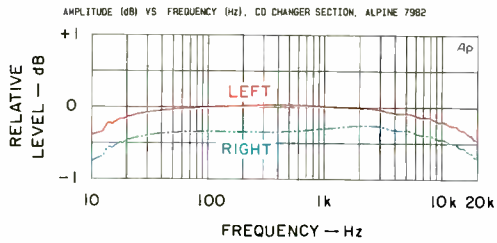

Fig. 6—Frequency response, CD section.

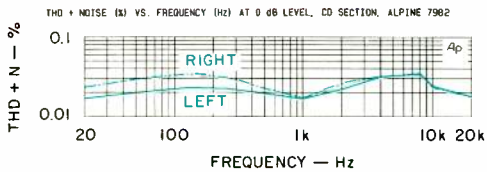

Fig. 7—THD + N vs. frequency, CD section.

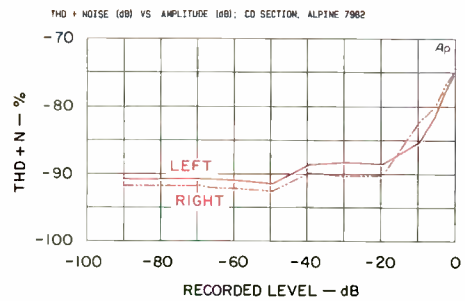

Fig. 8—THD + N vs. recorded level.

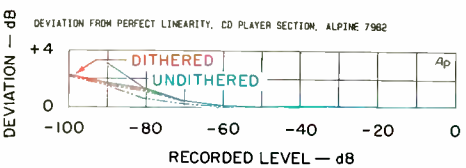

Fig. 9—Deviation from perfect linearity.

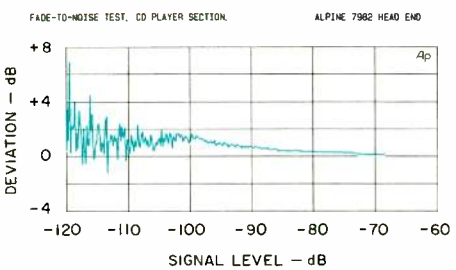

Fig. 10—Fade-to-noise test.

Notice, in Fig. 4, that as signal levels drop below 60 dBf, stereo THD + N tends to rise until, at some point between 20 and 30 dBf, the mono/stereo switching threshold is reached. Below this threshold level, THD + N in the stereo mode is substantially the same as for mono, since the 7982's circuitry then operates in the mono mode for both stereo and mono signals.

Stereo separation measured 34 dB at 1 kHz, dropping to 30 dB at 100 Hz and 27.6 dB at 1 kHz. Suppression of the 19-kHz pilot tone and 38-kHz subcarrier was about 50 to 60 dB, noticeably better than the 20-dB figures for last year's model. The residual 38-kHz subcarrier was suppressed by an impressive 73 dB. Alternate-channel selectivity was 82 dB, and capture ratio was 2.0 dB, as claimed.

THIS NEWER ALPINE HAS A REMOVABLE PANEL, FASTER DISC CHANGES, AND BETTER AM TUNING.

As for the AM tuner section of this unit, its frequency response (Fig. 5) was actually poorer than that of the earlier model, extending from 47 Hz to around 3.5 kHz before reaching an attenuation of 6 dB. Usable sensitivity measured 23 µV, close to the 22.5 µV claimed.

CD Measurements

Figure 6 shows the frequency response of the CD player section, with tone controls at their "flat" settings. Response is down 0.4 dB at 10 Hz and about 0.47 dB at 20 kHz. With the volume control set a few dB below maximum (for reasons I will discuss shortly), approximately 0.3 dB of mistracking between channels was evident.

Figure 7 shows how THD + N varies as a function of frequency for signals recorded at maximum level. Over most of the audio range, THD + N ranges between 0.02% and 0.03%. To maintain this low level of distortion, however, I had to operate the 7982 with its volume control at about 10 dB below maximum setting. If this was not done, the voltage amplification stages that follow the D/A converter went into overload. I can appreciate that the CD player section produces far higher output levels (more than 2.0 V) than the AM or FM tuner sections, but it seems to me that the designers of a combination such as this should have made it possible for the preamp voltage stages to handle CD output signals at any setting of the volume control. (Incidentally, this same problem was evident in the 7980.)

The tendency of the preamp stages to overload was also evident when I plotted THD + N (referred to 0-dB recorded level) versus signal level. The results are shown in Fig. 8. While THD + N remains very low (around –90 dB, or 0.003%) at levels below –20 dB, even with the volume setting reduced somewhat below its maximum, THD rises to around –75 dB (around 0.018%) for signals recorded at maximum digital level. Had I increased the volume setting to maximum, reproduced signals would have been severely clipped. The primary harmonic components were at 2 and 3 kHz (the second and third harmonics of the recorded signal), with higher harmonics evident at lesser amplitudes.

On the other hand, A-weighted S/N for the 7982's CD player section measured an impressively high 99.5 dB for the left channel and 98.9 dB for the right channel—unusually good for a car audio CD player.

Separation at 1 kHz measured 93.5 dB for the left-to-right crosstalk and 94.2 dB for crosstalk from right to left. Separation decreased substantially at higher frequencies, but at 16 kHz it was still a more than adequate 78 dB for the left-to-right measurement and 72.5 dB for right to left.

Figure 9 shows deviation from perfect linearity. For undithered signals at –90 dB, deviation approaches 3 dB for the left channel and is less than 2 dB for the right channel. With dithered signals, deviation at –100 dB amounts to no more than 2 dB. The fade-to-noise test results (Fig. 10) confirm the low-level linearity deviation and

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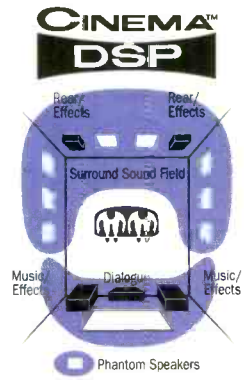

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also reveal that the EIA dynamic range of this player was approximately 111 dB. The more stringent EIAJ dynamic-range measurement yielded a reading of 94.6 dB for the left channel and 95.8 dB for the right channel. Frequency accuracy of the player section was very good, with a measured master-clock error of 0.0117%.

Finally, I assessed the ability of the CD player section to correct for disc defects such as scratches, missing data, or opaque surfaces caused by dust or dirt. The player successfully corrected or interpolated for missing data measuring 1.5 millimeters in length. That's well beyond the minimum requirements called for in the CD Standard, but some home CD players will track perfectly through missing data that is 2.0 mm or more in length. On the other hand, this player was very resistant to external vibration and shock—an extremely important characteristic for a CD player intended for mobile use.

As for sound quality and ease of use, there would be little point in my addressing those issues from my test bench or even from my reference listening room. Only a test drive can properly reveal the merits (or demerits) of any car audio system. So, I leave it to Technical Editor Ivan Berger to detail his experiences while putting this tuner/CD changer through its paces.

From my own point of view, I must commend Alpine for coming up with a DIN-sized, single-chassis unit that can handle three CDs at a time. While disc changing took longer than it does with separate, trunk-mounted, car CD changers (around 12 to 15 seconds), as I stated in my report on the first-generation version, this is a rather small price to pay for the convenience of having three hours or more of continuous music available in your dashboard. *Leonard Feldman*

Behind the Wheel

I said last year that I might make the then-current Alpine three-CD changer my new reference unit, if Tony Igel of Stratford Sound could shoehorn its two chassis into my dash. He could, and I did. Will I do the same with the new 7982? I'm less sure.

On the positive side, the newer Alpine has the convenience of a removable front panel, faster disc changing (13 seconds instead of a yawning 20 seconds or so), far better AM reception, and a more readable display (especially the amber mode, in daylight). On the other hand, although the 7982 sounds very good, the older version sounds a little better, just a hair more open and natural on every source.

The 7982's basic control layout is an improvement, with two exceptions. The D.A.P. band, which I use for AM and FM traffic reports on those few days I take the car to work, is less accessible now—you have to press "Func," then a preset button, instead of calling it directly. Instead of a broad up/down tuning rocker that can be separately set for manual or seek tuning, the 7982 has a sharper, less comfortable bar, whose action depends on how long you hold it down.

For now, I think the prior model, with its marginally superior sound, will stay on hand as my reference while I continue with the 7982 for daily use. Considering its mix of noticeable advances and minor flaws, I think many people would be overjoyed with it. Even I am impressed by the 7982 in many ways—but not as many ways as with the earlier version. *Ivan Berger*

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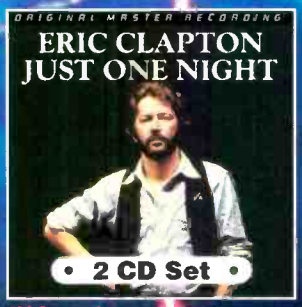

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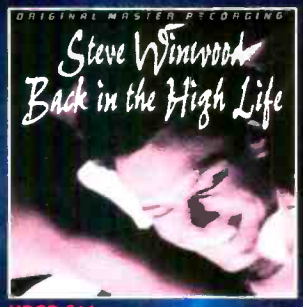

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EQUIPMENT PROFILE

SOUNDSTREAM DA-2 AMPLIFIER

Many THX-certified power amps sell at a premium over amps that would otherwise seem comparable based on conventional specs. Is the premium based on what the market will bear? Is it due to Lucasfilm licensing fees? Or does it cost more to make a THX amplifier? Perhaps it's a combination of all three. I'll leave it to you to decide, but, in point of fact, Lucasfilm does impose stringent requirements for THX certification of power amps, of which the most serious relates to power rating.

To meet Lucasfilm requirements, a power amp must put out a minimum of 28.28 V rms. With 8-ohm loads, that's 100 watts per channel. Although this would seem to be a relatively modest power rating nowadays, Lucasfilm insists that *the same output voltage be delivered into lower impedances as well.* For example, a two-channel THX power amp like the Soundstream DA-2 must put out a minimum of 28.28 V into 3.2-ohm loads. That's 250 watts per channel! Three- and six-channel THX amps get off a little easier as far as minimum load is concerned, but the bottom line remains the same: A THX power amplifier usually has a larger power supply than the average stereo amp.

Consider a two-channel power amplifier rated at 100 watts per channel into 8 ohms. In theory, a non-THX amp could get by with a power supply capable of delivering just 200 watts for the loads plus perhaps 50% more for circuit inefficiency. But a THX-certified amplifier of the same rating must have a supply capable of delivering 500 watts (with 3.2-ohm loads) plus an even wider safety margin for the greater loss in the output stage incurred when operating into a low impedance. I'm not saying here that well-designed, non-THX amplifiers shave things so closely; most deliver more power into lower impedances than they do into 8 ohms, which implies a supply capable of delivering that power. But most stereo amplifiers do not carry matters quite so far as Lucasfilm requires.

THE SOUNDSTREAM DA-2 PACKS A MIGHTY WALLOP INTO A MINUSCULE AND EFFICIENT PACKAGE.

Beefy power supplies are costly, especially when designed in the conventional manner, i.e., a line-operated power transformer, rectifiers, and filters. To handle high power at the 60-Hz line frequency requires a massive power transformer to prevent core saturation and huge filter capacitors to maintain the supply voltage between successive charge cycles. Soundstream sidesteps the problem in the DA-2 by using a high-frequency switching power supply.

The DA-2's supply operates at approximately 60 *kHz*, so it recharges the filter capacitors about a thousand times more often than a line-operated, 60-Hz supply. Microfarad for microfarad, the effectiveness of the filter bank is multiplied accordingly, although the capacitors must be specially designed to handle high-level, high-frequency ripple currents. Furthermore, at 60 kHz a relatively small ferrite-core toroid can handle the flux required to supply adequate power without saturating.

Thanks to this switching-mode supply, Soundstream manages to cram a 200-watt-per-channel THX-certified stereo power amp into a package only 1¾ inches high. Three DA-2s would stack up at about 6 inches and power a six-channel THX home-theater system at 200 watts per channel into 8 ohms, 350 watts per channel into 4 ohms, and a whopping 500 watts per channel into 2-ohm loads. Further, each DA-2 can be bridged for mono operation at double the per-channel power into twice the impedance (400 watts with 16-ohm loads, 700 watts with 8-ohm loads, and 1,000 watts with 4-ohm loads).

Switching supplies have another advantage when used in high-power amplifiers: A relatively low turn-on surge. When a conventionally powered amp is turned on, there's a huge in-rush of current as the magnetic field builds up in the transformer and the large filter capacitors take an initial charge. The actual surge depends on the precise point in the line voltage cycle at which the power switch makes contact but can be so large that it trips the circuit breaker. That's especially likely if multiple high-power amplifiers are plugged into the same line and turned on simultaneously.

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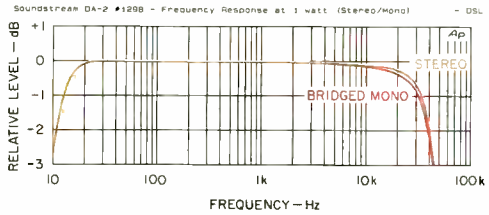


Fig. 1—Frequency response at 1 watt out.

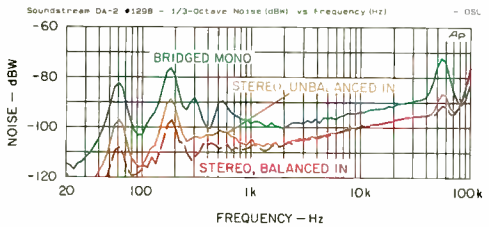
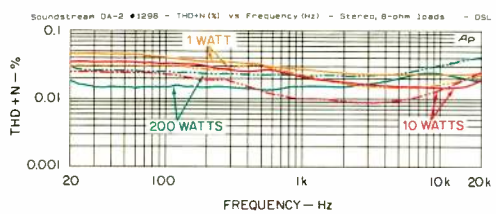


Fig. 2—Noise vs. frequency.



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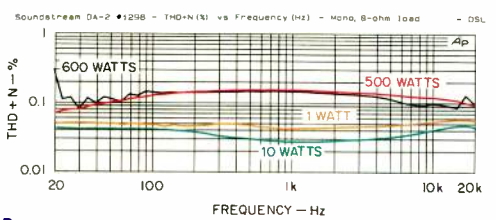

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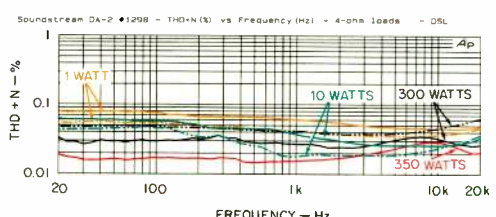

C

Fig. 3—THD + N vs. frequency for 8-ohm loads in stereo (A) and mono (B), and for 4-ohm loads (C; see text).

Switching-mode supplies can be designed to ramp up slowly to avoid the turn-on surge, as Soundstream has done. This is not to say that you can have three DA-2s plugged into the same house line, all delivering 500 watts per channel simultaneously; that's almost certain to flip any home breaker. But if you're using a 20-ampere line, you should be able to turn on three at once (they're rated for a 6-ampere turn-on surge), and once the amps are on, it's unlikely that you will require all channels to operate flat-out simultaneously over any appreciable time period.

Control Layout

The DA-2 features both balanced and unbalanced inputs via XLR and gold-plated RCA jacks, respectively, at each end of the rear panel. Between each set of inputs is a pushbutton that selects between them ("Bal/Unbal"); a second pushbutton, on the "Channel 2" input at the left of the back panel, selects between "Mono" (bridged) and "Stereo" operation.

Centered on the back panel is a circuit breaker, with an IEC three-wire jack for a removable line cord to its left and output connectors to its right. The latter are gold-plated, heavy-duty five-way binding posts spaced to accommodate "GR" type dual plugs. What's noteworthy about them, however, is that their through-holes will accommodate 6-gauge wire. Between the circuit breaker and the output connectors is an "Accessory Link" hookup, which permits the Soundstream C.2THX preamplifier (or any other preamplifier using a 5-V remote trigger signal) to turn on one or more DA-2 amplifiers.

The front panel has only a recessed power indicator and a "Power" switch that overrides the remote turn-on. (The switch is left in the out position when you are using the remote hookup.) When first plugged in (or when power is restored), the Soundstream DA-2 goes through an initialization sequence that can take up to a minute. If the amp is left on standby, the turn-on delay is much shorter.

Except for a pattern of small ventilation slots at the far left and right, the top and bottom plates are solid—presumably to help contain the powerful 60-kHz signal generated by the supply. Heat from the output stage is dissipated by finned extrusions that extend to the left and right of the main chassis. Thermal sensors, mounted on each sink, shut the amplifier down in case of overheating. The switching power transistors appear to use the amplifier's bottom plate as a heat-sink. The output transistors are clamped to the heat-sinks with a mounting bar rather

SPECS

Power Output: 200 watts/channel, 20 Hz to 20 kHz, into 8-ohm loads, at less than 0.1% THD with both channels driven; at 1 kHz, 350 watts/channel into 4 ohms, 500 watts/channel into 2 ohms; maximum single-channel output at 1% THD and 1 kHz, 240 watts into 8 ohms, 400 watts into 4 ohms, and 500 watts into 2 ohms; bridged mono, 400 watts into 16 ohms, 700 watts into 8 ohms, and 1,000 watts into 4 ohms.
Frequency Response: 20 Hz to 20 kHz, +0, –0.3 dB; 10 Hz to 45 kHz, +0, –3.0 dB.
S/N: 110 dB, A-weighted, re: 200 watts into 8 ohms.
THD: Less than 0.1%, 20 Hz to 20 kHz, from output of 1 to 200 watts into 8-ohm loads.
Input Impedance: 11.5 kilohms.
Slew Rate: Greater than 30 V/μS.
Damping Factor: Greater than 500.
Average Power Requirements: 120 V a.c., 400 VA.
Dimensions: 17½ in. W x 1¾ in. H x 15 in. D (44.5 cm x 4.5 cm x 38.1 cm).
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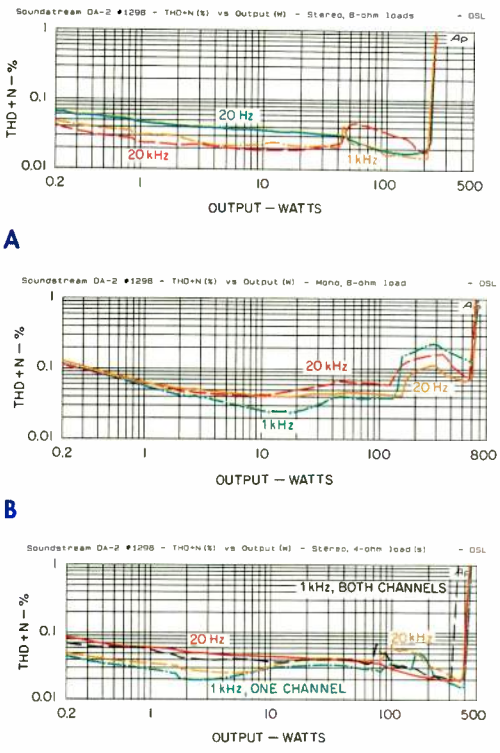


Fig. 4—THD + N vs. output for stereo operation into 8 ohms (A), for bridged mono into 8 ohms (B), and for 4-ohm loads (C; see text).

than being individually mounted with screws through the transistor tabs. This arrangement helps ensure better contact between the junction area of the device and the heat-sink.

Circuitry

The layout is neat, and component quality appears good. The power supply occupies its own board, which is centrally located within the case and shielded from the audio boards that flank it. Printed-circuit traces are wide where that's needed for current handling, with point-to-point wiring used only where necessary. Four 1,200-µF, 180-V electrolytics serve as the main power-supply filter. Soundstream claims that because of the high frequency at which the power supply operates, these filters have the equivalent storage capacitance of a 220,000-µF bank at 60 Hz. The main toroidal switching transformer appears to be hand-wound with a multifilar winding. The power line has r.f. filters to reduce 60-kHz energy flow into the house wiring.

No schematic was available for reference during my testing, but it seems apparent that the DA-2 employs output coils for protection against wayward loads. Soundstream claims, however, not to use current limiting in the output stage, relying instead on a circuit that senses the load and shuts down the system if the load impedance drops below 0.5 ohm.

The output stage operates in what is now known as Class H. For low to medium signal levels, the output devices are powered from relatively low-voltage rails; as the signal level rises and approaches the low-voltage rails, the voltage is increased to stay above the signal until, ultimately, full supply voltage is reached and the amplifier clips. This technique provides greater efficiency in the output stage during normal operation, reducing heat generation.

Soundstream prefers to keep the details of its Harmonic Phase Correction circuit close to its chest, but I was able to gather that the system is intended to keep distortion-generated harmonics in phase with the fundamental over a wider portion of the audio band than is typical with other designs. This is said to mimic the phase relationships that occur in the harmonic structure of musical instruments and thereby render distortion less audible.

Measurements

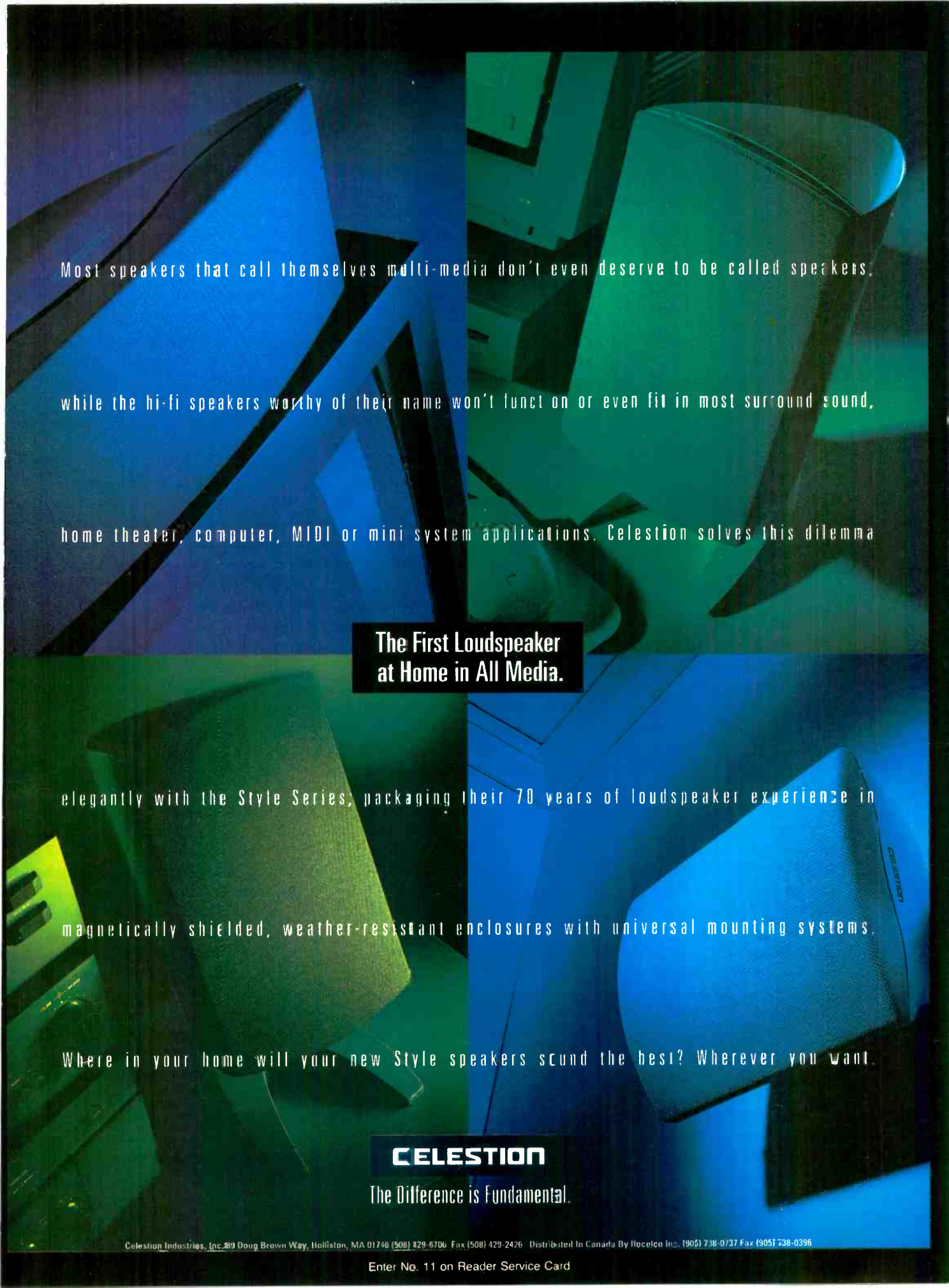
Switching supplies are two-edged swords; they eliminate the need for a large transformer and filter bank, but they potentially generate huge amounts of high-frequency noise, which must be kept from contaminating the music directly or via intermodulation. The DA-2 employs input filters in each channel to reduce these effects. The filters have an initial slope of 18 dB per octave and a cutoff frequency of 46 kHz. In the audio band, response is +0.0, −0.2 dB from about 18 Hz to 20 kHz, which meets THX requirements. Actual response is shown in Fig. 1 for both stereo and bridged operation. These curves were taken on the left channel, using the unbalanced input, but the response from the balanced input was the same, and the result for the right channel was so close to the left's that there was no point plotting it.

A small amount of 55-kHz switching noise can be seen in Fig. 2, but it's more than 85 dB below 1 watt (except in bridged mode) and, in my opinion, negligible. However, I did find it impossible to listen to weak FM stations on my lab tuner when operating the DA-2 near it. In fairness, the problem was mainly on weak stations, and I was using an indoor dipole. If you're in a stronger reception area and/or use a good outdoor antenna and a shielded downlead, you'll undoubtedly be in better shape.

Figure 3 shows THD + N versus frequency. Figure 3A depicts stereo operation with 8-ohm loads at output levels of 1, 10, and 200 watts per channel. At low levels, right-channel THD + N (dashed curve) is below left-channel distortion (solid curve). But the roles reverse at rated power, where left-channel distortion reaches a maximum of 0.03% at 8.5 kHz, while right-channel distortion continues to rise to 0.05% at 20 kHz—still only half that allowed by Soundstream's specification. At clipping, the DA-2 delivered 235 watts per channel (23.7 dBW) into 8 ohms and, with the IHF tone burst, managed 290 watts (24.6 dBW) of dynamic power a side into 8 ohms, for a dynamic headroom of 1.6 dB. Comparable results for 4-ohm loads were 455 watts per channel and 1.1 dB, respectively, and for bridged mono operation were 925 watts and 1.2 dB. However, the line voltage may have dipped during the 20-mS tone burst without registering on my slow-responding live-voltage meter, in which case this data may understate the DA-2's capability.

Bridged for mono with an 8-ohm load (Fig. 3B), THD + N just tops 0.15% at 500 watts, the maximum output at which I was able to maintain a 120-V line. The jagged nature of the 600-watt curve reflects the onset of clipping as the Audio Precision test gear attempted to maintain 600 watts with a line voltage that had sagged below the reference. I calculate that, had it been possible to maintain a 120-V power source, output at clipping for these conditions would have been 820 watts (29.1 dBW).

Similarly, it was impossible to maintain the correct line voltage with stereo operation



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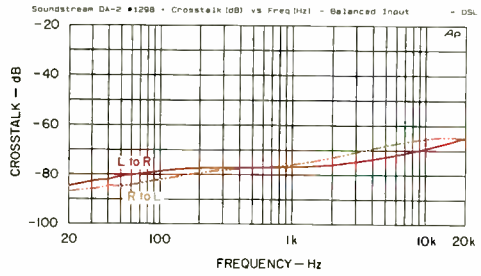

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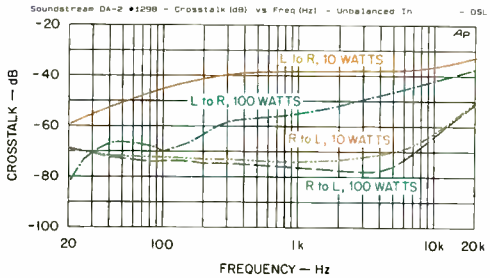

B

Fig. 5—Interchannel crosstalk for balanced input at 10 watts out (A) and for unbalanced output at 10 and 100 watts (B).

into 4-ohm loads at Soundstream's rated power of 350 watts per channel. Figure 3C therefore shows the results in stereo at 1, 10, and 300 watts per channel, where the line voltage could be maintained (again, with solid curves for the left channel and dashed curves for the right), but the 350-watt results are in mono, to maintain the proper line voltage. I expect the mono curve would be representative of two-channel operation for those whose power company is more generous than mine. The THD + N, which remains under 0.08% under all conditions, easily betters Soundstream's claim, and maximum output level (450 watts, or 26.5 dBW) exceeds spec by a decent margin.

The distortion curves of Figs. 4A, 4B, and 4C depict THD + N versus output using test frequencies of 20 Hz, 1 kHz, and 20 kHz. Because of the difficulty in maintaining proper line voltage at the power levels that this amplifier is capable of producing, I ran the 4-ohm curves with one channel driven and repeated the 1-kHz measurement with both channels operating.

The anomalies in the shape of these curves around 45 watts (stereo operation into 8 ohms), 150 watts (mono operation into 8 ohms), and 75 watts (stereo operation into 4 ohms) probably correspond to the point at which the output stage switches from the low-voltage rails to the high-voltage rails. Needless to say, the transition could be more seamless and may account for some of the characteristics I noted during my listening tests, but the distortion through the transition point is still relatively modest.

I also noticed what appears to be power-supply switching noise riding on the positive-going portion of the signal at particular output levels, which also may correspond to the anomalous region. Soundstream is convinced that these anomalies are an artifact of the measurement process, caused by switching noise entering the ground lines when one device (the Audio Precision test equipment) is connected to both input and output. I take extreme precautions to prevent ground loops in my test setup, but I cannot guarantee that there isn't enough stray capacitance between the Audio Precision's input and output that some high-frequency switching noise wouldn't leak through. If Soundstream is correct and the problem is one of leakage, it should not occur when driving loudspeakers.

The final set of curves, Figs. 5A and 5B, shows crosstalk versus frequency. The data is quite good from the balanced input but rather odd from the unbalanced input, where left-to-right crosstalk is substantially greater than right-to-left crosstalk and, furthermore, varies with signal level.

THE DA-2'S CLARITY AND IMAGE DEPTH THROUGH THE MIDRANGE WERE OUTSTANDING.

Sensitivity (100 mV for 0 dBW from the unbalanced or balanced input) is right on the THX spec; sensitivity for bridged mono is 51 mV. Output impedance is, at 0.22 ohm or less across the audio band, within a gnat's whisker (and experimental error) of THX requirements; the resultant damping factor is 310. Channel balance is near perfect (0.04 dB); input impedance (10.7 kilohms, balanced or unbalanced) is fine. The A-weighted noise was –90.6 dBW for the unbalanced input, –91.2 dBW for the balanced input, and –82.2 dBW for bridged operation with the unbalanced input; from a technical standpoint, better A-weighted noise figures than these could be expected.

Use and Listening Tests

Despite my demurral about measured noise, the Soundstream DA-2 was certainly not noisy in the listening room. At normal listening distance, no trace of electronic noise could be heard, and, even with my ear close to the speaker, electronic noise was barely discernible.

The immediate characteristic that struck me when listening to the DA-2 amplifier was its remarkably solid and powerful bass. Although its response is no flatter or more extended than that of other good power amps, it seemed as if it were plumbing depths yet unfathomed; the results were very gratifying.

The second quality to which I reacted was the DA-2's outstanding clarity and image depth through the midrange. This was particularly noticeable at low and moderate listening levels, both on solo classical instruments (harpsichord, piano, and violin) and on voice. On louder passages, however, the sound thickened perceptibly on choral passages and became more strident when reproducing stringed instruments, whether struck, plucked, or bowed. Interestingly, the low bass remained solid and clean at all levels, and, when really pumping out the watts, the amplifier seemed to regain its aplomb and sound better over the entire frequency range than it did at the middling level.

The Soundstream DA-2 packs a mighty wallop into a minuscule package. Under lab-test conditions, it gets warm and draws substantial current from the power line, but in normal use, it's efficient and runs cool as a cucumber. I really do believe you could stack three of these amps, power them from a single house line, and provide a few kilowatts of on-demand, short-term power to your home theater setup as conditions demand. That's a lot to say for this mighty mini. *Edward J. Foster*

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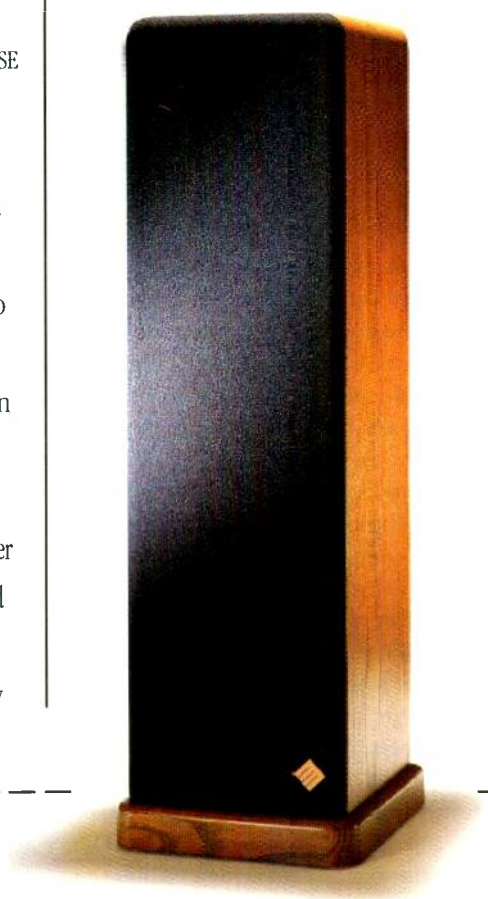

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EQUIPMENT **PROFILE**

STAX DAC-TALENT BD D/A CONVERTER

Stax can generally be depended on for excellent gear with out-of-the-ordinary performance and features. I have greatly enjoyed a number of its products over the years—electrostatic headphones, for example. A few years ago, the Stax DAC-X1T D/A converter was considered state of the art, so it was with some interest that I reviewed the newer, less expensive D/A converter.

What sets the DAC-Talent BD apart from other converters is that it uses battery power, for total isolation from the a.c. line. The unit runs off one set of batteries, isolated by relays from the charging system, while another set charges; when the battery charge falls to a preset point, the system switches over to the newly charged battery set, and the first set starts recharging. Other performance-enhancing attributes include the use of two Burr-Brown 1702 multibit D/A converter chips, double phase-lock circuitry to minimize the effects of incoming signal jitter on the regenerated clock signals, and an analog output section based on a plug-in, upgradable, current-to-voltage converter of the current-feedback type.

The system consists of three separate pieces: The ACD-1 a.c. line power supply, the BPS-Talent BD battery power-supply system, and the DAC-Talent BD D/A converter itself. The D/A converter's rear panel carries three selectable digital inputs: RCA-phono coax, BNC coax, and EIAJ optical (Toslink). The unbalanced analog output jacks use the same high-quality jacks as the RCA digital input. A seven-pin connector receives power from the battery power supply's captive output cable; a similar cable on the line power supply feeds the battery supply. On the front panel of the D/A converter are two unmarked, horizontally oriented toggle switches under a seven-LED display. The left switch selects between the three digital inputs, with the LED indicators above showing the current choice ("Opt," "RCA," or "BNC"). Three more LEDs show which incoming sampling frequency is being decoded; the last LED shows when the analog output has been muted by pushing the second toggle switch to the right.

The interior area of the D/A converter is taken up by a double-sided p.c. board, which carries input-selection circuitry at its rear-panel end and most of the remaining circuitry up near the front panel. Between these two circuit areas is a large space containing only a small plug-in daughterboard near the front of the board that holds the current-to-voltage analog output circuit. Another set of sockets near the rear of the board suggested that a much bigger daughterboard might be plugged in to accommodate a future upgrade. As it turns out, a large daughterboard, containing a different current-to-voltage section,

SPECS

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S/N: 118 dB.
Dynamic Range: 104 dB.
Channel Separation: 120 dB.
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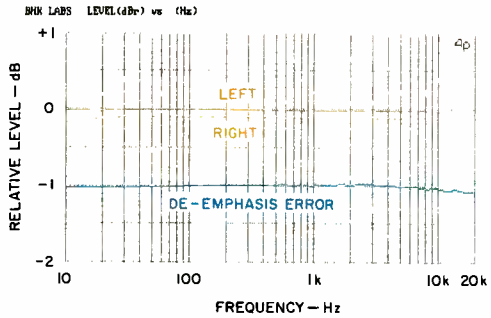

Fig. 1—Frequency response and de-emphasis error. The latter is displaced 1 dB for clarity.

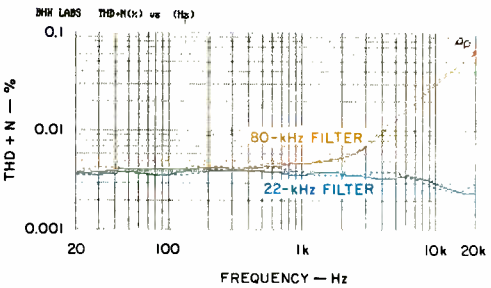

Fig. 2—THD + N vs. frequency. The rising curve for the 80-kHz filter is not distortion; see text.

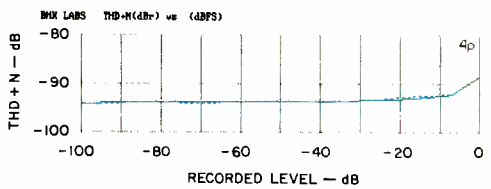

Fig. 3—THD + N vs. level.

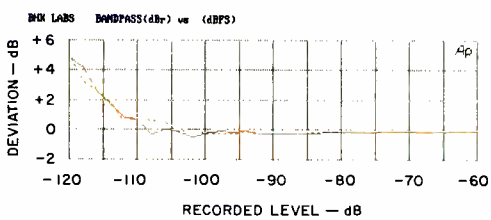

Fig. 4—Deviation from linearity.

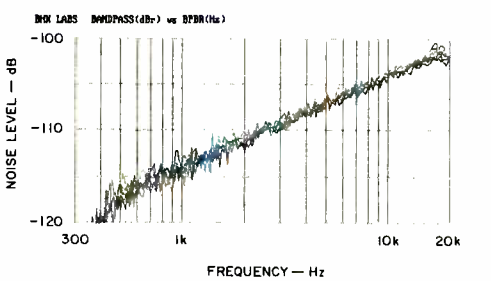

Fig. 5—Noise-modulation test; see text.

was available, so I obtained one in order to try it out.

As might be imagined, the battery supply box is largely (60%) filled with batteries—six 6-V, sealed lead-acid units, rated at 1.2 ampere-hours apiece. A motherboard in the remaining space mounts three plug-in boards that manage the charging and discharging (through powering the DAC) of the two sets of three batteries. A small piezoelectric device sounds when the battery charge gets low.

Of the three chassis pieces, the line power supply is the simplest and the least elegant in construction, having no front trim panel. Inside is an EI-core power transformer whose primary and secondary windings are on separate halves of a split bobbin. A small p.c. board holds the a.c. line fuse, rectifier diodes, and the main filter capacitor (a 3,300-µF, 16-V electrolytic).

Circuitry

Each incoming coax signal is isolated by a transformer. Inverter logic gates amplify and square up the transformer-secondary signals that are applied to a signal-selector IC, as are similarly squared-up signals from the Toslink optical receiver. The selected output is routed to a surface-mount Yamaha YM3436C input digital receiver. The secondary phase-locked loop is contained on a small, potted daughterboard carrying surface-mount parts. (Because I had no schematic, this discussion is based on my examination of the units and is necessarily less complete than I would like.) A separate voltage-controlled oscillator for each incoming sampling frequency is indicated on the block diagram in the owner's manual.

Of interest here is the following digital low-pass filter, which is the new NPC SM5842AP. The DAC-Talent BD is one of the first components I've seen to use this filter. It has a wider, 32-bit accumulator, as opposed to the 25-bit accumulators in the somewhat more commonly used SM5803AP and SM5813AP digital filters. The effect of having more accumulator bits is greater low-level accuracy in the filtering operation. In addition, the digital interface of this new filter allows data-word lengths of up to 24 bits. Output of the digital filter goes into the two Burr-Brown 1702 multi-bit DAC chips. Final analog output, in the case of the current-to-voltage (I-V) board originally supplied with the system, is via

THE STAX IS ISOLATED FROM THE A.C. LINE BY BATTERY POWER AND FROM JITTER BY DUAL PHASE-LOCK CIRCUITS.

Analog Devices AD846 current-feedback op-amps used in the stage where the DAC's output current is converted to final audio output voltage. There does not appear to be a final anti-imaging low-pass filter in this design. The alternate I-V board is all discrete (no IC op-amps), in a circuit arrangement that I have no information about.

Measurements

Most of the measurements were done with the originally supplied, op-amp I-V board. Differences between the performance of this board and the alternate, discrete I-V board will be reported where they are significant.

Frequency response is shown in Fig. 1 for both channels without de-emphasis; response with the discrete I-V board was quite similar. Also shown (offset to –1 dB for clarity) is the right channel's deviation from perfect de-emphasis response (in other words, the de-emphasis error); left-channel de-emphasis error was essentially identical. Square-wave response (not shown) indicated the usual linear phase behavior and clipping of the ringing at digital full-scale when playing track 16 of the CBS CD-1 test disc; apparently, the new SM5842 digital low-pass filter is like its earlier relatives in this regard.

Figure 2 shows THD + N as a function of frequency at digital full-scale for 22- and 80-kHz settings of my measurement set-up's low-pass filter. Usually, I display

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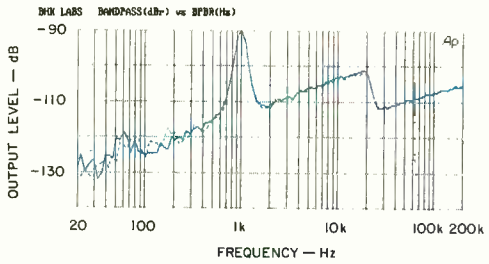

Fig. 6—Third-octave noise analysis; see text.

distortion versus frequency only for the 22-kHz measurement bandwidth. This time, however, I'm showing the 80-kHz results as well, to illustrate a phenomenon whose significance has just jelled for me. This phenomenon is common in D/A converters that use eight-times-oversampling digital filters without a low-pass filter following D/A conversion. What looks like increasing distortion at higher audio frequencies for the 80-kHz bandwidth is actually an increasing amount of the 352.8-kHz oversampling frequency and its harmonics, in the D/A process' stair-step approximation of reconstructed samples. As the signal frequency increases, the magnitude of the steps increases because there are fewer of them per period of the signal frequency. (With measurement bandwidth opened up to 500 kHz, there is even more of this out-of-band energy.) It is not audio-frequency signal distortion per se, but its presence could possibly cause some distortion in the rest of the audio system due to slew-rate limiting, frequency beating, etc. in following equipment. Who knows—this may be partially responsible for some of the undesirable qualities often attributed to digital sound. The phenomenon is not unique to this converter, I am certain, and I will be reporting on it in subsequent reviews of D/A converters.

Figure 3 shows THD + N as a function of digital level at 1 kHz. The results are quite good here.

Input/output linearity at 1 kHz, plotted in Fig. 4 as a deviation from perfect linearity, is excellent. Figure 5 shows another test of low-level linearity, the noise-modulation test, devised by Richard Cabot of Audio Precision. A 40-Hz signal is set at amplitudes ranging, in 10-dB steps, from –60 to –100 dB relative to digital full-scale. The analyzer scans the range above 300 to 400 Hz with a swept third-octave filter. The curves should overlap, with any deviation indicating low-level nonlinearity. The results of the Stax for this test are excellent, as good as I've seen.

I GOT AN EXCELLENT SENSE OF SPACE, DETAIL, PUNCH, AND BASS EXTENSION WITH THIS STAX SYSTEM.

Interchannel crosstalk for both of the I-V boards was better than 110 dB down over most of the frequency range, even approaching that level at 20 kHz.

Test results for S/N, dynamic range, and quantization noise for both I-V boards are listed in Table I. As can be seen, the new, discrete I-V board has

TABLE I—S/N ratio, quantization noise, and dynamic range, in dB, with IC op-amp and discrete current-to-voltage boards; see text.

	OP-AMP BOARD		DISCRETE BOARD	
	S/N Ratio, –120 dB Signal			
Bandwidth	LEFT	RIGHT	LEFT	RIGHT
Wideband	91.4	91.1	92.2	91.6
22 Hz to 22 kHz	93.6	93.8	93.8	93.8
400 Hz to 22 kHz	93.8	93.8	94.0	93.9
A-Weighted	95.7	95.7	95.8	95.8
	S/N Ratio, 0-dB Signal			
Wideband	96.4	95.9	97.8	96.0
22 Hz to 22 kHz	106.4	106.3	112.1	112.1
400 Hz to 22 kHz	106.6	107.0	112.7	112.5
A-Weighted	109.8	109.6	114.9	114.6
	Other Measurements			
Quantization Noise	–92.6	–93.2	–92.4	–93.2
Dynamic Range	96.7	96.0	96.1	96.2

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slightly better ultimate noise levels. In my test with an undithered, 1-kHz, –90 dB tone (not shown), the S/N of this converter with either I-V board was good enough to easily see the three-state (+1 LSB, 0, and –1 LSB) waveform. Figure 6 is a plot of noise in a third-octave bandwidth (with a dithered, –90 dB, 1-kHz signal). Results were the same whether the a.c. line cord was plugged in or not. Overall absolute polarity was correct, with a positive-going impulse resulting for a known positive-going digital input signal.

Use and Listening Tests

Digital signal sources on hand during the review period included Krell MD-10 and PS Audio Lambda CD transports, which fed the Stax system under review as well as a Sonic Frontiers SFD-2 and other, experimental, D/A converters. Analog source equipment (used for sonic reality checking) included an Oracle turntable fitted with a Well Tempered Arm and Spectral MCR-1 Select moving-coil pickup feeding a Vendetta Research SCP-2C phono preamp, Nakamichi's ST-7 FM tuner and 250 cassette recorder, and a Technics open-reel recorder. Preamps used were a First Sound Reference II, a Forssell tube line driver, and a Quicksilver Audio unit. Power amps used were a Crown Macro Reference, Quicksilver M-135s, and Arnoux MB300A and 7B digital switching units. Speakers were B & W 801 Matrix Series 3s, augmented by an experimental subwoofer using two JBL 1400Nd drivers.

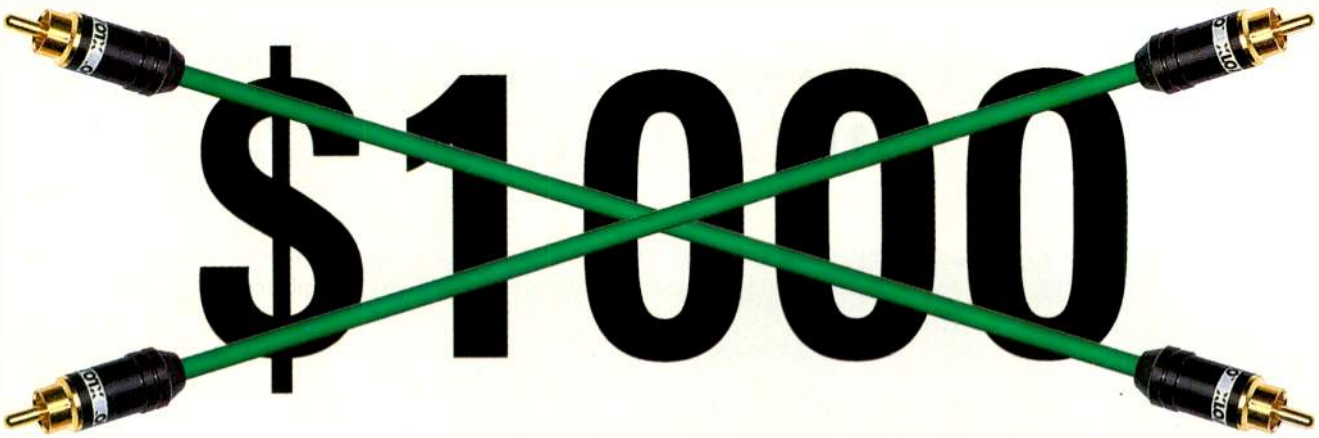
Initial listening to the Stax D/A converter system was done by switching it through my Quicksilver preamp and out to whatever power amplifier I was using at the time. The resultant sound was smooth and listenable. However, resolution, spatial replication, and overall musical believability were not of the order obtained with my present reference setup using the Sonic Frontiers SFD-2 with balanced outputs feeding a Forssell tube line driver modified for balanced input, and unbalanced output feeding the power amplifier.

I then decided to connect the Stax D/A converter's output directly into the Crown Macro Reference or into an Arnoux 7B switching amp, both of which have input level controls that allowed me to do without a preamp. First up was the new I-V board: "Wow!" my listening notes say, "this really sounds quite good! Excellent sense of space and good definition and detail." Bass extension, punch, and tunefulness were exceedingly good—as good as or better than my reference setup. With the original IC op-amp I-V board reinstalled, sound was very similar to that with the discrete I-V board—but if I had to make a choice, I would opt for the discrete I-V board. As to overall sense of space and realism, though, the nod still goes to my reference setup by a narrow margin.

No operational glitches occurred in the use of the Stax D/A converter system. One evening, I had left it powered on without feeding a.c. to the charger, and my wife heard a weird sound emanating from the lab the next morning—the "battery-low" warning beep. In my system, with the a.c. cord plugged in and batteries charging, I left it on for long periods of time and had no problems doing so.

In conclusion, I think the Stax DAC-Talent BD D/A converter is a good piece, and I definitely enjoyed listening through it.

Bascom H. King



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AURICLE

ADCOM GFA-5800 AMPLIFIER

I am reluctant to call any power amplifier a "best buy" or a "breakthrough." There are a number of excellent high-quality power amplifiers on the market, and some are quite affordable; Aragon, Bryston, Hafler, McCormack Audio, and PS Audio all have very good products at good prices. I suspect, however, that the Adcom GFA-5800 may still be a "classic." Just as Adcom once changed the standards of the power amplifier market with the 555, it has introduced a new product that may similarly change the market again.

Company Address: 11 Elkins Rd., East Brunswick, N.J. 08816.
For literature, circle No. 94

The Adcom GFA-5800 provides most of the detail and sweetness of high-end tube amps with the power delivery, control, extended bass, and flat upper treble of high-end transistor amplifiers. It is a very different and far better-sounding amplifier than any Adcom product I have heard to date—and Adcom's past products were pretty good. It is also a little difficult to believe that this amplifier is in the $1,500 price range. In fact, I had two high-end loudspeaker manufacturers refuse to believe it until they saw for themselves that it really was driving my reference Apogee Studio Grands. I can't think of a better compliment for an amplifier or one that does more to indicate that this is a product that deserves attention.

FOR ONCE, AN AMP THAT CLAIMS TO COMBINE SWEETNESS WITH MUSCLE ACTUALLY DOES.

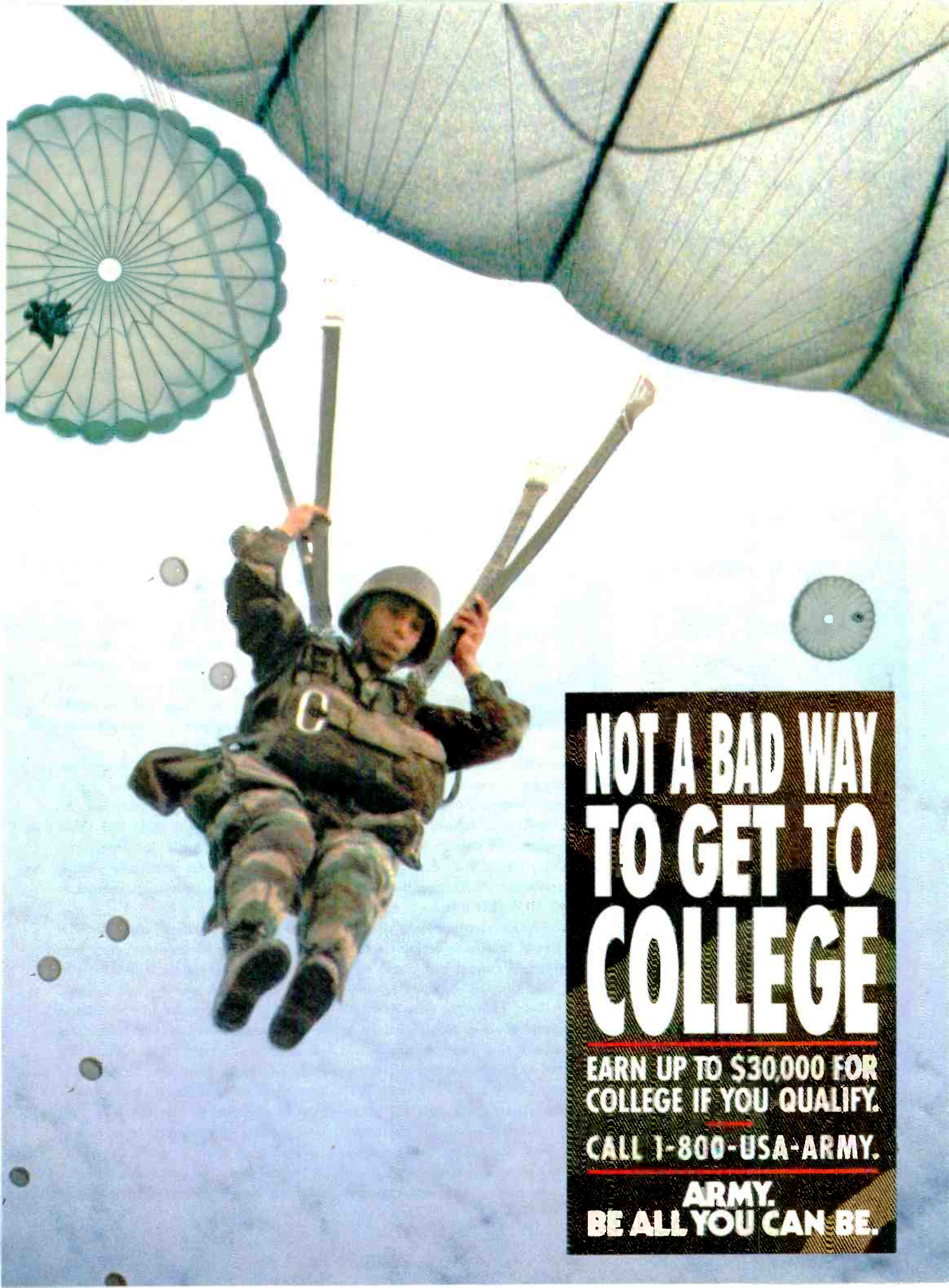
Part of the reason this amplifier sounds so good may be that much of its design was conceived by Nelson Pass, whose new Pass Laboratories' Aleph line has emerged as one of the best-sounding products in the ne plus ultra price range of high-end products. At the same time, Adcom has also used its long production runs to take advantage of economies of scale and to put a great deal into the product.

The GFA-5800's circuitry is very different from that of previous Adcom amplifiers. The power supply has limiting to prevent a rush of power to the transformer and capacitors at turn-on. It has completely separate main power supplies for each channel, which take power from a large toroid transformer but do not even share the same ground connection. It has 150 joules of energy storage for each channel, and the power-supply ripple voltage is normally less than 1%.

The front-end circuitry for each channel has its own regulated high-voltage supply, which eliminates interaction between the early gain stages and the output stages and also helps to reduce noise. This amplifier's front-end operates at a higher voltage level than its output stages do, to reduce distortion and allow the front-end to drive the output stages to their supply rails, thus putting all available power to the load.

All audio elements use MOSFETs, and even the input transistors are power devices capable of delivering 2 amperes of current. Adcom believes that the high input impedance

Photo: Michael Groen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of MOS-FETs allows a very simple pass-through, and provides high thermal stability, high output-stage bias, low offset voltages, and reliable operation with very high output currents and voltages. Adcom also claims that the "characteristics of the MOS-FET is sonically superior to the bipolar transistor, delivering all of the muscle of bipolar circuitry with the sweeter qualities found in tube equipment." I have heard this kind of claim countless times for different devices and circuits, and I would leave it buried in the manufacturer literature—except that it is not a bad description of the GFA-5800's sound.

The inputs offer balanced operation, which is tied directly into the front-end, without the use of active circuitry or op-amps, and common-mode rejection is in excess of 40 dB. The gain path of the GFA-5800 is very simple; it only uses three stages versus five or more in many competing amplifiers. The front-end circuitry is single-ended Class A, and each of the channels is biased to about 100 watts of idle current to provide near-Class-A operation.

THIS IS THE KIND OF PRODUCT WHICH SHOWS THAT THE BEST OF THE HIGH END CAN BE TRULY AFFORDABLE.

The current sources in the circuit are doubly regulated for stability. Very little use is made of feedback. The input devices are matched to within 0.25%, and the output stage uses MOS-FETs that are matched to within 2.5%. Each output-stage channel uses 16 very high-capacity devices (20 amperes of output current each), and each channel is capable of withstanding transients of about 3 kW. The GFA-5800 can deliver complete power into 2-ohm loads and is stable driving 1 ohm or less. Distortion is only slightly higher at 2 ohms than at 8 ohms.

Modular construction puts the active circuitry for each channel on a single mechanical block formed by the heat-sinks, and it assures short signal paths. Each channel also has its own cooling tunnel backed up by a thermostatically controlled d.c. fan. In practice, the GFA-5800 did not exhibit any noticeable mechanical or electrical hum, and I did not even hear whether the fans were running. The unit, incidentally, runs cool even after prolonged listening to loud musical passages.

The GFA-5800 is rated at 250 watts per channel into 8 ohms and 400 watts into 4 ohms. IM distortion at full power is rated at less than 0.05%, and THD into 8 ohms is rated at 0.02% at 1 kHz and only 0.16% at 20 kHz. Power bandwidth is 3 Hz to 130 kHz, dynamic headroom is 2.1 dB, damping factor is greater than 1,100, and rise-time is 2.2 µS. There are both balanced and unbalanced inputs with gains of 29 and 26 dB, respectively. The input impedance is 30 kilohms. The rated S/N is less than 100 dB, and the Adcom sounds—well, maybe *doesn't* sound—like it!

All of this is packed into a relatively small chassis (8 x 17 x 13¼ inches), although the amplifier weighs a fairly hefty 57 pounds without its optional rack mount. The front panel has no features save for an off/on switch and five LEDs to indicate whether power is on and to warn of overdriving or overheating. The rear panel has a.c. and power-supply fuses, balanced and unbalanced inputs with a switch to choose between them, and two sets of universal binding-post terminals per channel to make bi-wiring easier.

The Adcom GFA-5800 did an excellent job of driving my Apogee Studio Grand, B & W 801 Matrix Series 3, and Thiel CS5 speakers. It had no problems with Quad ESL-63s or difficult loads like Spendor BC-1s, and it seemed extraordinarily insensitive to differences between interconnects and speaker cables.

With all of the speakers I could find, the GFA-5800 delivered excellent, deep bass power and control—to the limit the speaker permitted. Bass was live and dynamic without the unattractive loss of control that becomes a bother. The sound was closer to what I expect from Krell or Jeff Rowland Design amps than from amplifiers anywhere near this price range. You may be surprised to find out how good your speakers are when you first try an amplifier of this quality.

The real factor that makes this amp outstanding, however, is its ability to deliver

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midrange and upper midrange information in such a way that it seems to expand the amount of information available as well as reduce any edge or harshness. "Sweet" and "liquid" are overworked words that have little direct meaning in terms of sound quality, and yet they still seem to apply to the Adcom GFA-5800. This is very definitely not one of those transistor amplifiers whose middle and upper octaves seem to give extra detail at the expense of also adding upper octave energy and a touch of harshness.

The GFA-5800 was particularly good with demanding solo piano, violin, and harpsichord recordings. These are instruments that a number of otherwise good amplifiers often make more "interesting" than musically natural, particularly with close-miked LP and CD recordings. The GFA-5800 makes them musical without any of the loss of upper octave detail you find in some warm transistor or tube amplifiers. The bite of brass and the reed sound of the clarinet were reproduced as you'd expect to hear them in a live performance, without the slight electronic sound "roughening" I expect from most transistor amplifiers.

Early in my reviewing, I spent most of my time concentrating on musical instruments and was only struck by how well this amplifier did with voice when I realized that I had also gone through some prolonged listening sessions with solo and mixed male and female voices and had never been bothered by anything. I don't expect an amplifier to change the timbre and dynamics of voice unless there is something seriously wrong with it, but I do expect to hear slight changes in air and vocal character of a kind that I do not hear in live music. The Adcom GFA-5800 kept them to a minimum.

The imaging, soundstage, dynamics, and transparency of the Adcom GFA-5800 had the kind of realism and integration I only expect to find in far more expensive products. I was surprised that the Adcom imposed no coloration in these areas. I normally expect transistor amplifiers anywhere near the GFA-5800's price to make the soundstage seem a bit forward, to place instruments a bit too precisely from left to right, and to deprive them of natural depth. The Adcom had as deep a soundstage as the input material permitted, and instruments were imaged with natural size, definition, and depth. At the same time, the soundstage was wide and open, without exaggeration.

In short, the Adcom GFA-5800 stands out even in a world where almost all amplifiers now sound good. It does everything exceptionally well for its price, and its upper midrange and treble and overall musicality are hard to find in any amplifier not costing at least twice its price. Getting the best of tube and transistor sound from one amplifier has become an audio cliché, but the GFA-5800 comes very close. This is the kind of product that shows the best of the high end can be made truly affordable. While it may have competition, it is a product I would be certain to audition if I planned to spend more than $1,000 for my amplifier. I leave it to the marketplace to decide whether the GFA-5800 will be a "best buy," but its sound quality is of such high caliber, I am certain that this amp will get a lot of high-end audiophile attention.

Anthony H. Cordesman

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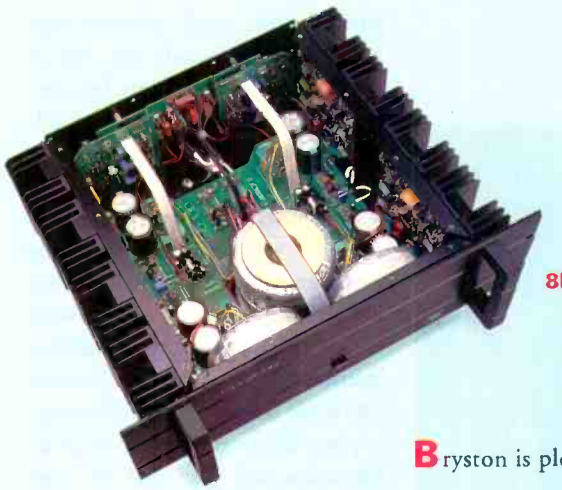

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THIEL CS1.5 SPEAKER

The current trend in loudspeakers is to make them as small as possible, hide them in walls, or have a system that consists of small left and right satellites with a separate woofer or subwoofer. There are, however, practical limits to how small you can make a really good speaker and to how well you can hide one. Trying to get full-range performance from a small speaker always means a sacrifice in bass capability. Building a speaker into a wall virtually always means a major sacrifice in soundstage performance and often in frequency response as well. Using a separate woofer or subwoofer almost always means audible problems in the crossover region—unless the crossover frequency is well below 100 Hz.

Thiel takes a different approach in the CS1.5, a full-range floor-standing loudspeaker clearly designed to be kept several feet away from the side and rear walls. At the same time, it is relatively compact, measuring 8½ inches wide, 11 inches deep, and 33 inches high. Its low visual profile and sloping front, together with the fact that it is deeper than it is wide, make it seem smaller than it is.

I'd much rather live with the visual image of a small floor-standing loudspeaker like this Thiel than with the more obtrusive look of a box speaker placed on many of the stands I've seen recently. And while the Thiel CS1.5 is, at $1,990 per pair, not inexpensive, a true price comparison with small shoebox-sized speakers must include the cost of stands. You will never get top performance by locating any loudspeaker worthy of the name on a piece of furniture or in a bookshelf.

The Thiel's cabinet is very well finished, with an attractive grille that does not have to be removed for best performance. The cabinet walls are an inch thick and have extensive internal bracing to reduce vibration. The baffle is sloped to provide proper phase alignment and transient information and, like that of most other high-quality speakers, has smooth, round edges to reduce energy diffraction and provide a more open sound.

The tweeter is a 1-inch metal dome with a large magnet, vented pole piece, and reinforced rear chamber for low resonant frequency and wide bandwidth. The 6½-inch woofer uses a rigid aluminum diaphragm to eliminate cone break-up and energy storage; a short-coil, long-gap magnet to reduce distortion, and a copper pole piece to maintain a stable magnetic field. The woofer has two magnets with a total weight of more than 2.4 pounds; the second magnet has reversed polarity to reduce the stray magnetic field of the loudspeaker and allows the CS1.5 to be positioned nearer the TV in an audio/video system. There is a passive bass radiator to lower bass resonance and eliminate possible vent noise. The 18-element, first-order crossover is phase-accurate and uses polypropylene capacitors and low-oxygen, air-core inductors.

Frequency response is ±3 dB from 42 Hz to 22 kHz. Thiel's detailed frequency response curves exhibit

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exceptionally smooth performance from 50 Hz to 2 kHz and only minor irregularities up to beyond 20 kHz. The 30° off-axis response is very close to the main-axis response and is only about 5 dB down at 20 kHz. Time and step responses are also very good, revealing exceptionally fast, clean response, with excellent phase coherence.

The only caution I would give about the specs is that the speaker's rated 4-ohm impedance drops to as low as 3 ohms. I did not find that the CS1.5 posed any problems for well-designed power amplifiers, and it did not seem to be a difficult load. There are, however, a number of receivers and a few power amps that don't perform well with low-impedance speakers.

THE CS1.5s GIVE YOU WHAT IS ON YOUR RECORDINGS, WITHOUT COLORING OR ROMANTICIZING.

The first things that struck me about the sound of the Thiel were its smoothness and speed. The term "monitor" is much overworked, but it is perhaps the best term to apply to the CS1.5. There is very little coloration in the midrange and no roll-off or exaggeration in the treble. While there do seem to be some small irregularities in the response somewhere around 4 kHz, I did not hear any that significantly colored voice, piano, or guitar.

Furthermore, the Thiel has a great deal of transient detail and resolving power. It may not match the best ribbon speakers in this regard, but it is the equal of many electrostatics and is much better in reproducing subtle, low-level musical and soundstage detail than most of the small to moderate-sized monitors that I have auditioned. The CS1.5 also is as fast and detailed in the upper bass and lower midrange as it is in the upper midrange and treble—outstanding performance in this price range.

The Thiel CS1.5 does not seem to favor one kind of music or recording over another. These speakers simply give you what is on your recordings, without coloring or romanticizing—a naturalness that is particularly welcome on voice and strings but

also comes through quite clearly on solo piano and percussion sounds such as cymbal and snare drum.

This accuracy in frequency and detail is matched by good soundstage performance. The CS1.5 does not dramatize the soundstage or produce a large and open soundstage with every recording. Depth and width are natural rather than "exciting." If anything, the soundstage is just a bit smaller than normal. The apparent listening position is a bit forward, and there is a feeling of being slightly above the soundstage.

The CS1.5 does a very good job of making naturally recorded stereo music *sound* natural. Many smaller monitors impose a fixed soundstage on the music they reproduce; for good or bad, they become the concert hall and alter the music accordingly. The soundstage of the Thiel may initially seem understated by comparison, but what you hear is the recording and not the speaker. Imaging is equally natural. Some small stand-mounted monitors almost "etch" the imaging, providing a more defined image for each instrument than is actually on the recording. The CS1.5s do not artificially fix the image in place, and they do not alter its size.

The Thiel's bass, however, is not deep or powerful by high-end standards. This may present problems in large rooms or where bass power is a key consideration. The CS1.5 certainly has as much or more bass than most speakers its size, and it does produce considerable power to below 50 Hz, if not much below 45 Hz. It has exceptional bass detail within its range, and its bass response rolls off very smoothly, without the boost or hump that many small and medium-sized monitors exhibit just above their bass cutoff frequency.

Coupled to the speaker's flat and extended treble, this lack of added bass warmth or boost can make the CS1.5 seem a bit lean and lacking in bass energy. This is likely if you place the cabinet 3 feet from a rear wall and 5 feet from a side wall, as called for in Thiel's instructions. Try the CS1.5s in a medium-sized room, and place them closer to the rear wall for a touch of room reinforcement. Also, use the spiked feet and avoid an amplifier that is dry or lean.

BASS DETAIL IS EXCEPTIONAL, AND RESPONSE ROLLS OFF SMOOTHLY, WITHOUT A BOOST OR HUMP.

The CS1.5 is capable of excellent dynamics and a surprising amount of output, bettering many speakers in these respects. Fine for classical, jazz, and most rock, it's a speaker for those who enjoy music and accuracy more than sheer power.

The Thiel CS1.5 is an excellent example of how far medium-sized monitors have come in the last few years. It may not have the deep bass or dynamic range of its more expensive siblings—and if I had the money, I would prefer the Thiel CS3.6. That speaker, though, costs almost twice as much. What the CS1.5 does provide is an excellent soundstage and upper bass, midrange, and treble I'd associate with speakers costing a great deal more. With the right placement, the CS1.5 is an outstanding buy, one that makes true high-end sound affordable. *Anthony H. Cordesman*

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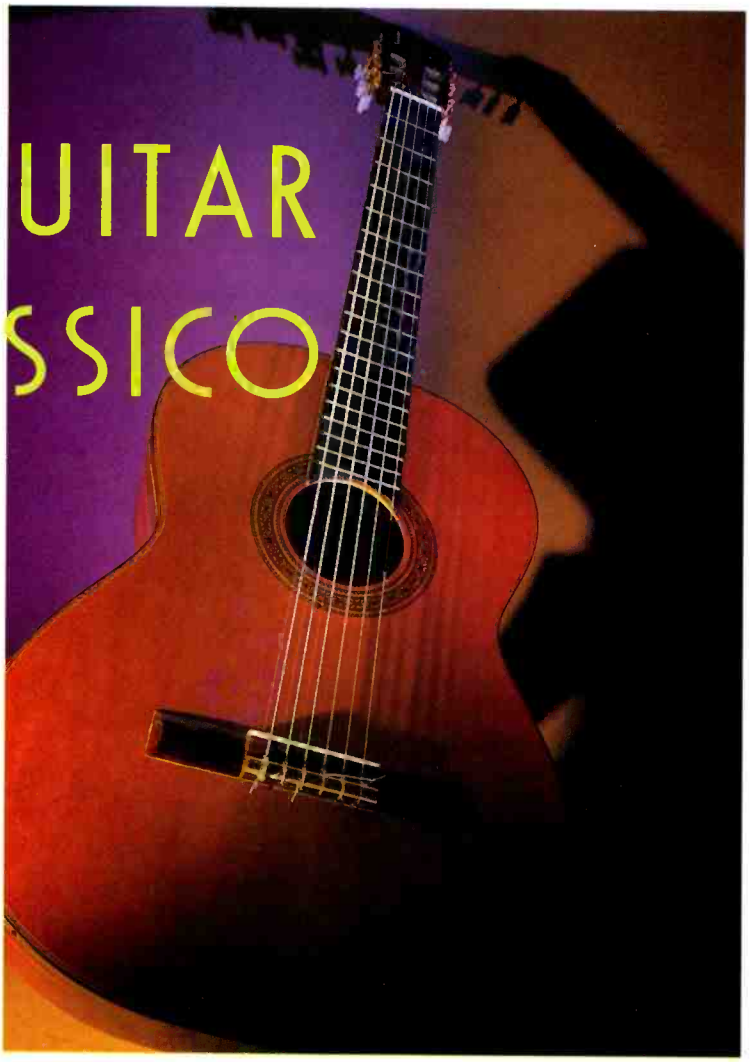

Photograph: Michael Groen

The Seville Concert

John Williams, guitar;
Orquesta Sinfónica de Sevilla, José Buenagu
SONY CLASSICAL SK 53 359
CD; DDD; 58:19
Sound: A, Performance: A+

J. S. Bach

Julian Bream, guitar
EMI CLASSICS CDC 5 55123 2
CD; DDD; 69:56
Sound: A–, Performance: A

With Andres Segovia's death, the "guitar godfather" mantle naturally fell to the next generation of virtuosi, who really came of age in the '60s, landing on that oddest of couples, John Williams and Julian Bream, two guitarists whose approaches are almost night and day. Unlike the Maestro, who kept the limelight on himself to the end, Williams and Bream have maintained low profiles for years. Thus, it's serendipitous that they should simultaneously release new programs to give us a sort of aesthetic "Clash of the Titans."

For the Australian whiz-kid Williams, the effects of a long career have been salutary indeed. After toying with rock in his 1970s band Sky and big-band pop in the '80s, Williams has returned to the repertoire that sustained him in his earlier days with this "greatest hits" retrospective, *The Seville Concert*. Recorded in 1992 at Spain's Royal Alcazar Palace using the resonant articulation of Super Bit Mapping, Williams is dazzling on solo chestnuts like Isaac Albéniz's blistering "Asturias" and dancing "Sevilla"; in ensemble with the Orquesta Sinfónica de Sevilla, he is inspired on Vivaldi's buoyant Concerto for Lute and the grandly serene, if overexposed, Adagio from Joaquín Rodrigo's "Concierto de Aranjuez." Less familiar selections include Yuquijiro Yocoh's "Sakura Variations," its lush minor mode evoking Japanese flower gardens; Agustín Barrios Mangoré's shimmering tremolo étude "Sueño en la Floresta," and Nikita Koshkin's schizophrenic tone poem "Usher Waltz," a demanding guitarristic tour de force and tribute to Edgar Allan Poe. Williams' strength has always been his technique, and

Villa-Lobos: Discovery of Brazil: Suites Nos. 1 to 4

Slovak Philharmonic Choir and Slovak Radio Symphony Orchestra, Roberto Duarte
MARCO POLO 8.223551, CD; 79:03

As one of the most original composers of this century, Heitor Villa-Lobos expressed his Brazilian nationalism by using folk song materials of his country as the source of inspiration in his colorful music. The complete "Discovery of Brazil" is clearly an epic in music. Its music was originally written for a 1937 film that used an idealized story and characters to tell of the crossing of the Atlantic to Brazil in 1500 by Portuguese explorers.

Some section titles give an idea of the massive score: Moorish Impression, The Rattlesnake, Celebration in the Forest, Vision of the Navigators. Suite No. 4 adds a baritone soloist and chorus to depict the first Mass in Brazil, with Latin hymns mingling with the wild melodies of the Indians. It brings together diverse elements for a lyrical and spiritual apotheosis in sound. *John Sunier*

it has never been more powerful. However, with the years has come a deeper insight into dynamics and interpretation that makes this record simply *brilliant.* It's so good, in fact, that the most hardened musical curmudgeon will not mind the occasional programmatic cliché.

If Williams' reputation rests on technical prowess, Julian Bream has always been known for his romantic readings—and, if

anything, his *J. S. Bach* takes him further into the realms of *personal* style. Just as Williams revisits previously recorded works, Bream casts his gaze back on one of his primary preoccupations. Recorded at the Forde Abbey in Dorset, England, also in 1992, Bream explores standards such as the exquisite Prelude, Fugue, and Allegro, BWV 998, taking his time as he slowly unveils its spine-tingling mysteries, and the lighter, more sprawling Suite in E Minor, BWV 996, whose bouncing movements are often excerpted but here receive a thoughtful and satisfyingly complete performance. Perhaps most challenging—and telling—is Bream's assault on the grandiose Chaconne from the Partita BWV 1004. This theme and variations, because of its nearly 16-minute length, is difficult to maintain with the limited range of the guitar. Clearly in his maturity, Bream has learned the secret of pacing. Rather than race ahead, he lets the music breathe, emphasizing the emotional dissonance here, expanding and relaxing there. In his hands, the Chaconne becomes a meditation, progressing from serious beauty to something almost whimsical, its final briskly punctuated chords anticlimactic but ever so breathtakingly beautiful.

The contrast between Williams and Bream can be perfectly heard in their performances of the Prelude to the so-called Fourth Lute Suite in E Major, also known as the Partita BWV 1006a. Williams does just the Prelude, whereas Bream performs the entire suite. For Williams, this transcendent harmonic drama moves flawlessly and inexorably toward the final ornamental turnaround at a midtempo trot that carries you along without time for anything other than sweet emotion. For Bream, the evolution is more in the tension of the statements, pausing at the ends

of phrases, lingering over big round notes, settling almost anticlimactically on a final tone—more as a *prelude*, which, of course, in this context it is. Both interpretations are laden with feeling, but Williams goes for the visceral impact while Bream prefers the more cerebral route. This is the wonderful thing about music: It can serve such divergent masters equally well.

The joy of having two godfathers is the anticipation of more chiaroscuro like *The Seville Concert* and *J. S. Bach* to come. Let's hope their appearance marks the beginning of newfound energy rather than just a reflection on successful careers. *Michael Wright*

Kevin Volans: Kneeling Dance; David Lang: Face So Pale; Steve Reich: Four Organs; Robert Moran: Three Dances

Piano Circus
ARGO 440 294-2, CD; DDD; 53:45

Quite a leap from ensembles of yore such as The First Piano Quartet, this mixed sextet of Steinway-ticklers, Piano Circus, has specialized for about five years in British and American composers of a broad minimalist persuasion.

David Lang's "Face So Pale" dissects a ballad by Guillaume Dufay, dividing its original three parts among the six pianos. Lang wanted to create a "nervous vocal tradition," and he succeeded well. It may even make *you* nervous—though not nearly so nervous as Steve Reich's tedium study, in which four ensemble

members switch to the pseudonymous four electronic organs. It's said to be the only composition existing in which the sole activity, during its entire 16-minute length, is the gradual lengthening of individual notes in just one chord.

Kevin Volans' "Kneeling Dance" gives you 23 more chords than the Reich work, and they will surely be appreciated. It's an enjoyable little dance piece. Robert Moran's "Three Dances" are even more relishable. They originally were created for actual dancers, and there is also a version for full orchestra; here they are transcribed for six synthesizers. All three dances are quirky, witty, and not so minimal that their 19-minute duration becomes at all tedious. *John Sunier*

Officium

Jan Garbarek, saxophones; The Hilliard Ensemble
ECM 445 369-2, CD; 77:41

With the saturation of Gregorian chant already reaching the level of parody (note the Benzedrine Monks of Santo Domingo), it seems ECM may be late to church with this combination of 13th- through 16th-century polyphonic hymns and chants underpinning the saxophone improvisations of Jan Garbarek. But this is home ground for The Hilliard Ensemble, and Garbarek has been exploring links between medieval and contemporary music for the last six years or so.

Garbarek's keening saxophone brings an uncharacteristic yearning to these sacred texts. While the Hilliards intone the serene

sounds of contemplation, Garbarek seems fraught with anguish. As often happens on his recordings, the more subtle the backing, the more strident he becomes, making his soprano sax sound an obliterating whine rather than a celestial plea. It's like a warning that all

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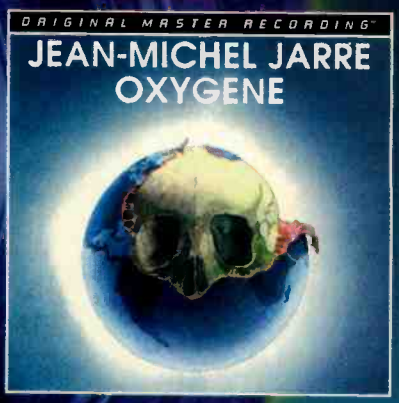

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is *not* serene in the monastery, but I don't think that is the intent.

The Hilliard Ensemble, as ever, is sublime, and when Garbarek catches the spirit, his improvisations are graceful embroideries.

John Diliberto

Ave Maria

Vinson Cole, tenor;
Ascension Music Chorus, Dennis Keene
DELOS DE 3138, CD; 64:44

There is a change going on in the sound of the American professional chorus, and it is for the good. The smoother, thinner, and more blended sound is an immense assist to the willing listener. Time was (the day before yesterday) when our professional choruses were all too often aggregations of would-be opera singers, each striving to outdo his or, especially, her neighbors; this sort of massed vocal power is appropriate, if not historically accurate, for any 19th-century grand opera and for big celebration music of numerous sorts, but it is out of place in the rest of the choral literature.

Looking at the cover of this CD, directed by a strict professional, you will instantly "hear" that sound! Such a profusion of buxomness and bulk, dressed to the nines (and 10s), low-cut gowns, ample flesh, white tie and tails—the works. But just *listen!* To my astonishment, this chorus sings lean. It has power, all right, but also blend. The wave of the future? I hope and predict. Not surprising, perhaps, since it is a close descendant of familiar U.S. groups conducted by those indomitable Americans Gregg Smith and Roger Wagner.

The program is not on the conventional side either, though it does range from the sublime to the corny (that unspeakable Bach-Gounod "Ave"). There are other "Ave Maria" programs by the hundreds, year after year (I myself must have conducted three or four), and many hundreds of settings of the familiar "Hail Mary" text, but mostly the same familiar works reappear (as might be expected). Here they are too, but only a few of them, from Schubert (out of Sir Walter Scott's *Lady of the Lake*!) to Victoria. Mostly this program goes off on interesting sidelines—Fauré, Holst, Mendelssohn, Pablo Casals, Duruflé, and two Bruckners. Some of this is nothing very profound as music, but all of it does listen well.

Moreover, the usual obligatory pair of 16th-century items, Palestrina and Victoria, wonder of wonders, is sung by a half-size semi-chorus sounding for all the world like an authentic little-boys choir! Look again at that cover and be amazed!

There are assisting artists—notably organ and tenor solo, also harp and piano. The tenor Vinson Cole is sincere and dedicated, but his excellent voice has developed a big waver and he slides upward into many of his notes. Okay if you like it. He is not really an asset to this recording in spite of profuse quoted praises. *Edward Tatnall Canby*

Sebastiàn de Albero: Sonatas Para Clavicordio

Joseph Payne, harpsichord
BIS CD-629, CD; 68:31

Let's first deal with the incorrect terminology here: The Spanish called harpsichords "clavichords"! (What they called clavichords is not a detail I am privy to.)

The many recent releases of obscure early harpsichord compositions fill holes in the recorded keyboard repertory—and are inexpensive to produce, to boot. Unfortunately, many of these works sound like the sort of pieces that would be more enjoyable to play yourself, providing you had a harpsichord handy, than to listen to. That's not so with this exciting collection—though I'm anxious to get my hands on the published music.

Albero worked for the Spanish royalty at the same time as Domenico Scarlatti (Albero was organist of the Royal Chapel). Many similarities exist between the two composers' styles: A binary form that predates the keyboard sonata as we know it, extravagant leaps, rapidly repeated notes, trills in one or both hands at once, parallel scales, glissandos, hand crossings, and horn- and trumpet-call effects. The influence of Spanish gypsy music on both composers is heard in harpsichordal special effects that try to capture the driving excitement of the zapateado and fandango rhythms.

The 17 short sonatas here are as varied as the 550-odd Scarlatti sonatas. As with all other harpsichord recordings, this should be played back at a lower level than that for most CDs, for proper and realistic tone. This exciting music doesn't depend on loudness for its effect! *John Sunier*

Photograph: Annie Leibovitz

Bright Red

Laurie Anderson

WARNER BROS. 9 45534-2, 52:19

Sound: B, Performance: B

Laurie Anderson is writing the code that connects synapses between perception, reality, and possibility. Since her 1982 debut, *Big Science*, she's been the droll commentator and reality check on this thing we call life. On her 1989 album *Strange Angels*, perceptions became more personal, and a bit of that remains on *Bright Red*, which finds her returning to the sparse electroshock arrangements characteristic of her music a decade ago.

While her art and metaphors are based on technology, Anderson has never glorified high-tech so much as warned against it. She sings a virtual lament about people lost in the Internet on "The Puppet Motel," and on "Night in Baghdad" she explores the contradictions in the beautiful fireworks over Iraq during the Gulf War, beamed back like an MTV video on CNN. "Baghdad" and a few other songs are survivors from Anderson's performance work *Stories from the Nerve Bible*, which she toured in 1993.

But Anderson is also looking beyond the world, and judging from songs like "Freefall," she hasn't yet found any answers. "There is another world/Spinning inside of this one," she intones, offering the suggestion that the surface is just the slipcover for another surface.

Producer Brian Eno returns Anderson to her D.I.Y. (do-it-yourself) electronic sound and is probably responsible for the oblique angles of some lyrics. Yet this album is not as musically compelling as her past works, with its reliance on sparse rhythm grooves to hold up skeletal melodies. Despite collaborations with guitarist Adrian Belew and accordionist Guy Klucevsek and a duet between Anderson and another master of the talk-sing style, Lou Reed, she's ultimately standing alone. On her AIDS dirge "Love Among the Sailors," she says, "There is no pure land now/No safe place." Ever the cynic, even Anderson's thin illusions have slipped away. *John Diliberto*

Thirty Years of Maximum R&B

The Who

MCA MCAD4-11020

Four CDs, 5:02:13

An absolute textbook example of what a boxed-set retrospective should be. All the best stuff is included plus some previously unreleased songs ("Early Morning Cold Taxi" is the best), live versions, snippets of on-stage patter, and some odd bits. There would have been more lost songs here, but the *Odds and Sods*, *Who's Missing*, and *Two's Missing* albums, together with Pete Townshend's two *Scoop* collections, pretty much drained the wells. Chris Charlesworth, the Who chronicler who compiled this set, has done a fabulous job of condensing all things Who into four CDs. Sound quality is brilliant, thanks to the remixing and remastering by Andy Macpherson and Jon Astley, and the accompanying 72-page book is gorgeous—loaded with photos, memorabilia, and essays by Townshend, Who insider Keith Altham, and journalist Dave Marsh. An absolutely essential collection.

Michael Tearson

Harry Connick, Jr.

COLUMBIA CK 64376, 63:00

Boyish crooner gets down with some funk and does a credible job of it. Skeptics may have been expecting some watered-down, sanitized pap from Harry Connick, Jr., something along the lines of Pat Boone's take on Little Richard's "Tutti Frutti." But to my ears, Harry sounds more comfortable in this loose, laid-back New Orleans-Memphis R&B bag than in his regular role as America's No. 1 big band crooner.

Connick demonstrates some naturally soulful phrasing and sly vocal nuance on tunes like the jaunty "(I Could Only) Whisper Your Name," the punchy title track, and the grooving Al Green-flavored ballad "Between Us." And he doesn't have to ask permission to get down on the ebullient Mardi Gras number "Here Comes the Big Parade"; Harry's been to enough Mardi Gras parades to know just what to do.

The presence of New Orleans icons like bassist George Porter, Jr., guitarist Leo Nocentelli, and drummer Joseph "Zigaboo" Modeliste (charter members of The Meters) keeps this one solidly rooted in the pocket. And Harry adds some characteristic N'awlins piano flair on the giddy "Funky Dunky," the rockin' "To Love the Language," and "Booker," a somber tribute to the late, great New Orleans piano stylist James Booker.

I'm not sure what fans of Connick are going to make of instrumental funkathons like "Joe Slam and the Spaceship," experimental interludes like "Follow the Music," or the wailing heavy-metal guitar on "Honestly Now (Safety's Just Danger . . . Out of Place)." Given his well-carved niche in the marketplace, this whole thing comes off as incredibly daring. And for me, it works. *Bill Milkowski*

Full Circle

Dixie Dregs

CAPRICORN 2-42021, 40:03

The Dixie Dregs were often called "The Mahavishnu Orchestra of Rock." So perhaps it's only fitting that for their first studio album together in 12 years, they have enlisted the services of former Mahavishnu violinist Jerry Goodman, who replaces Allen Sloan.

The brain behind this fiery fusion outfit remains Steve Morse, a virtuoso guitarist who produced the session and wrote all the material (with the exception of The Yardbirds' "Shapes of Things," which gets a vigorous reworking). The question remains, what exactly is it that these boys are fusing here? We know they have one foot firmly planted in the rock camp, as drummer Rod Morgenstein (recently with pop/metal band Winger) reminds us on hard-hitting numbers like "Aftershock" and "Ionized." But the Dregs aren't really incorporating much improvisation into the formula, and they don't really swing, so the other foot is definitely not landing in the jazz camp. Morse, being an impeccably precise player as well as an intense perfectionist in the studio, probably has more in common with the exacting science of chamber music. This aesthetic comes to the fore on baroque-inspired tunes like "Calcutta," "Yeolde," and the tongue-in-cheek "Pompous Circumstances" and "Sleeveless in Seattle." But the guys do let their hair down and jam on the electric bluegrass breakdown "Goin' to Town."

Morse is an astounding player and an intelligent composer. His Dixie Dregs are the thinking man's Van Halen. *Bill Milkowski*

Eileen Ivers

GREEN LINNET GLCD 1139, 45:13

This is Eileen Ivers' solo debut. She's an Irish fiddler from the Bronx, but hers is no ordinary Irish fiddle album: She employs African percussionist Kimati Dinizulu to excellent effect, and guitarist/pianist Gabriel Donohue adds the exotic sounds of bouzouki, zither, and harmonium to the mix. Still, Ivers' fiddling is the star attraction, and she has lots of style and presence, plus a fabulous tone. With her superb improvisational skills, she often leads a tune into uncharted territory, especially on the opening "Flowing Tide" medley and on "Pachelbel's Frolics," which is built on the theme of the famous canon and moves gradually from a stately beginning to something like an Irish breakdown. With a resumé that lists Hothouse Flowers, Hall & Oates, Fields of America, and Cherish the Ladies, Ivers is a talent to watch, one with the potential to transcend her genre. *Michael Tearson*

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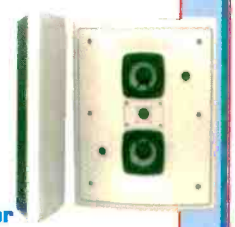

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The Dark Ride
Iain Matthews
WATERMELON CD1025, 46:23

Iain Matthews has been almost too prolific since relocating to Austin, Texas, but his work has been at an astonishingly high level. The latest album, *The Dark Ride*, may be his best yet. Beautifully produced by Mark Hallman, it's the document of a man confronting old demons. Here, Matthews shares with us personal sentiments such as rapprochement with his daughter ("Tigers Will Survive [Part II]") or resisting the pernicious effect of passive aggression ("I Drove") or turning 40 and feeling miserable ("The Dark Ride"). Two strong covers are Michael Fracasso's "Save Her Love" and Tim Buckley's "Morning Glory," the latter sung as a duet with Sara Hickman. Robert McEntee and his Dobro guitar are vital contributions. *The Dark Ride*, another honest and strong set by Matthews, is an album of sweet listening and songs that will leave you thinking.

Michael Tearson

:Woodstock
Jimi Hendrix
MCA MCAD-11063, 57:00

In the wake of CD reissues that are sonically inferior to album masters, and what we consider to be a dissapointing assemblage of Jimi waxing the blues (*:blues*, which was reviewed in *Audio*'s September issue), our anticipation was decidedly not great for MCA's latest mining of its newly acquired Hendrix catalog. But Hendrix's performance at Woodstock was in some ways the same high water mark that his Monterey appearance was. This is Hendrix minus the visual gymnastics—definitely a low-energy vibe but with some guitar virtuosity that, even today, sounds futuristic.

:Woodstock presents only half of his Woodstock set; still, despite the presence of extra band members that day (a second guitarist and two percussionists) and some tuning problems that may tax the listener, Hendrix's legendary performance rings through. Versions of familiar songs such as "Red House" and "Voodoo Child (Slight Return)" are truly inspired, and new instrumental jams are even better. But the tour de force is "Woodstock Improvisation," a five-minute stream-of-guitar-consciousness that reveals a side of Hendrix wholly mesmerizing and amazing. As a guitar hero, he's never been bettered.

Jon & Sally Tiven

Amplified Heart
Everything But The Girl
ATLANTIC 82605-2, 36:38

On the album cover, Tracey Thorn and Ben Watt stand looking away from each other, he with his shirt and pants unbuttoned, she with her belt unlatched and shirt pulled halfway up. Are they getting up from bed? Going to bed? Do they regret the decision? These are the questions examined on *Amplified Heart*, an album of mature music with complex themes that go beyond the usual love-angst.

Thorn has one of the most natural voices in pop. It's an expressive instrument, but she nevertheless conveys the intimacy of someone sitting right next to you. The music, composed by Thorn and Watt, tends toward breezy lite-jazz à la Sade at times, but with veteran folkie sessioneers including drummer Dave Mattacks and master bassist Danny Thompson, and some guitar playing by Richard Thompson, even those moments have an emotional resonance that reflects the album's romantic ambivalence.

John Diliberto

Adios Amigo:
A Tribute to Arthur Alexander
Various Artists
RAZOR & TIE RT 2814, 53:36

As far as the very overplayed phenomenon of the tribute album goes, *Adios Amigo* differs because it's an absolute necessity. Arthur Alexander died in 1993, just after the release of his triumphant comeback, *Lonely Just Like Me* (Elektra/Nonesuch/American Explorer 61475-2). That album marked the end of a 15-year hiatus during which the songwriter exiled himself from music, depriving fans of the incredible talent that left its mark on The Beatles (especially John Lennon) and so many others, some of whom appear on *Adios Amigo*. They include Roger McGuinn, Elvis Costello, Robert Plant, Felix Cavaliere, Gary U.S. Bonds, Chuck Jackson, John Prine, Arthur's old friends Dan Penn and Donnie Fritts, and others, who do up 17 of his songs with affection and relish. The excellent house band for the project includes Penn, Fritts, Spooner Oldham, Mickey Curry, and longtime *Audio* writer Jon Tiven. (Tiven coordinated and produced this entire project, with superb results.) Razor & Tie has also released a terrific retrospective, *The Ultimate Arthur Alexander* (RE 2014), if you want to hear the vintage stuff, and Warner Bros. has reissued his 1972 sessions under the title *Rainbow Road* (45581-2).

Michael Tearson

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See Part I of the exam on page 107 and Part II on page 109.

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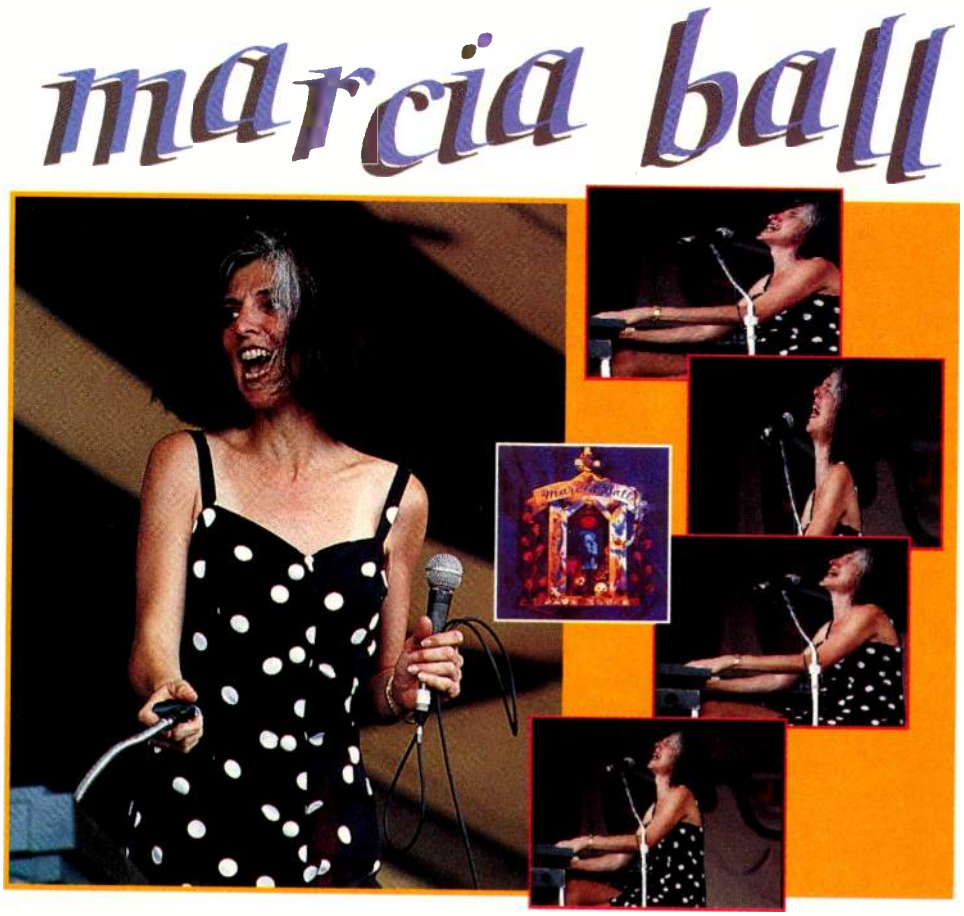


Blue House
Marcia Ball
ROUNDER CD 3131, 53:52
Sound: B, Performance: B+

To call Marcia Ball a walking jukebox of New Orleans R&B doesn't give her nearly enough credit. Sure, she can play Professor Longhair's knuckle-busting piano runs as if she were his spiritual heir. Granted, she's equally at home crooning old Irma Thomas hits. And when she's pounding the daylights out of her piano toward night's end, you can't forget that the music labelled rock 'n' roll was once Crescent City R&B in the hands of such local favorites as Little Richard and Fats Domino.

Over the years, Ball has learned to sing with more power and confidence. Yet she hasn't sacrificed the aching vulnerability in her voice, a legacy of her days as a country act. No less a talent scout than Jerry Wexler, the Atlantic Records impresario who produced Ray Charles, Aretha Franklin, and other legends, once picked Ball as a major talent. Regrettably, the sides he produced for her early in her career were never released.

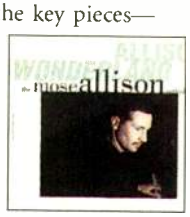
While commercial success has eluded her, Ball remains a top club draw and a Gulf Coast heroine. *Blue House*, her fourth CD for Rounder, features her touring band performing largely original material. Even the covers are well chosen; the Joe Ely rave-up "Fingernails" ("I keep my fingernails long/So they'll click when I play the piano") could have been written for her.

Ball has always seen the romantic side of life on the road. She recalls her childhood on the Texas/Louisiana border—dreaming of busting out of her hometown—in "Down the Road." "Sparkle Paradise" pays tribute to a Texas club. Live, Ball's shows prove her enthusiasm hasn't waned. They aren't as much performances as private parties; on a given night, halfway through the second set, it's not clear if Ball or the audience is having more fun. Only the crowd's shouts of appreciation can stop her when she's egged on by the ghosts of New Orleans R&B greats.

Blue House is the next best thing to seeing this road warrior in a club. In fact, the album so closely tracks Marcia Ball's live performances, sans lengthy solos, that you can't help but wonder why Rounder didn't just cut her live. Maybe next time. *Blue House* will do nicely until then. *Roy Greenberg*

Allison Wonderland: The Mose Allison Anthology
RHINO/ATLANTIC R2 71689
Two CDs, 2:18:50

There's never been anybody like Mose Allison. A consummate piano man whose sharp sense of irony is his best friend, he's represented here by 47 selections dating from 1957 to 1989, including all the key pieces—like "Young Man's Blues" and "Parchman Farm," for starters. Some find Mose's peculiar singing tough to take, but his grace, humor, great jazz sensibility, and Mississippi accent all make him valuable. With Rhino's typically excellent remastering and annotation, this is a superb anthology. Simultaneously, Sony Legacy has reissued Allison's three CBS recordings as a set called *High Jinks! The Mose Allison Trilogy* (J3K 64275);



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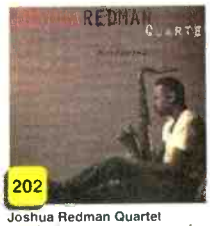

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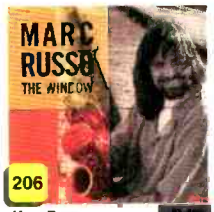

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The Window
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Hiroshima
L.A.

210
Santana
Brothers

212
Wessell Anderson
Warmdaddy In The Garden Of Swing

213
Rohn Lawrence
Hangin' On A String

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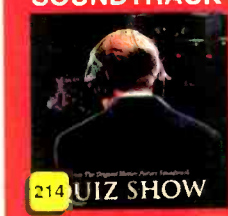

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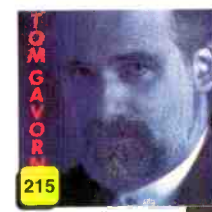

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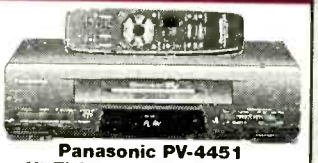

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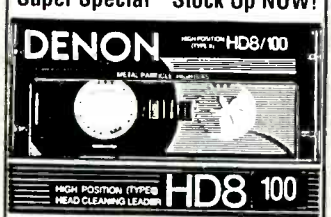

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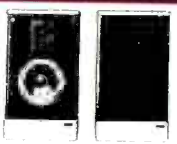

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each album has bonus tracks added. Good stuff but really for completists and hard-core fans. *Michael Tearson*

Big Band Theory

Carla Bley
WATT/ECM 78118-23125-2, 49:21

If she employs one at all, Carla Bley's "big band theory" is one of impressionistic form, of a small ensemble grown bigger and richer but no less intimate—one that, surely, owes more to Charles Mingus than to Stan Kenton. Indeed, Bley's sly but, for the most part, straightforward arrangement of Mingus' "Goodbye Pork Pie Hat" is a direct nod to this inspiration. Still, as always, Bley's original pieces follow consistent themes through ever-changing moods, anchored by Bley's piano, Steve Swallow's bass, and Gary Valente's powerful trombone. "Birds of Paradise" is a suite-like track that moves ably from the symphonic to a Gil Evans-style cool without missing a beat; "Fresh Impression" lifts that same theme yet swings like mad. Throughout, *Big Band Theory* is far from academic, containing some of Bley's loosest, most spontaneous work to date. *Larry Blumenfeld*

Houston Ghetto Blues

Hop Wilson
BULLSEYE BLUES BB 9538, 49:31

No amount of digital processing will ever remove the grit from these sides. With *Houston Ghetto Blues*, recorded in Houston in the early 1960s, we have an outstanding example of music as medicine for the soul, instead of music as product.

Hop Wilson has long been a rarity in the blues world. His urban music was built around his steel guitar, typically played on his lap with a slide; imagine Elmore James playing Delta blues on a Hawaiian steel guitar. Wilson was little noticed outside of Texas, and rarely recorded. Few musicians have carried on his legacy (Sonny Rhodes comes to mind). After one listening, however, Wilson's riveting honesty and brooding intensity rival that of better known peers. Among the backing musicians here, Elmore Nixon deserves special mention for his two-fisted piano work.

Be forwarned that the production is slapdash, Wilson turns the vocal chores over to an unidentified singer on a handful of tracks, and the CD contains alternate takes of several performances. Nonetheless, this is a very welcome release, with some rare and genuinely moving music. "Merry Christmas Darling" is as blue as this music should ever be. *Roy Greenberg*

The Water Is Wide

Jane Bunnett
EVIDENCE ECD 22091-2, 65:58

Jane Bunnett doesn't draw from the Coltrane-Shorter axis of soprano saxophone. Her sound veers closer to Steve Lacy's acerbic tone and squirrelly abstractions. Those abstractions, however, are muted on *The Water Is Wide*, where Bunnett plays a mix of originals and standards.

The Water Is Wide is a varied affair, shifting from a perky reading of Rahsaan Roland Kirk's "Serenade to a Cuckoo" to trumpeter

Larry Cramer's "Burning Tear," a long modal build, with Bunnett wrapping her soprano around the groove with serpentine lines. An expedition called "Influence Peddling" features some particularly fiery interplay between Bunnett and pianist Don Pullen.

For this album, Bunnett has also recruited singers Sheila Jordan and Jeanne Lee, two women from opposite ends of the jazz spectrum. They essay their different styles, wordless vocalese, and interpretive singing on a pair of tunes but come together on the traditional hymn "The Water Is Wide." Their voices intertwine like smoked ice, Lee's husky drawl contrasting with Jordan's more urbane stylishness.

With drummer Billy Hart and some stunning trumpet work from Cramer, *The Water Is Wide* is a strong album that perhaps lacks a definitive focus but reveals some interesting connections. *John Diliberto*

No Words

Tim Hagans

BLUE NOTE CDP 7 89680 2 3, 66:31

Tim Hagans is no stranger to his fellow musicians. At the ripe young age of 40, he has a resumé sporting extensive sideman work with lots of heavies. Oddly, his debut album as a leader is marketed under Blue Note's "Young Artist" product line.

Co-produced by Hagans with the seemingly ubiquitous Joe Lovano—who plays both tenor and soprano saxophones here—*No Words* is a sextet date that sheds light on

Hagans' compositional abilities and musicianship. An adept trumpeter, he plays convincingly and compellingly whether he's blowing hard or offering an introspective look at his music. Guitarist John Abercrombie continues to impress as a thinking man's player, demonstrating immense sensitivity that is typified by his work on the waltzy ballad "For the Music" as well as during the groove tune "Noogaloo," where he and the bandleader play well off each other. The rhythm section—pianist Marc Copland, bassist Scott Lee, and drummer Bill Stewart—shows equal care interpreting these nine Hagans compositions, although I fail to see the need for the Fender Rhodes electric piano which surfaces during "Immediate Left," a track reminiscent of *Bitches Brew*, and amidst the funkified "Housewife from New Jersey." *Jon W. Poses*

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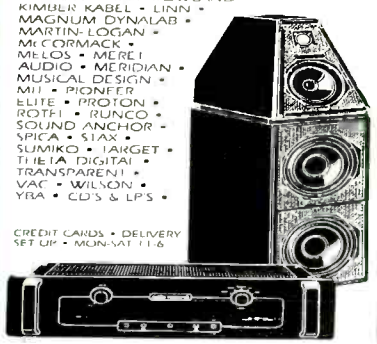

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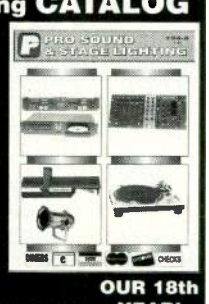

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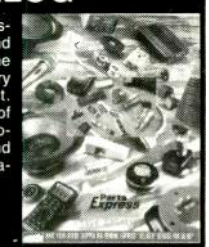

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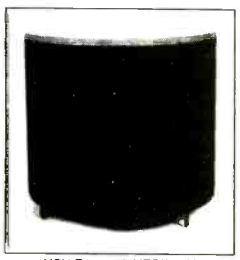

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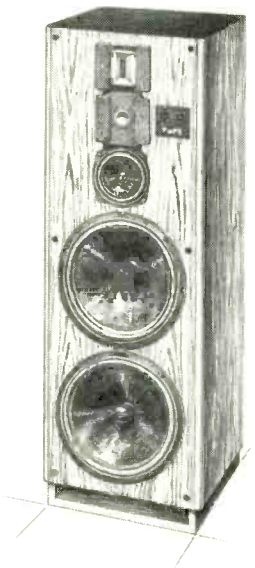

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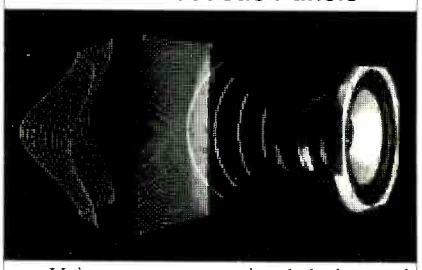

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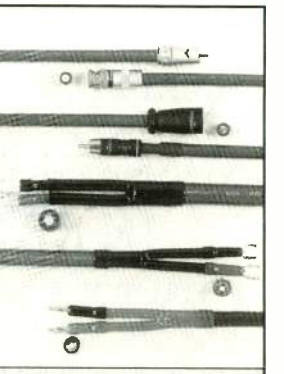

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PlayBack

AUDIOPRISM
Iso-Bearing Vibration Absorbers

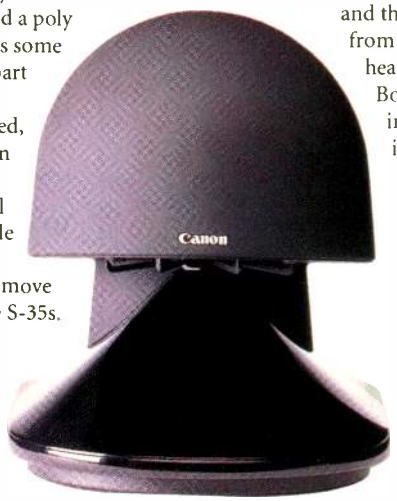
Most audio components have mounting feet located at the four corners of their bottom plates; while these feet protect against scratching the surface on which the component is placed, they are usually inadequate for reducing vibrations. The AudioPrism Iso-Bearings are designed to absorb vibrations that would cause degradation in sound. They come in two sizes: The regular Iso-Bearings, which can support 4.4 pounds each, and the Iso-Bearing 3.3s, which can support 17 pounds each. The smaller Iso-Bearings will support lighter components such as CD players, cassette recorders, and tuners; they should be placed between the bottom of the component and the mounting surface, and they are large enough to keep the mounting feet of most components from touching this surface. The larger Iso-Bearing 3.3 is designed for heavier components such as amplifiers and even some loudspeakers. Both versions did a good job of absorbing vibration energy, including some severe impact shocks. They seemed best at isolating CD and record players from external shocks. I consider them a worthwhile investment (three regulars for $49.95, three 3.3s for $79.95). **E.M.L.**

For literature, circle No. 122

CANON S-35 Speakers

Grade: C

"Wide-Imaging Stereo Speakers" is what Canon calls these little speakers, which boast an unusual design. With a center-mono signal, the image is certainly "wide." The design has two drivers, a dome and a poly cone, arranged almost coaxially, as some car speakers are. The interesting part is that this driver pair is aimed down—at part of an inward-curved, truncated cone that Canon calls an "acoustic mirror." The result is something over 120° of horizontal dispersion, which gives a very wide sweet spot. That's great for a kitchen system, where you might move around a good deal relative to the S-35s. The best sound was with the speakers at ear height. Another good application for this big sweet spot is TV watching, particularly since the drivers are magnetically shielded. Electric bass, piano, and vocals were okay, but cymbals and snare drums had a strange timbre. Overall, at $399/pair the S-35 is a mixed bag, but this may be the only system that works in some applications. **E.P.**



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Grade: B

GE SUPERADIO III

Grade: A

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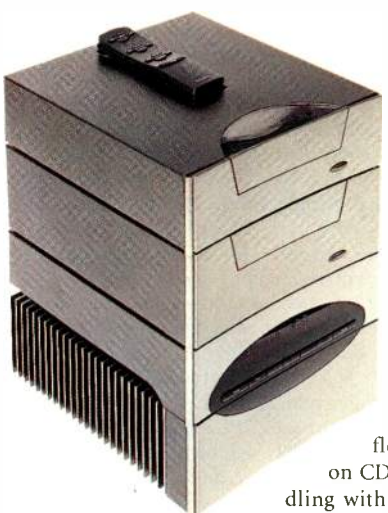
For literature, circle No. 123



Grade: A-

harman kardon
Festival 500 Music System

With its sleek design and near-seamless stack of four modules, the cinch-to-assemble Festival 500 appears as a modern, miniature version of the robot from the '50s cult movie *Kronos*. It includes a full-featured CD player, a cassette deck with auto reverse and Dolby B/C/HX Pro NR, a programmable FM/AM tuner, and an amplifier rated at 60 watts/channel into 4 ohms and capable of driving two sets of loudspeakers. I auditioned the Festival 500 with its optional $399 two-way speakers; whether I placed them on the floor or a shelf, the sound was impressive, especially on CD, handling with equal authority the acoustic filigree of Rosanne Cash and the cavernous thrash of Nirvana. In our metal-frame office building, neither AM nor FM reception was particularly good, what with a minimal antenna; many urban and most suburban locations should be better. Cassette recordings were decent if not spectacular. My review sample was a bit imprecise in its CD and cassette track skip, but otherwise the Festival 500 deserves consideration if you're willing to part with $1,599 for a pretty but secondary, place-anywhere system.—K.R.

For literature, circle No. 121

"PlayBack" mini-reviews are the result of short, sweet, and sometimes deadly testing by our all-too-experienced editors and writers. These hands-and-ears-only write-ups may look like new product announcements, but the grades and text reflect what the reviewer thought after less than an afternoon's "honeymoon."—*E.P.*

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