
AUDIO
THE EQUIPMENT AUTHORITY
MARCH 1994
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QUAD 67
CD PLAYER
INTERVIEW
TONY SCHWARTZ
YOU KNOW HIS COMMERCIALS
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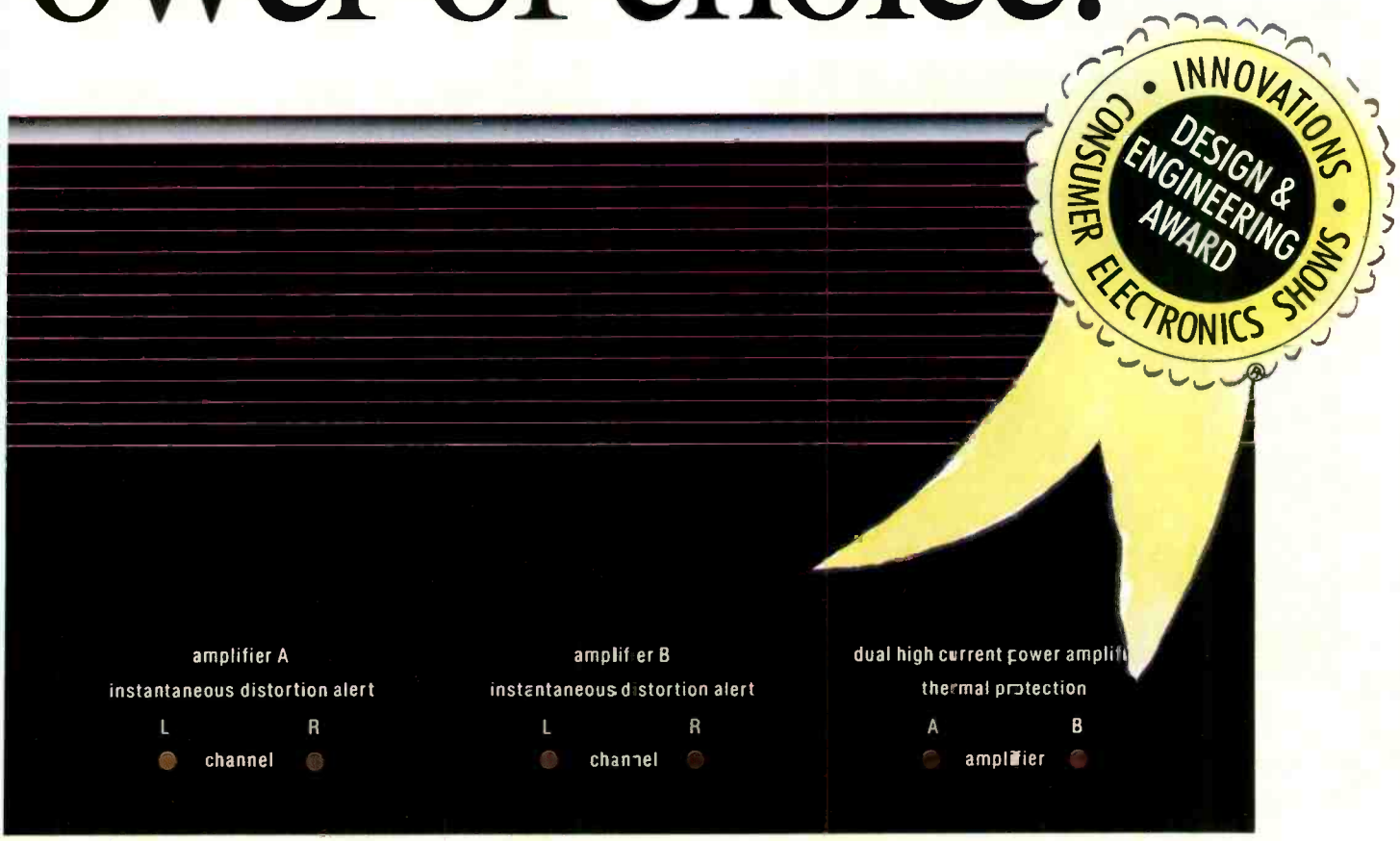

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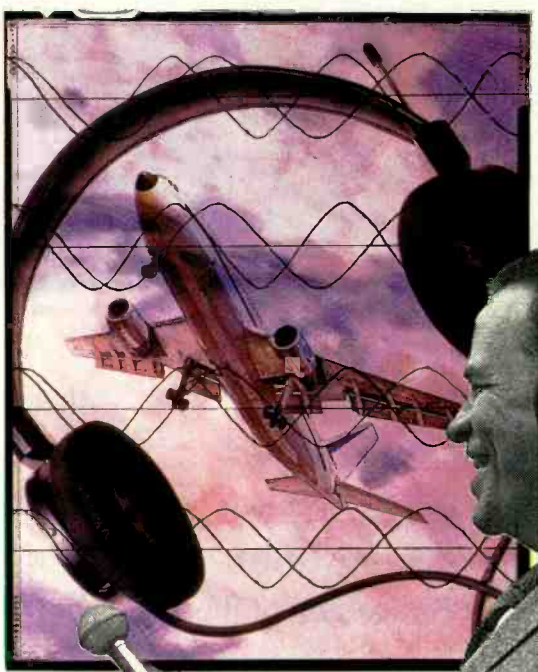

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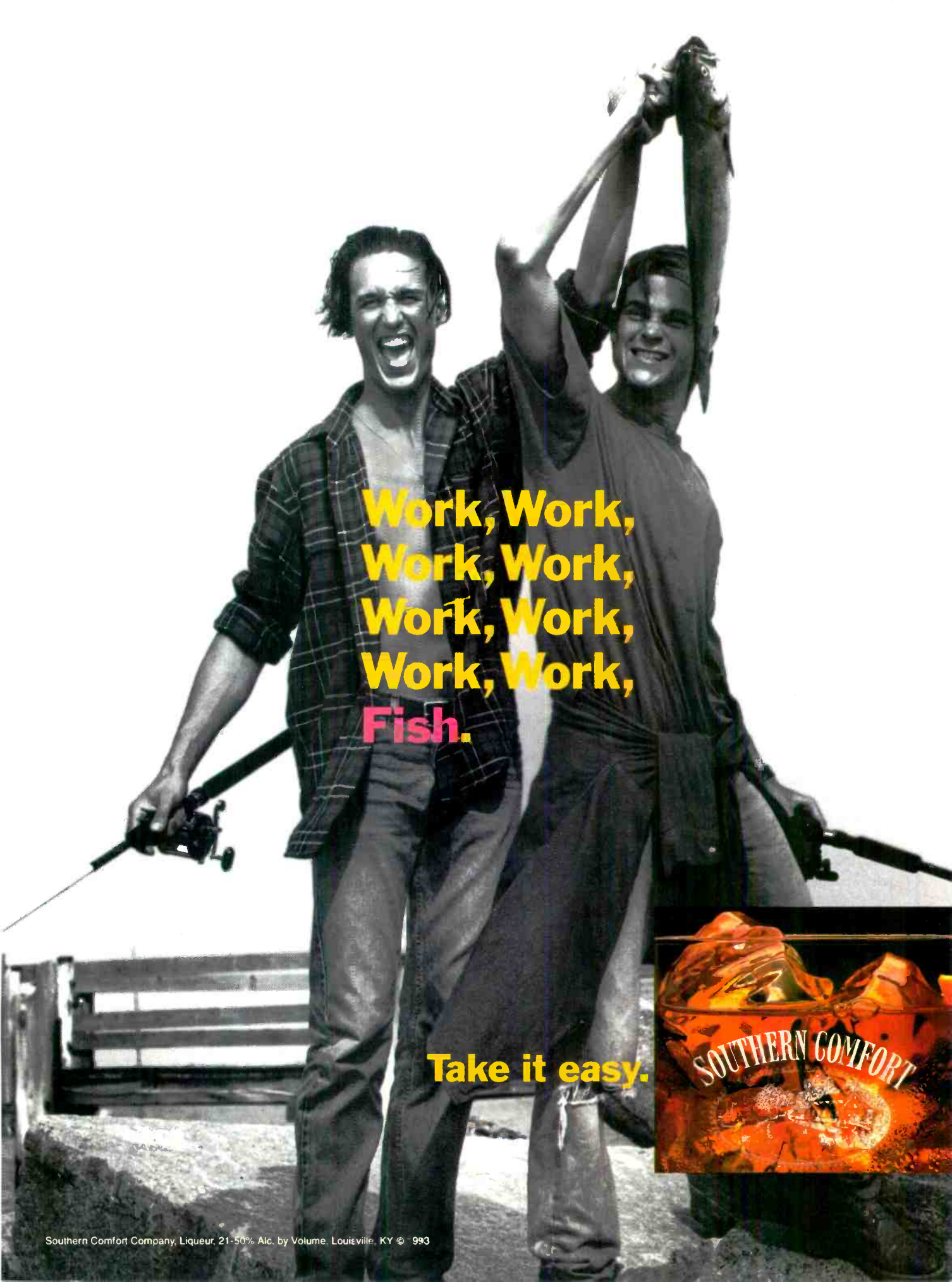

FAST FORE-WORD

There was a lot going on at the just-concluded Winter Consumer Electronics Show in Las Vegas, but perhaps the nicest event of all was the party for Paul W. Klipsch, who was celebrating his 90th birthday. In addition to the obligatory cake, which Mr. K cut, there was a wonderful and fascinating video giving details of his career, and I think it would be extremely popular if it were generally available. I was pleased to note the presence of two of our masthead editors, John Eargle and Don Keele, who worked for Klipsch at different times. I am told that Gary Reber of *Widescreen* magazine did an interview with Mr. K and asked him what he would like to be remembered for. My informant tells me that PWK thought for a while and then said, "Being right." I still have one of the yellow buttons with "Bullshit" printed on it in Old English Script that Klipsch used to give out in the back of Audio Engineering Society technical sessions when someone young and unknowing (like me) tried to reinvent the four-cornered wheel. Happy birthday, Paul, and many more!

The mood of the Show was good, and apparently business was better both there and in the preceding few months. It seems that more people attended than last year, and from the way it looked to me, they stayed longer. The Show people said that the exhibits took more floor space in Las Vegas than ever before. Couldn't prove it by me, but I do know that I had so many obligatory press conferences and meetings that once again I could not cover the whole Show. I heard some one-liner jokes that got me laughing, and I'll share them with you.

From Larry Frederick of Phoenix Gold: "Rap music is a bunch of test tones with voice-overs." From Roland MacBeth of Cerwin-Vega: "Speaker makers have more fun because they don't take themselves very seriously." Our West Coast sales lady, Paula Mayeri, quipped, "There are more hotel rooms within one block of Tropicana and Las Vegas Blvd. than in all of San Francisco." That's sort of an in-joke because of the new hotels just built along that part of the Vegas Strip.

There wasn't a true blockbuster new product or piece of news that set the industry on its ear, though maybe I'm jaded. Instead, there were more nearly evolutionary products and news. I was most interested in various new speakers; ones from Genesis, Infinity, Vero Research, and Duntech got me to sit down for more than just a minute. I was impressed by the small size of Sony's new MZ-E2 MiniDisc player, barely larger in its main dimensions than the MD itself and said to play more than seven hours with the three-AA cell pack attached. Pioneer had a wham-bam demonstration of Dolby AC-3, the new digital five-channel discrete system which has been approved by the Grand Alliance for use in HDTV broadcasts. It repeated a demo I'd heard at the summer Show with five separate langauges being spoken, one in each of the tracks and each understandable. It wowed me again.

AUDIO
THE EQUIPMENT AUTHORITY

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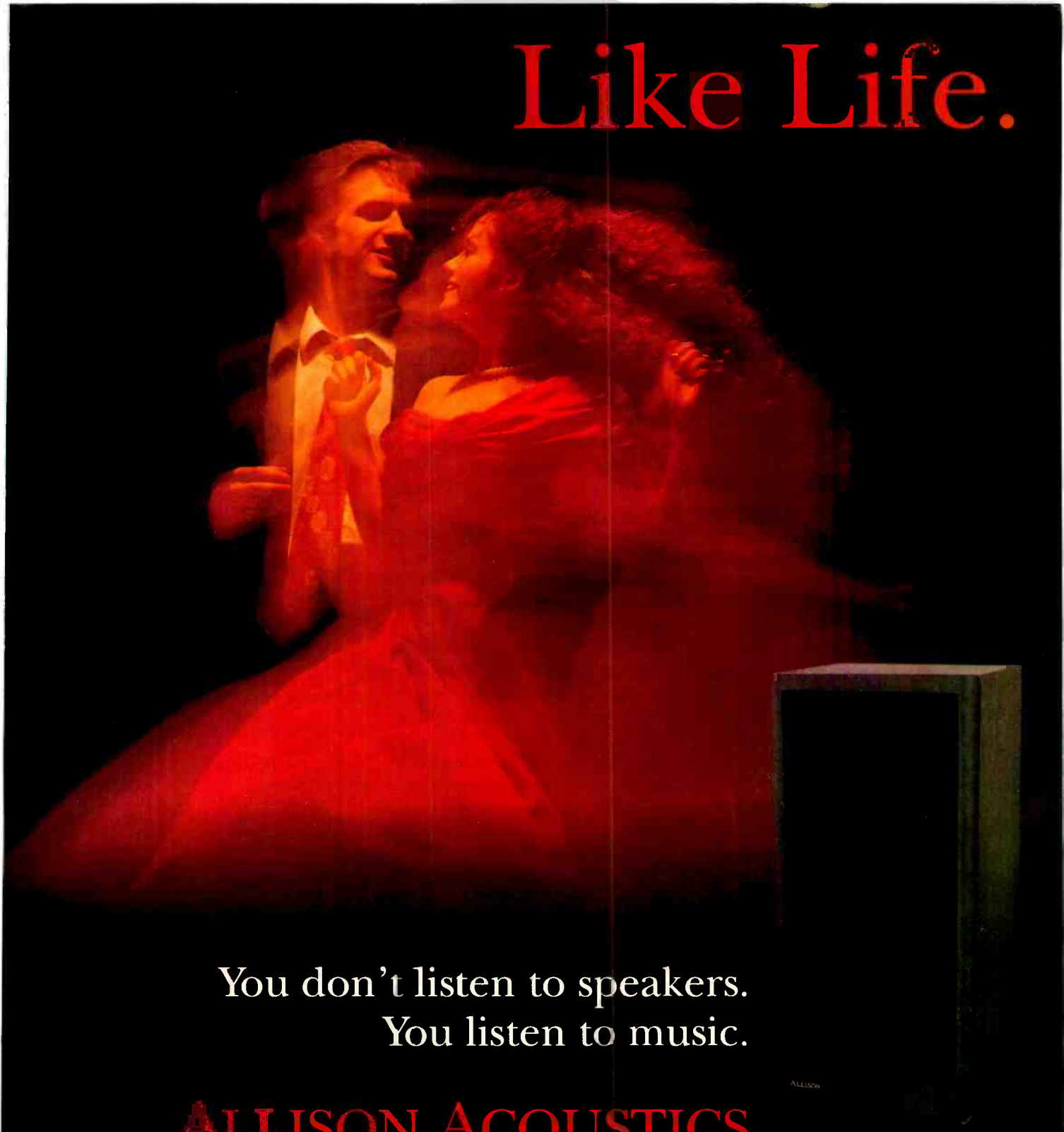

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Digital Phase Speaker

Dear Editor:

I was delighted with D. B. Keele, Jr.'s review of the Digital Phase AP-1 loudspeaker (December 1993). It is always inevitable that some of his measurements will differ from those of the manufacturer. This can be caused by differing test equipment (we use the LMS by ATI) and test methods. I want to explain some of our procedures to clarify some of those differing results.

Don Keele's anechoic measurements showed the AP-1 to have "a shelved response between 45 and 130 Hz, where the level is down about 4 dB." We have not experienced the shelf that he measured between 45 and 130 Hz. We use a ground-plane measurement at 1 meter, as it better indicates how the driver sums with the port at 1 meter in front of the cabinet (as opposed to near-field "summed" curves, from which we have seen the same results as those in the review). Since there are no walls with a typical ground-plane measurement, it is difficult to get a single microphone to accurately measure at 1 meter when the port is located on the back of the cabinet. To get a true ground-plane curve on the AP-1, we seal the port in the back of the cabinet and put an identical port on the front of the cabinet (to facilitate a single mike). The results show that the AP-1 is only –1.5 dB at 35 Hz. If you look at Fig. 12 in the review, the peak acoustic output (without room gain) very closely matches the peak input power, indicating no problems with roll-off in the lower octave.

The language of the patent is slightly different from what was stated in the review. The review quotes that patent as stating ". . . a controlled resonance is developed within the cabinet and the entire cabinet vibrates." The actual language of the patent states ". . . a controlled resonance is developed and the entire platter vibrates."

The review also states that our crossover is a 12-dB/octave system. Although it is a 12-dB/octave design (electrically), in combination with the natural roll-off of the drivers the result is a 24-dB/octave roll-off.

One last item: The review stated that the cost of the product is $1,250 per pair. Although this was accurate and is the retail value of the AP-1s, we are now selling them factory direct for $899 per pair.

Daryl Powell
President, Digital Phase
Chattanooga, Tenn.

The May Issue May Not Amount to a Hill of Beans in This Crazy World . . .

Dear Editor:

I read with great interest the letter from Edward Lopez, "Cars and *Audio* Don't Mix" (December 1993). His sentiments echo mine.

I am a longtime audio enthusiast and subscriber to audio magazines, starting with excellent combinations such as AR-2 loudspeakers and the late, lamented *High Fidelity* magazine. I recently allowed my subscription to the "other" audio magazine to lapse, since it was trying too hard to be all things to all people.

I strongly concur with Mr. Lopez's complaints about too much coverage of car audio. In this age of specialization, as he points out, if anyone is really interested in automobile audio, there is a plethora of publications on the newsstands to address that need. I subscribe to *Audio* hoping it will remain devoted to audiophiles in the traditional sense. If it doesn't, I guess I will have to join Mr. Lopez and look elsewhere.

Frank X. Hamel
Tracy, Cal.

. . . But We'll Always Have October

Dear Editor:

Like Edward Lopez, I dislike the *Audio* car stereo issue, but I have endured it for the last 19 years. I have never considered cancelling my subscription; I feel your Annual Equipment Directory in October by far makes up for any issue I dislike. In conjunction with Laura Dearborn's book *Good Sound*, the October issue is my Bible, and I return to them both time and time again.

Russell Miller
Garden City, Mich.

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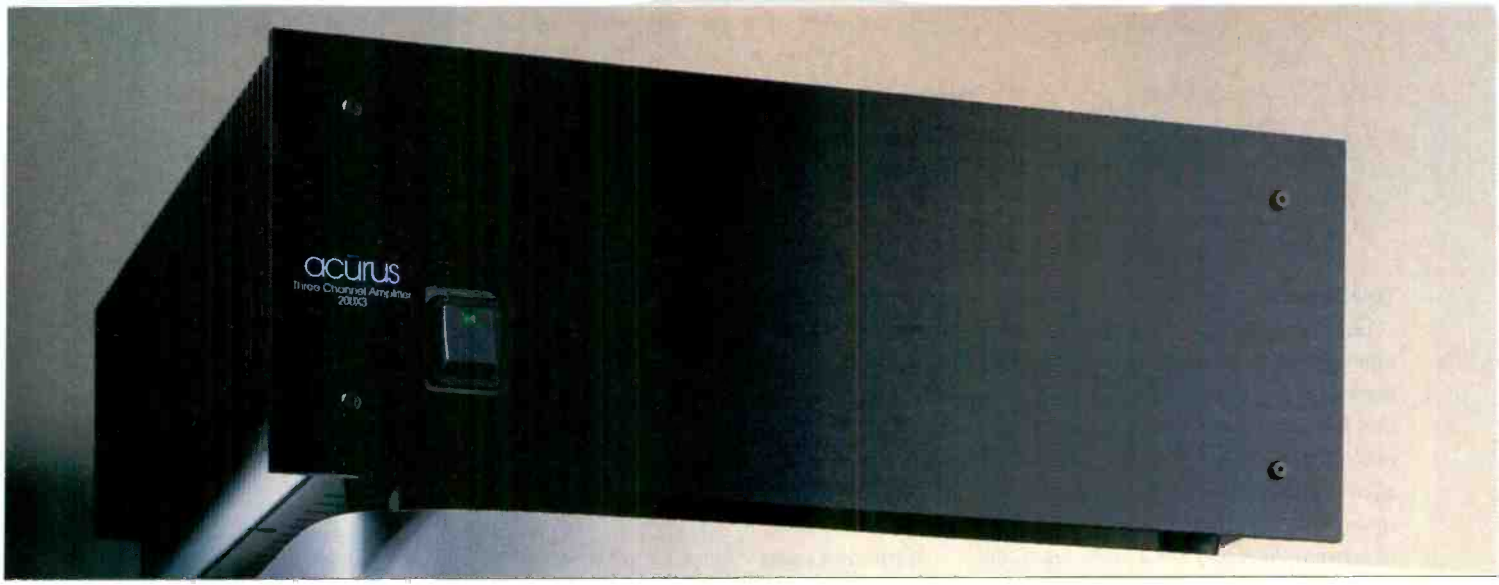

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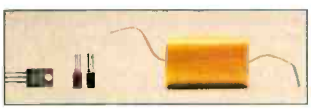	Fully discrete analog components allowing for optimized design and placement.	Integrated circuit chips requiring large amounts of signal correction just to get the circuit to work.
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AUDIO CLINIC

JOSEPH GIOVANELLI

Tape Squeal

Q. *I have collected many fine open-reel tapes. Over the years, a number of these tapes have developed a squeal. I can't tell if this happens as the tape passes over the guides, the heads, or what, but it definitely affects the quality of the playback. When I separate the tape from the guide that's located between the supply reel and the heads, the squealing stops. I have cleaned all parts of the tape path, but this has not helped at all. Is this a problem with the deck, with tape lubrication, or what? How can I save a wonderful collection?*—Name withheld

A. In most instances, the squealing you have described is caused by evaporation of lubricants and plasticizers from the tapes themselves.

In decks that use pressure pads to hold the tape against the heads during playback or recording, the combination of worn pads and "dry" tapes can cause squealing. If that's the case, simply replacing the pads will stop the noise.

If your deck permits, you might also try reducing tape tension just a bit. I've had some success with this method, but it can be difficult to do with some tape decks.

In most instances, there is no cure that will permit the tapes to play as they once did, at least not on a permanent basis. So, while the squeal is still diminished, you should make copies of those tapes you've temporarily fixed (as outlined below) and, perhaps, those that resist fixing.

You can usually stop the squeal temporarily, with a silicone lubricant. I use Wonder Mist, but it seems to me that Slip-It (which I haven't tried) would work as well. Spray just a bit of the lubricant on the tape just before it passes the first guide. (I usually spray both the backing and the oxide surfaces.) This small amount of lubricant will be deposited on guides and heads, taking the place of the tape's lost lubricants. Its effects will, hopefully, last for the entire copying session.

Sometimes the squeal starts again before the copy is complete. When this occurs, you must rewind the copy and the original, squealing tape to an editable point. You must then relubricate and resume copying.

I have never had it happen when I have done all of this, but it seems at least possible that the heads might clog because of excess lubricant. Obviously, you would then have to clean the heads and resume copying as before.

If you own cassette tapes, be prepared to follow these same procedures to save some of those that have been around for some time.

Wall-Shorted Inputs

Q. *My preamplifier shorts unselected input terminals to ground via 10-ohm resistors, to prevent possible signal leakage. Would this cause possible harm to the source components connected to these shorted inputs?*—Name withheld

A. The practice of shorting unselected inputs to ground has been carried on for nearly as many years as there have been high-fidelity sound systems. In earlier days, these shorts were made directly to ground, without the 10-ohm resistors you mentioned. This posed no problem, since output circuits were then coupled via capacitors to the preamplifier inputs.

Many modern devices are directly coupled in order to maintain good phase linearity and low frequency response. A direct short here can sometimes cause a small current flow in the output circuit. (I have serviced equipment in which that current gradually increased because of the heating of the output IC, to the point where that device self-destructed.) The 10-ohm resistor avoids this reaction. The impedance to ground is still low enough to prevent signal leakage from the unselected inputs to the selected one, even when capacitive coupling is involved. A

If you have a problem or question about audio, write to Mr. Joseph Giovanelli at AUDIO Magazine, 1633 Broadway, New York, N.Y. 10019. 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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EDWARD TATNALL CANBY

INTERACTIVE CHITCHAT

As I live onwards toward 2001, audio life gets zanier and zanier—at least that's the way it sounds to me. Somebody important once said that those who ignore history are doomed to repeat it, warts and all. You can bet on that! So, having very neatly disposed of that word *Virtual* (like a butcher wrapping meat in plastic), I now move on to its more famous relative—*Interactive.*

Now, nobody can deny that our only 100% interactive audio remains today as it was at its beginning in 1875, the telephone—if interactive means what I hope it is intended to mean (eventually): Truly equal two-way or multiple-way communication. Those wimps and weaklings who think this lively term means 97% a mass of advertising in one direction, and maybe 3% return communication via a few pushbuttons are not being straightforward. Their motive is profit. If a gang of thugs, with a slightly different motive, attacks an individual, would this be deemed interactive? If a mob of soothing do-gooders converges on a single person with vast quantities of love and persuasion, is *this* interactive? As some of us used to say, come off it.

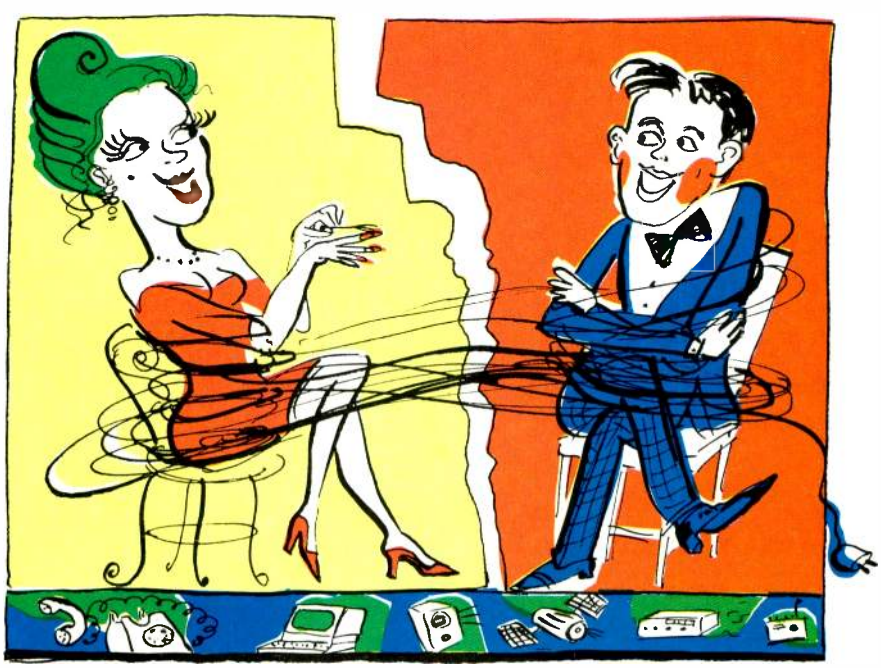
INTERACTIVE IS A NEW BUZZWORD, BUT ITS SENSE IS ANCIENT, ALMOST FOREVER.

Like so many profound inventions, the telephone was a culmination when the time was ripe. Maybe it was the ultimate example, though Alexander Bell-with-the-beard won the subsequent patent battle. Bell and Elisha Gray filed for the telephone at the Patent Office on the very same day within a few hours of each other. But Gray's was merely an intent to file, which turned out to be a sad mistake on his part. So Bell was triumphant.

What's a "long-distance" call, interactive and wholly two-way, in these days? If by satellite, maybe 40,000 to 45,000 miles or so, up, back, and around the earth's bends. Bell's beard waggled a long-distance message from one room to the next, urgent but not exactly awe-inspiring: "Mr. Watson, come here, I need you." Mr. Watson's reply is not recorded. He probably rushed through the door without saying anything at all, unless perhaps "Eureka!" If room-to-room was then long-distance (indeed it was), keep in mind that the first working optical phone connection, a mere halfway across Chicago, was only minutes ago in the telephone time scale.

Curiously, the good old telegraph comes clicking and clacking back again as a super preview, the first true interactive medium, though not audio. Wow—in no time at all it will be 150 years old! It, too, was truly equal, either direction, and electrical as well. Increasingly long-distance, too, when, as in optical communication today, repeaters and connections were developed. As usual, telegraphy offers even more parallels today than the telephone and much earlier. It prefigures, now, a major non-audio trend in our interactivity, the computer net, ranging from local libraries and college classrooms to Internet the world over, not to mention a passel of industrious hacks. And all of this via digital coding, not analog words, both now and then.

Isn't this what Morse really projected in his first, somewhat pompous, demo in Washington before a batch of important Congressmen in tall black hats? That was the 1840s. His famous first "words" on that occasion—"What hath God wrought?"—were typical of the period. Though a bit on the inane side as we decode them today, they raised in-



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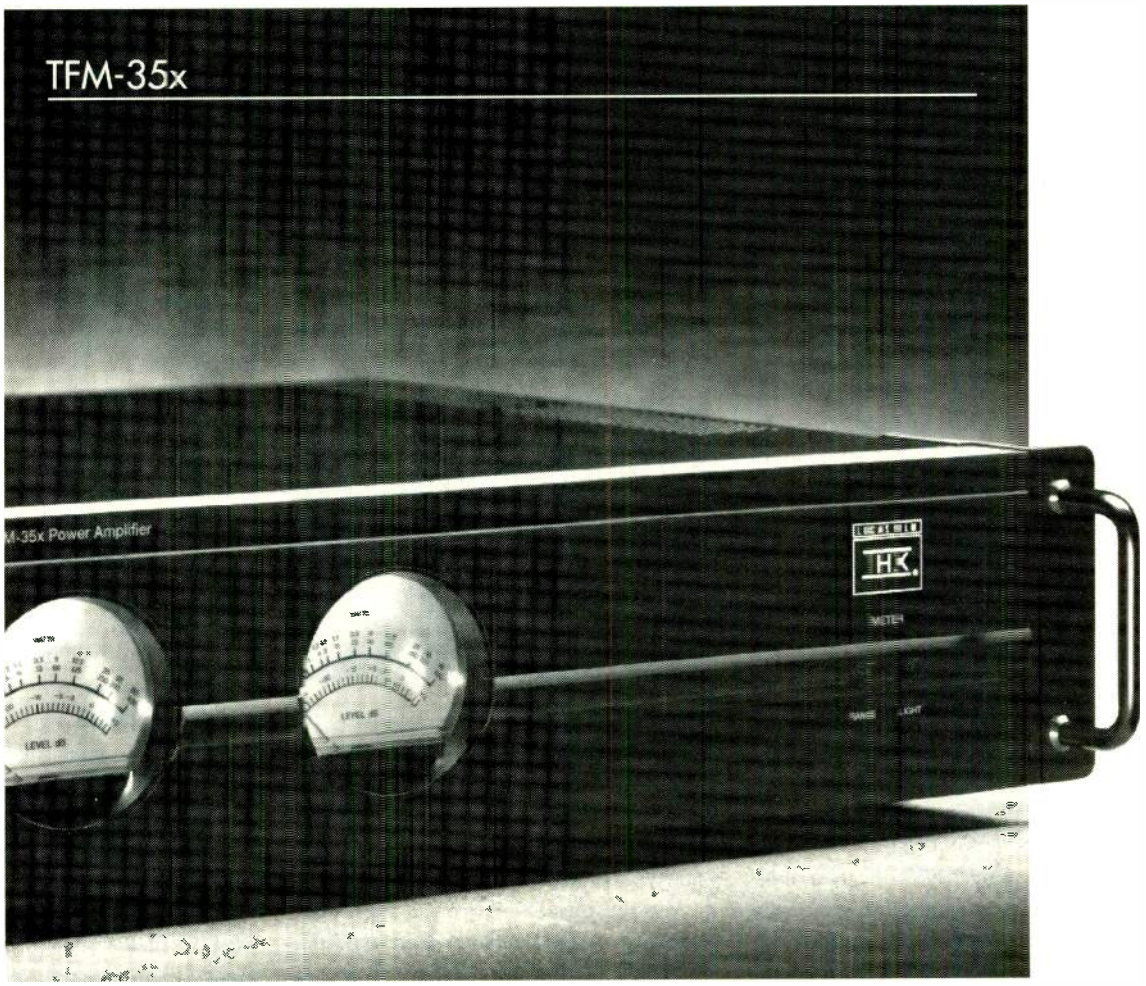

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teresting questions of English grammar (what is the present tense of "wrought"?).

Those words, of course, were preceded on the first telegraph line by a much more informative interactivity, a prolonged digital chitchat between Morse in Washington and his working colleague in Baltimore as to how the machinery was actually performing.

Surely this is the ultimate sort of interaction we all have in mind, at least, as the communicative hope for our future. The short-wave hams of the last 70 years or so have kept it vibrantly alive in their area, with never-ending enthusiasm, if you will overlook *their* inanities, which are multitudinous. I have a retired audio friend who is a ham, and takes his radio with him wherever he goes. "Well, Joe, what kind of weather you got out there?" and on and on. Even so, it is a potent force, this Interactive.

Oh yes, the truck drivers. Let no more be said, except that television's Roseanne has a beauteous but mixed-up sister who, last I knew, was applying for truck drivers' school; she wanted to drive an 18-wheeler. This after a stint as a police officer, her ideal career. Anybody out there want to, er, interact with Roseanne's sister? She's not the only sister in a big truck.

I suppose at this point I must give way to a few points. Our new and ubiquitous Interactive, the word you see everywhere in audio, does not necessarily mean the complete equality of direction I've been talking about. The trouble is, where do you stop, how far do you go? To some promoters, Interactive is an excuse for overwhelming advertising in the home. Somehow we will have to weather that overwhelming force, once it invades. It'll be awful, at least from my viewpoint. What is the poor consumer supposed to do? Why, naturally, *consume.* What else? So long as he does so, and willingly, Interactive of this sort will push ever more strongly, with every technical refinement that may maximize the effect or, should I say, the torture.

What remedy? In the end, competition, I suppose. Not merely 2½ giants (see the Canby Principle of years ago) but a thousand little Interactives. My feeling is that time is all on the little guys' side here. Small operations *can* be successful, where the giants fall on their faces through sheer overdose of pressure! People do react when pushed around, though it takes an astonishingly long time for that to happen, as we all know.

Interactive is a new buzzword, but its sense is ancient, a lot more ancient than Samuel F. B. Morse. *Direct* Interactive? It's forever. The interesting scientific question now is, how long have people been using words and sentences to communicate with each other? Phew—some question! All sorts of new techniques, including the various new ways of dating, make it a hot topic. The heat is presently on the Neanderthals, not very far back, the real cave men, but it may shift a million years earlier before we realize it. That search, in the total absence of recorded audio, is based mainly on the physical organs of ancient throats as inferred from jaws, teeth, and such. Remarkable what they can do—but the distinction between grunts, screeches, whoops, and actual *language* is a very tricky business.

DISTINGUISHING BETWEEN GRUNTS, WHOOPS, AND ACTUAL LANGUAGE IS A TRICKY BUSINESS.

You must have followed the astonishing chimps, who have been revealed to be able to understand a big variety of words, though they cannot "speak" them. Wrong throat. Like us, like the pigeons that thrive on city streets, like a hundred pests and plagues, the chimps have unsuspected capabilities. The key, in their case, is human sign language. Through sign language they become interactive with human beings to a very precise degree. What next?

So, to return where I was, I assume that in the end our interactive miracles will not necessarily be *equal*, to and fro, but at least to a sensible extent partially interactive—you may go the reverse direction a bit beyond present capabilities, which are: Channel Change; ON/OFF. Not counting a hurl of the TV out the nearest window. You'll be able to do SOMETHING beyond the totally passive.

This is an enormous present need. So I think that the arrival of Interactive, though grossly exploitable as a come-on term, has its good reasons and maybe even healthy reasons.

We are *not* a passive animal by our ancient endowments; we are very much intercommunicative. Have you ever been to a silent party? We get together mainly to talk and talk. Any movie of "natural" inhabitants, as in Africa, will show the same—they, too, talk and talk and talk and hugely enjoy it. It is our instinct to intercommunicate, no matter how silly the content!

But times change—we are now THERE with everybody anywhere, and our urge has found new outlets. We adapt just like the pigeons. And so I close with an interactive miracle—a TV show—that I have never seen, but which was written up in *The New Yorker* magazine some time ago, the issue of March 18th, 1991 on page 34. I've kept it around all this time. The show, called *Dan's Apartment*, is, or was, on New York night cable, in the wee hours.

Dan is, or was, just an ordinary young New York guy, on his own, not (yet) married, a student type living in a sort of pad, an apartment mostly furnished by his mom, maintained in bachelor style, i.e., unmade bed, unwashed dishes, nondescript second-hand furniture. Early Inertia, he called it. A mess. Like a thousand others of the sort. As he said, nobody in his gang visited—too depressing. But this Dan had vague ideas of grandeur in a media way. He went to media school and learned techniques, then had an idea: Why not put my apartment on interactive cable? Not too difficult, via his school connections. He gave up some elaborate fantasies and settled for the crude, a phone number and some sort of camera, which a caller could direct in rudimentary fashion to look this way and that. At Dan's place. Exactly as it was, Early Inertia.

Astonishingly, *Dan's Apartment* on TV was an instant success. The phone never stopped ringing. People tried for weeks to get through, just for a look. At what? Close-up of an unmade bed? Dirty dishes? Messy bathroom? Beat-up furniture? The cable people were astounded, the experts were wowed, offering sage reasons in words of many syllables, though as baffled as Dan himself. Maybe you and I can do better. Dan was simply showing us what pigeons we are. And predicting our interactive future? Probably. A

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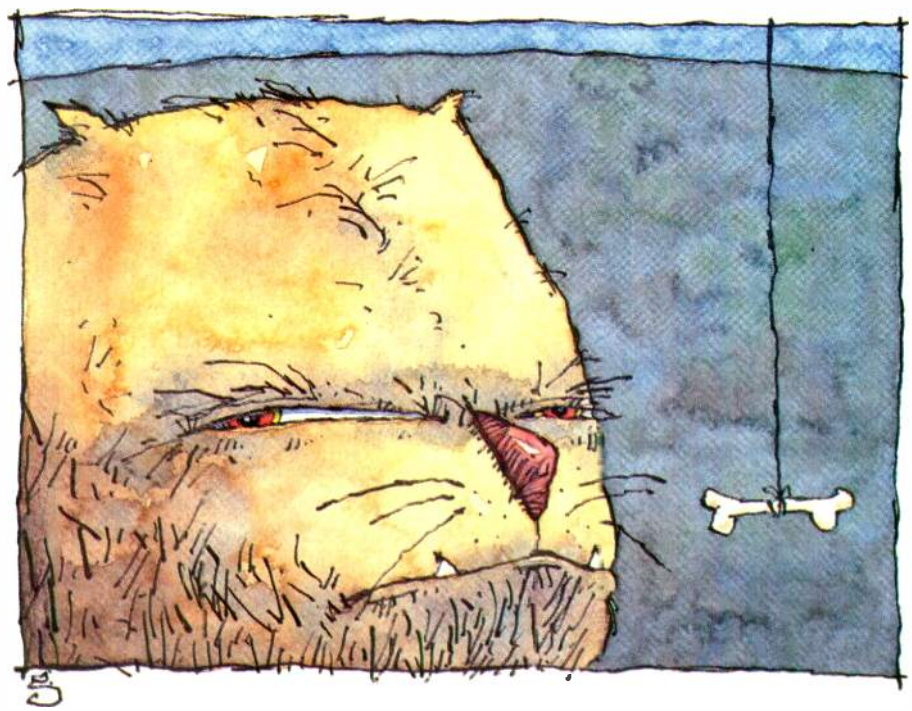
JOHN EARGLE

AUDIO'S FIBER DIET



The first transcontinental phone call took place between New York and San Francisco early in 1915, some 40 years after the invention of the telephone. What made this feat possible was a combination of careful systems engineering—and the use of only three vacuum tube amplifiers in the 3,000-mile signal path. Over the two decades preceding World War II, transmission quality had improved to such a point that coast-to-coast radio broadcasting links were routinely provided by the telephone company. In at least one instance, recordings of the San Francisco Symphony Orchestra were made in RCA's Hollywood studios via carefully equalized phone lines coming directly from the War Memorial Opera House in San Francisco.

The last three decades have ushered in an information age that requires more channel capacity than the early AT&T engineers could ever have imagined. This has been driven by entertainment needs as well as the requirements of computer networking; the specific requirements of simple person-to-person phone conversations are a very small part of the whole. Large microwave antennas dot the countryside, and the number of geosynchronous satellites continues to grow to meet the ever-increasing needs of local and global information exchange.

Satellites are expensive, and their quantity is ultimately limited. But fiber-optic "wiring" is cheap and virtually unlimited in quality. Furthermore, the wiring of America is proceeding apace and will ultimately provide the primary information path to and from homes and businesses in America.

It is easy to focus our attention on technology, forgetting about the problems of managing it all. The technology must pay for itself as it is developed, and there are entrepreneurial companies that specialize in beneficial "packaging" of it. For example, many businesses with locations across the country now routinely use in-house teleconferencing facilities for meetings that, just a few years ago, would have required personnel to fly in and spend one or two nights at costs now considered prohibitive.

A COMMUNICATIONS GIANT PREPARES TO POUNCE BACK INTO PRO AUDIO.

In a literal replay of RCA's Los Angeles to San Francisco audio link of the 1940s, Lucasfilm implemented in the early '90s a digital audio hookup between its northern and southern California film postproduction facilities. Specifically, this enabled Ron Howard, director of *Backdraft*, to audition the final mix of the film without having to make a trip to the Bay Area facility. So successful was the link-up that a new company, Entertainment Digital Network, or EDnet, was formed to develop the technology and promote its use in the arts. Perhaps the most celebrated example of this technology is Frank Sinatra's new album *Duets*, in which all of the singers who accompanied Sinatra virtually "phoned" their parts in!

Just before the opening of the Audio Engineering Society Convention in New York's Javits Convention Center in the fall of 1993, veteran record producer Phil Ramone directed a recording session, from a Manhattan location, that combined a vocalist in Gloria Estefan's Miami studio and an instrumentalist in Capitol Records' Hollywood studios. New tracks can now easily be added to a multitrack master tape by sending a signal, or signals, for headphone monitoring and providing a

Illustration: Courtney Granner

return path for the new signal. Additional channels can be used for synchronizing and communication purposes. Fiber-optic links are preferred because they are land-based and have relatively short delay times as compared to satellite links. Perceptual encoding/decoding methods, such as Dolby's AC-2, are generally used because they provide high-quality reproduction with the necessary reduced bit rate to match the characteristics of the links.

Another example of AT&T's determination to rewire America was also demonstrated at the AES Convention, this time on a more modest and local scale. While the major carrier of music today is the CD, many consumers blithely assume that digital technology has transformed the modern recording studio. Not so—at least, not yet. There are still many more analog multitrack recorders to be found than digital ones, and digital mixing facilities are as yet rare indeed. For the most part, the modern studio is still an analog-based operation, with digital transfer entering the scene at the last stages of album postproduction.

Many of the large recording consoles today have an "instant recall" feature that allows all control settings to be recorded and stored so that a remix session can be scheduled for a later time, with all controls reinstated to their previous positions. This takes the form of position encoders on each knob, switch, or fader on the console, enabling all settings to be duplicated at a later time. What AT&T has done is use the position encoders to generate a set of instructions for digital mixing and other processing that virtually apes the actual analog processes going on in the console itself. While the console is purely analog, the data from the position encoders is fed to a complex digital processor in which all of the analog functions have been previously modelled as digital ones.

The net result is that the console can operate in both analog and digital domains at once. The studio owner does not have to opt for either digital or analog mixing capability; he can have one or the other—or both at the same time.

It's curious that it is the telephone companies, with all their long history and installed base of relatively prosaic phones, that are leading the way into an increasingly digital future. A

A Discrete Proposition

Ten years ago the CD promised "perfect sound...forever."

But something vital was missing for those with a an ear for the discreet.

Call it sonic character. Or audio integrity. But the embedded nuances that breathe brilliance and vividness into a recording were lost simply because data could not be accurately decoded and played back.

Until now.

Introducing the DS Pro Generation V digital processor from Theta Digital.

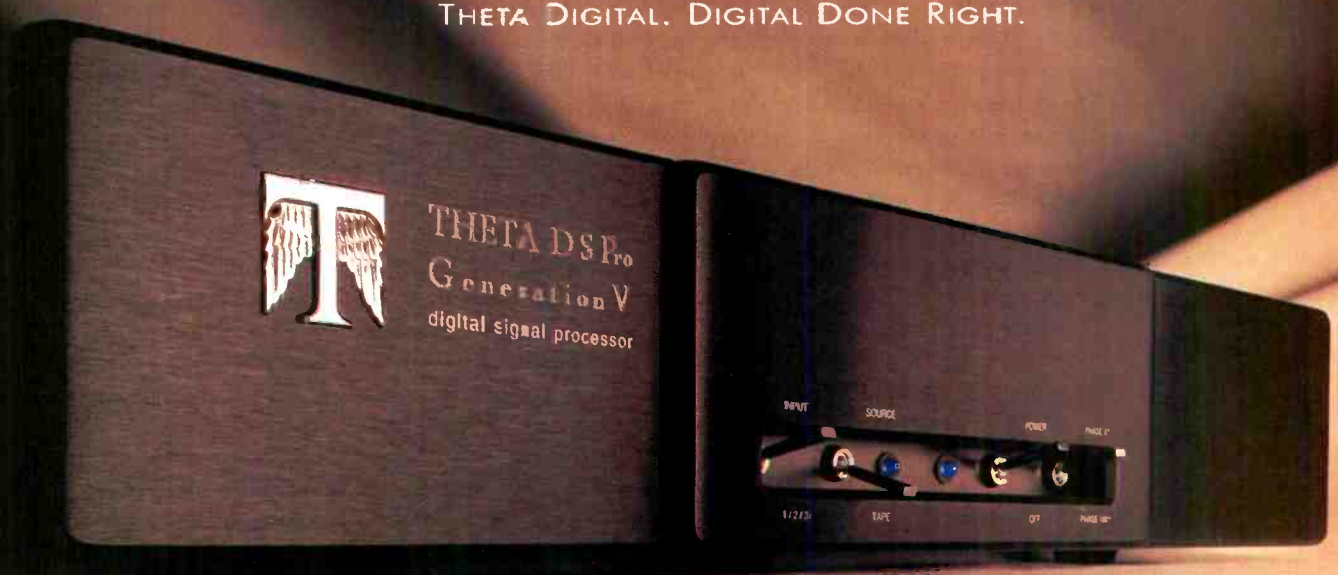
The Generation V is the progeny of years of Theta research and evolution, surpassing not only our proprietary standards for high-quality digital playback, but also those of competitors which sell for thousands of dollars more.

Featuring an all-new, fully-discrete, analog section with its large open-loop bandwidth, current feedback configuration the Gen V has ultra-fast slew rates and extremely low peak error and settling times. And the class-A design produces the smoothest waveform transitions possible, eliminating subtle crossover distortion.

All of which means digital playback has finally come of age.

We propose that you spend a quiet moment with a DS Pro Generation V.
You're in for the most fulfilling CD listening experience to be heard anywhere.

Theta Digital. Digital Done Right.



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ROAD SIGNS

IVAN BERGER

SCHOOL FOR STEREO

Installation class at R.I.T.O.P under direction of Peter Masterjohn.

You expect good sound and a cosmetically perfect installation from a stereo maker's demonstration car. Manufacturers usually hire top professionals to do them. What I didn't expect, when I saw KEF's new demo car, was a fine-sounding, professional-looking installation done by students.

The students are from R.I.T.O.P., the Richard Inferrera Team of Professionals. (Inferrera, who runs Rich's Car Tunes in Watertown, Mass., is among the country's better known installers.) The 12-week course, which costs $4,500, starts with the basics of good sound and car electronics, then goes on to advanced system architecture, custom design and fabrication, and similar topics.

The school is in the same building as Rich's Car Tunes, which lets Inferrera not only give seminars but also "sniff out what's going on each day and make suggestions." The school's director, Peter Masterjohn, has had about 20 years of experience in car stereo. Engineers from audio manufacturing companies (of which the Boston area has a wide supply) give seminars as well.

Bus Trouble

There was a time when it seemed that every car stereo maker spent its research budget on new ways to wire DIN plugs differently from everybody else's. No more. Maybe they got religion, maybe they just used up all possible DIN-plug permutations, but car stereo has been shifting more and more to that standard home audio connector, the phono plug. I've even seen home-standard optical and coaxial connectors used to carry digital signals in the car. Have we finally reached the era when car stereo components of all makes can happily be plugged together as they are in home stereo?

Not quite. Along with new kinds of signals, the digital age has also brought new control functions and system architectures that require connections home systems don't use or need. With no home precedents to follow, each car stereo company is following its own lead, and devil take the hindmost.

For example, while CD changers in home systems are accessible, not tucked away in closets, cars have trunk-mounted changers controlled by head units in the dash. The control links vary according to the changer's manufacturer. Any "standardization" is accidental, occurring only among car stereo companies who buy their changers from the same source. And when a company adds new functions (as Sony did, with its Unilink system that lets the in-dash unit know the title of the disc being played), it has to revise the connection scheme.

Further changes in system architecture require yet more new links. If the signal stays digital all the way to the amp (as in Pioneer's new Optical Digital Reference System), such processors as equalizers, ambience/surround controllers, noise-driven level controllers, and anti-noise processors (not all of which yet exist) can be moved out of the dash and out to where the amps are. That also mandates control lines from the dash. Off-hand, I can think of four proprietary control buses: Sony's Unilink, the IP bus in that Pioneer system, the Eclipse bus, and the motherboard bus of Rockford Fosgate's Symmetry system. (Symmetry uses plug-in boards that perform equalization, crossover, and other functions—some of them analog, incidentally.)

Standardizing all these control interfaces so that all manufacturers' products play happily together would give audiophiles more flexibility in optimizing their individual car systems. It may even happen, but not until the manufacturers standardize on what functions need to be controlled. For now, they're too busy dreaming up new functions to provide—which, at this stage, is far more important.


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The CS150s unique cabinet insures maximum flexibility.

Think of it. Not only do you save $199, but this center channel speaker is based on Polk's new breakthrough technology, Dynamic Balance™. The same technology used in the critically acclaimed Polk S and LS series loudspeakers to assure you of sonic purity.

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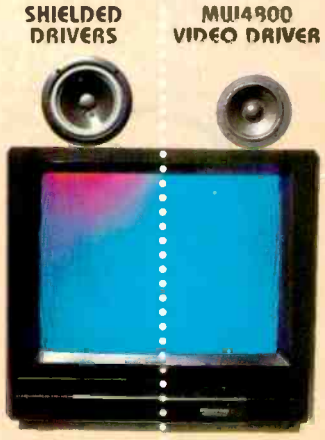
The center channel is free through March 31, 1994. After that, this remarkably low price has only one place to go. Up.



Unlike other shielded drivers, Polk's new video driver is engineered to guarantee no video interference.

THE NEW CS150 FROM THE SPEAKER SPECIALISTS OF

polk audio

Daniel Sweeney

SOUND CONDITIONING THROUGH DSP

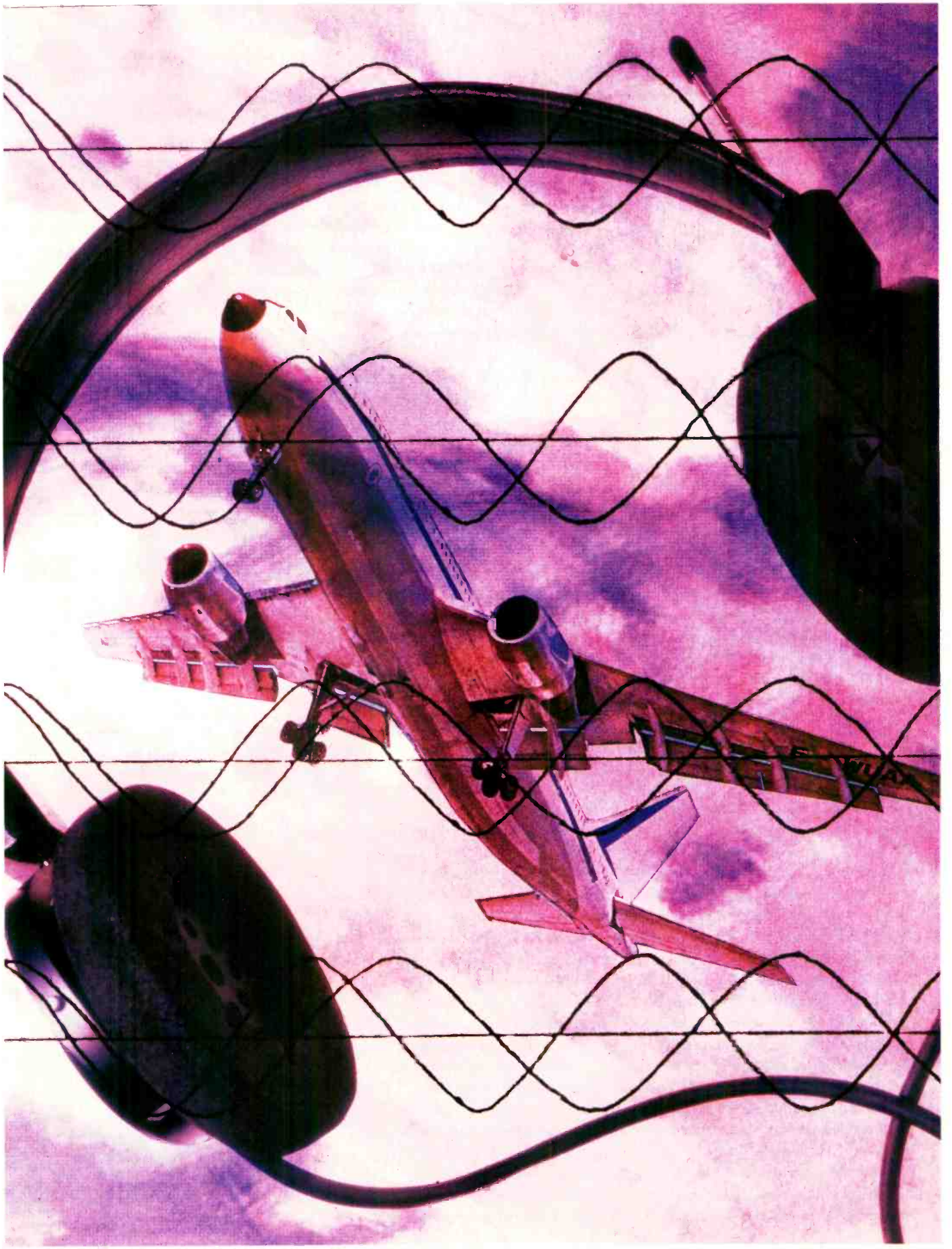
Our listening spaces, at home and in the car, are generally the weakest links in our audio systems and the ones we have the least control over. In the living room, we have always been able to exercise a bit of control through furniture choice and placement. In recent years, those who value a room's sound over its appearance could also use bulky fiberglass absorbers and even bulkier diffusers, but the size and appearance of these devices has mostly confined them to studio use. And now, an active, all-electronic alternative—digital signal processing (DSP)—promises to outperform even the most aggressive physical room treatments.

At least in theory, DSP can improve sound two ways—by lowering ambient sound levels (even in a car) and by reducing the effects of room modes and early reflections. It attacks both of these fundamental problems through active cancellation (on which more later).

Digital signal processing can, of course, be used for functions such as equalization and limiting now handled in the analog domain. But the power of modern, high-speed processors permits its use for far more complex procedures, ones radically different from traditional signal processing. This is not just simple equalization, reverberation, ambience synthesis, or phase manipulation. Rather, it is a very open-ended, adaptive processing that varies the way it treats the signal according to information it receives.

Before discussing noise cancellation or active control of room modes and reflections, I'd like to point out that DSP-based room conditioning is still an emerging technology, with only a few consumer applications so far. Room controllers using DSP have been shown by Audio Alchemy, B & W, Snell, and SigTech, but only the latter (reviewed in *Audio*, December 1993) is available.

Photograph: David Hamsley



At this point, the only noise-cancellation devices on the consumer market are headphones (a special case—they're analog) from Active Noise and Vibration Technologies (ANVT), Koss, Noise Cancellation Technologies (NCT), and Sennheiser, though other companies sell similar 'phones to aviation and industrial markets.

ACTIVE NOISE CANCELLATION

Anyone who has ever gotten the polarity wrong on one speaker of a stereo pair has inadvertently experienced active noise cancellation. When both speakers reproduce the same low frequencies, the output from one speaker cancels the equal but opposite-polarity (anti-phase) signal from the other, and the bass disappears. Similarly, a woofer's front and back waves would cancel each other at a given room location if the speaker were simply suspended in mid-air with no baffle to keep these waves apart. This phenomenon, destructive interference, occurs whenever two wave trains of the same spectral composition or shape meet in an anti-phase relationship.

Active noise cancellation uses destructive interference in a controlled way, cancelling unwanted sounds by generating "anti-noise" signals (inverted-polarity copies of the original noise) through an amplifier and speaker.

Destructive interference in a listening space normally produces troublesome suck-outs—dips in frequency response at various locations in the room—that contribute to perceived colorations in the audio system response. In the past, this has been simply a death-and-taxes sort of thing, a problem one just had to live with in any audio installation. Now, largely through advances in DSP, it is possible to control the phenomenon selectively, using it to null out unwanted sounds at precise locations within the listening space.

In principle, active noise cancellation is extremely simple. A microphone picks up the sound to be cancelled, a processor generates an inverse replica of the noise, and an amplifier and loudspeaker put out this processed anti-noise at the same acoustical power as the noise itself. When the original and inverted noises meet, they cancel. In practice, however, the processing required is usually quite sophisticated.

The concept is not all that new. The first patents for active noise cancellation date back to the '30s (see sidebar), as do the first experiments with the technique. Later, in the early '50s, Harry F. Olson confidently wrote about numerous anti-noise applications as though the technology were already mature. But it most certainly wasn't mature back then, and indeed almost 40 years passed before the first commercial devices appeared, in the late 1980s.

The basic model of active noise cancellation, for all its rational appeal, rests on some unwarranted assumptions about microphones, amplifiers, loudspeakers, and feedback systems in general. The model is true enough as far as it goes, but by failing to address the limitations of the hardware used in the system, it doesn't go nearly far enough. Because of these stubborn hardware-based limitations, none of the early experimental active noise-control systems based on this rudimentary model worked very well. To make them work would have required the kind of extremely extensive compensatory signal processing possible only through DSP. The one, very limited, exception to this seems to have escaped the early experimenters. But it was later addressed in the very first commercial products using active cancellation technology—headsets.

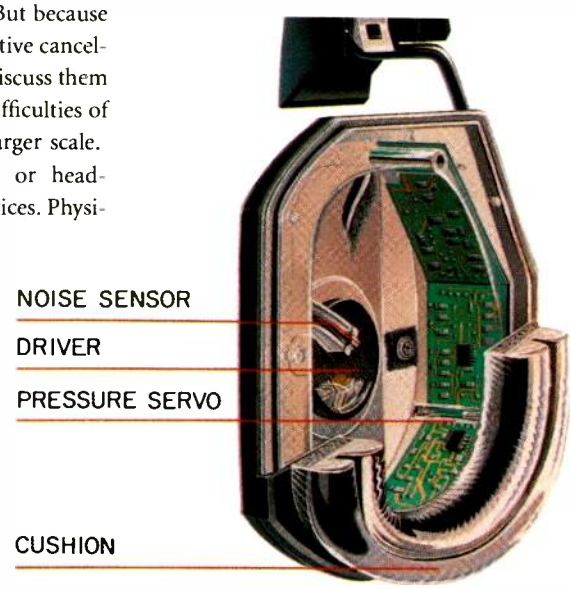
NOISE-CANCELLING HEADSETS

At least in their current embodiments, noise-cancelling headsets, or headphones, have nothing to do with DSP. But because they provide a clear model of active cancellation, it seems appropriate to discuss them briefly before considering the difficulties of applying the technology on a larger scale.

Noise-cancellation headsets, or headphones, are relatively simple devices. Physically, such a headset consists of fairly standard dynamic headphones driven by a small amplifier/processor. In all of these devices, a small microphone attached to the headphone picks up ambient noise in the environment and converts it into an electrical signal. The electrical signal remains in the analog domain while its polarity is reversed, and it is equalized to counteract the loading effects of the ear cavity before finally being amplified and fed to conventional electrodynamic drivers in the headphone housing. The anti-noise signals from these drivers cancel out the ambient sounds at the ear canal. A comparator circuit within the processor makes the system self-adjusting. This type of system is basically a simple feedback loop, quite close in concept to the motional feedback approach embodied in the Velodyne subwoofer. It also hews pretty closely to the simplified model of active noise cancellation described in the preceding section.

Straightforward though they are in principle, such headsets do pose significant design problems, which probably account for their relatively late arrival on the scene. The headphone drivers must not be permitted to feed back at the microphone, and the total transit time through the system must be kept extremely short so that no audio input can outrun the loop. Also, the ear equalization can be a bit tricky. But in general, sound cancellation at the ear is a relatively easy task, at least when this is compared to some other uses of active cancellation technology.

Inside a Bose noise-cancelling headset made for aircraft crews



Although sound-cancelling headphones have just reached the consumer market, they have been sold for several years as hearing protectors for people who work in airplane cockpits. The companies making such headsets include ANVT, Bose, David Clark, Sennheiser, and Telex, most of which are also contemplating industrial applications where the technology would supplement passive ear protectors. (*Editor's Note:* Passive and active protectors work very well together, since passive protectors are mainly effective at high frequencies and active cancellation systems are most effective at low frequencies.—*I.B.*) Japan Airlines (JAL) now provides noise-cancelling headsets in its first-class and business-class cabins on some flights, while ANVT is also attempting to sell headphones to musicians and recording engineers. By cancelling out environmental noise while reproducing a microphone or tape feed, these 'phones would allow users to monitor in extremely noisy environments.

WHOLE-ROOM QUIETING

Within the family of noise-cancellation applications, a more likely candidate for consumer use is whole-room quieting, the use of anti-noise to isolate a listening room or a car's passenger compartment from environmental sounds. This would allow the listener to enjoy music against a background of relative silence. Here the anti-noise would function something like those invisible shields or force fields beloved of science fiction writers.

Whole-room quieting is an intriguing proposition, particularly in the automobile, where background noise is such an obstacle to one's listening enjoyment. Imagine driving at freeway speeds and hearing no more background noise than in a quite living room. Unfortunately, active room quieting, whether in the car or in the home, still represents a tremendous engineering challenge to present technology, and has never been demonstrated in the presence of wide-range random noise.

A brief examination of some of the problems involved indicates why perfecting the technology has proven so difficult. When sound decays within an enclosed space, the sound will normally be subjected to scores or even hundreds of reflections from room boundaries before it loses sufficient energy to become inaudible. Sound may linger in small spaces for over a second and in large spaces for several seconds while the reflections pile up; each reflection changes the phase relationship of the wave train for any given point in space.

It doesn't require a great deal of thought to comprehend that a cancellation signal defined for one point in space will not cancel sounds at adjacent points, and in fact may reinforce them; furthermore, cancellation signals will increase the total amount of acoustical power in the room, thus giving rise to yet more noise that must be cancelled, resulting in a classic infinite-regression dilemma. Even leaving aside the problem of additional noise caused by the cancellation signal, the cancellation loudspeakers would have to emit hundreds of different cancellation signals per second just to handle the reflections of ongoing ambient sounds.

And that's just one problem. A noise-cancellation system consiting of microphone, processor, and amplifier itself constitutes a signal path, and appreciable time is required for the signal to pass through that path. So how do you get the system to

NOISE CANCELLATION IN THE '30s

New ideas tend to arise in many minds at once, when the time is ripe for them. So it's not surprising that at least two inventors were issued noise-cancellation patents in the early 1930s.

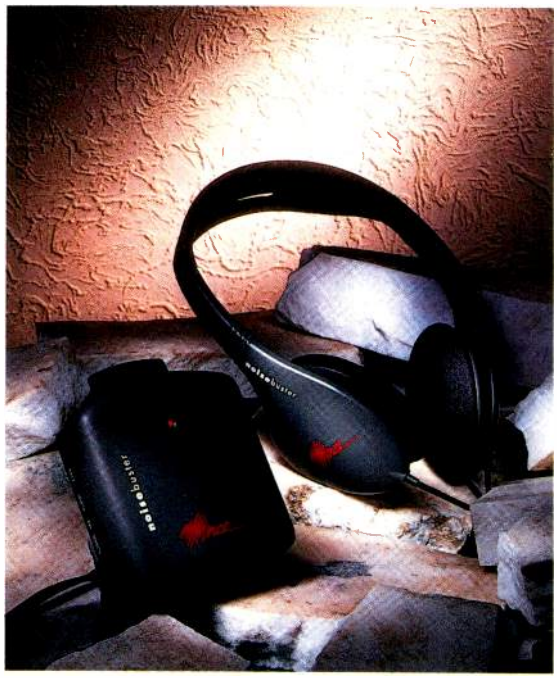
The first, Henry Coanda, applied for his patent on the last day of 1932 and received it in January 1934. His patent covered noise cancellation by mechanical and electromagnetic systems, though he also discussed using amplifiers in the system.

Less than a month later, Doktor Paul Lueg, of the University of Bonn, submitted his patent application. It was more elaborate than Coanda's, involving the use of microphones, amplifiers, and speakers. It also covered a number of applications far beyond the technologies of the time, including some that are still challenging, even with today's technology.

The idea behind the patent was a good one. The idea of filing for one turned out not to be. The National Socialist (Nazi) party, which had just seized power, quickly saw the military relevance of noise cancellation. At first, they classified Lueg's application as a secret. Later, they declassified the application, saying it was nothing new. Later still, they recognized the patent's originality, but they declared such military applications as annihilating gun and exhaust noise not to be feasible. Lueg's arguments over these government decisions apparently cost him his position at the University of Bonn—and may have led to the firing of his academic mentor as well.

While Germany did not issue Lueg's patent until 1937, Lueg followed up the military declassification of the idea by filing applications in other countries in 1934. (His U.S. patent, No. 2,034,416, was issued in June 1936.) Politically, that proved to be another error; though the army had declared it wasn't interested, Lueg's application for patents elsewhere was considered treason. Lueg felt threatened by the Gestapo and still feared arrest even after the war ended.

By 1939, with no chance of any further work in physics, the 40-year-old Dr. Lueg switched to medicine, becoming a doctor of medicine in 1945. After a few months working in a military hospital at the end of World War II, he eventually opened a practice in 1951, in Cologne. He died in 1979. *Ivan Berger*



Noise-cancelling headsets are now available at consumer prices from (clockwise from top left) NCT, Koss, ANVT, and Sennheiser

respond to high frequencies? Aren't you going to be hundreds or thousands of wave cycles behind before you can generate even a single cancellation signal? (And remember, you need a very great number of cancellation signals to handle reflections, not just one.)

Thus, active whole-room quieting, in the strictest sense, appears to be virtually impossible. But some approximation has been achieved already under special conditions.

Before we discuss the specifics of how whole-room quieting is approximated, we need a new model that goes considerably beyond the simple analog feedback loop used in noise-cancelling headsets. That's where DSP and inverse filter functions come in.

To see just how DSP will come into play in this new model, let's go back to the transit-time problem. If we look at both the listening space and the noise-cancellation system in terms of their transfer functions, we find that the transit-time problem is even more complex than it first appeared; indeed, the transfer functions of the room and of the microphone, amplifier, and loudspeaker used in the cancellation system are very different. The noise in the room changes over time as it is propagated through the air and reflected from boundaries; at the same time, the sample of the noise picked up by the microphone changes as it passes through the signal chain, especially through the loudspeaker. By the time the noise and the cancellation signal finally meet, they aren't necessarily a very good match, so complete cancellation won't occur. The noise may actually be reinforced at some frequencies, due to the behavior of the cancellation loudspeaker.

A simple feedback loop just isn't going to work in this context. The cancellation signal has to be preconditioned by DSP to reflect the changes in both the noise and cancellation signal over time. To perform such preconditioning effectively, the processor must be able to predict both spectral

and phase changes in the noise as it traverses the space in question and changes in the cancellation signal as it passes through the signal chain and then into the cancellation zone. To do this, the processor has to create inverse filters that compensate for the filtering effects of the room itself and of the entire cancellation system, from microphone to speaker. Furthermore, the system must not mistake the cancellation signals picked up by its sensors for the noise to be cancelled. Finally, the system must have a second sensor within the cancellation zone to detect any offsets between the cancellation signal and the noise. Such offsets will then be used to generate a feedback signal to make additional corrections within the processor.

Can this be done today? To some degree active quieting can already be achieved within a room at a single point, and with noises whose waveforms are known and predictable. But nobody has ever demonstrated active quieting in free space at even a single point when a broadband noise of a random and unpredictable character was present. In theory, such quieting might be accomplished (at least at lower frequencies) with multiple microphones and multiple cancellation loudspeakers combined with a processor sufficiently powerful to coordinate the array, but the technology to do so has not been perfected. And here we're discussing merely single-point quieting. Even a poor approximation of whole-room quieting represents a problem of very much greater complexity, and one that is surely years away from being solved. In fact, anyone who tells you that anything approaching true whole-room quieting is just around the corner is either ill-informed or making misleading claims.

On the other hand, the fact that active quieting is possible *at one point in space* opens some interesting avenues. If perfect single-point quieting can be achieved (so that the acoustic energy added by cancellation signals doesn't register at a listener's ears so long as he's confined to that one place), then, by extension, some semblance of whole-room quieting can be achieved by the creation of *multiple single-point zones of silence* within a room. By strategic positioning of such zones one could create the semblance of a quiet room for a number of listeners even though the actual acoustical energy in the listening space might still be quite high. Such approximate whole-room quieting has been achieved in the laboratory when the noise to be cancelled is narrowband, fairly low in frequency, and predictable. It's easier to cancel noise at many points if the noise is regular and periodic than to cancel it at even one point if the noise is completely random. And, interestingly, road and engine noise in an automobile are narrowband, concentrated in the lower frequency ranges, and quite predictable in character.

Why are narrowband, predictable noises easier to cancel than random noise is? Because if the noise envelope can be completely characterized, then the sensor requirements for the system are much reduced, and the transit-time problem will be avoided because the system knows about the noise before it has actually occurred. The system may not need a primary sensor at all but may use an FFT of the noise, stored in memory. Or perhaps an engine tachometer will be the primary sensor, so the entire noise envelope may be predicted from simple changes in engine speed. In this light, the passenger compartments of automobiles appear to be very promising subjects for active quieting.

Prototype systems for multi-zone quieting in an airplane cabin have in fact been demonstrated by ANVT. A much simpler system, which only acts at low frequencies, is currently available in the Nissan Bluebird automobile sold only in Japan. In Germany, Bosch has been working on a noise-cancellation system for automobile passenger compartments for several years, but details have not been made available to the public.

Perhaps the first such system we shall see in the United States is one addressing a single automotive noise problem, exhaust noise. The system is known as an electronic muffler, and NCT has already installed prototypes in some New York City buses and is attempting to make OEM sales to the Big Three.

Basically, an electronic muffler is an attachment to an exhaust pipe that cancels low-frequency engine noise with a loudspeaker (higher frequencies are absorbed by a fiberglass lining). While large and expensive compared to conventional mufflers, the electronic kind has two significant advantages. First, these mufflers are much more effective in terms of quieting, and, second, according to proponents, they impose virtually no load on the engine and thus improve engine efficiency and horsepower. At least in performance cars, they are probably the wave of the future.

Yet another approach to active noise reduction in cars involves the suppression of structure-borne vibrations from the engine. Most automobiles made today have compliant engine mountings that filter out some engine vibration, but these mountings fall off in effectiveness with decreasing frequency. By bracing the engine with mechanical actuator arms that respond to crankcase vibrations with appropriate arm movements, engine vibrations can be very effectively cancelled over a broad range of frequencies.

In regard to ambient noise cancellation in stationary listening spaces, very little work has been done beyond the theoretical,

At least in theory, DSP can lower ambient noise and diminish problems caused by room acoustics.

If the system can't tell curable problems from incurable ones, it wastes its powers on things it cannot fix.

excepting the noise-cancellation headsets described earlier. The sole commercial product for cancelling noise in free space is a duct-silencing system developed a couple of years ago by Digisonix. This has specific audio application, since it has been installed in some recording studios to silence air-conditioning systems, but at several thousand dollars per unit, it is not likely to find much of a market in the home.

Whatever the application, any room-quieting system where a microphone sensor and cancellation loudspeaker are involved is necessarily bandwidth-limited both by restraints on processing time and by the response time of the cancellation loudspeaker. Beyond a certain frequency, any loudspeaker-based system will simply lack the speed to keep up with the disturbance, if the disturbance is random, unpredictable, and presented to the processor by means of a transducer pickup. Fortunately, as one ascends in frequency, one can use highly effective passive absorbers. One can also employ another type of controlled destructive interference, active vibration cancellation, which we discussed in an automotive context.

For example, one might prevent sounds from entering a home by making its interior walls more effective sound barriers through active control. Basically, one would apply accelerometers or velocity pickups to the walls and then use some sort of actuator to counteract the vibrations.

Such techniques have already been used in atomic submarines to prevent their mechanical sounds from passing through the hull and then received by hydrophones on hostile vessels. (I have been informed, to my surprise, that the control electronics for these systems are analog.)

More complex systems for vibration damping are being developed for industry by NCT. The company aims to perfect active vibration-cancelling enclosures for noisy industrial machinery and eventually for home appliances, followed by vibration-cancelling windows and wall panels for domestic use.

ROOM OPTIMIZATION

Beyond the fairly obvious applications of noise cancellation discussed above lies a whole other family of applications concerned with the way reproduced sound builds up and decays in a listening room. Prototype room optimizers have been announced by A.I.P. of Canada, Snell, and B & W, while Harman International is also at work in this area. However, any discussion of these applications should focus on Snell (which has used MusicSoft operating-system software developed in collaboration with Audio Alchemy) and SigTech, since they are the sole manufacturers to demonstrate relevant products thus far. While both companies' processors perform many sophisticated operations on the signal, they mainly serve two functions: Taming room modes (natural room resonances) and changing the way the listener perceives the overall decay of sound in the listening room—which includes mode control, to some extent.

Room modes occur at frequencies where room dimensions and loudspeaker placement cause standing waves, with resultant departures from linearity in the amplitude and time domains. Middle- and high-frequency modes may be effectively addressed with various kinds of passive acoustical devices such as absorbers and diffusors, but passive solutions to low-frequency problems tend to involve devices of impractically large dimensions—certainly too large for easy use in most domestic listening spaces. In contrast, active cancellation requires no more visible hardware than a loudspeaker, as long as it has enough bass extension to counteract the offending mode with an anti-phase output of equal magnitude. In fact, the same loudspeakers used for music playback can be used simultaneously to create the cancellation effect.

The SigTech and the Snell processors both enable the user to do just this, addressing room modes by feeding a correction signal to the stereo loudspeakers. (The now discontinued Phantom from Shadow Acoustics, a division of Threshold Corporation, accomplished much the same thing with an outboard subwoofer, though the processor circuitry was analog.)

CREATING A REFLECTION-FREE ZONE

In addition to taming room modes, both SigTech and Snell aim to use active sound cancellation to improve loudspeakers' stereo imaging. Their systems will at least partially cancel the first reflections from all the room's surfaces except the rear walls, so that directional cues in the recording are not muddled. This is an attempt to create some semblance of a live end/dead end (LEDE) listening room of the sort discussed by Don and Carolyn Davis in many articles over the years and installed in many recording studios throughout the world.

An LEDE room can certainly be created by totally passive means, but the equipment required to do so tends to be pretty cumbersome, not to mention expensive. For all but the most fanatical consumers (like the author), the cosmetic liabilities of this approach are entirely unacceptable. But what if one could instead create a zone of silence around the studio sweet spot and cancel those early reflections by active means?

That's exactly what SigTech claims to do now, and what Snell aims to accomplish with future products, although much more is going on in either system than simply active sound cancellation.

The Snell system has not been made available for sale as of this writing. The SigTech system, though, has been on the

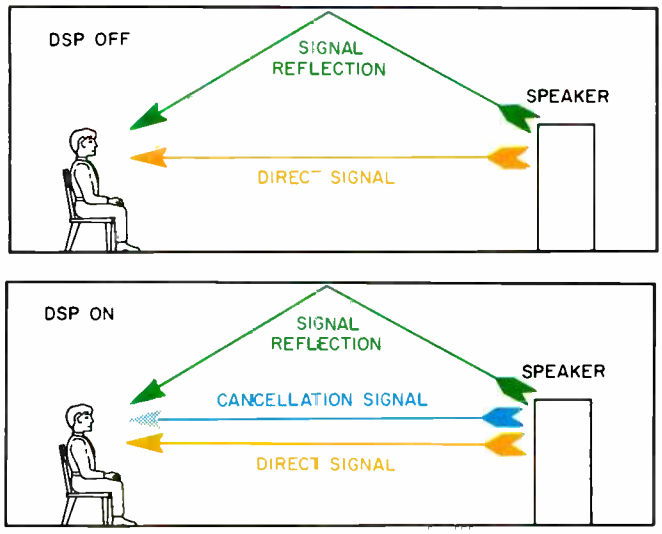
market for some time. Thus, the discussion that follows may not be entirely applicable to the fully developed Snell product when it eventually does appear.

At any rate, both systems entail an initial FFT measurement of the listening space, by a trained technician employing measuring equipment that is not part of the consumer package. These measurements are stored in the processor's memory and are then used by the system to shape loudspeaker response. Neither system is fully adaptive, that is, it does not make corrections based on a continuous microphone input; instead, the processor is calibrated on the basis of one-time FFT room measurements, and the user is then enjoined not to move anything or change the furnishings.

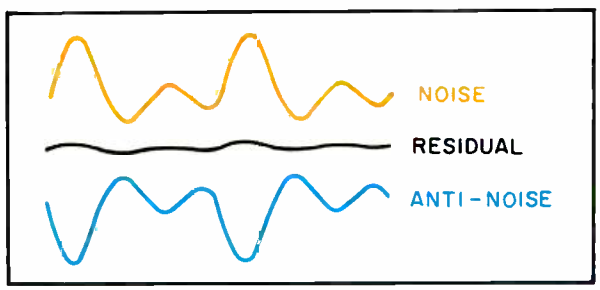
The primary aim of the processing is to precondition the output of the loudspeaker to improve the measured impulse response of the speaker system at a single listening position. In this type of system, some acoustical cancellation does take place after the music signal has already passed through the loudspeaker but much of the processing is purely electronic and occurs prior to power amplification. The preconditioning is accomplished through a process called digital convolution, which construes the effects of room acoustics on the direct output of the speaker system as a filter function; an inverse digital filter is then synthesized by the processor to counteract the room's acoustics. This calls for DSP, not just because of the complex analysis and synthesis required but also because both amplitude and time-domain anomalies are being addressed simultaneously.

It might be objected that the whole business could be accomplished with a multiband parametric equalizer combined with a series of bandwidth-limited, all-pass filters to correct for phase anomalies. But because the spectral curve of reflected sound varies over time as an impulse decays in a room, so must the correction. An equalizer set to a constant curve can only correct for room reflections at one point in time, so it is really not equivalent to a DSP inverse filter.

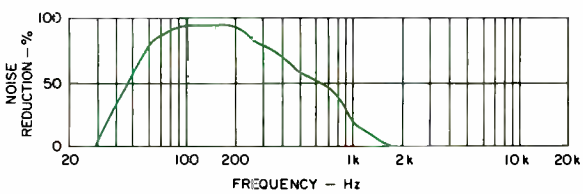
Such processing certainly makes for clearly audible changes at the listening position, and the SigTech unit has found some acceptance in professional monitoring facilities. But according to Ken Kantor



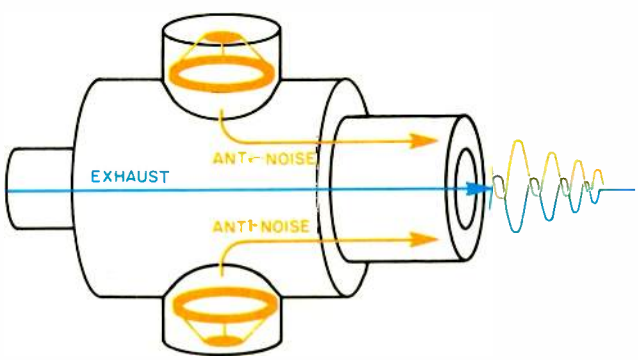
Control of room boundary reflections through signal cancellation (courtesy of Snell Acoustics)



The principle of noise cancellation



Noise-cancelling headsets are effective only for low frequencies (after NCT)



Anti-noise bus muffler (courtesy of NCT)

of NHT, who is currently engaged in digital speaker-correction research for his own company, all such systems using only two loudspeakers and one measurement microphone are troubled by "singularities" in the listening room's transfer function. "There are nulls in the room response that you simply can't fill, no matter what you do at the loudspeaker, and the system itself doesn't know which problems it can fix and which it can't. So it starts throwing coefficients at insoluble problems, and ends up with nothing left for problems it is able to address. . . . I think we should concentrate on correcting the problems of the loudspeaker with DSP, and leave the room till later. There's just too much going on in the room, and we haven't worked out the mathematical solutions to all the problems."

Active noise cancellation gets constructive results from destructive interference.

I myself have heard demonstrations of the SigTech system and can attest that it dramatically reduces the audibility of room modes, but I cannot confirm the validity of the manufacturer's claims in regard to early reflections. I have been less impressed by the demonstrations than by listening experience in LEDE rooms. But without having performed instrument tests on the system, I am hesitant to comment further. I assume, however, that any active system which attempted to cancel early reflections containing high frequencies could only work over a narrow sweet spot. This is because the cancellation signal would create reflections of their own, increasing the total amount of acoustic power in the room—exactly the same problem we encounter in whole-room quieting.

Obviously, the use of the same loudspeakers for program reproduction and room correction is fraught with difficulties as well; representatives of both SigTech and Audio Alchemy have admitted that the two-speaker limitation imposes serious restraints on the technology. In this light, the question quite naturally arises, why not use dedicated cancellation transducers? Doug Goldberg, a consultant to Audio Alchemy, suggests that such would be the preferred approach, but no one in a marketing position is advocating that. If consumers balk at lining their walls with absorbers and diffusors, how will they react to adding several pairs of additional speakers and amplifiers? Whether or not a dual-use stereo pair is the correct approach, it simply must be made to work, for commercial reasons.

DSP AND SPEAKERS

Active cancellation can be used for dealing with loudspeaker problems, irrespective of acoustic problems in the room. For example, active vibration cancellation can be used to counteract such undesirable speaker vibrations as cone breakup, oil-canning, cabinet talk, and so on. Instead of treating these misbehaviors with such passive tactics as damping, cabinet braces, and clamps, manufacturers could conceivably treat them with active cancellation techniques. At least one manufacturer, Audio Alchemy, is already conducting experiments along these lines.

Three applications immediately suggest themselves: Creating an infinitely stiff driver, cancelling the rear wave from the driver, and quelling cabinet vibrations. At least the first of these three may become reality fairly soon; Doug Goldberg informed me that Audio Alchemy is experimenting with an actively controlled subwoofer cone whose breakup is opposed by an actuator.

By using the systems already developed for duct silencing and electronic mufflers, one could produce a theoretically perfect transmission-line loading for a cone, with no reflections or resonances, with a duct only a few feet long. A separate cancellation woofer would be required, but since it would be under feedback control, it would not have to have inherently high accuracy. (I am not the first to suggest this, though the high cost of building it might prevent any commercial realization.)

The third notion, that of an actively quieted cabinet, has much to recommend it, and could result in a very substantial weight reduction in high-performance loudspeakers. Whether it is feasible with present technology is debatable. Irene Lebovics, Marketing Director for NCT, told me, "It's an interesting idea, but I don't think it could be done today. The vibrations you're trying to cancel are just too complex." However, Rick Weissman of Harman Kardon suggested that the task could be accomplished with the technology currently used in submarine quieting, while adding that "passive techniques using resonant dampers could be equally effective."

Though I believe these applications will all come to pass, my simplified descriptions gloss over the difficulties involved. This is especially true of the transmission line and the actively damped cabinet.

LOOKING FORWARD

Active cancellation based on DSP is an exciting technology that meets a multitude of needs. It can be used to protect people against annoying and/or dangerous noise levels. It can also be used in combatting, at least to some extent, acoustical problems encountered when listening to music in homes and cars. Such a technology would provide a basis for ambience-retrieval and synthesis systems to work optimally without continually combatting conflicting spatial cues from small, familiar listening spaces. Active cancellation technology, intelligently harnessed, might also improve basic speaker technology, though that remains to be seen. Certainly, DSP-based active cancellation will be brought to bear on both rooms and speakers in an attempt to overcome their more stubborn limitations. And whatever the ultimate effects on the listening experience in the home, DSP will tend to challenge traditional electromechanical engineering with software solutions, and will bring a different type of designer to the fore. A

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The Audio Interview

DAVID LANDER

TAPE MASTER

"I know how it is to be quiet, to listen and watch...," confides An-Mei Hsu, a central character in Amy Tan's novel *The Joy Luck Club*. "You can close your eyes when you no longer want to watch," she adds, "but when you no longer want to listen, what can you do?" Like the fictional Mrs. Hsu, Tony Schwartz comprehends the inexorable nature of listening. "People don't have earlids," he's fond of noting.

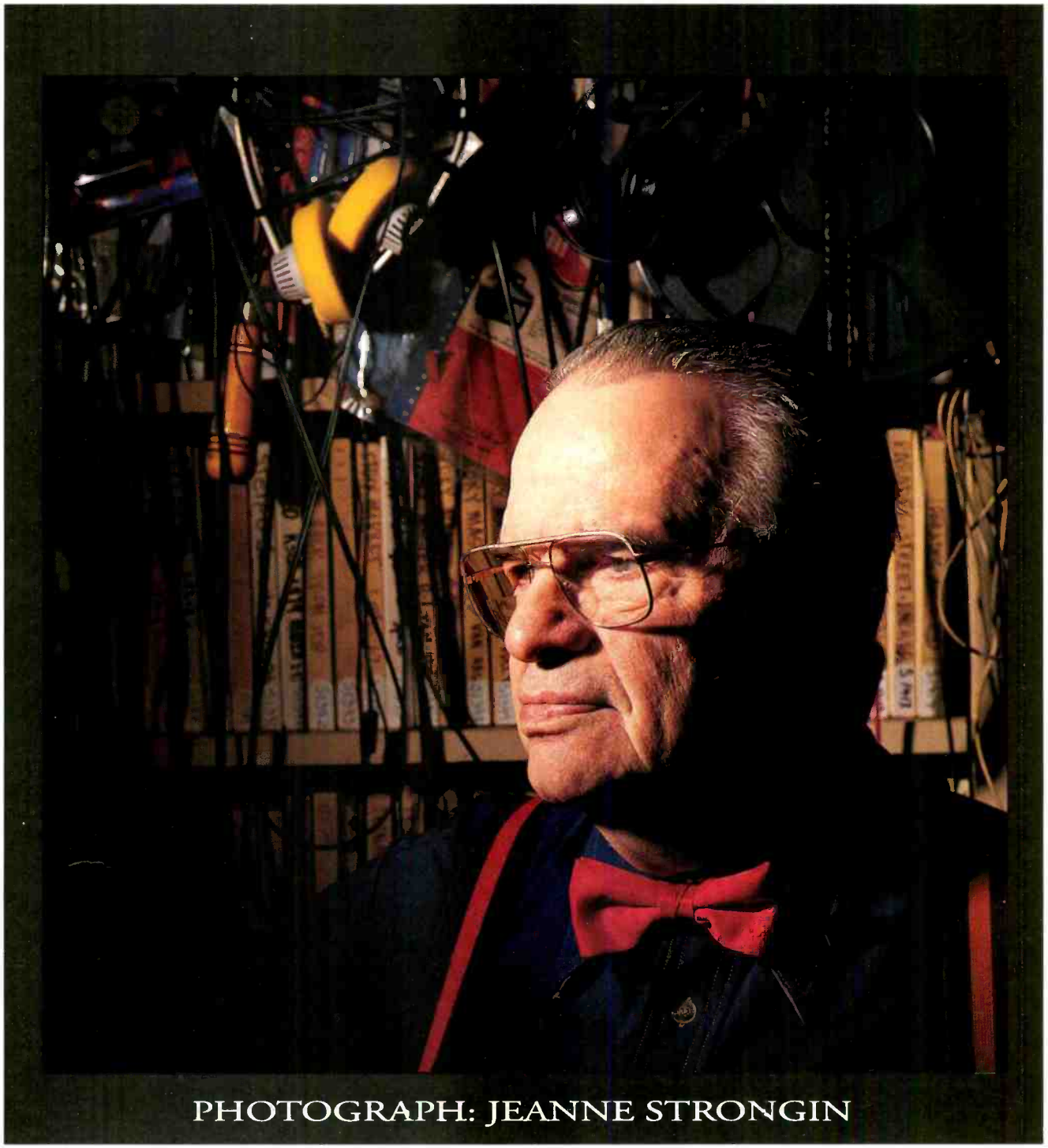
No one who knows Schwartz would accuse him, as another protagonist in *The Joy Luck Club* is accused, of being "not hard of hearing...hard of listening." During a multifaceted career in communications, he has exhibited a rare ability to listen to the sounds around him.

This skill has been carefully honed over the decades as Schwartz recorded sounds, and then played them back for others whose reactions he observed. Nearly half a century ago, he rigged an open-reel machine for portable use and began an aural documentary of his postal zone, then known as New York 19. That chunk of midtown Manhattan, though relatively small geographically, was (and remains) vast in cultural terms.

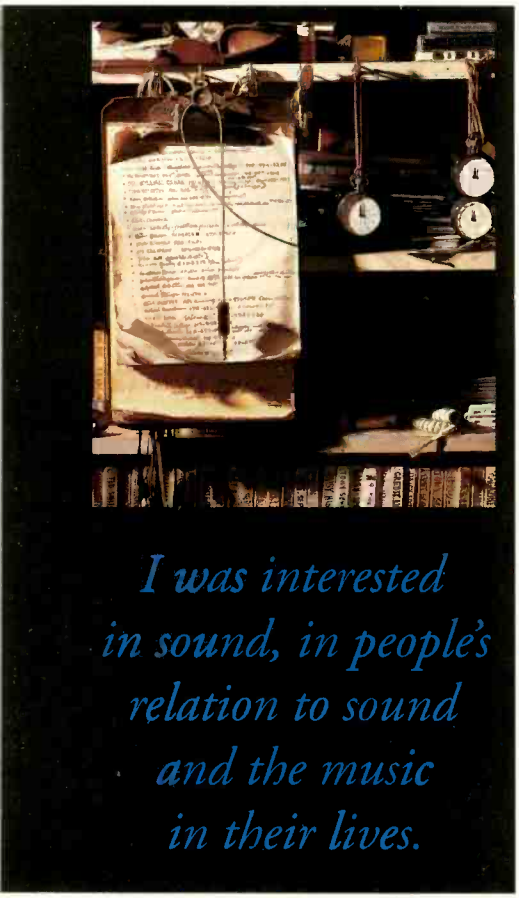
The sounds on his recordings range from pneumatic drills to garbage trucks, from the thunder of storms to that of subways. They include the voices of birds, of barking dogs, and brawling alley cats. And human voices—a painter, a plumber, a pitchman hawking pens, newspaper vendors, nightclub barkers, taxi drivers.

Recorded musical moments feature instruments ranging from bagpipes to a soda bottle and songs from places that include Israel, India, Nigeria, Romania, and more. A Puerto Rican man translates nostalgic lyrics about his birthplace as they issue in Spanish from a restaurant jukebox. A French immigrant serenades her baby with a folk tune learned from her own mother in Normandy. Too, the taping of chil-

HWARTZ



PHOTOGRAPH: JEANNE STRONGIN



I was interested in sound, in people's relation to sound and the music in their lives.

dren has been a Schwartz specialty. Young people, he has observed, "make the folk music of the city," and he has found them doing so in New York's parks, playgrounds, and streets.

Tony Schwartz's tapes have formed the basis for radio programs, a nightclub act, and more than a dozen record albums. His recorded sounds have been integral to Broadway plays, and he's done the audio tracks for two Oscar-winning short films. His recordings of children led to a career in advertising that has netted him scores of awards. Along with product spots, Schwartz's ad portfolio contains an exceptionally large number of public service commercials, and he has done work for four presidential candidates.

One renowned political spot, which some analysts feel assured Lyndon Johnson's 1964 victory over Barry Goldwater, begins with a girl picking petals off a daisy. Not quite in sequence, the child hesitantly counts them: "1—2—3—4—5—7—6——6...." When she reaches 9, an adult male voice cuts in, quickly counting down from 10 to zero. Then, from behind a mushrooming cloud, President Johnson's voice proclaims, "These are the stakes, to make a world in which all God's children can live or to go into the darkness."

Afflicted by agoraphobia since age 13, Schwartz, except on rare occasions, refrains from travelling outside New York City. His ailment, however, hasn't kept him from lecturing around the world. He does this at places as prestigious as Harvard's Graduate School of Public Health, where he's been an adjunct instructor for the past 10 years, via telephone. For all the recent talk about the information highway, it's a road Tony Schwartz has helped to pave.

Schwartz lives and works in two adjoining buildings, one of which was previously a small church called Iglesia Pentacostal El Calvario, on Manhattan's West Side. He turned 70 last summer, and *Audio* helped mark the occasion with several conversations focusing on his longstanding preoccupation with sound. As is especially appropriate with this interviewee, most were held by phone. *D.L.*

When was your first hands-on experience with audio electronics?

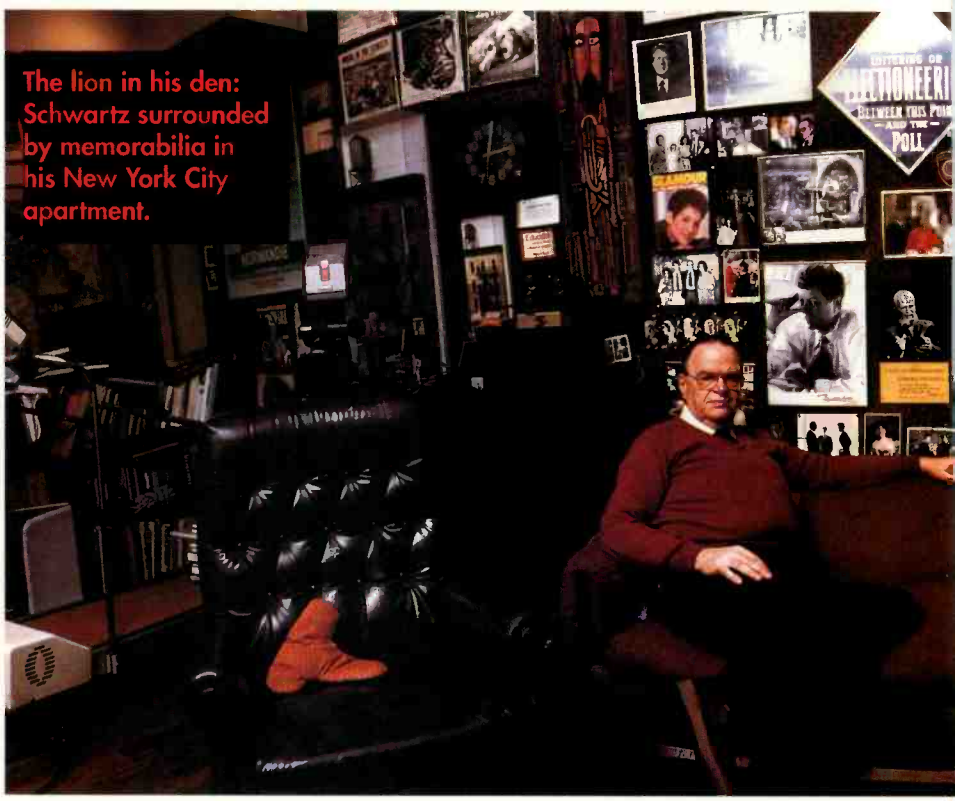
I was born a gadget hound. In high school, my brother had started building a one-tube receiver. I finished it, and then I joined the amateur radio club. Out where we lived, four miles out of Peekskill [New York], I put up two masts and built a big antenna. I bought a receiver, I think it was a Hallicrafter, and got my amateur radio license. I used to talk with people around the world. But they were only interested in the technical aspects of communications. How am I coming in? What equipment are you using? What's the strength of my signal? I wanted to ask, what sort of work do you do? What do you have for breakfast?

At what point did you actually begin recording?

In about 1945. I had a job on 44th Street [in Manhattan] in a little place called Graphics Institute, and there was a record shop next door. One day they had a Webster wire recorder in the window—it was $139.95—and I bought it.

I expect you jumped at the opportunity to record on tape.

I had the first Ampex 600 in New York City. It had a boost on the high frequencies on record, and if I recorded the BMT [subway], and the brakes squealed, it would overload. I wrote Ampex a letter and tried to be technical. I said,"When I record any high-frequency, high-volume sound, it distorts." They wrote and said,"We have a 10-



The lion in his den: Schwartz surrounded by memorabilia in his New York City apartment.

dB boost on the high end, so follow the score and anticipate any high-frequency sounds." I wrote back and said that the BMT doesn't publish a score! Then I got a Magnecorder. It had the boost in playback. You could do more with that.

How did you modify your early tape recorders for use outdoors?

I built a portable generator for the Magnecorder. And I made a control box that I could wear suspended from my neck with a strap. It had a volume control, a VU meter, a jack for earphones, and a microphone jack. I'd go out with the tape recorder in a car and, with a coiled, 75-foot line that ran to the control box, I could record anything on the street or walk into a store, an auction, whatever. Another unit I adapted for field recording was one made by the Amplifier Corporation of America, a machine designed for on-location recording. But it had to be set up. You had to open it, put your tape on it, and record the way you would if you had an electric machine. It was made to be handled that way. I removed the VU meter from the panel inside and cut a hole and remounted it in the case, which brought it to what was the top of the unit if you were holding it by the handle. That way, I could see it. I also extended the volume control and on/off switch shafts and cut holes in the cover that were large enough for my fingers so I could operate the controls from outside. I put jacks on the top for earphones and for a microphone. I could carry that machine in my hand. I also put a strap on it that I could wear over my shoulder.

Field recordings, such as this one of a street shoeshine man, used a 16-lb. portable ACA recorder with controls relocated so they could be operated from outside the cover.

Classrooms are poor acoustic environments, so as an experiment Schwartz had carpet and drapes put in. The students could then hear much better.

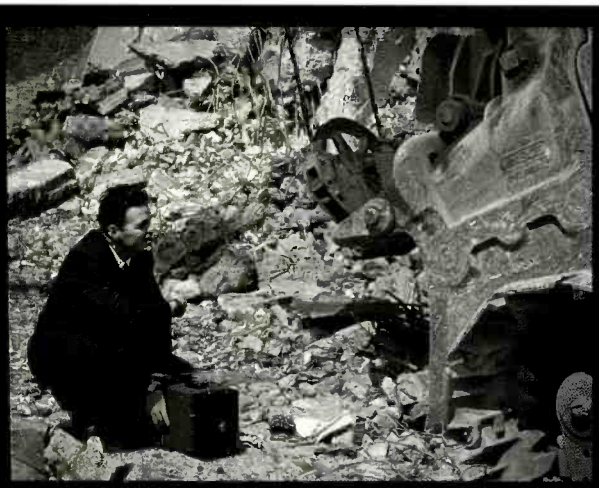
Joseph Meehan

You've said you'd leave the Magnecorder in the car while you moved around with the portable control box that you had connected to it. I take it that this control box was a lot lighter than the recorder itself.

Oh God, yes.

You also had an early Nagra, didn't you?

The Nagra came later. I was visiting a doctor friend of mine, and the Nagra salesman was showing him the first wind-up model here. I said I'd like to buy it, and he sold it to me. So I had the first Nagra in the United States. It had batteries for its electronic functions and a wind-up spring motor for its transport. The largest reels it could take were 5-inch, but I liked it because it was portable.



To make a sound-effects recording of a steam shovel, Schwartz went direct to the source.

You could say that I communicate to work rather than commute to work.

To reduce a sub ect's awareness of the recording process, the mike and output jack were sometimes hidden up Schwartz's s eeves.

Folk singers, such as Pete Seeger and Fred Hellerman, were favorite subjects for Schwartz.

What inspired you to record the things you did?

I was interested in sound, in people's relation to sound, and the music in their lives.

In fact, you've collected a lot of music, folk music from various places and tape recordings with people. How did you get in touch with them?

I found several vehicles for doing that. One, I got the Webster Wire Recorder Company interested in publishing a booklet of all the people who had bought recorders. When they put your name in, they would include the categories you were interested in. When I found anybody interested in music or folklore, I would send him a wire recording that showed what I was interested in. But I did something else. When I got into tape, I would make radio programs for stations around the country and around the world, asking people to exchange folk songs with me. I'd send them to the program director. On small stations, in many places, he'd also be the morning man, and he'd integrate these tapes into his programming. For other countries, I would make them in foreign languages, but—suppose I wanted to do one in French—I would use a person who learned French here and had an American accent. So someone in France would know it was an American asking to exchange material. I collected maybe 40,000 songs from 46 countries.

You also recorded a number of folk singers who later became household words. How did you make contact with them?

I used to listen to WNYC, and I recorded Oscar Brand's *Folk Song Festival* every week. I happened to meet someone who had been on the show, and I mentioned that I had recorded him. He asked if he could come over and hear the recording. At that time, the average folk singer had no money and couldn't cut a disc to hear how his songs sounded. These people didn't have recorders. I'd find out how to contact them, call them, and say, "I recorded you, if you want to hear the program you were on, fine." When they came, they'd say,"Gee, I'm working on this song, could I record it?" So I built up a whole collection of material by Burl Ives, Josh White, Richard Dyer-Bennet, Pete Seeger, The Weavers, Harry Belafonte, and many others.

You also had your own weekly WNYC program. What was it called?

Sounds of New York. That started in the middle '50s and ran for at least 20 years. I would broadcast the sounds of life, people, music that I recorded in my home by people who came to me from all over the country and the world. I would use tapes I got through the mail, tapes I recorded on the streets.

You also made some record albums that were, in effect, anthologies of voices and sounds.

I think I did 14 records for Folkways—and one for Columbia on the New York City taxi driver. [Folkways founder] Moe Asch had heard of this material, and he asked me if I'd put out records. He was wonderful. He would never censor anything you did, and he would always publish the notes you wanted to write. He had real respect for the artist.

Clearly, it was impossible to earn a living at this. You started out earning yours in commercial art. Tell us about the transition to creating ads.

In the late '50s, Art Kane, the photographer, asked if I would speak about my hobby at the Art Directors Club. When Steve Frankfurt, who at that time was an art director at Young & Rubicam, heard me talk and play my recordings of children, he asked if I could use real children in commercials. They didn't use three- or four-year-olds because they couldn't read. I said, of course I could do this. With tape, I'd sit a child down and say, let's play a game—you say what I say. The child would say it with his own charm three or four times till I got what I wanted. I'd record all the child's lines in a sequence, then I'd call in an adult to be the mother or another child to be the person he or she was talking to. The first commercial I did was the first to use a real child as the voice for a child. It was for Johnson's baby powder, and it ran on TV for 16 years. So, overnight, I was in a new business. I was doing all the commercials for Johnson's baby powder and bath oil, for Hoffman's soda, for Ivory Snow, Ivory Flakes. I became known as the person who recorded children.

How did you break out of that mold?

Doyle Dane [Doyle Dane Bernbach, a New York agency known for the creativity of its ads, among them numerous legendary print and TV spots for the Volkswagen Beetle] called me and asked if they could buy the use of certain sounds on one of my records, *Sounds of My City.* They said they'd pay $15 a drop. That means every time they put the needle down and took a sound, they'd pay $15. If they took 10 sounds, it would be $150.

These were to evoke New York City during spots for American Airlines. In fact, you ended up doing much more than supplying sounds for a couple of spots in the campaign. How did that come about?

Luckily, they came over and told me what they wanted. I did six demos for them on tape, but they wouldn't listen to them. They said, "We only judge scripts." I didn't write any scripts, I designed them from sounds. But I transcribed them, and they rejected all of them, said they were awful. I said, "Please listen to them." They did, and I ended up doing 45 commercials for 10 of the cities the airline served. When I didn't have the sounds of those cities, or didn't know what they were, I would look the cities up in the encyclopedia and see what industries might be there. Then I'd check to see if I had any sounds that would relate to them. Or I would record new ones that would do the job.

You've said information is lost when spoken words are put down on paper. Was that the problem with the scripts you prepared from your demo tapes, that something vital was lost in the translation from sound to print?

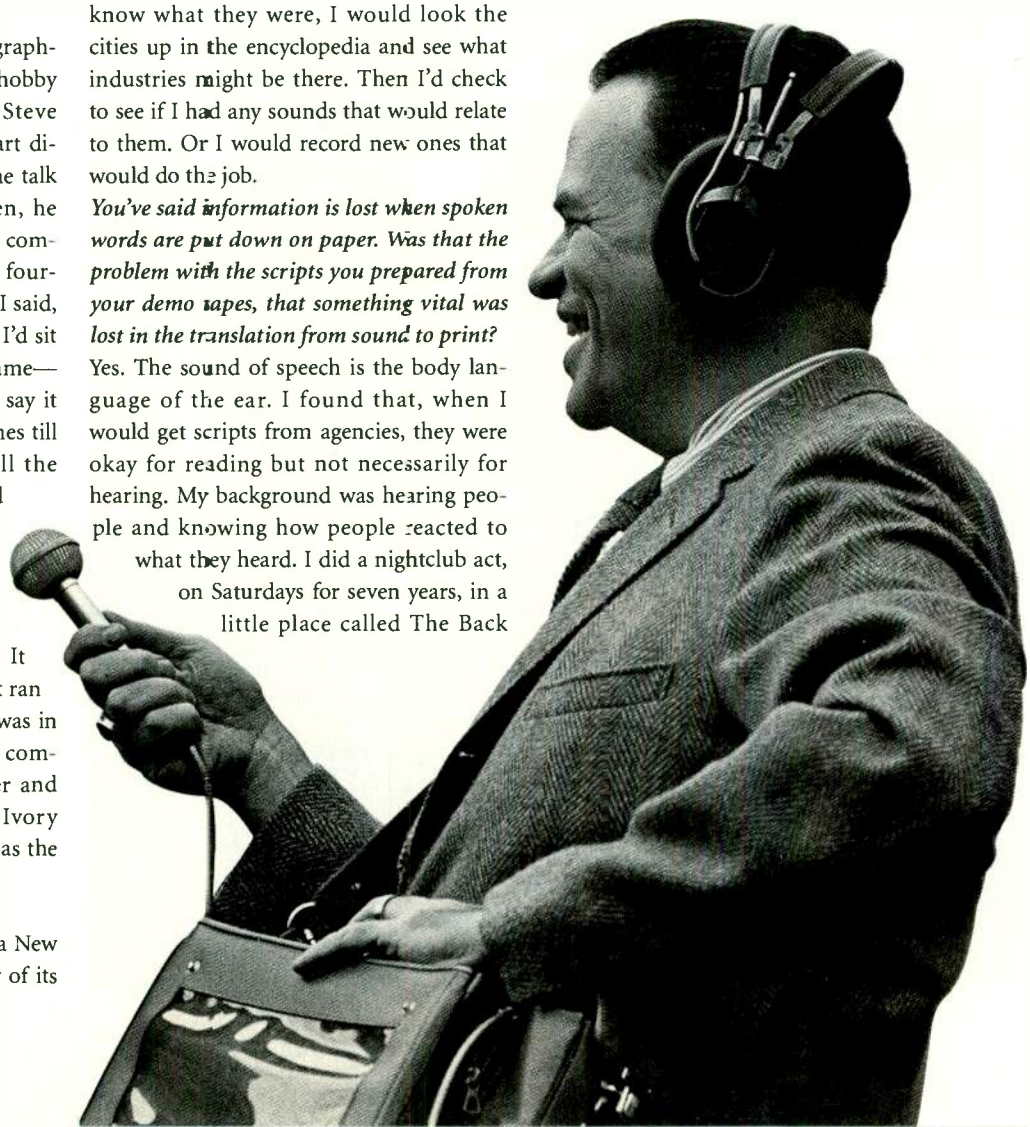
Yes. The sound of speech is the body language of the ear. I found that, when I would get scripts from agencies, they were okay for reading but not necessarily for hearing. My background was hearing people and knowing how people reacted to what they heard. I did a nightclub act, on Saturdays for seven years, in a little place called The Back Room on Sixth Avenue. I would have a theme, and I would present material consisting of segments of sound or voices that might run anywhere from 20 to 60 or 70 seconds. I would comment between them. In doing that, I learned how people reacted to words, music, and other sounds, what aspects of sound moved people.

Advertising, these days, tends to be a group effort. A copywriter and art director, for example, will create an ad together. Has your part of the formula been limited to sound?

In advertising, I originally did the sound and some copy. Now I do the whole thing. Up to the time I started doing commercials, the sound was done after the visual elements had been shot. I reversed the procedure.

You claim your commercials use radio and TV as interactive media. How so?

Most of the advertising community is concerned with getting messages to people, not how to get into their minds. But the reactions people have to what they hear in a



When someone hears or sees something that relates to his life, it's striking a responsive chord.

Working with Jimmy Carter on his 1976 campaign commercials was one of the high points of Schwartz's career.

The blind poet Moondog also proved to be adept at listening closely to sounds.

commercial, reactions which are based on their life experiences, are part of the meaning of the commercial. I try to be aware of what people are concerned with, what they're interested in. With that knowledge, I can predict how they'll react to the material I use and, by properly structuring the material, I can actually plan their reaction. For example, the press complained that the Lyndon Johnson daisy commercial was foul. But what made it seem foul to them was the interactive quality, people bringing what Barry Goldwater had said to mind. Goldwater was never mentioned in the commercial, but he had spoken for the use of nuclear weapons three times in the previous year. When the commercial evoked nuclear war in people's minds, and Johnson said he was against it, people thought of Goldwater's statements and asked themselves, whose finger do I want on the trigger?

So it was the listeners and viewers who put Goldwater into the commercial.

Yes. You see, the content of electronic media is its effect on people. In working on a commercial, I'm concerned with the effect it will have on people who listen to it or look at it.

In other words, the ad was successful because it struck a responsive chord. *[Schwartz titled the first of two books he has written* The Responsive Chord. *It was published in hardbound by Anchor Press/Doubleday in 1973, and an Anchor Press paperback version followed in 1974.* Media: The Second God *was published in hardbound by Random House in 1981 and in paper by Anchor Press/Doubleday in 1983.]*

When someone hears or sees something that relates to his or her life, it's striking a responsive chord, and there's a resonance created. The real content of any commercial is that resonance. It exists between the stimuli in the commercial and the response in the viewer's or listener's mind.

Your ads for the Johnson campaign were your first for a political candidate. How did you happen to start at the top of the political advertising totem pole?

In 1964, Doyle Dane asked me to work on the Lyndon Johnson campaign. They wanted me to do sound for six or seven commercials. One was a five-minute spot, Kennedy and Johnson talking about ending

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Bell Biv DeVoe: Hootie Mack (MCA) 00412

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Reba McEntire: It's Your Call (MCA) 00422

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MS 524

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nuclear testing. I did that, and they asked what we could do for a 60-second version. I then went to the shelf and took down a completed spot that I had done a few years before about the dangers of nuclear war and speaking for a strong United Nations—I had taken some social issues and treated them in commercial form as part of my WNYC program. I had a child counting, the countdown, and the sound of the explosion, and I said we should put Johnson's words at the end, where the announcer was speaking. So they brought over tapes of five hours of Rose Garden speeches with the scripts and a section underlined that they wanted to put in. It made the point they wanted, but it didn't sound right. So I listened through all the speeches and found a section that had the right sound and the right meaning, and I edited it down a little and used that. Those words happened to have been written by poet W. H. Auden.

You've said that the girl's reversing two numbers while she was counting was spontaneous. Did you keep that in because it added credibility?

Yes. It was reality. It was the way the child talked.

You maintain that sound is the primary focus of your television commercials as well as your radio spots. Why?

Well, television is an acoustically structured medium. It's the first medium with a visual component where the eye uses the brain as the ear always has. There's never a picture on television. It's a scanning dot. The picture is made in your mind, just as words are. If I say hello, by the time I get to the o, the first syllable is gone. Your brain has the ability to (1)Register the momentary, fleeting vibration; (2)recall previous registrations, and (3)expect future ones. I'll show you how you can expect something and fill it in. If I say, "for the rest of your..."

Life.

"Things go better with..."

Coke.

That's evoked recall. Radio and television communicators have to learn that evoked recall is the recall that's most meaningful. Learned recall, what someone remembers about a commercial afterward, has less relevance. I'm much more interested in what someone thinks of *while* he's listening to a commercial. When something a person hears strikes a responsive chord with something stored in his mind, it has much greater meaning. The listener or viewer actually becomes part of the work force employed in the creation of the commercial's meaning.

You've expressed the view that, in a TV commercial, every cut to another visual is a further distraction.

Yes. I've won first place in the advertising category at the Cannes Film Festival with a commercial that had one still picture—two Coke bottles with straws and beads of condensation.

Your way of doing ads has obviously seemed radical to some clients. How have you managed to overcome their preconceptions about the sort of work they could expect from you?

I devised a way of selling to people—saying, if you pay me to do it the way you want, I'll also do it the way I think it should be done. Once they heard both versions, 95% of the time they bought it the way I felt it should have been done.

You've helped create a vast body of public service advertising for causes ranging from anti-smoking and AIDS to seat belt safety and women's rape crisis centers. You've donated time and talent to national organizations, the Sierra Club being just one example, and local organizations that include New York's Fire Department, several hospitals, the police union....The list just goes on and on. How long have you been doing this? Do you seek these groups out, or do they find you?

I've been doing anti-smoking commercials since 1960. I'm still doing them; I'm working on two today. I work two ways. I do commercials that come to mind when I hear about things that should be done. Then I'll call and say, here's something I've thought of that could be meaningful for you. And people call me about other things. My reputation reached the point where Harvard called me and asked if I'd teach communication at their Graduate School of Public Health.

You've also taught aural perception to teenagers at one of New York City's private schools. Would you talk a bit about that?

I asked the school for all their students with learning disabilities and got many who were dyslexic and others who just weren't listeners. I got them involved in editing tape. Every student had a tape recorder, and the editing forced them to listen. The first tape I gave them was one where I said,"Hello, uhhh, my name, uhhh, is Tony, uhhh, Schwartz. I would like you, uhhh, to take out, uhhh, all the uhhhs in this tape except where they are, uhhh, content." Now, the only one that was content was where I said I'd like them to take out all the uhhhs in this tape. I did a three- or four-minute tape that way, and they had to cut out all the uhhhs. And I designed games where listening was an essential component. I gave them 60 sounds and told them to arrange these any way they wanted to tell a story. Then I had every student do a biography in sound in any way he or she wanted. One girl did it on all the records that she had heard growing up.

As you've pointed out, classrooms aren't designed for listening.

I think most classrooms are the worst acoustic environments, the worst place for listening. I did an experiment with a carpet company many years ago. I had them carpet classrooms and put drapes in. Students were much more able to hear in a room like that.

You created sounds for the Broadway production of* The Miracle Worker, *which told Helen Keller's story and included things that might be heard in a home for the insane. What other Broadway plays have you worked on?

Two for the Seesaw. The Cool World. One More River was a play that took place on a boat. They needed African jungle sounds. In my back yard on 57th Street, there used to be women hanging out clothes to dry, so I recorded the squeaking of the clothesline pulley. At reduced speed, it sounded just like jungle birds. The Museum of Natural History called and said these were the best recordings they ever heard of a certain type of African jungle bird. [*Laughter.*]

You also did soundtracks for two films, both shorts, that have won Academy Awards. One of these,* Monroe, *was based on a story by cartoonist Jules Feiffer about a four-year-old who gets drafted.

The other one, which I think was much more important, was done in the early '70s: *Frank Film.* It was an autobiography of a young man, Frank Mouris, who worked on it for five years. He had heard me speak at Harvard, by telephone, on

THE FOLKWAYS TAPES

Tony Schwartz's record albums are currently available on cassette from the Smithsonian Institution, which now owns the Folkways record label. Tapes are recorded from the masters, and original liner notes are included. The cost is $10.95 per cassette plus $2 for shipping and handling the first item and another 50¢ for each additional item shipped to addresses in the U.S. For a catalog or to order by mail, write to Folkways Mail Order, 414 Hungerford Dr., Suite 444, Rockville, Md. 20850. You can order by telephone, using your credit card, by calling 301-443-2314.

sound, and decided that, whenever he finished his film, he wanted me to do the sound for it. He called me one day and came here and brought a nine-minute biography with 11,700 stills in it. I put it on the projector and looked at the first minute and rewound it. Then I put on a tape recorder and held the microphone in front of him, turned on the film again, and said, "What the hell is this?" And he started describing it. That was one track. [The film's visual component comprises one still image after another, all of which speed by. The soundtrack consists of two separate tracks that Schwartz mixed to create two layers, or parallel lines, of sound. One is Mouris' narrative, while the other is a verbal sequence of associations that relate to items in the catalog of stills he has created. For example, when food images appear on screen, Mouris discusses food on the narrative track, while, on the other, he recites: "Food for thought, French fries, fried onions, frosty frappes, frankfurters...."]

That's the narrative track, the one on which he relates the most important aspects of his life, starting from the time of his birth.

Yes. Then I said, "Go home and write down all your associations to the pictures in the film." He did that and came back. And I put the film on again, and he ran through all his associations as the film was running. Most of them begin with the letter F.

As in Frank, and Film—or Fast Frank Film, as he jokes at one point, commenting on the speed with which the images fly by. The two tracks you created and combined to create a single soundtrack is a great match for his visual originality.

That film won first place in, I think, 78 film festivals plus the Academy Award. But the film without the sound is nothing, and the sound without the picture is nothing.

You've been lecturing for many years on aspects of communication theory and practice, and you've been doing it by telephone. How and when did this begin?

In the '60s. People would call me and ask if I'd speak. I'd say "Yes, but I do it by phone."

There was no resistance to the method?

No. I told them why. And I would send a tape for them to play, with maybe 20 examples of things I would relate to in my lecture. Between examples on the reel of tape, I would put a two-second length of white paper leader. When I was through introducing a segment, I would press a button on my touch-tone phone as the signal for them to play the next segment. They would hear my amplified telephone voice and would hear my prerecorded segments in full-fidelity sound.

When you did your first telephone lectures, did you feel the lack of visual contact?

No. In fact, I remember that, at one place where I was going to speak, the University of Virginia, the woman who was making the arrangements asked, "Well, how can we understand what you're saying without a picture?" So I said, "What did you say?" And she said, "How can we understand what you're saying without a picture?" I said, "I don't understand." Then she said, "I'm saying it clearly," and I said, "Yes, but I don't have your picture." [*Laughter.*]

Many years ago, my cousin and I cofounded an art studio, which later became a small advertising agency. He lived outside of New York City, on Long Island, and I wanted to show that he really didn't need to come to work everyday. So I said, "For a week or two, have anyone who wants to show you something slip it under the door and call you on the telephone intercom. See how many times you really have to open the door." It turned out that it was once each week for two weeks.

You've worked by phone for many years with a particular announcer, Bob Landers, who lives on the West Coast. How many commercials have you done with him via long distance?

Thousands.

Literally?

Yes. I used to call him, direct him, and listen to him as he read the copy into his recorder. Then he'd send me the tape by airline messenger service, and I would have it the next morning. Then he read into a microphone, and his words travelled over a full-frequency line from his home near San Diego to a satellite uplink. They were sent up 22,500 miles and came down to a receiving station on Staten Island in New York City and, from there, moved by full-frequency line to a recorder in my office. You might say, for all practical purposes, I had a 45,000-mile microphone cable. Now we are using a digital service with the latest fiber-optic technology. Actually, I am able to dial up anybody, anywhere in the world, who has digital lines and the same digital encoding/decoding equipment.

You've told the Library of Congress, which wants to acquire your recorded material, that you have over 10,000 audio tapes, both open reel and cassette, as well as more than 800 videocassettes and 150 16-mm films. Do you ever throw anything out?

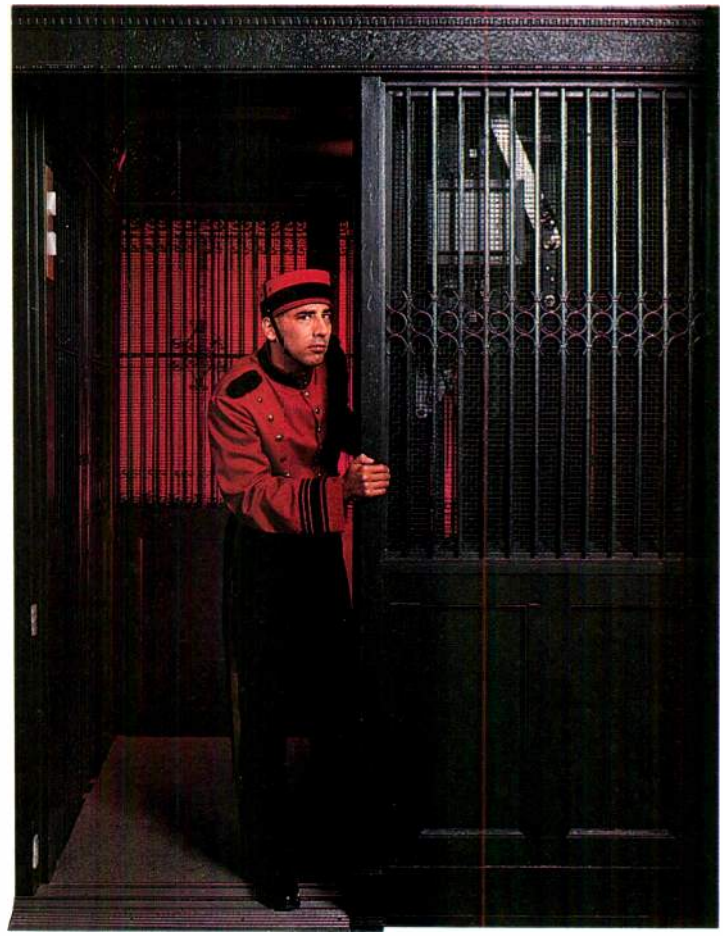
I keep everything I've ever done. I have two rooms upstairs, which are like library stacks.

Your agoraphobia certainly hasn't limited your creativity. In fact, in many ways, it seems to have expanded your horizons.

Apparently I'm good enough at my work that people come from all over to see me. I communicate to work rather than commute. A

DIAL-AN-AD

For *Audio* readers who would like to hear his ads with their own ears, Tony Schwartz has put two of his most powerful advertisements on a special answering machine. To hear these commercials, one originally produced for the New York Fire Department and later used in 800 U.S. cities, and the original audio rough for the "daisy" commercial, call 212/586-3821 between February 25 and April 1, 1994. You'll hear how Schwartz's inventive layering of sound drives his message home—and you'll learn one of the simplest, most effective ways to guard against loss of life and property in case of fire.



Going down?

YOU DON'T NEED TO LOWER YOUR STANDARDS to have music throughout your house. While most multi-room systems are adequate at background levels, who wants to spend eternity listening to elevator music? At Linn, we developed the KNEKT™ Multi-Room System with one goal in mind, delivering the music. PEOPLE NEED MUSIC. Music is important. Exploring the world of music in the comfort of your own home is therapeutic. It will help you relax, stimulate your imagination, change your mood, and provide entertainment and pleasure for your whole family. A SOUND INVESTMENT. At our innovative factory in Scotland, we produce the most advanced and best sounding hi-fi. Skilled and dedicated people and our unique single-station-build philosophy ensure a standard of construction and reliability simply not possible on a production line. Our modular approach to system and product design allows you to improve or expand your system over time in affordable steps. And, with your Linn retailer on hand to provide assistance long after your initial purchase, you can expect your hi-fi to last a lifetime. People who love music have built our business, so we look after them. MUSIC FOR YOUR LIFE. To learn more about Linn Hi-Fi and the many ways in which Linn can make music a more important part of *your* life, phone Audiophile Systems, Ltd., our U.S. distributor, at 1-800-546-6443.

1-800-LINN HI-FI

music for life™

Henry Kloss Speakers. Factory-

Henry Kloss, creator of the dominant speakers of the '50s (Acoustic Research), '60s (KLH) and '70s (Advent), brings you Cambridge SoundWorks, a new *kind* of audio company with factory-direct savings.

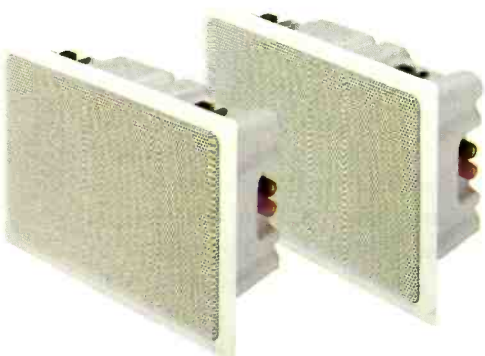
Our Center Channel speaker ($149) and our Center Channel Plus speaker ($219) are perfect for Dolby® Surround Pro Logic® systems. They offer very high performance, and are magnetically shielded. Center Channel Plus can fit *under* your TV.

The Powered Subwoofer ($599) and Slave Subwoofer ($299) by Henry Kloss provide room-shaking bass (over 100 dB at 30 Hz!). Great for pipe organs and effects in movie soundtracks. Built-in 200w amplifier. 15½" × 26½" × 10¼" (each model)

Our surround speakers, The Surround ($399 pr.) and The Surround II ($249 pr.) use dipole radiator technology to reproduce surround effects the way they were meant to be heard. Non-directional ambient sound literally surrounds you.

The Surround II *The Surround*

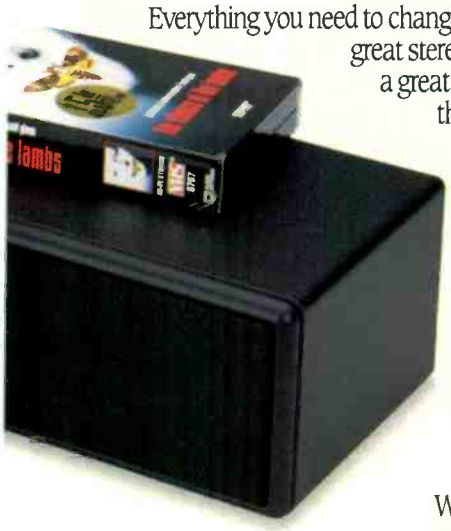
NEW! The Cambridge SoundWorks Model Six continues a 40 year tradition of high performance, high value two-way acoustic suspension loudspeakers by Henry Kloss. The Model Six with its 8" woofer, delivers very natural, accurate, wide-range sound—for only $119 each, factory-direct. Your choice of three beautiful cabinet finishes.



Ambiance™ In-Wall speakers ($329 pr.) offer an unbeatable combination of performance, value and ease of installation.

Direct Prices. 1-800-FOR-HIFI.

Everything you need to change your great stereo into a great home theater. $867.



The dual-subwoofer Ensemble® speaker system gives you ultimate room-placement flexibility for best real world performance. *Audio* magazine says it may be "...the best value in the world." With black-laminate subwoofers ($599), or black vinyl-clad subwoofers ($499).

The Ensemble II subwoofer-satellite speaker system by Henry Kloss is one of the best values in the country. We think it's better than speakers costing twice as much. Because we sell it factory-direct, it's only $399. *Stereo Review* says it "performs far beyond its price and size."

With a Cambridge SoundWorks Charge Card, qualified customers can charge purchases from our catalog—with no payments and no interest for three full months. No annual membership fee.

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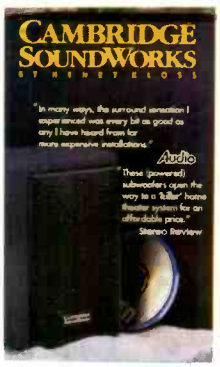
If you have any questions...if you want the free catalog including components from Cambridge SoundWorks, Pioneer, Philips, Sony and more... or if you would like to order, call us toll-free, 8AM–Midnight ET. All products are backed by a 30-day guarantee.



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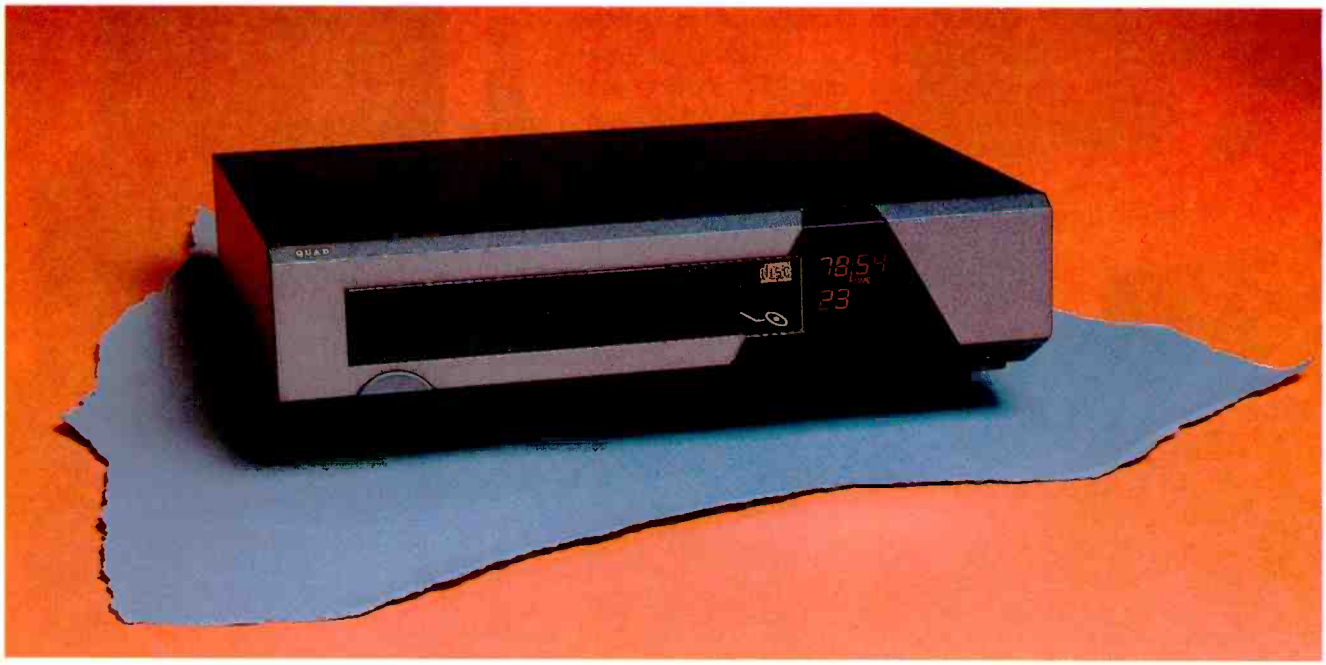
EQUIPMENT **PROFILE**

QUAD 67 CD PLAYER



These days, you can buy a CD player for little more than $100. Why, then, would anyone spend nearly $1,500 for one? The answer became obvious as I put the Quad 67 through its paces on the test bench and in my listening room. To put it succinctly, the Quad 67 is one of the finest-sounding CD players I have ever auditioned. And for those of you who believe that technical measurements bear little relationship to sonic performance, let me state that the test results of this Quad unit were as impressive as its sonic performance.

According to the venerable Quad Electroacoustics Company, which is based in the United Kingdom (Quad was organized back in 1936 under the name of the Acoustical Manufacturing Company), the 67 Compact Disc player uses a Philips CDM 9 engine with a delta-sigma modulation decoder. (Delta-sigma modulation is a variation of bitstream technology. The chief advantage of the delta-sigma chip is that the accuracy of conversion is not dependent on the accuracy of the master clock and is therefore not susceptible to clock jitter.) This is said to provide a player whose measured performance is very close to the theoretical optimum. According to Quad, the CDM 9 engine is extremely well engineered and has a very low error output; the 67 is claimed to have a very high tolerance for damaged or faulty discs, even those that are badly marked or out of specification. It is also extremely quiet in its operation.

THE QUAD 67 IS ONE OF THE FINEST SOUNDING CD PLAYERS I HAVE EVER AUDITIONED.

Control Layout

The Quad 67 is supplied with a full-function remote control. The designers of this elegant machine recognized—rightly, I believe—that most people simply want to play a Compact Disc from beginning to end. Accordingly, the front panel of the Quad 67 has few controls. Once the player is hooked up to your amplifier, pressing the on/off button at the lower left of the panel turns on power to the unit. Pressing the open/close flap, near the display area, opens the disc drawer. To simply play a disc from start to finish, you gently push the drawer after loading the disc. The drawer retracts, and play begins. The remote control need not be used at all under these circumstances.

SPECS

Frequency Response: 20 Hz to 20 kHz, ±0.1 dB.
Phase Linearity: Within ±0.5°, 20 Hz to 20 kHz.
S/N: Greater than 100 dB.
Crosstalk: Greater than 100 dB at 1 kHz.
THD: Less than 0.002% at 1 kHz.
Audio Output Level: 2 V rms, maximum.
Power Consumption: Approximately 14 watts.
Dimensions: 12.6 in. W x 3.2 in. H x 9.5 in. D (32.1 cm x 8 cm x 24 cm).
Weight: 7.7 lbs. (3.5 kg).
Price: $1,499.
Company Address: 111 South Dr., Barrington, Ill. 60010.
For literature, circle No. 90

The Quad 67's rear panel is simplicity itself.

For more elaborate operation, the remote control comes into play. If the remote's functions are to be used, the disc drawer is closed by means of the drawer open/close flap rather than by pushing on the drawer itself. When this approach is taken, the display shows the number of tracks and total playing time, but play does not begin until the command is given via the remote. Once play begins, the display shows current track, index number, remaining time of the current track, whether

QUAD QUOTES A LOW 0.002% THD, BUT I MEASURED A STILL LOWER 0.001%.

pause mode is activated, and various programming indicators. If an operating error occurs, such as loading a disc upside down or the presence of a badly damaged disc, "Error" appears in the display.

The remote control sports numeric buttons (to directly access and to program up to 50 selected tracks), a "Random" play button, forward and reverse "Index" keys, forward and reverse "Search" keys, "Track" advance or reverse keys, and keys for "Play," "Pause," "Stop," and "Store" (programming).

The rear panel of the Quad 67 is equipped with the usual pair of analog output jacks and with a coaxial digital output jack. A separate three-terminal (grounded) line cord is provided, since this CD player is sold internationally by Quad (different countries require different types of line cords). Access to the power-line fuse is available from the rear panel.

Measurements

Figure 1 shows overall frequency response of the Quad 67 player, from 10 Hz to 20 kHz. Deviation from perfectly flat response is even less than the 0.1 dB quoted by the manufacturer, and output levels from the left and right channels match almost perfectly.

Figure 2 shows how THD + N varies as a function of frequency. In fact, the distortion and noise hardly vary at all, remaining at approximately 0.003% throughout the entire spectrum. While 0.003% exceeds the 0.002% claimed by Quad, bear in mind that Fig. 2 shows the sum of harmonic distortion *plus noise.* In a spectrum analysis of the harmonics of a 1-kHz signal, made at maximum recorded level (Fig. 3), the fourth- and fifth-harmonic components are nearly 110 dB below reference level. Computing the distortion percentage contributed by the combination of these two harmonics yielded a result well under 0.001%, let alone the 0.002% claimed by Quad!

If you have been following my "Equipment Profiles" of CD players for the past few years, you may recall that in the test of THD + N versus signal amplitude, all of these players exhibited a slight rise in distortion as maximum recorded level was approached. Usually, these increases in THD were attributable to the beginning of overload in the analog output stages following D/A conversion. Now, take a look at Fig. 4: There is virtually no increase in the Quad 67's THD as maximum recorded level is reached. As far as I can recall, this is the first CD player to exhibit this phenomenon.

Figure 5 is a spectrum analysis of a 1-kHz signal and its quantization distortion products at 90 dB below maximum recorded level. In the curve made using an undithered recorded signal, note the distortion "spikes" at the fifth, seventh, 11th, and 13th harmonics of the fundamental. Reading the left-hand vertical scale, you can see that *average* noise levels hover around –120 dB. By contrast, when a dithered signal is analyzed, the quantization distortion "spikes" are not present. As I have explained many times, the dithering of low-level signals allows these signals to be recovered with minimum distortion and at levels that would otherwise not be possible. However, using dithered signals results in a penalty: Overall noise level increases by several dB. However, in the case of the Quad 67 (refer to right-hand scale in Fig. 5), there seems to be virtually no increase in average noise level—or at most a very minimal increase. The noise level is still hovering around –120 dB. I can't explain this, but the measurements don't lie!

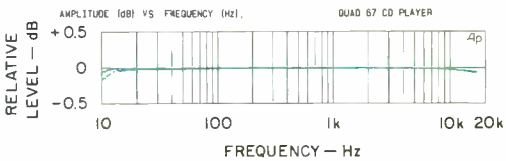


Fig. 1—Frequency response.

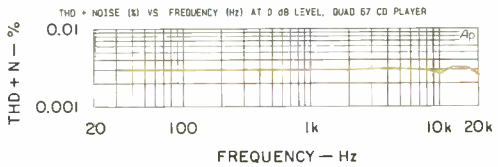


Fig. 2—THD + N vs. frequency.

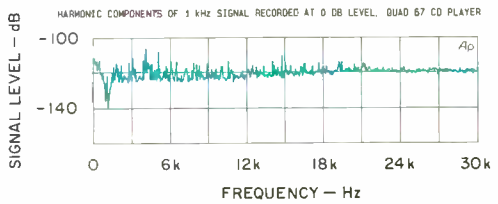


Fig. 3—Spectrum analysis of harmonics of 1-kHz, 0-dB signal.

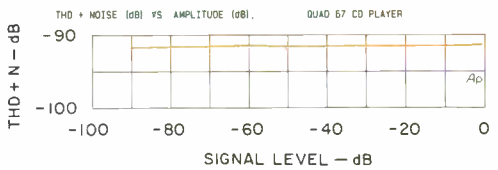


Fig. 4—THD + N vs. level.

Channel separation at 1 kHz was 107 dB in one direction and 108.5 dB in the other, decreasing to between 87 and 88.5 dB at 16 kHz. Overall A-weighted signal-to-noise ratio measured 116.2 dB for the left channel and 113.3 dB for the right. I also checked the frequency content of residual noise when playing the "no-signal" track of my CBS CD-1 test disc. Major power-supply-related noise spikes at 60 and 180 Hz were down more than 115 dB below maximum recorded level.

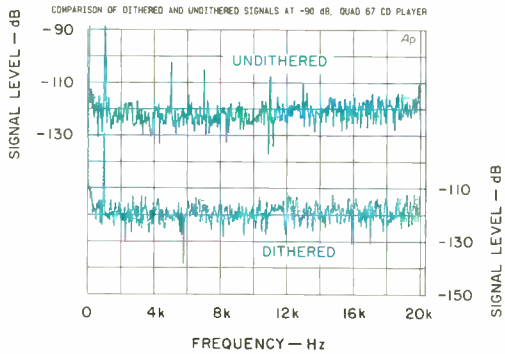


Fig. 5—Spectrum analysis of 1-kHz signals at –90 dB. (Use right-hand scale for "Dithered" curve.)

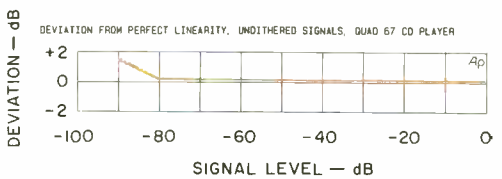


Fig. 6—Deviation from perfect linearity, undithered signals.

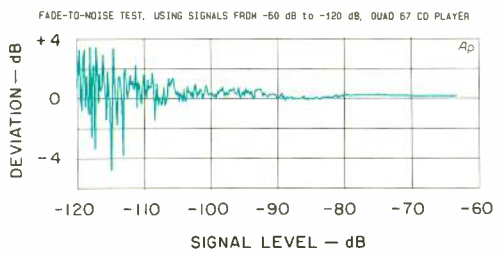


Fig. 7—Fade-to-noise test.

Using undithered signals in the range from 0 dB (maximum recorded level) to –90 dB, I next plotted deviation from perfect linearity, shown in Fig. 6. At the lowest signal level (–90 dB), the deviation is just slightly greater than +1.0 dB.

The fade-to-noise test results, shown in Fig. 7, serve two purposes. This test is another indication of linearity and also enables me to calculate dynamic range. When I used the EIA Standard of measurement, dynamic range was approximately 108 dB; using the EIAJ method of assessing dynamic range, I came up with a figure of 95 dB for the left channel and 95.1 dB for the right.

The one additional test I made was of the master clock's accuracy. It was within –0.0006%, suggesting that even those who have perfect pitch will not detect any deviation when listening to music with this player.

Use and Listening Tests

Before subjecting the 67 to listening tests, I used a Pierre Verany test disc to verify Quad's claim that this player can track discs that have been damaged or that are missing relatively long lengths of data. Not surprisingly, the 67 was able to track sections of the test disc that had 1.5 mm of missing data without so much as a momentary glitch. When I played a track in which two successive lengths of missing data (each 1.5 mm in length) were deliberately encoded in the disc, the 67's pickup and error-correction circuitry were able to navigate this as well. I noted, too, during these preliminary tests that access time to various tracks was extremely fast—faster than on most CD players I have tested, even the more expensive ones.

Accompanying my sample Quad 67 CD player was a disc entitled *Handel's 1720 Harpsichord.* The five suites by George Frideric Handel (Isis Records CD003) feature Martin Souter playing the Smith harpsichord, an instrument that actually dates from around 1720. Readers familiar with the harpsichord will recognize that its sharp, percussive sounds tend to accentuate any brittleness that is imparted to discs by less than perfect CD players. The sharp transients inherent in this instrument's sound can be grating to the ear if not reproduced properly. Quad obviously chose to send this disc with the 67 to illustrate how well the harpsichord can be reproduced by their player, and indeed, this listener's ears can confirm that it succeeded admirably.

Of course, I auditioned a variety of CDs from my own collection as well. I used such recent releases as Beethoven's String Quartets (Op. 59, Nos. 2 and 3) performed by the Cleveland Quartet (Telarc CD-80268) and a disc containing Brahms' Serenade No. 1, Op. 11, and his Variations on a Theme by Haydn, Op. 56a, featuring the Atlanta Symphony Orchestra under the direction of Yoel Levi (Telarc CD-80349). I find that properly recorded chamber music, and string quartet in particular, is an excellent program source when judging sound quality of a CD player. The intimate microphone placement generally employed in these recordings enables you to clearly discern the sound of each string instrument and judge its musical accuracy. With the Quad 67 CD player, I could not have asked for a cleaner, brighter sound. The reproduced music came as close to a live performance as I have heard from any digital program source.

EVERYTHING I HEARD OR MEASURED SHOWED ME WHY SOMEONE MIGHT SPEND THIS MUCH FOR A CD PLAYER.

Clearly a CD player with a suggested price of about $1,500 is not a component that every listener will flock to purchase. But for those who care deeply about how music is reproduced in their homes and to whom cost is a secondary consideration, I strongly recommend that they audition this elegantly designed Compact Disc player produced by our British cousins.

Leonard Feldman

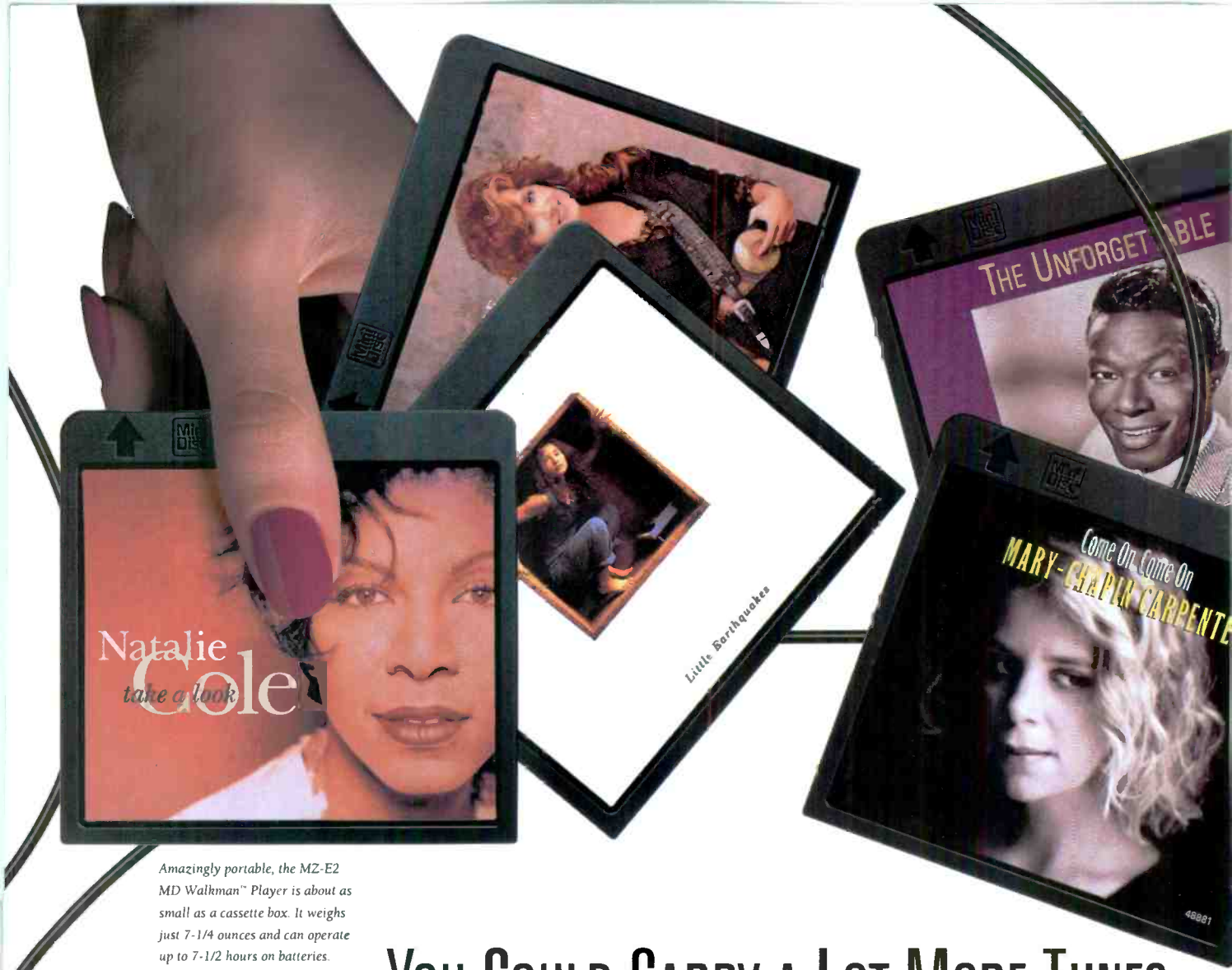
SONY

What If Cassettes Weren't Cassettes?

You Could Find a Song in a Second.

Ever try searching for a song on cassettes? You could grow old waiting for the tape to wind its way through the player. It makes you wonder why they ever called it "fast forward!"

But now there's MiniDisc – the ultra-miniature music carrier that's personal and portable. MD uses laser optical technology to find your music instantly and precisely. So no matter where your favorite songs are located, you'll never play that old waiting game again.



Amazingly portable, the MZ-E2 MD Walkman™ Player is about as small as a cassette box. It weighs just 7-1/4 ounces and can operate up to 7-1/2 hours on batteries. Bringing the power of MiniDisc performance to all of your on-the-go activities.†

YOU COULD CARRY A LOT MORE TUNES.

If you think cassettes when you think of portability, think again. Thanks to the digital magic of MiniDisc, your albums are smaller, lighter and more mobile than ever before. In fact, you can store nearly four MiniDiscs in the space of one cassette.

And there are hundreds of great albums on MiniDisc. From labels like Atlantic, BIS, Capitol, Capriccio, Chrysalis, Columbia, DMP, Elektra, EMI, Epic, Liberty, Reprise, Rykodisc, SBK, Sony Classical, Virgin and Warner.

You Could Listen For a Lifetime.

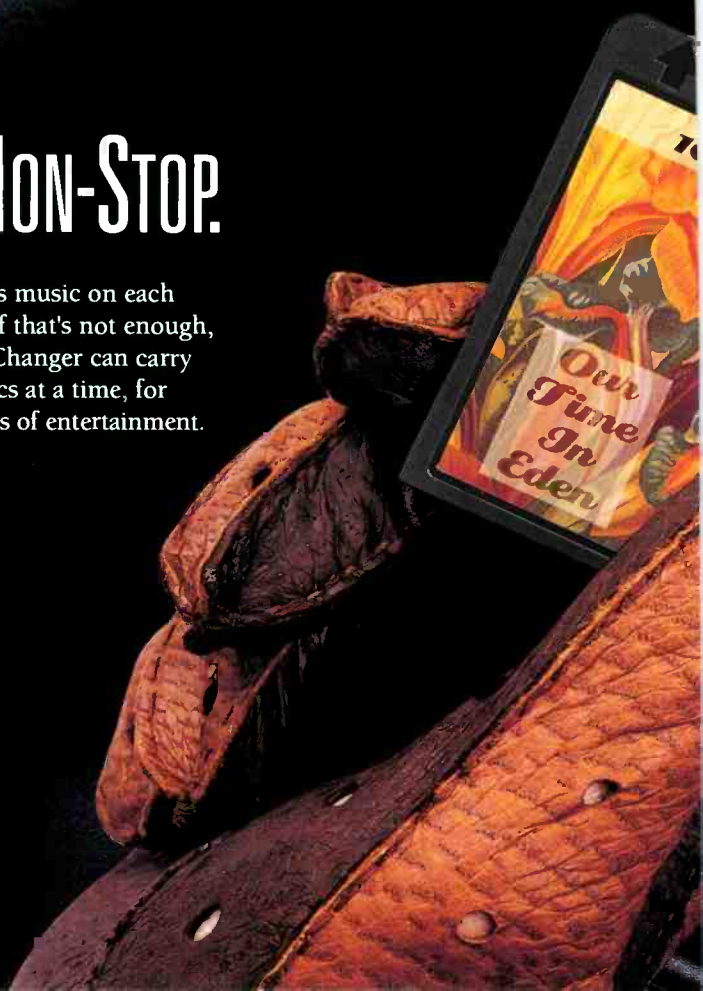
While you may love to jam with your music, you don't want your music to jam. Or stretch. Or wear out due to constant use.

MiniDisc has a better way. Each album comes in its own special cartridge that protects against fingerprints, scratches and abuse. And MiniDiscs play without contact, so the discs never wear. What's more, all MiniDisc players feature electronic shock protection. So even if you encounter some bumps in the road, your music shouldn't skip a beat.

You Could Enjoy Music Non-Stop.

When it comes to getting into music, nobody "flips" over cassettes. Because flipping from Side A to Side B has to be one of the least loved rituals around. Even auto reverse players interrupt the music enough to ruin the rhythm.

With MiniDisc, there's never any interruption to slow you down. You get up to 74 minutes of continuous music on each album. And if that's not enough, our car MD Changer can carry four MiniDiscs at a time, for nearly 5 hours of entertainment.



Why be limited to one cassette when you can play four MiniDiscs? The Sony MDX-400 Car MD Changer is an in-dash head unit that comes with an easy-to-load 4-disc magazine. There's also AM/FM diversity tuning, rotary remote and detachable face security. The MDX-400 can even control an optional Sony UniLink™ CD changer or digital preamp.

You Could Record as Never Before.

It takes a lot of effort to record on cassettes. First you have to plan your music program. Then you have to determine if you have enough tape. And if you ever want to replace a song, you might as well start all over again.

MiniDisc makes it easy. You can resequence songs at the touch of a button. If you erase a track, all subsequent tracks are instantly renumbered. And if you have to replace a track with a longer song, the MiniDisc recorder will automatically find the right space on the disc. In fact, a MiniDisc can be recorded and re-recorded more than a million times, without any loss in sound quality. Making it the ideal digital disc for the mixes you make.*

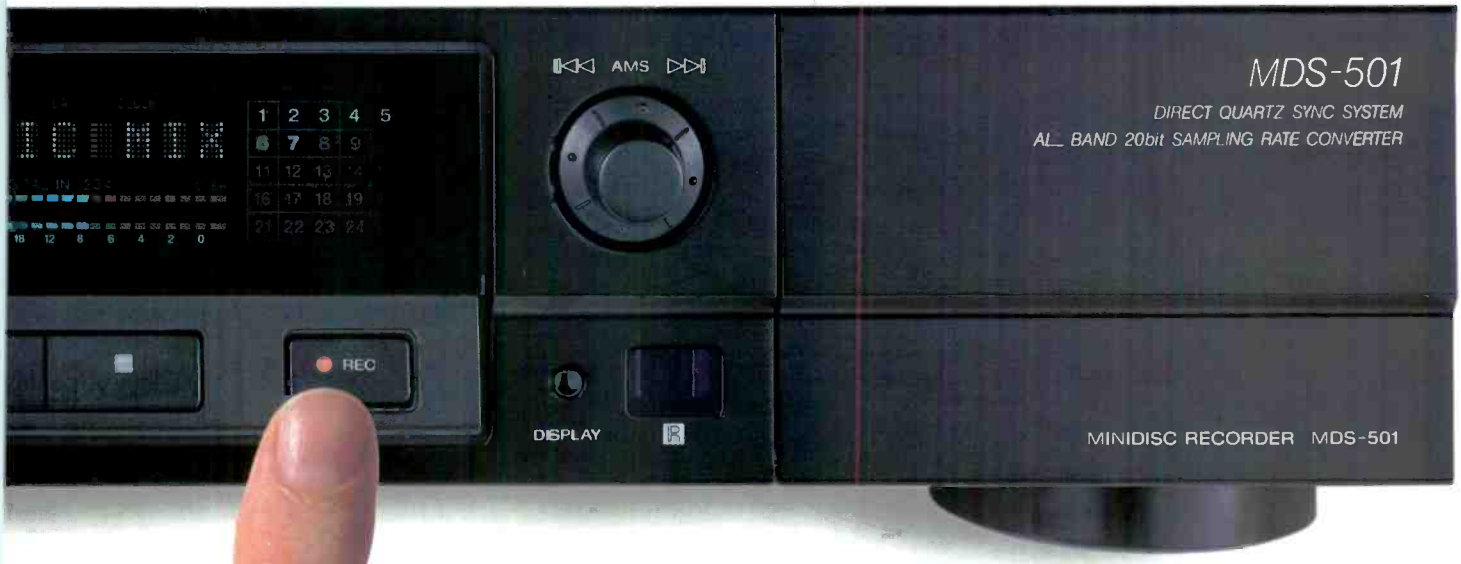
The Ultimate Cassette™ is a MiniDisc.

Digital. Portable. Recordable. Instantly accessible. Virtually unshockable. MiniDisc does everything a cassette does – only better.

And only Sony offers such a wide variety of MiniDisc products. In addition to the models shown, there's an MD Walkman Recorder. A car in-dash MD Receiver. An MD Mini Component Deck. A complete MD Tabletop Music System. And both 60 and 74 minute MD Recordable Discs.

So if you're considering the ultimate cassette system for the future, guess what? The future isn't a cassette.

It's a MiniDisc.



Sony's MDS-501 MiniDisc Recorder complements any hi-fi component system. It offers great sound and important editing functions like Erase, Move, Divide and Combine. There's also a unique Multi-Jog Dial for quick access to any track.

For the ultimate in recording convenience, record on a Sony MiniDisc. Our MDW-74 disc uses incredible magnetic technology to make recording incredibly easy. A tough, ultrasonically welded shell protects your music from daily abuse while a safety tab prevents accidental erasure. And the supplied adhesive labels make it simple to ID your MD.

SONY

Sony Electronics Inc.
1 Sony Drive, Park Ridge, NJ 07656

*MiniDisc products incorporate Serial Copy Management System which will not prevent you from making a direct digital-to-digital copy from a digital source, but will prevent a second direct digital-to-digital copy from being made. †Product available early 1994.

For your complete personal guide to all Sony consumer electronics, we're introducing *Sony Style* magazine. To receive your copy for $4.95, plus $1.50 shipping and handling, call 1-800-848-SONY. Visa and MC. Offer expires 4/94.

EQUIPMENT PROFILE

SCIENTIFIC FIDELITY CROWN JOULE SPEAKER

What can a startup audio company do when it receives a particularly unfavorable review on its first loudspeaker product? Not much, as it turns out. Scientific Fidelity (Sci-Fi for short), founded only five years ago by designer Mike Maloney and Cameron Hamza, received such a review on its first system, the Tesla, in another audio magazine. Prior to this review, Scientific Fidelity's sales were increasing at an impressive rate, and it had just expanded from 12 to 65 U.S. dealers. After the review, U.S. sales dropped more than 90% in one month. Oh, the power of the press! Fortunately, during the same period, Sci-Fi's export sales took off, and now more than 90% of all Scientific Fidelity's products are sold overseas. (Hey, I didn't realize the press had so much power. Who can we pick on next?!)

Maloney feels that Scientific Fidelity didn't get a fair shake, because the product the other reviewer received was damaged in transit and did not represent then-current production. In my reviews, I do my best to insure that the product I am supplied is performing as intended by the manufacturer. If I believe something is amiss, I will contact the company and give it the opportunity to correct the problem, or I will leave things as they are if the product is performing as designed. (See the comments in last September's issue about the buzzing tweeters that were replaced in the Genesis Genre I systems.)

The Scientific Fidelity Crown Joule reviewed here, a high-performance but smaller derivative of the Tesla, performed very well for me in both listening and measurements. The Joule is billed as a very high-performance mini monitor that the company feels can compete not just with other mini monitors but with any system three, five, or even 10 times its price. It's basically a small two-way vented system utilizing a 6½-inch carbon-fiber cone woofer/midrange and an aluminum dome tweeter. Maloney states that even though the Joule is fairly small, it is still a full-range system with surprising bass.

A number of not-so-typical design features distinguish the Joule. The enclosure is

SPECS

Type: Two-way vented box.
Drivers: 6½-in. cone midrange/woofer and 1-in. dome tweeter.
Frequency Response: 38 Hz to 30 kHz, ±3 dB.
Sensitivity: 81 dB.
Crossover Frequency: Electrical, 2 kHz; acoustical, 1.25 kHz.
Nominal Impedance: 8 ohms.
Recommended Amplifier Power: 50 watts minimum.
Dimensions: 14 in. H × 10 in. W × 15 in. D (35.6 cm × 25.4 cm × 38.1 cm); optional stands, 23½ in. H × 14 in. W × 18 in. D (59.7 cm × 35.6 cm × 45.7 cm).
Weight: 25 lbs. (11.4 kg) each.
Price: $1,590 per pair in black, white, cream, rosewood, or granite polyester-resin finish; stands, $390 per pair.
Company Address: 6301 Riggs Pl., Los Angeles, Cal. 90045.
For literature, circle No. 91

very heavy (it's made of inch-thick medium-density fiberboard) and has no parallel walls; the front baffle is a casting that's faceted to minimize diffraction. The woofer mounting system isolates the woofer frame from direct contact with the enclosure. The rear-mounted vent tube is flared at both ends to minimize port noise. The crossover frequency is uncommonly low for a two-way system. And the looks are stunningly good. The cosmetics and finish of the Joule are extraordinary, worthy of a museum piece. (In fact, Sci-Fi's Aurora preamp and Trillium power amplifiers were selected for permanent display in the Royal Museum of London and are under consideration for New York's Museum of Modern Art.)

The Joule is named for the English physicist James Prescott Joule, one of the great experimental scientists of the 19th century, who was honored by having the physical unit of energy and work named for him. The Tesla system, still the top of Sci-Fi's speaker line, is named after Nikola Tesla, the inventor of alternating-current electricity and a true genius.

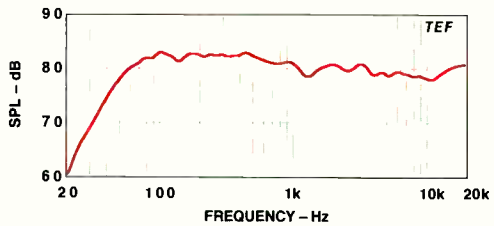


Fig. 1—Anechoic frequency response.

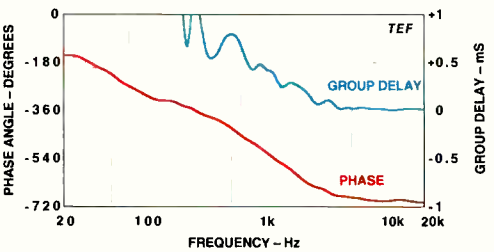


Fig. 2—Phase response and group delay.

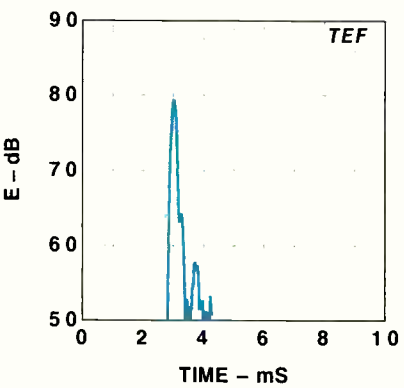


Fig. 3—Energy/time response.

The Joule's woofer is manufactured for Scientific Fidelity from the company's own designs. The tweeter, a SEAS unit, has a rigid aluminum dome covered by a mechanical protective structure that doubles as an acoustic lens to broaden coverage in the high-frequency range.

The woofer's very stiff cone is made from carbon fiber that is woven into cloth, soaked in resin, and then pressed into shape. The long-throw voice-coil is a two-layer, edge-wound copper design, wound on a Kapton former. The cone is suspended by a high-compliance, high-loss Norsorex surround that flexes freely at low frequencies but also absorbs energy at high frequencies to damp outward-travelling mechanical waves in the cone. The pole-piece has a bullet-shaped aluminum extension that protrudes out through the center of the cone; it appears to be attached to the cone like a dust cap but does not move with the cone, remaining stationary while the voice-coil moves around it. This visually distinctive part conducts heat away from the voice-coil and thus increases the power handling of the Crown Joule's woofer. (Though Scientific Fidelity calls it a phase plug, I don't think it actually has much to do with acoustic radiation or phasing.)

The drivers are mounted to the rear of the cabinet's front panel and have no externally visible means of attachment. The woofer is isolated from the front panel by a technique that Sci-Fi calls R.I.D.S. (Resonance Isolation and Damping System), which utilizes two rubber gaskets, one in front of the woofer and one behind, and a compression ring to hold the woofer against the cabinet. This effectively minimizes transmission of vibration to the cabinet, because no part of the woofer frame is in direct contact with it.

No crossover circuit details were provided with the Crown Joule, but its crossover appears to be a relatively conventional second-order high- and low-pass electrical design with impedance compensation, constructed with premium components but with a couple of interesting wrinkles. First, the crossover frequency is quite low, about 1.25 kHz (determined later by measurements). Such a low crossover frequency can greatly improve the vertical coverage of a system, if the system's acoustic phasing at crossover is properly coordinated. The low crossover frequency spreads the inevitable nulls in the vertical coverage, caused by the vertically spaced drivers, to higher and lower vertical angles, thus flattening the response in the primary vertical window. However, such a low crossover frequency can also stress a tweeter by causing overexcursion at the low end of its operating band. Second, the tweeter is driven by a source of very low impedance, made up in the network by several 10-watt power resistors forming an L pad. Maloney says that this low-impedance source flattens the tweeter's response and helps to control tweeter excursion, thus making a low crossover frequency possible. The power resistors that form this L pad are attached to a hefty aluminum angle bracket that acts as a heat-sink.

The crossover network itself appears to contain nine parts, not counting paralleled components: Four resistors, three capacitors, and two air-core inductors. The network is attached to a piece of fiberboard mounted to the rear of the input connection panel (which does not support bi-wiring) and is hand-wired point-to-point, without terminal strips. The parts count was determined by physical observation of the network with the input panel removed. The actual topology of the network was not completely clear, because some of the parts and connections were obscured with hot-melt adhesive. Electrical and acoustical

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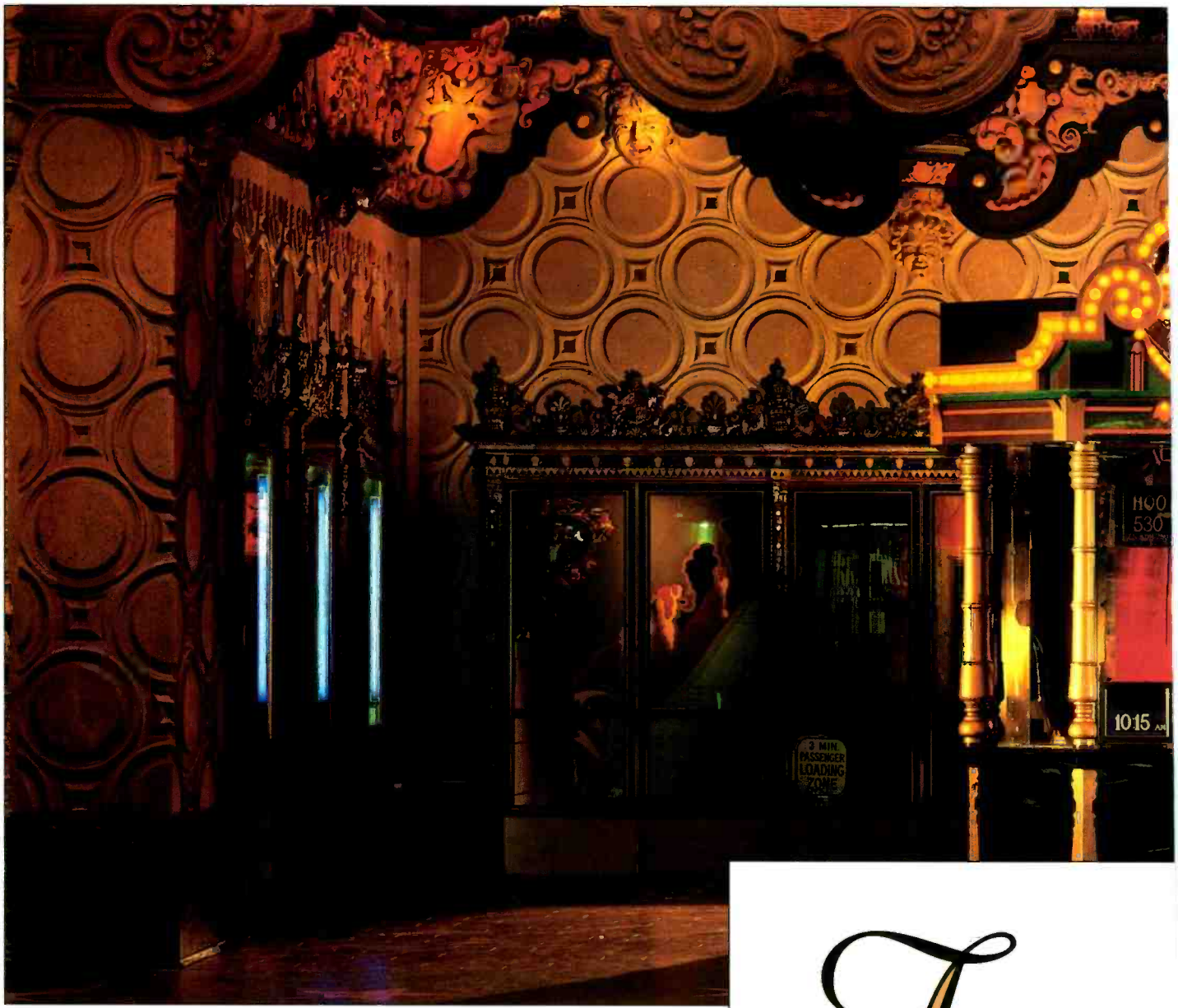

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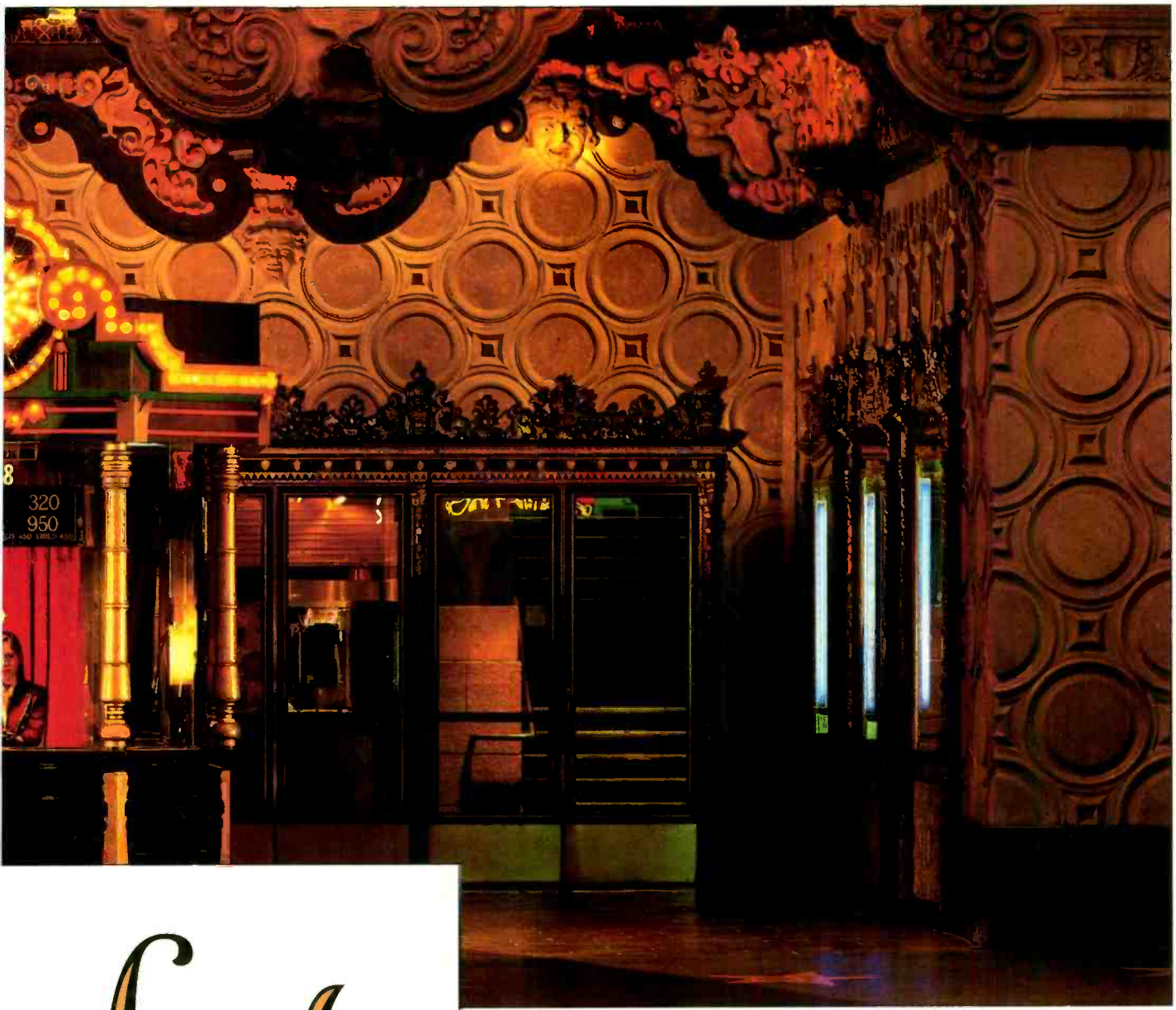

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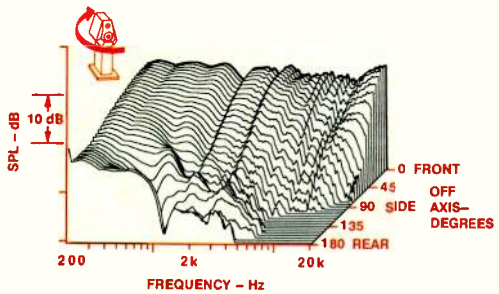

Fig. 4—Horizontal off-axis frequency responses.

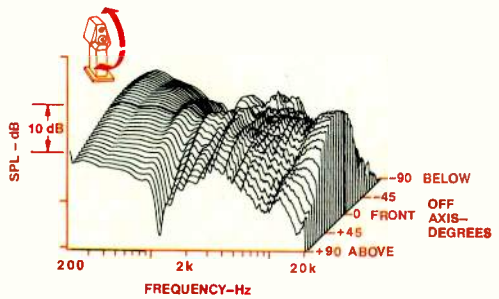

Fig. 5—Vertical off-axis frequency responses.

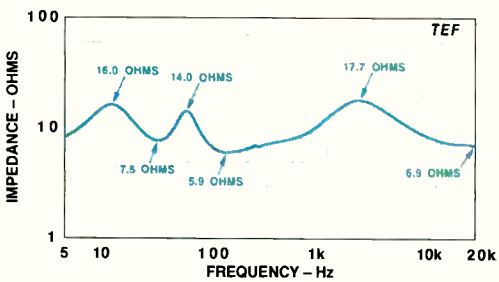

Fig. 6—Impedance.

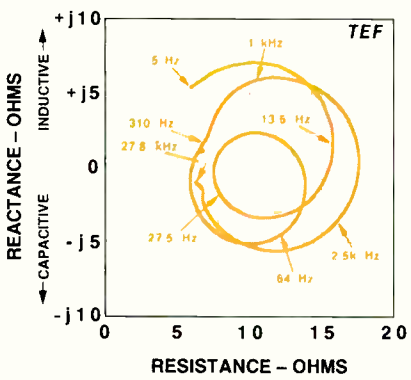

Fig. 7—Complex impedance.

measurements were later made to reveal more details of the crossover network.

The Crown Joule comes with an optional stand, called the Setting (Joule rhymes with Jewel, hence the name of the stand), which must be filled with sand or similar granular materials for proper setup. The Setting supports the Crown Joule on four cone-pointed bolts, each 5 inches long. These bolts extend down into the sand inside the Setting, and provide a dissipative sink for unwanted vibrational energy created in the system's cabinet. Spikes are supplied for the bottom of the Setting.

Measurements

The on-axis anechoic frequency response of the Joule is shown in Fig. 1 (1 watt, 2.83 V rms, tenth-octave smoothed). Measurements were taken 1 meter from the front of the cabinet, on the tweeter's axis. With the Joule mounted on the Setting, the tweeter is 36 inches above the floor. I used a combination of elevated free-field and ground-plane measurements to derive the curve.

Overall, the curve in Fig. 1 is fairly flat and extended and does not have any major peaks or dips. The response above 500 Hz exhibits a very gentle roll-off of about 0.9 dB/octave (3 dB/decade) up to about 11 kHz, where the response then rises slightly. Above 20 kHz, the response continues to rise and reaches a very sharp peak (13 dB above average level, with a Q of about 25) at the tweeter dome's resonance of 26 kHz. Note the low sensitivity, which averages only 80.9 dB from 250 Hz to 4 kHz but is actually 2 dB hotter in the upper bass and lower midrange, from 80 to 500 Hz. Low efficiency is not bad in itself, as long as the speaker can generate adequate acoustic output if fed enough power. Often, especially in smaller speakers, efficiency is traded off for deeper bass extension, a valid exchange.

The right and left systems matched very closely. One system was about 0.5 dB hotter than its mate, but this deviation was spread fairly evenly across the whole audible range.

A speaker's overall crossover response includes both the acoustic response of the drivers themselves and the crossover's electrical response. To check the Crown Joule's acoustic crossover characteristics and its inter-driver relative phase, I compared axial response with the tweeter wired normally and with its wiring reversed. With the tweeter's polarity reversed in this manner, the Joule's response exhibited a sharp, deep null (about 20 dB) at 1.25 kHz. This identified the overall crossover frequency and showed that the woofer and tweeter, when normally connected, are essentially in phase through the crossover region, a very desirable condition. The fact that the Crown Joule has both a low crossover point and drivers that are in phase means that the speaker's vertical coverage should be very good. Acoustically, the crossover is very close to the optimal 24-dB/octave Linkwitz-Riley configuration, which exhibits no lobing.

The electrical component of the Joule's crossover response was determined by measuring the voltage-drive frequency response at the drivers' terminals. This showed that the signal fed to the tweeter was considerably attenuated, by an average of about 15 dB over the range from 2 to 8 kHz, and that its response exhibited a gentle upward tilt above 2 kHz. (The tweeter apparently has a sensitivity of about 95 dB and needs to be attenuated by about 15 dB to match the woofer's sensitivity.) Below 1.5 kHz, the signal to the tweeter rolled off at 6 dB/octave until it levelled off by about 32 dB of attenuation below 200 Hz; this high attenuation should protect the tweeter from any overload. The crossover's output to the woofer exhibited a classic second-order Butterworth (12-dB/octave) low-pass response at 700 Hz.

The phase and group-delay responses of the Joule, referenced to the tweeter's arrival time, are shown in Fig. 2. The phase curve is well behaved and rotates only about 180° above 1 kHz. The group delay falls with frequency to about 4 kHz, then becomes quite flat. This is due to both woofer/tweeter physical offset and crossover characteris-

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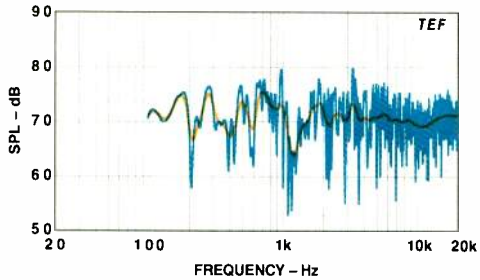

Fig. 8—Three-meter room response.

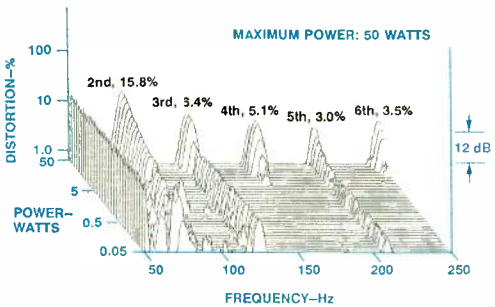

Fig. 9—Harmonic distortion for E_1 (41.2 Hz).

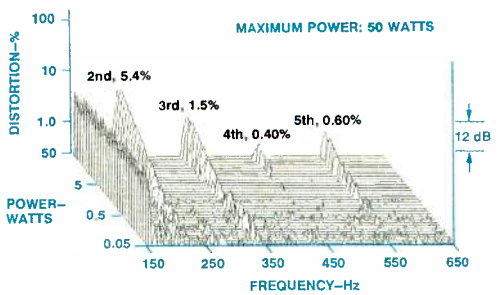

Fig. 10—Harmonic distortion for A_2 (110 Hz).

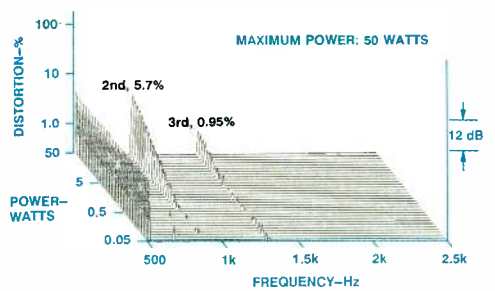

Fig. 11—Harmonic distortion for A_4 (440 Hz).

tics. The rise below 1 kHz is due to the inherent delay caused by the roll-off characteristics of the woofer in the bass range. Additional variations are due to minimum-phase variations in the magnitude response, which would disappear if the response were flat through this range.

The Joule's energy/time response is shown in Fig. 3 (1 meter, on axis, 2.83 V rms). The test parameters accentuate the response from 1 to 10 kHz, as usual—only in this case, that frequency range *does not* include a significant part of the crossover region, because the crossover frequency is quite low. The main arrival, at 3 mS, is quite compact but is followed by a delayed response, which is down about 23 dB from the main peak.

Figure 4 exhibits the horizontal "3-D" off-axis responses of the Joule; the bold curve at the rear of the graph is the on-axis response. The off-axis horizontal response is very uniform. In the primary ±15° listening window, the response is extremely uniform, staying within ±1 dB all the way up to 20 kHz.

The vertical off-axis "3-D" curves of the Joule are shown in Fig. 5; the bold curve in the center of the graph (front to rear) is on axis. In the primary listening window of –5° to +15°, the response is very uniform. For angles within ±35° of on axis, the response exhibits no severe dips at the crossover; it's only beyond these angles that significant dips are evident. The low crossover frequency—and the in-phase response of the woofer and tweeter through the crossover region—contribute to this excellent vertical coverage, one of the best I've seen.

Figure 6 shows the Joule's impedance magnitude versus frequency, plotted over the extended range from 5 Hz to 20 kHz. A relatively high minimum impedance of 5.9 ohms occurs at 130 Hz, and a maximum of about 17.7 ohms occurs at 2 kHz. The low-frequency impedance exhibits the classic double-hump characteristic of the vented box. The dip at 35 Hz indicates the approximate location of the Helmholtz tuning frequency, where the box loading is at its maximum.

Between 20 Hz and 20 kHz, the curve has a max/min variation of about 3 to 1 (17.7 divided by 5.9). This variation, coupled with the fairly high minimum impedance, means that the Joule will be only somewhat sensitive to cable resistance. Cable series resistance should be limited to a maximum of about 0.1 ohm to keep cable-drop effects from causing response peaks and dips greater than 0.1 dB. For a typical run of about 10 feet (3 meters), 16-gauge (or heavier) cable of low inductance should be used.

Figure 7 shows the complex impedance of the Joule, plotted over the range from 5 Hz to almost 30 kHz. No surprises here. Between 20 Hz and 20 kHz, the impedance phase (not shown) reached a maximum angle of only +29.9° (inductive) at 890 Hz and a minimum of only –30° (capacitive) at 76 Hz. With these moderate angles and relatively high minimum impedance, the Joule will not be a problem for any amplifier; it is a true 8-ohm system.

When subjected to a high-level sine-wave sweep, the cabinet of the Joule was quite inert except for some slight activity of the side walls at and near 230 Hz. The 6½-inch woofer has a linear excursion capability of about 0.4 inch, peak to peak (±0.2 inch)—relatively high for a woofer of this size—and it overloaded quite gracefully. The reduction of cone displacement at the 37-Hz vented-box resonance frequency was quite good. The displacement was only about 25% of the value attained with the port covered for test.

A peculiar phenomenon occurred when the speaker was driven at or near its box resonance (35 to 45 Hz) with voltages in excess of 12 V rms (about 20 watts). The Joule made a moderate buzzing sound that was significantly reduced or eliminated when the port was partially or fully covered (thus turning the speaker into a closed-box system). I traced this to a noise that the surround was generating in a localized area on the bottom of the woofer. Apparently the surround was flapping because the high acoustic pressures on the back of the cone

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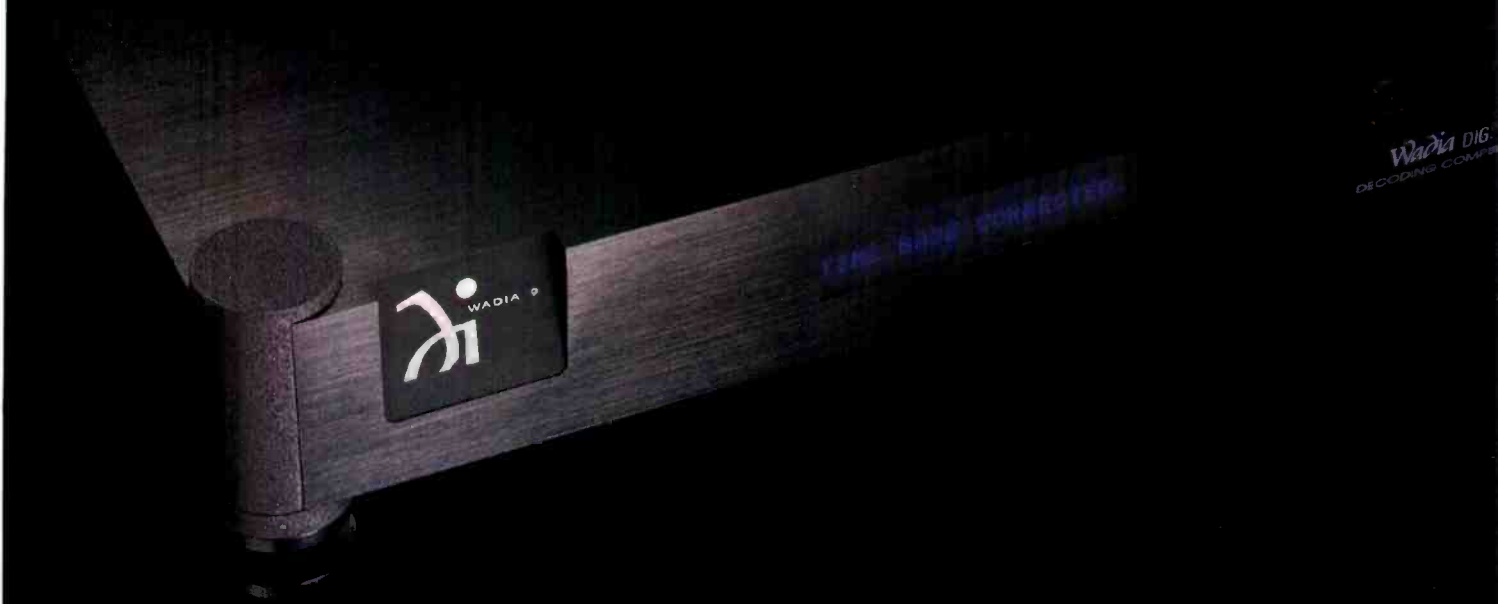

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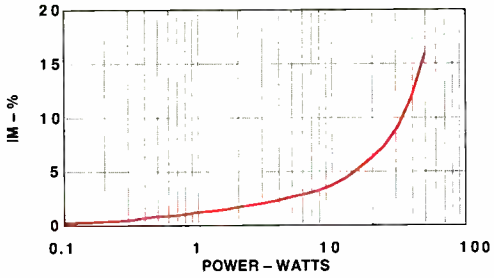

Fig. 12—IM distortion for A_4 (440 Hz) and E_1 (41.2 Hz).

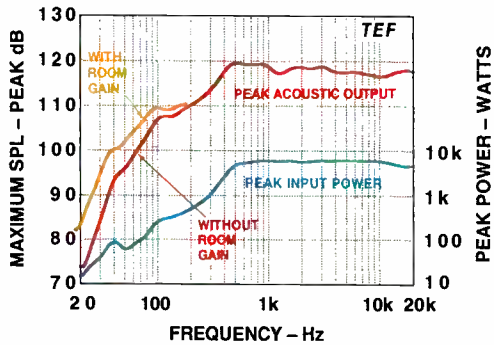

Fig. 13—Maximum peak input power and sound output.

at box resonance forced the cone to stop vibrating, leaving the surround to flap. (The back pressure in a vented box at and near box resonance is significantly higher than in a closed box with the same input level.) This problem may have been due to the loose, high-compliance surround the manufacturer chose.

Figure 8 shows the 3-meter room curve of the Joule, with both raw and sixth-octave smoothed responses. The Joule was in the right-hand stereo position, mounted on the Setting and aimed toward the main listening position; the test microphone was placed at ear height (36 inches) at the listener's position on the sofa. The speaker was driven with a swept sine-wave signal of 2.83 V rms, corresponding to 1 watt across the rated 8-ohm impedance. The direct sound and 13 mS of the room's reverberation are included.

Excluding a dip near the crossover, at about 1.1 kHz, the averaged curve in Fig. 8 fits a fairly tight, 9-dB window and an even tighter window, of about 4.5 dB, above 3 kHz. But why the dip at crossover in the room curve (which includes both direct and reflected signals) when there's no such pronounced dip in response on and near the axis? It could be that the Joule's energy response is down in this frequency region due to the fairly wide holes in the radiation pattern where it aims toward the floor and ceiling. If the crossover occurred at a higher frequency, there would be several much narrower peaks and dips in the vertical polar response that might average out when the reflections are considered.

Figure 9 shows the E_1 (41.2-Hz) bass harmonic distortion with input power ranging from 0.05 to 50 watts. The second harmonic reaches a moderate 15.8%, with the third at 6.4% and the fourth at 5.1%. Higher harmonics were at 3.5% or less. With an input of 50 watts, the Joule reached a usable maximum level of about 92 dB SPL at 41 Hz. Note the sudden jump in the distortion above 25 watts at the third through sixth harmonics. This corresponds to the previously mentioned flapping of the surround that occurs in the bass range.

Figure 10 shows A_2 (110-Hz) bass harmonic distortion. The predominant distortion is a fairly low 5.4% second harmonic and 1.5% third. Distortion levels of higher harmonics are quite low, 0.6% or less. With a 50-watt input, the speaker reached a quite usable maximum level of about 100 dB SPL at 110 Hz.

The A_4 (440-Hz) distortion is shown in Fig. 11. The only significant distortion products are 5.7% second harmonic and 0.95% third. Higher harmonics were below the noise floor of my measuring gear. The E_1, A_2, and A_4 harmonic distortion levels are quite good for a 6½-inch woofer system. With a 50-watt input, the Joule reached a quite usable maximum level of about 100 dB SPL at 440 Hz.

Figure 12 shows IM distortion versus output, over the range from 0.1 to 50 watts, for 440-Hz (A_4) and 41.2-Hz (E_1) tones of equal power. The IM distortion rises to the moderate level of 16.0% at 50 watts. For a speaker that reproduces both frequencies of this test with one driver and has no intervening crossover, this distortion is quite reasonable.

Figure 13 shows the Joule's short-term peak-power input and output capabilities, as a function of frequency, measured using a 6.5-cycle, third-octave-bandwidth tone burst. The peak input power was calculated by assuming that the measured peak voltage was applied across the rated 8-ohm impedance.

The peak input power starts at 16 watts at 20 Hz, rises to 96 watts at 40 Hz (which coincides approximately with the tuning frequency of the vented box), falls slightly at 50 Hz, and then rises fairly smoothly to about 6,200 watts (±223 V peak!) above 500 Hz. No additional distortion was noted in the crossover region, 1 to 2 kHz. No dynamic offset was evident in the bass range, a good trait.

With room gain, the maximum peak output rises very rapidly from 82 dB SPL at 20 Hz to 100 dB at 40 Hz, reaches a slight plateau of about 110 dB between 100 and 200 Hz, and then rises into the region of 116 to 120 dB above 500 Hz. Systems of higher sensitivity usually have peak levels in the region of 120 to 130 dB. However, the Joule's peak levels of 116 to 120 dB are more than adequate, though it takes a very powerful amplifier (such as the amp I used for the measurements, a Crown Macro Reference operated in bridged mono mode and developing 6 to 7 kW) to achieve them. Note, however, that with a typical 100-watt amplifier, whose peak power capabilities will be no more than 200 to 300 watts, the low-efficiency Joule will only be able to reach peak levels of about 105 dB before amplifier clipping sets in. This may not be adequate if the system is played loudly, with average levels of 95 to 100 dB. The Joule's peak level capability in the bass range is significantly higher than all the other mini-monitor-sized speakers I have tested and is only somewhat lower than some of the big guys.

Use and Listening Tests

Gorgeous, stunning, and sensual are a few of the words that came to mind after I had set up the Crown Joules on their Setting stands. The multifaceted shape of the Joule and its rosewood polyester-resin finish are just superb! (Don't tell me that only

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performance is important when you make a speaker purchase; the looks are important also, especially if you end up paying big bucks for high-end speakers.) The Crown Joules do not include a grille. Fortunately, the drivers themselves are quite sexy looking, and I didn't miss the grille (though my wife, more of a traditionalist, did not like the grille-less look).

The Settings were not as straightforward to set up as other stands. Sand or other material has to be used to fill them up, to insure proper operation. If the stand is not filled, its fairly thin walls are free to vibrate and will generate extraneous noises. Recommended fills include play or dry sand, dredged or "dead" (fine) sand, fish gravel, and, if mobility and cost are important, cat litter. The Setting's weight can vary from 35 pounds for the cat litter to 80 pounds for fine sand. I chose cat litter. (Our cat just loved these speakers. I wonder why?)

The Joules came with a brief, two-page set of instructions covering such topics as installation, placement, break-in period, and care and cleaning. The Settings came with their own single-page instruction sheet. In phone discussions, Mike Maloney stated that a far more comprehensive set of instructions is in the works. He added that he follows the George Cardas method of speaker placement based on the "Golden Ratio" (approximately 0.618 to 1, or 1 to 1.618), and will include some of Cardas' setup guidelines in the manual.

My listening equipment consisted of the Krell KRC preamp and KSA-250 power amp driving the Joules through Straight Wire Maestro cabling. Listening was not done in the bi-wired configuration, because the Joules do not support bi-wiring. My reference units were B & W 801 Matrix Series 3 speakers, while Onkyo and Rotel CD players provided source material.

I set up the Crown Joules in my usual locations—significantly away from the rear and side walls of my listening room, 8 feet apart, and aimed in toward my listening position at the couch. These locations do not provide much side- or rear-wall reinforcement in the bass range.

First listening was done by my 20-year-old son, to a new rap CD he had just purchased. His comment was: "This is great, these babies have some bass!" We were both impressed with the overall bass/treble balance and smoothness. The Crown Joules really did sound like much larger systems, with big-speaker extended bass. In informal listening, the Crown Joules sounded very similar to my reference speakers, only significantly less sensitive. Later, more serious, listening revealed just how close the Crown Joules were to the references—quite close!

I compensated for the sensitivity difference between the Joules and my reference speakers by using the Krell preamp's remotely controllable 6-dB gain function when switching between speakers. Fortunately, the Crown Joules are just about exactly 6 dB less sensitive (or less efficient) than the 801s (80.9 dB versus 87 dB measured sensitivities).

When level-equalized, the Joules sounded surprisingly similar to the 801s, both in voicing and quantity of bass and in bass extension. When I played them at moderate levels and stood up, facing sideways or rearward (thus minimizing directional cues), it was hard to tell them apart! This is quite surprising considering the size differential between the Crown Joules and the 801s. It's only when they're played very loud, with material that has a lot of low bass, that the Joules start sounding compressed and somewhat distorted. I suspect that part of this problem was amp clipping, since I was not monitoring this.

PLAYED AT THE SAME LEVEL, THE JOULES SOUNDED SURPRISINGLY LIKE MY BIG REFERENCE SYSTEMS.

On *The Mannheim Steamroller Christmas* (American Gramaphone AGCD-1984), the Joules performed at their best, negotiating with much expression and verve all the special sounds and effects on this super CD.

On full orchestral material with vocals, such as Handel's *Ottone, Re De Germania* (Harmonia Mundi 907073.75), the Joules did a very credible job on soundstaging and dynamics, reproducing well the cleanliness of this excellent recording.

The Joules passed the pink-noise stand-up/sit-down test with much aplomb, sounding essentially the same at all listener positions. They were even slightly more uniform on this test than my references! The Joules' spectral balance on pink noise was quite good and again sounded quite similar to the 801s. However, the Joules were not quite as smooth and added a slight tonal quality to the pink noise. (Even when speakers sound quite similar on music, pink noise will smoke out the differences.) The Joules did as well on this test as any speakers I've tested.

With third-octave band-limited pink noise, the Crown Joules did not have any usable output in the 20- and 25-Hz bands but had quite usable output at 31.5 and 40 Hz. At 50 Hz and higher, they could generate quite decent levels of clean bass. The Joules overloaded gracefully and didn't generate much in the way of higher order harmonics. The main difference in bass between the Joules and the 801s was the capability of the reference speakers to play much louder.

On the exceptionally well-recorded German import *Benedetto Marcello: Four Sonatas for Harpsichord* (Jecklin CJEC 5001), the Joules performed flawlessly in re-creating the intimate sounds of this keyboard instrument. (If you like harpsichord, this is a must-have CD: Perfect recording, excellent composition, and a great-sounding instrument. It's the best harpsichord recording I know of! Gene Pitts, *Audio* Editor, agrees.)

Even on certifiably non-audiophile material, such as the hit country CD by Alan Jackson, *A Lot About Livin' (And a Little 'Bout Love)* (Arista 07822 18711-2), the Joules produced an all-around good, well-balanced sound, particularly on bass. I wanted to jump up and do a line dance! (Hey, where else can you find opera, country, and rap in the same review?)

While "everybody knows" that small systems can't have any bass response, Scientific Fidelity knows better. It has done a super job in trading efficiency for bass response. Although less efficient than most speakers, the Crown Joules can speak with authority if driven with a higher power amplifier. In accuracy, smoothness, and stellar good looks, the Joules do not have much competition. I give them a high recommendation, your budget permitting. *D. B. Keele, Jr.*

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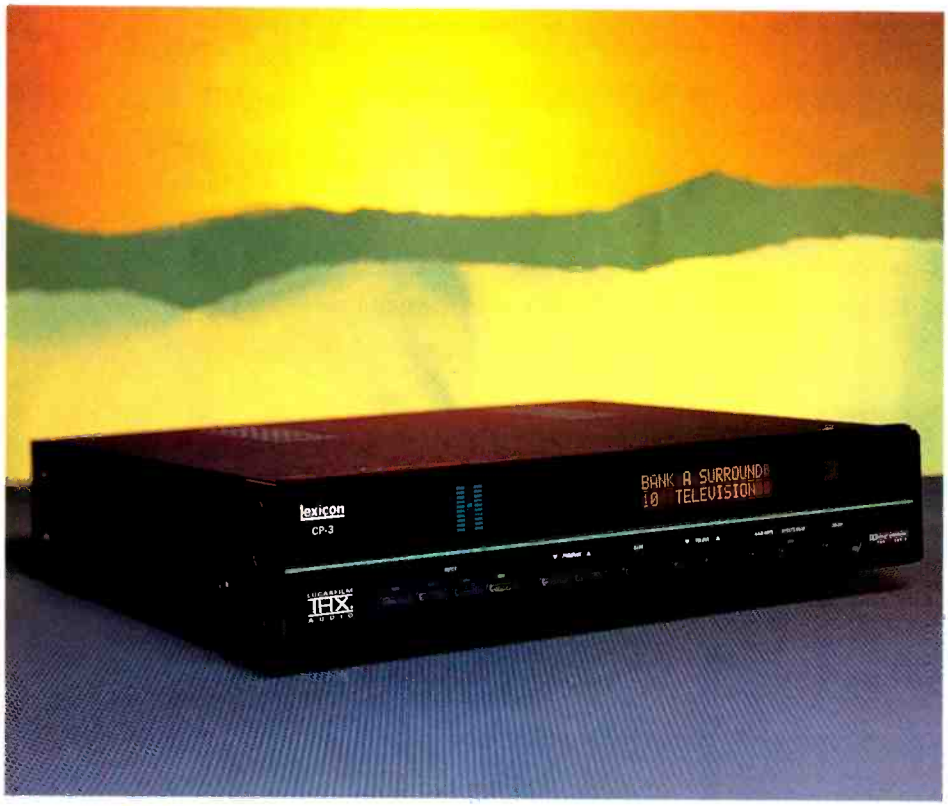
EQUIPMENT **PROFILE**

LEXICON CP-3 SURROUND PROCESSOR



Wine connoisseurs have no difficulty distinguishing between Lafite Rothschild and a cheap California varietal. Similarly, audiophiles hear differences among surround sound processors and among Dolby Pro Logic decoders—even among THX systems that purportedly are equivalent. Some digital Pro Logic decoders are "digital" only insofar as they use digital delay in the surround channels; others, like the Lexicon CP-3, are *fully* digital and use digital signal processing for both decoding and enhancement.

Also, digital systems can often be updated and upgraded simply by replacing the read-only memories (ROMs) that hold their operating instructions—something that's being done to the CP-3 right about now. The CP-3 I tested is being replaced by a CP-3 Plus, identical in all respects save for a ROM upgrade, which older CP-3s accept,

and a new control jack that's not available as an upgrade but which few users will need. (See the sidebar for details.) It's fair to say that Lexicon knows digital signal processing from the inside out and has an uncommon degree of experience in this field. All this is demonstrated in the CP-3.

The CP-3 is an extraordinarily flexible device. Thankfully, the CP-3 is accompanied by two excellent manuals, one detailing theory and design, the other explaining how to employ the system for best results. Each is clearly written; study both, experiment, and you will be able to derive remarkably convincing sound fields.

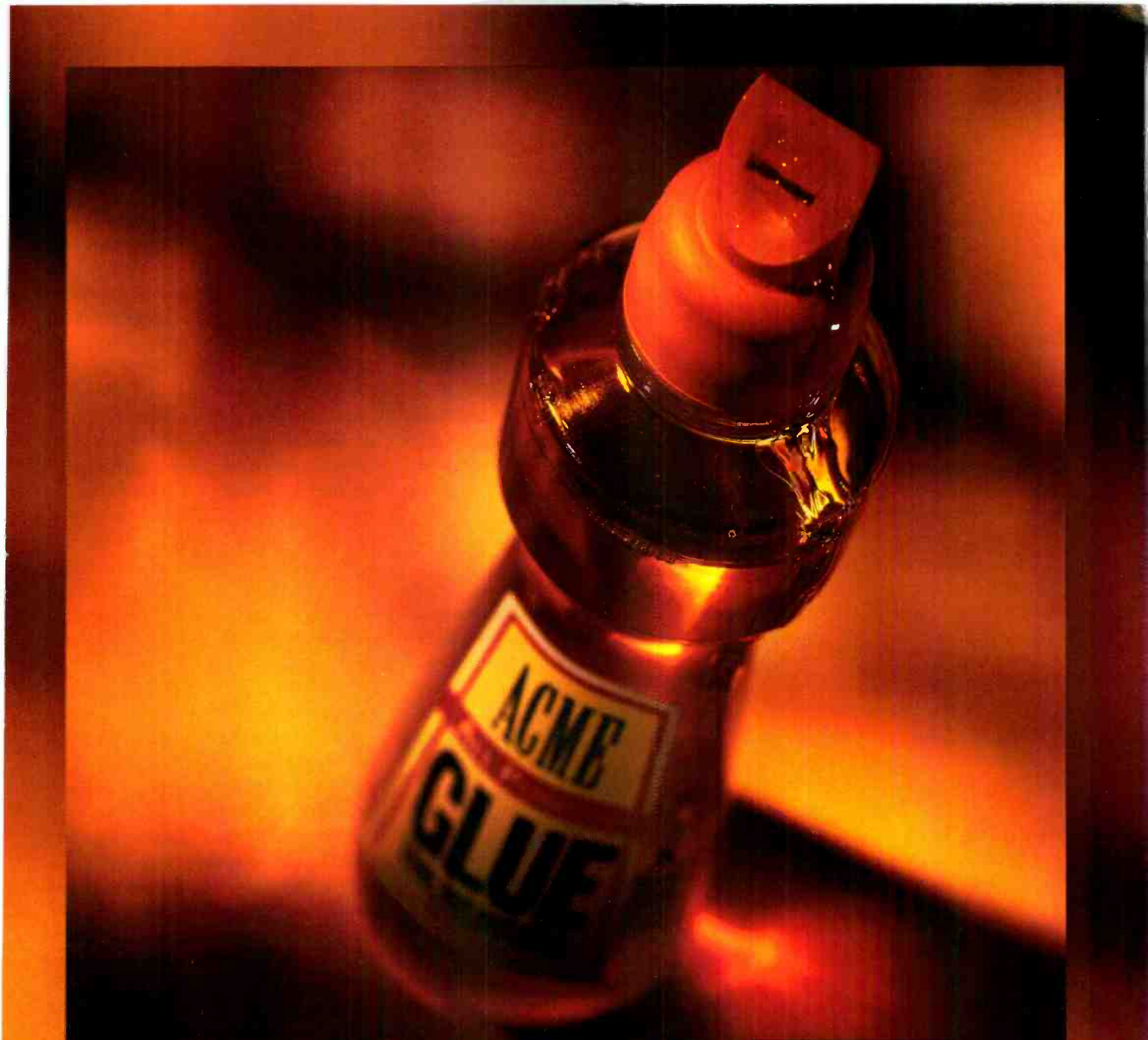
Features and Functions

The CP-3 offers 45 signal processing programs, arranged in three banks of 15 registers. Factory presets include three Panorama modes (Normal, Wide, and Binaural), three Ambience modes (Small, Medium, and Large), three Reverb modes (Small, Medium, and Large) and six Surround modes (TV, Music, Full, Mono, Dolby Pro Logic, and THX Cinema).

AMONG SIGNAL PROCESSORS, THE LEXICON CP-3 IS DEFINITELY *GRAND CRU CLASSÉ.*

The Panorama modes are effective in restoring natural ambience when using a pair of loudspeakers to play recordings made with closely spaced two-microphone arrays, which have plenty of ambience when heard through headphones. In the Panorama modes, left and right signals are crossfed, with delays and polarity inversion, so that a delayed signal from the right speaker cancels the sound from the left speaker as it traverses the head and reaches the right ear, and vice versa. This is done to compensate for the differences between speaker and headphone listening. Lexicon's approach differs from first-order interaural cancellation in that it generates multiple delayed signals. The first of these cancels the arrival of the direct sound at the opposing ear; subsequent signals cancel the previous cancellation signals (the first-order right-cancellation signal reaching the left ear, etc.).

This technique can be extraordinarily effective with recordings that contain natural ambience—provided that the front



Odd as it may seem, most speaker companies don't make their own drivers, the fundamental components that produce the sound. Instead, they assemble their systems using other peoples' parts. Then, they try to compensate for the inevitable deficiencies and mis-matches.

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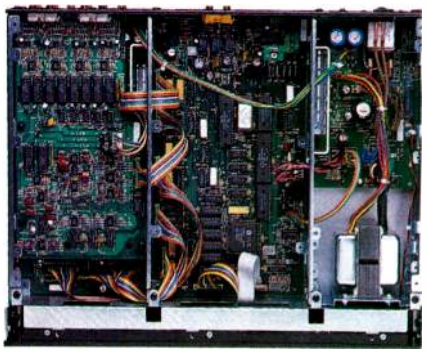

SPECS

Frequency Response: Unprocessed channels, 10 Hz to 100 kHz, +1, –3 dB; processed channels, 10 Hz to 18 kHz, +1, –3 dB; subwoofer channel, 10 Hz to 80 Hz, +1, –6 dB, 24-dB/octave roll-off.

THD at Maximum Level: Less than 0.025% at 1 kHz; subwoofer channel, less than 0.025% from 10 Hz to 100 Hz.

S/N: No more than 90 dB, A-weighted, re: 1-kHz maximum level.

Inputs: Four stereo pairs.

Minimum Input Level: For maximum output, 300 mV; for Dolby Surround level, 35 mV.

Input Impedance: 100 kilohms in parallel with 100 pF.

Outputs: Left, right, center, subwoofer, left and right side, and left and right rear.

Maximum Output Level: 6 V.

Output Impedance: 500 ohms.

Video Inputs: Three composite, NTSC-M Standard.

Video Input Sensitivity and Impedance: 1 V, peak to peak, 75 ohms.

Video Outputs: One composite, NTSC-M Standard.

Video Output Level and Impedance: 1 V, peak to peak, 75 ohms.

Dimensions: 17½ in. W × 3¾ in. H × 14½ in. D (44.5 cm × 9.4 cm × 36.8 cm).

Weight: 18¼ lbs. (8.3 kg).

Price: $3,200; software upgrade for earlier CP-3s (see sidebar), $250 plus installation.

Company Address: 100 Beaver St., Waltham, Mass. 02154.

For literature, circle No. 92

speakers image well, the room reasonably well damped, and the system is calibrated both for the angle between the speakers from the listening position and for listener position. These parameters in the CP-3 are adjustable and can be saved. The sweet spot over which maximum benefit is obtained is relatively narrow, but some improvement is apparent over a reasonable area.

The Normal Panorama mode is designed for recordings with bass energy distributed evenly across the stage (for example, well-recorded classical music); Wide is for jazz, rock, or pop with centered bass, and Binaural is only for recordings made with a dummy head. You can adjust bass spread either by selecting Normal and increasing the effects level (from the expanded remote control) or by selecting Wide and decreasing the effects level.

Whereas the Panorama modes restore natural ambience contained in the recording, the Ambience and Reverb modes generate *synthetic* ambience to aid recordings that lack the real McCoy. With these modes, listening position is less critical since synthetic ambience is generated in the room by the side and rear speakers. It's noteworthy that the CP-3 simulates ambience *in stereo*, i.e., separately for left and right channels. This helps preserve frontal imaging, which often becomes imprecise with other systems.

AS PROCESSORS GO, THE CP-3's DISTORTION IS QUITE LOW, BY AN ORDER OF MAGNITUDE.

The CP-3's Ambience modes generate the early reflections (within the first few hundred milliseconds) that exist in a concert hall. The Reverb modes are concerned with late reflections and sound decay. Both are based on classical studies of the reflection patterns in good concert halls. Although the Ambience modes are involved primarily with early reflections, you can control decay via the Liveness parameter. The three Ambience and Reverb modes (Small, Medium, and Large) suggest the size of the hall being simulated. Studies have shown that side-arriving sound is the key to good ambience, and both modes work best with side speakers. However, if you disable the side channels during setup and use the Ambience or Reverb mode, the CP-3 automatically adopts a form of Panorama and mixes the side outputs into the front channels.

The Surround modes seem to be meant primarily for video programs, with Music designed for music-video presentation. (Panorama, Ambience, and Reverb are likely to be preferable for CD playback.) The Dolby Stereo surround channel of music videos is monophonic and incapable of conveying fully natural ambience. It's really designed for special effects. Even if some ambience makes it into the surround, the mono rear does not provide directional clues. In the Music mode, front signals are delayed by 20 mS (to prevent localization) and fed to the sides. Inverse steering keeps any predominantly front-left or front-right signals out of the side channels, and the rear ones are fed with a THX-enhanced surround channel. To preserve musical purity, Dolby steering is not used in front, so this is not a mode meant for dialog.

The TV mode is designed to counteract the vagaries of television sound—programs and commercials that alternate between mono and stereo and are handled indifferently at the studio—to the extent that's possible without prior knowledge of how the program was butchered. This mode uses directional steering to enhance center dialog and to remove it from the left and right channels while preserving as much separation as possible. It's an amalgam of Dolby B noise reduction in the rear and THX re-equalization on all channels, and parallel-connects the side channels with the front to widen the frontal image.

Mono is Lexicon's conversion mode for monaural soundtracks. Commonly used stereo synthesizers, such as complementary comb filters, may be effective with music but spread dialog amorphously when used on video programs. Lexicon's approach attempts to distinguish between speech and music, generates synthetic stereo from the latter, and directs the former to the center speaker. This mode also features variable treble roll-off and an Academy filter to restore the tonal balance of old films, the program material with which you'd use it.

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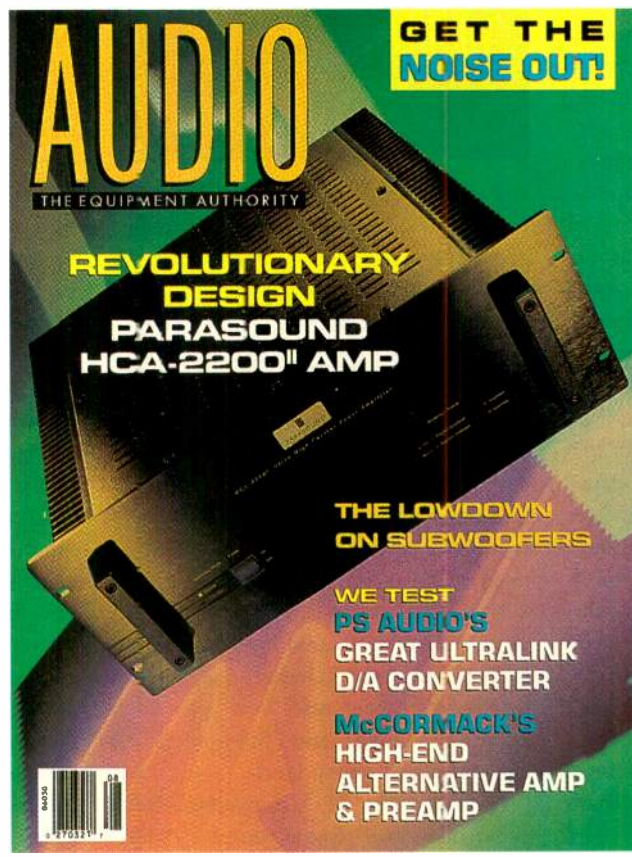

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Lexicon's digital Dolby Pro Logic offers key advantages compared with analog and hybrid decoders. Among these are continuous monitoring and adjustment of relative level and phase; this is done to correct channel imbalance and azimuth error in the source and thereby improve steering and dialog stability. Lexicon takes advantage of the digital approach to delay all outputs by 20 mS—comparable to the acoustic delay from the screen to the front-row seats in a theater. The delay gives the CP-3 time to determine sound direction and adjust the matrix prior to signal processing. This further improves dialog stability and steering and provides a better spread of ambient material and music when dialog is present. Of course, the surround channel is delayed by an additional 15 to 30 mS to meet Dolby Laboratories' requirements.

The THX Cinema mode expands on Dolby decoding by re-equalizing the front channels to correct for differences between home and theater acoustics and by timbre-matching the side channels to the front to account for the difference in perceived response between sounds arriving from the front and the sides. Finally, the side channels are decorrelated to prevent localization of surround information. The rear channels are inactive in the THX mode if you're using THX surround speakers; if not, the side and rear channels are fed the decorrelated signals.

The final surround mode, Full, reproduces unprocessed music over all speakers for all-enveloping background music or to achieve maximum acoustical output from the system.

Controls and Connections

Typical of digital products, the CP-3 has relatively few panel controls. At the far right is the "On/Off" button; proceeding leftward are buttons for "Effects Mute" (which defeats all signals added by the CP-3), "Main Mute" (which mutes sound completely), "Volume" up and down, "Bank" (to cycle through the three memory banks), "Program" up and down (to access the programs stored in each bank), and input selection. The first three inputs switch both audio and video signals; the last input selects the fourth audio input and the first video input, for simulcasts. When there's no input, the CP-3 generates a blue background for on-screen menus with audio-only programs.

There are two displays. A two-channel input-level display, calibrated against the Dolby reference level, is above the input selectors. (It can be disabled if it becomes distracting.) On the upper right is a two-line LCD that indicates the active program

MUCH OF THE AMBIENCE IN MY RECORDINGS WAS HIDDEN UNTIL THE CP-3 REVEALED IT.

and aids in setup and parameter modification. If you use a monitor, these indications appear on screen and are more complete than is possible with the LCD.

On the rear panel is a master "Power" switch and an IEC line connector, three NTSC-M (composite video) phono-jack inputs, and an NTSC-M output jack for the monitor. (The CP-3 does not accommodate S-video wiring. Some videophiles may find this limiting, but S-video hasn't really taken hold yet.) Audio connectors are clustered on the right: Four stereo input pairs, a "Tape Out" stereo pair that conveys unprocessed buffered audio from the selected source, and eight "Output" jacks—pairs for "Front," "Side," and "Rear" plus single jacks for "Center" and "Subwoofer." All are gold-plated phono jacks.

Normally, the CP-3 is operated from either of its two remote controls: A full-function, 36-button expanded remote or a simplified, 18-button standard remote. Either permits you to turn the system on or off, select among the four inputs, adjust volume and left/right and front/rear balance (the last by a four-pad array), and activate "Main Mute" to silence all signals or "EFX Mute" to bypass all processing and silence the center, side, and rear speakers.

Operation

As mentioned, the CP-3 has three 15-register memory banks designated Preset, A, and B. When you receive the CP-3, the 15 basic surround modes exist in each bank. You can access any mode from the panel or from the expanded remote and modify any parameter of any mode in the "A" or "B" bank in like manner and save it for future use. When you recall a mode, the bank letter, register number, and name appear in the display. You can customize names and reset the CP-3 to factory presets via a multistep process that discourages accidents.

The standard remote accesses five programs. Although these are designated Night Club, Concert Hall, Music Surround, Television, and Movies, the standard remote actually accesses the B2, B6, B10, B11, and B15 registers. If you haven't modified those registers, the descriptors apply; Night Club is Panorama Wide, Concert Hall is Ambience Large, and Movie is Home THX Cinema. If you have modified the registers, the standard remote calls up the modified parameters. When you power up the CP-3 from the standard remote, bank B is automatically chosen; otherwise, the system enters the same mode it was in when turned off.

Measurements

Digital systems offer tremendous dynamic range, but that range is realized in practice only if the dynamic range of the input signal matches the A/D conversion window, that is, if a maximum input exercises the full number of bits available in the converter. The Lexicon CP-3 offers manual and automatic methods to achieve this level match; it also offers an S/N Optimizer that continuously matches the converter to the signal. During setup, the user selects manual/automatic and Optimizer settings, which are stored individually for each input.

Lexicon recommends initial settings for the manual mode (+6 dB for a videodisc, combi-player, or tuner; +3 dB for a cassette deck, and –3 for a CD player), which are locked in by turning off Auto Level. Although the input display warns of overload, in actual use it's more convenient to set the manual level fairly high, activate Auto Level, and play a few high-level passages. The CP-3 automatically reduces input gain to prevent overload; when you're convinced you've played the loudest passages, you can either readjust the manual level to agree with the Auto Level setting and turn Auto Level off or simply leave

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Auto Level on permanently. (Since the system may generate a click if it later finds a higher level and adjusts the gain, the purist may wish to switch Auto Level off and take his chances on a subsequent overload. The S/N Optimizer continuously adjusts input gain and can induce occasional clicks, so it's deliberately turned off in the Ambience and Reverb modes.)

For bench tests, I let the CP-3 self-adjust to a 2-V, 1-kHz input while using Auto Level, set the manual control to the same reading (–3 dB), and turned off Auto Level and S/N Optimizer to prevent the settings from changing as I conducted the tests. I then adjusted the volume to +5 dB, to provide just about unity gain to the front outputs. With these settings, my standard 0.5-V input signal corresponded quite closely with the Dolby reference level.

Laboratory measurements made on signal processors can be misleading, especially when signals are delayed and summed, as they are in the CP-3's Ambience and Reverb modes. Though potentially desirable from the sonic viewpoint, delays and summation generate comb-filter effects that render response and distortion measurements meaningless. To evaluate the CP-3, I tried to concoct tests that would exercise the device without leading to erroneous conclusions. Most of the data was taken in the Pro Logic and THX Cinema modes, which (with the exception of surround-channel decorrelation in THX mode) do not delay and sum information.

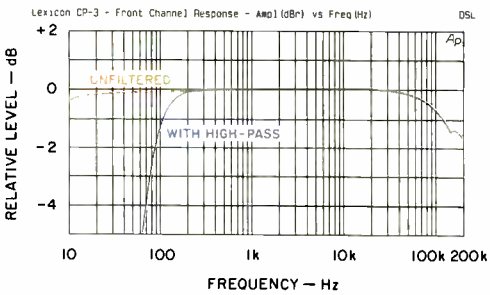

Fig. 1—Front-channel response, unprocessed mode. Note expanded scale.

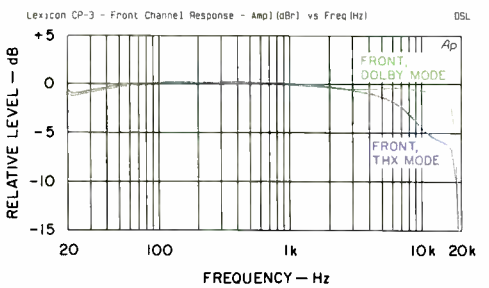

Fig. 2—Front-channel response, processed modes.

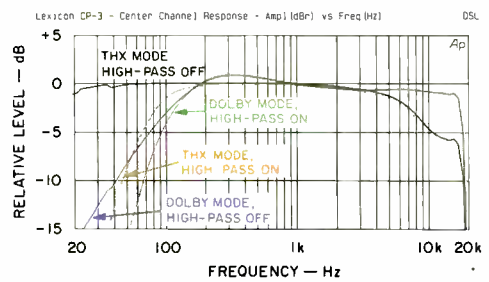

Fig. 3—Center-channel response.

Figure 1 depicts front-channel response with and without the internal 80-Hz high-pass filter. Although I took these curves in the Panorama Normal (P1) mode, I turned on "Effects Mute," so the curves correspond to unprocessed operation. Under these conditions, response is within +0, –0.2 dB from 18 Hz to 55.2 kHz (+0, –0.4 dB from 10 Hz to 75 kHz) with the filter off. The filter cuts off at 80 Hz with a slope of 12 dB/octave, precisely in accordance with THX Standards. I repeated the measurement in the Dolby Pro Logic and THX Cinema modes (with "Effects Mute" on), and the results were essentially identical. "Effects Mute" apparently bypasses the processor entirely except for the filter.

Figure 2 compares front-channel response in the Pro Logic and THX modes, this time with effects unmuted and the high-pass filter (HPF) off. With Pro Logic, response is +0.1, –1 dB from 24 Hz to 14.75 kHz, with a high-frequency –3 dB point of 18.05 kHz. In the THX mode, response is almost identical out to 2 kHz and is down 1 dB at 4 kHz and down 3 dB at 7.83 kHz. The difference reflects the re-equalization called for in THX and is not response error. (Note that this response curve, and all that follow, have different horizontal and vertical axes than Fig. 1.)

Comparing Figs. 1 and 2, it's clear that 18.05 kHz is the cutoff point of the A/D anti-aliasing filter and sets the high-frequency limit for all processed channels. From the differences between my data and that taken on the Lexicon CP-1 by Howard A. Roberson in the November 1989 issue of *Audio*, it seems that Lexicon has increased the sampling rate of its A/D converter. The CP-3 doesn't quite make the magic 20-kHz mark, but 18 kHz is arguably good enough and increasing the sampling rate to get to 20 kHz would increase the workload on the processor by about 10%.

Figure 3 shows center-channel response in the Pro Logic and THX modes, both with and without the 80-Hz HPF. When the HPF was active, I chose the Small speaker center mode; when it was off, I used the Full center mode. With Pro Logic, response is within +0.8, –3 dB from 100 Hz to the 18.05-kHz magic frequency without the HPF and –3 dB at 115 Hz with the filter. Interestingly, with THX, response doesn't exhibit the upper bass rise and, without the HPF, is essentially flat to 20 Hz (–1 dB at 21 Hz). With the HPF, it's down 3 dB at 80 Hz—right on target. Treble response is tailored in accordance with the THX re-equalization curve.

Figure 4 shows rear-channel response in the Pro Logic mode. (Rear outputs aren't used with THX.) The –3 dB points are at 18 Hz and 5.5 kHz (HPF off), a bit less than the treble limit called for by Dolby Labs. The HPF rolls off bass response below 80 Hz. Pro Logic side-channel response is essentially the same as that in the rear.

With the exception of the subwoofer curve, Figs. 1, 2, and 4 show left-channel response only. Right-channel response also was measured in each case and was essentially the same as the left. In THX, however, the side channels are decorrelated and the response differs, so I've shown both channels in Fig. 5. The right-channel jags reflect the decorrelation. The circuit also causes a variable phase angle between the left and the right side channels, but it changes so abruptly with frequency that a plot would be meaningless. (With Pro Logic, the CP-3

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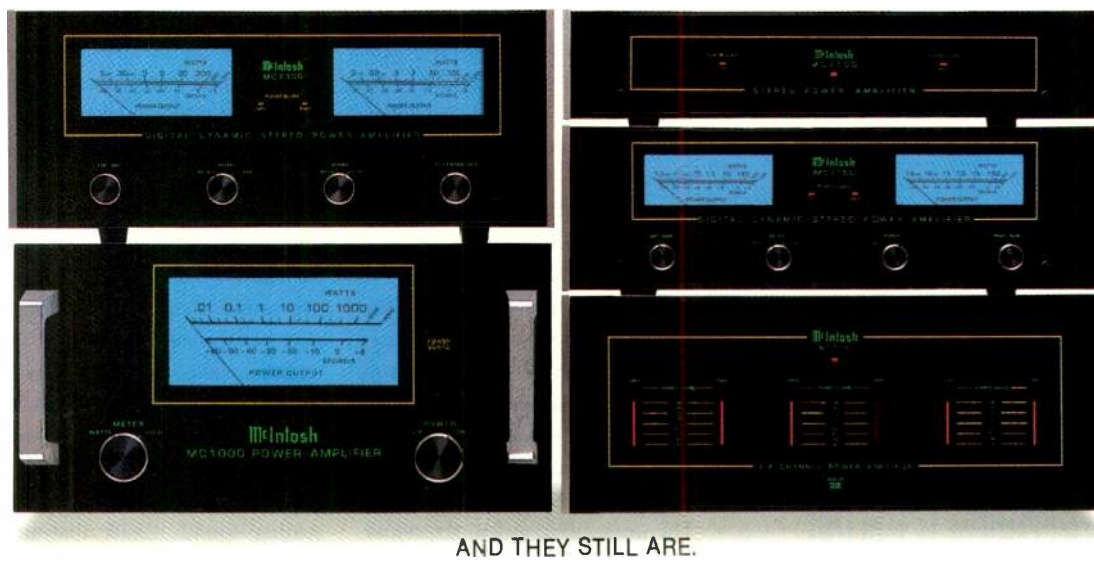

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does not decorrelate the rear channels; the two are in phase across the band.) Note the relative dips around 4 and 7 kHz, with peaks at approximately 5 and 9 kHz. These reflect timbre-matching of the side channels with the front and are not errors.

Figure 6 shows the subwoofer channel's response, which has a 24-dB/octave crossover at 71 Hz. (Note that the scale in this figure extends down to 10 Hz.) The slope meets THX Standards, and the frequency is close to the 80-Hz target.

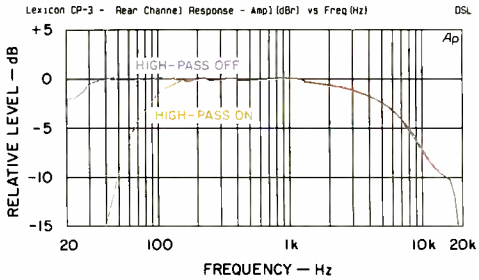

Fig. 4—Rear-channel response.

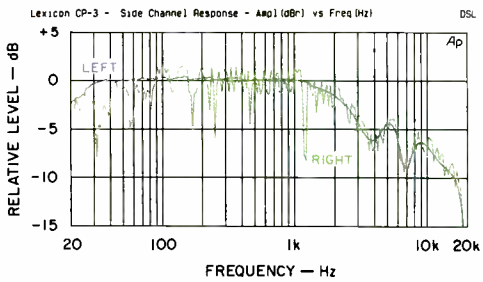

Fig. 5—Side-channel response with THX decorrelation; see text.

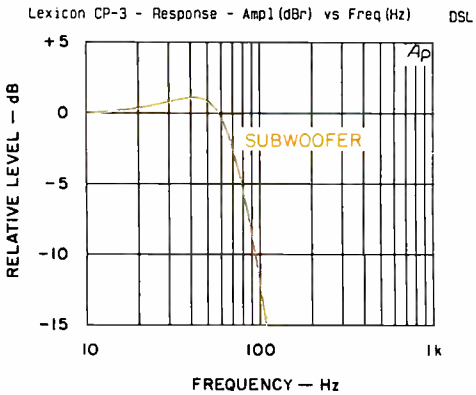

Fig. 6—Subwoofer-channel response.

Figure 7 plots THD + N versus frequency at a 2-V level for each output over its relevant frequency range in the Pro Logic mode. (For these curves, I set input and system gain to maximum, +12 dB, to avoid overloading the A/D converter at high frequencies.) Judging by these curves, the CP-3 has excellent performance, as processors go. It's not unusual to find curves that lie an order of magnitude higher.

I also measured THD + N versus output at 1 kHz on each channel except subwoofer (which was measured at 25 Hz), using the gain settings stated in the previous paragraph (Fig. 8). It's clear that the CP-3 meets its 6-V output spec with a good safety margin; center and rear channels crank out over 7 V and the front and subwoofer over 9 V at clipping—more than adequate to exercise any power amplifier to the maximum.

Output impedances (480 ohms on the main channels, 110 ohms at the recording output) and input impedance (96 kilohms) also suggest there'll be no problem interfacing the CP-3 with other gear. Maximum gain was 21.6 dB to the front outputs in the Pro Logic mode. Gain to the recording output was –0.1 dB. Video switching was essentially transparent: No gain or loss, and response down only 0.15 dB at 4.2 MHz.

Noise and separation were measured with the gain settings stated at the beginning of this section. The A-weighted noise, referenced to 0.5 V, was –80.3 dB or lower for all channels in the Pro Logic, THX, and Panorama Normal modes. The worst noise was in the center; front channels were about 2 dB better, and the rear ones almost 9 dB better. Results for the side channels (in THX) were –87.9 dB. With the gain settings I used, maximum level was 3.4 V and the red level indicators glowed merrily. Referencing noise to maximum level, as Lexicon does, increases S/N by 16.7 dB, to at least 97 dB on all channels—well above Lexicon's 90-dB spec.

Channel separation, measured in the Pro Logic mode, was excellent across the front, which indicates good dialog steering. (Front left or right to center was about 51 dB, center to left or right front about 47 dB.) Center to rear, rear to center, and left to right front separation (at least 27.6 dB) were adequate but not outstanding. Front left or right to rear (at least 36.8 dB) split the difference.

Use and Listening Tests

I used the Lexicon CP-3 in my listening room, with a stereo pair of loudspeakers driven by the front channels, and in my home theater, using a six-loudspeaker THX setup. I had a few initial problems in the THX setup mainly related to hum pickup from the six-channel power amplifier that I used. Once I moved the CP-3 and rerouted the cables, the hum disappeared. Since I didn't have hum problems with other equipment I've used in this setup, I suspect that the CP-3 may be a bit more sensitive than average in this regard. However, taking a bit more care in placement of the CP-3 is a small price to pay for the excellent performance it delivers.

Two of my favorite video test discs are *The Last of the Mohicans* and *Always*. There are many subtle sound effects in the former—rustling leaves, flowing water, birds, low-level dialog in the presence of off-stage warfare—and great flyovers in the latter. On inferior processors, you have to strain to hear the dialog in *Mohicans* and many of the sound effects are lost. Not with the CP-3. I heard detail that run-of-the-mill processors overlook, and off-stage imaging was superb and uncommonly stable. The flyovers in *Always* panned smoothly, with virtually no change in character except for the Doppler effect of approaching and receding sound. Chalk that up to THX's timbre-matching between surround and front channels. If this is not the finest THX processor on the market (I don't claim to have heard them all), it's sure up there with them.

As impressed as I was with the CP-3's THX performance, I was blown away in my audio listening room. I've used a fair number of sound processors and have generally found them exciting. But after a time, especially on solo instruments, the ersatz effects wear thin to my ears.

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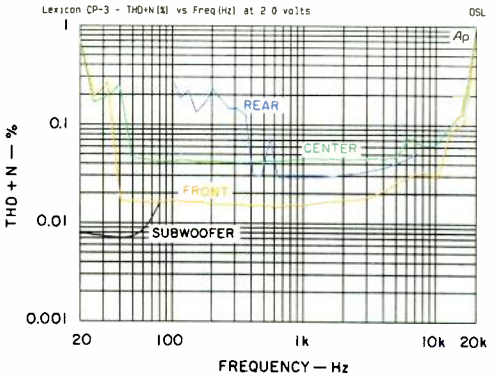

Fig. 7—THD + N vs. frequency.

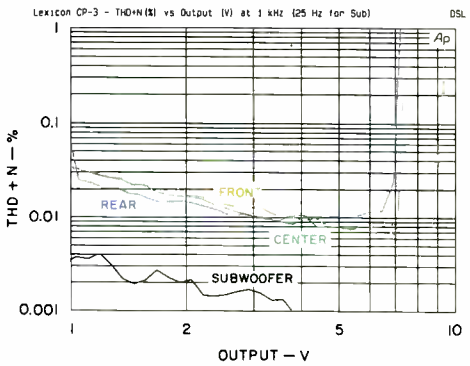

Fig. 8—THD + N vs. output.

Although the CP-3's Ambience and Reverb modes can be delightful and arguably are more convincing than most, what really turned me on was Panorama. To use Panorama, you must first calibrate the system for your listening position vis-à-vis speaker angle and seat placement relative to the centerline. Once this is done, you're ready to roll.

I based most of my judgment on DATs that I recorded with known microphone types and placement. Usually I use only one pair of microphones, never more than three mikes. I chose solo piano recordings, orchestral recordings, chamber groups, and voice that I recorded in a variety of venues.

I have recordings of pianist Diane Spencer, made two weeks apart, of the same program played on different pianos and recorded with different microphones in different halls. The first was made at Ithaca College's Walter Ford Hall using omni microphones spaced 3 feet apart and 10 feet back from a Steinway D. The second was made in Evans Auditorium of Lewis & Clark College. The piano was a Grotrian grand that puts Steinway to shame. I used PZM omni microphones on the lip of the stage, 10 feet from the piano and 3 feet apart.

Both halls have good ambience, and the recordings sound fine in stereo—but CP-3 Panorama really opened them up! The piano was more focused, there was more air surrounding it, and the Evans Auditorium ambience was remarkably re-created in the listening room. Details that weren't heard in stereo—the performer singing softly—came to life. Effects settings somewhere between Normal and Wide were best on these tapes.

I also found improvement in a third recording of Ms. Spencer, made in Bruno Walter Auditorium at Lincoln Center. This hall is a poor recording venue; the acoustics are nondescript, and there's air conditioning noise and lighting hum. I used coincident cardioids placed a few feet from the piano to reduce the hall noise, and the recording is very dry in stereo. Wide Panorama didn't make a silk purse out of this sow's ear, but it helped. The opening chord of the "Eroica" Variations became startlingly real, and I could hear details lacking in the stereo presentation.

For a recording of sopranos Betty Wilson Long and Bethany Beardslee, made at Searles Castle in Great Barrington, Massachusetts, I used cardioid microphones spaced at 3 feet, to reduce the reverb time. Normal Panorama restored ambience and provided a clearer distinction between soloists and piano.

I also used coincident cardioids in a recent recording of the music of Robert Dix, at Artur Holde Hall in Westport, Connecticut. Panorama processing midway between Normal and Wide induced a remarkable improvement in image depth and instrument placement. Another recording in that hall, of the Berkeley Chamber Players—this time with widely spaced omnis—responded less well to processing, while a solo piano recording made with coincident cardioids responded uncommonly well.

The conclusion I draw is that the simpler the recording technique and the more closely spaced the microphones, the greater the improvement with Panorama. The Berkeley recording has adequate ambience in stereo; much of the ambience in the others was hidden until the CP-3 revealed it. Moreover, the revelation occurs without artificial enhancement!

Among signal processors, the Lexicon CP-3 is definitely *Grand Cru Classé.*

Edward J. Foster

CP-3 Versus CP-3 Plus

At press time, Lexicon announced it was upgrading the CP-3 with new control software in ROM and a new control-output jack (not available for the older units). The upgraded model is the CP-3 Plus.

The main difference is said to be a new method of extracting stereo, rather than mono, ambience from Dolby Surround and similar matrix signals. Signals normally steered to any front position will not be sent to the sides, and amplitude of the two surround channels will be adjusted to maintain overall power response when signals are panned to the surround. Lexicon says that "The stereo music in soundtracks will be reproduced with a full stereo spread, unencumbered by the relatively narrow separation of the front speakers."

Center-channel delay will be controllable, and the sub-bass boost parameter will be available in all modes. Levels will be automatically reset as each input is selected. And front-to-back balance settings will be storable as presets.

Home automation systems will be able to toggle on CP-3 Plus features without toggling off those that were on already. And an added five-pin DIN jack will put out a 5-V trigger when the CP-3 Plus is turned on (to operate turn-on relays for an entire system) and when the unit is switched between modes that process the main front channels and those that don't.

The new software (Version 4.0) is in a socketed ROM, supplied with a chip puller and full instructions, but Lexicon strongly suggests that it be installed by dealers. Adding the new DIN jack would require factory replacement of the entire circuit board, at a cost (about $1,000) that Lexicon does not consider practical. *Ivan Berger*

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AURICLE

AUDIO ALCHEMY DTI, XDP, AND POWER STATION TWO D/A CONVERTER SYSTEM

Digital-to-analog converters and signal conditioners, outboard from transports, have come a long way from the days when you either had to spring for several thousand dollars or only got a cheap black box that used off-the-shelf digital technology, a few tweaks, and just possibly a better analog circuit. Today you can get D/A converters (often called "digital signal processors" by high-end companies) for under $1,000 that offer better sound than did the $5,000 units of a few years ago. Even better, just as much attention usually goes into the analog sections of such units as into the digital.

Audio Alchemy is one of the firms helping to advance the state of the art in digital sound. It offers a wide range of products, and several are designed to control the jitter coming from CD players as well as provide D/A conversion. The combination under review consists of three units that can also be used separately. The Digital Transmission Interface (DTI) lists for $199 and is intended to condition the digital signal output from a DAT or CD player. The Extended Digital Processor (XDP) sells for $499 and provides digital-to-analog conversion. You have a choice of power supplies for this combination: The regular Power Station sells for $99; the much more sophisticated Power Station Two sells for $199. Audio Alchemy products are often available as packages priced significantly lower than the sum of their parts.

A $1,000 D/A SETUP LIKE THIS SYSTEM CAN SOUND BETTER THAN $5,000 UNITS OF A FEW YEARS AGO.

The DTI accepts the digital output from a CD player or transport, DAT, MD, or LaserDisc player using either coaxial (RCA) or Toslink connections. Digital output from such consumer-level equipment uses a single cable connection that combines left- and right-channel data, a set of control codes, and a synchronizing clock signal.

Due to such factors as CD rotational instabilities, power-supply variations, and poor cable shielding, the clock signal recovered by a D/A converter may not be as steady and exact as possible. This instability is termed jitter and is said to lead to inaccurate alignment of the recovered signal's musical events.

The DTI effectively "reclocks" the digital signal. It first buffers the incoming digital signal from the CD player, conditions the signal to improve its quality, and then presents it to a Crystal CS8412 digital receiver, which separates the signal into its component clock and data signals in the I²S format. A phase-locked loop removes much of the imprecision in the clock signal and thus reduces the jitter in the S/P DIF data. The filtered clock and data signals are sent to the I²S output, a Crystal CS8402 digital transmitter. This transmitter reassembles the data in the S/P DIF format and feeds a coaxial RCA jack that can be used with any digital signal

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processor or digital-to-analog converter. The DTI also has front-panel switches that allow you to select between the coax or Toslink digital input and between normal or inverted polarity.

The point is that you can now buy an outboard device at a very reasonable price that will provide a digital signal cleaner of jitter than that from all but a handful of expensive digital transports. I used the DTI with a number of low- and mid-priced D/A converters and run-of-the-mill CD players and transports. In each case, soundstage detail and air appeared improved. Baritone, tenor, and soprano voice became richer, and tenor and soprano were more musically natural on song cycles. Strings gained added harmonic detail and sweetness. Cymbals buzzed less and sounded more like cymbals. Classical acoustic guitars lost much of their steel string sound. A Mozart horn concerto gained in brass detail. Transients, dynamics, and air all improved, and so—sometimes—did the feeling of natural pace or rhythm.

I found that the title track on Bruce Dunlap's *About Home* (Chesky JD-59) provided a clear indication of how much the DTI can improve a low-cost front-end. Listen to upper midrange percussion detail with and without the DTI, and I believe you will hear the benefits immediately. Audio Alchemy recommends two other CDs. Solo instruments have cleaner harmonics and become more focused on Antonio Vivaldi's *Six Double Concertos for Flute, Violin, Strings, and Harpsichord* (Sony Classical SK-45867). The separation and interplay of instruments within massed strings become clearer on the London Philharmonic recording of *Arnold Overtures* (Reference Recordings RR-48CD).

The DTI makes the most noticeable improvement with cheaper or older CD players, but its benefits vary sharply by player and associated D/A converter. Even when it makes the most improvement, this improvement is still a matter of nuance that largely affects the resolution of low-level musical detail. At the same time, the DTI reduces listening fatigue and the flatness and boredom of cheap digital sound. For $199, it may be your cure for "digititis."

The XDP is a separate unit and has front-panel muting and de-emphasis switches. It is not a standard D/A converter, and can only be driven from an I²S output such as that of the DTI. It buffers the incoming digital signals before passing them on to a Burr-Brown DF1700P digital filter, which in turn sends them to a Philips SAA7350 noise shaper and sigma-delta modulator. The output from this chip is passed to a Philips SAA1547 (DAC-7) integrator, which provides differential audio signals. These feed an all-discrete, differential analog stage that again filters the audio signal and drives the RCA output jacks.

AS YOU MIGHT EXPECT, THE PREMIUM-PRICED POWER SUPPLY MAKES THE XDP SOUND BETTER.

The XDP D/A converter provides a distinctly cleaner and more detailed sound than I have heard from most low- to medium-priced bitstream CD players, two-piece players, and Japanese 18- or 20-bit machines. A combination of the DTI and XDP provides richer and more powerful bass, which also is usually tighter and more dynamic. The midrange has more detail, particularly with naturally miked recordings that have some ambient sound. Treble is extended and has its natural bite without hardness. Dynamics are tighter, and transients are faster; this particularly shows up on the new 20-bit recordings.

The DTI-XDP combination has an impressive ability to open up the soundstage and give you back the sweetness and air in music that is lacking in most mid-fi CD players. It is this ability that is most important in judging what the DTI-XDP combination can do to improve an ordinary digital front-end. As a chamber music buff, I want to hear all of the instruments; I do not want to have a CD player confuse ancient and modern instruments. If a solo singer or instrumentalist was recorded in a hall, I want to hear that hall. I don't want to have Dorian recordings featuring the Troy Music Hall sound like I am listening in a recording studio. When modern percussion recordings—such as Cody Moffett's CD, *Evidence* (Telarc CD-83343)—bring back the speed and excitement missing in the first generation of digital sound, I want to hear it.

While the XDP is very clean, has very flat and extended highs, and delivers excellent value at its price, it does have competition. Some audiophiles may prefer a more romantic sound, with less treble information—such as they'd get from Theta Digital's Cobalt 307. If I could afford $1,000 just for a D/A converter, I would certainly compare the XDP to a unit like McCormack Audio's DAC-1 or to some of Audio Alchemy's more expensive units before I made my decision.

As is the case with virtually every piece of audio gear I audition that has an optional power supply, the XDP does sound better with that supply, the Power Station Two. It has three six-pin power output sockets, providing ±8 V for the digital and ±18 V for the analog circuits from separate transformers of about 2.5 amps capacity connected to their own regulators and grounds. The digital and analog circuits are completely separate and are only connected at the line cord. With the Power Station Two, the XDP not only becomes more musically natural, it has more apparent detail and dynamic life. This combination of added musicality and detail is all too unusual in moderately priced digital gear, and the Power Station Two is very reasonably priced.

In short, the Audio Alchemy DTI, XDP, and Power Station Two are for audiophiles who can't afford to throw several thousand dollars into digital signal processing. They provide true high-end sound. They take the boredom and the edge out of most CD players. You can't get much better value for money, and they provide an upgrade that brings back musicality and sharply reduces listening fatigue. These components may not be the state of the art, but they are a real pleasure to listen to.

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One of the side effects of the classical guitar's having "come of age" in the middle of the 20th century was that it arrived at a time when high Romanticism was out of favor. This aesthetic prejudice has lingered for many years, but now that we have a sufficient critical mass of musicians eager to explore alternatives, Romantic music has begun to reappear in guitar programs. Two examples of this newly rediscovered repertoire can be found on releases by Anthony Glise and Gerald Garcia, who tackle the effusive early 19th century in contrasting ways.

On *Anton Diabelli: The Complete Sonatas for Solo Guitar*, the award-winning American composer and performer Anthony Glise approaches his "world premiere" with the zeal of a scholar combined with the *joie de vivre* of the Romantic enthusiast (he even resides in the Austrian Alps!). This is a remarkable record on several counts, not the least of which is the music of Diabelli.

Anton Diabelli (1781 to 1858) was born near Salzburg and spent a great deal of his career amid the bright lights of Vienna, then the cultural capital of Europe. A guitarist and composer of renown, Diabelli is better remembered as the successful publisher of Beethoven and Schubert. Many of Diabelli's own compositions were clever little gems that have survived in various anthologies. But his great works were three sweeping virtuosic sonatas which he, in fact, published in a single volume and which are recorded here in toto for the first time.

Diabelli's guitar sonatas are, if anything, slightly less ebullient than those of his popular contemporaries Giuliani, Sor, and Carulli, but in some ways they are better *music*. Clearly influenced by Beethoven and the Vienna school, these sprawling

GLISE AND GARCIA TACKLE THE ROMANTIC GUITAR REPERTOIRE IN DIFFERENT WAYS.

works extract unbelievable drama from the small-voiced and harmonically limited guitar. The Sonata in F Major, in particular, is full of rich chiaroscuro, opening with a bold Allegro moderato statement, slowing to a somber Andante sostenato, and then racing through an eight-minute Finale with more than enough notes to tie up the fingers of the most accomplished modern

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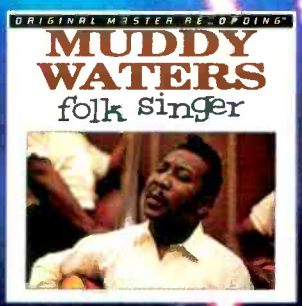

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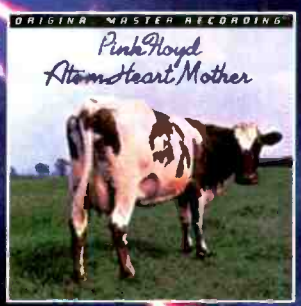

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The warm, full voice of Garcia's guitar contrasts with the lighter voice of Glise's.

technician. The two other sonatas, in A major and C major, are less demanding and caring, but charming nonetheless. Listeners will find the concluding Rondo of the A Major to be the most familiar tune here, its gurgling arpeggios often gracing guitar programs.

Equally interesting is Glise's use of a guitar made by Georg Staufer of Vienna, a neighbor of Diabelli's who taught America's great luthier, C. F. Martin, his craft. This instrument, circa 1828, is a small-bodied guitar that Glise, in his ardor for correctness, has strung up with finicky gut strings. Intrinsically, such a guitar (upon which this music may have originally been played!) is hard to play expressively or without distracting gut string noise. Glise achieves both, wringing harmonic subtlety, dynamic contrast, and clean execution from its delicate presence, all exquisitely captured digitally with great fidelity by recordist Thomas Ransom. Through it all, Glise excels in his performance, bringing to life this music with fine attention to Romantic interpretive style, infused with vigor and technical virtuosity.

Rather than attempt to replicate the milieu on *Romantic Guitar Favourites: Paganini, Mendelssohn, Schubert*, Gerald Garcia instead plunges into the Romantic period armed with a modern guitar and a bunch of transcriptions, mostly his own. Citing the inspiration of Liszt and the early 19th-century guitarist J. K. Mertz, Garcia bypasses guitar compositions in favor of works that are more tangentially related.

Perhaps most guitaristic are works by Niccolo Paganini, who also played guitar and regularly performed with guitarist Luigi Legnani. Included is the pyrotechnic Caprice No. 9, originally for violin, with its soaring, breakneck scales—difficult to play with guitar technique—yielding a tour de force that is the highlight of this recording. Also included is Paganini's familiar Grand

Sonata for violin and guitar, which Garcia has impressively compressed into a solo guitar piece, combining the chordal accompaniment and rippling violin melodies.

For the remaining program, Garcia has chosen to transcribe a suite of "Songs Without Words" by Felix Mendelssohn and play Mertz's arrangements of songs by Franz Schubert. These are in curious stylistic opposition, since Mendelssohn's songs rely on resonant block chording while Schubert's songs employ harmonically interesting arpeggios. Of the two, perhaps the Mendelssohn is the less successful on the guitar. While a piano's range allows the voicings to breathe, the guitar must compact them, resulting in a thick, heavy sound. Fortunately, Garcia's modern instrument can sustain the chords, but the music seems slightly clumsy on the guitar. Best of the lot here are the two "Venetian Boat Songs," whose dark minor keys are quite evocative.

Far more delightful are Schubert's songs, including the melodious "Praise of Tears," "Love's Messenger," and "Fisher Maiden," which glide gracefully across the strings as if meant for the guitar (indeed, Schubert is reported to have kept a guitar by his bedside and composed frequently on it, for want of a piano). These airy works embody the essence of sweet Romanticism, and Garcia's performance is lush and expressive, liberally endowed with the somewhat hyperbolic phrasing often associated with "Romantic" interpretation. The sound of Garcia's guitar is appropriately warm and full, in contrast to the lighter voice of Glise's instrument, though it is just slightly inclined toward the bass registers.

The renewed attention to the music of the Romantics by artists like Anthony Glise and Gerald Garcia is a welcome development and is part of a wider trend toward uncovering more of the treasures lurking in the archives of this once-slighted era.

Michael Wright

Berio: Duetti (34) for Two Violins; Sequenza VIII for Violin Solo; Due Pezzi for Violin and Piano; Corale for Violin, Two Horns, and Strings

Carlo Chiarappa, violin; Romano Valentini, piano; Accademia Bizantina; Carlo Chiarappa

DENON CO-75448, CD; 68:20

Luciano Berio, one of the most avant of this century's avant-gardists, has long cultivated the endearing habit of distributing miniworks of music among friends and idols the way less gifted people send birthday cards: The aphoristic fiddle duets here (the shortest is 29 seconds, the longest is 3:56) bear dedications to, among others, Béla Bartók, Pierre Boulez, Lorin Maazel, Rodion Shchedrin, and Igor Stravinsky. The *Sequenza* comes from that series of unaccompanied works Berio composed to show off the virtuoso gifts of interpreter friends, and the *Corale* expands that solo violin piece into a small chamber work.

Not exactly easy music to hear, this, but intriguing, in an unorthodox way, and at its best, quite captivating—also handsomely performed and recorded. *Paul Moor*

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Prokofiev: Sonata for Flute and Piano; Jolivet: Chant de Linos; Boulez: Sonatine for Flute and Piano
Marina Piccinini, flute; Andreas Haefliger, piano
CONNOISSEUR SOCIETY CD 4183
CD; 49:14

The best flute recording I've ever heard, including those from ultra-well-known performers who make dozens of CDs and sell millions, well, thousands anyhow. Not only the recording, but the music and the performances.

Do we still call Sergei Prokofiev "contemporary"? He is much less so now than Brahms was when I first heard Brahms. Such a pleasing, gracious, humorous sonata, this one, all light and truth and smiles, and so expressively played—*the* very best. It dates from Russia, mid-World War II, 1941 to 1943, while Hitler invaded. Music has so many ways of expression, in so many situations.

After this Prokofiev, you will be so *with* the performers that you will go on to the relatively unknown André Jolivet (1905 to 1974) with confidence. Indeed, it follows, not too far from the same neoclassic vein—real classic, not neo-baroque. It is a brilliant yet lesser work than the Prokofiev but palatable all the same.

And then Pierre Boulez! Now there's a generally forbidding composer, to most of us. These two players, though, carry right on into the deliberately scrawny tongue-twisting brrrs for the flute, the clouds of atonal flute sparks, and so on. For my ear this is serial music, that curious sense of variations which is *de rigueur* in so much of this school of composition, the same series of basic tones again and again in transformations. So curiously like classic jazz! For the same reason, if utterly different.

After the first two works, Marina Piccinini (Canadian) and Andreas Haefliger (Swiss) can carry you safely through Boulez with even a bit of pleasure. That's what we need! The Connoisseur CD is tops—such a lovely vibrant surround (at a church in Harrison, N.Y.) and such expert control of the piercing showers of high notes that abound. If the piano is a bit background, it is in the music itself, not the miking.

Edward Tatnall Canby

To the Edge of Dream: Works by Messiaen, Takemitsu, Lutoslawski, and Stravinsky
John Williams, guitar; Garth Hulse, oboe d'amore; Paul Crossley, piano; Tristan Murail, Ondes Martenot; John Shirley-Quirk, baritone; London Sinfonietta; Philharmonia Orchestra; Los Angeles Philharmonic; Esa-Pekka Salonen
SONY CLASSICAL SMK 53473, CD; 74:27

Why should only the rock world have its "concept" albums? Here's an imaginative effort making excellent use of the CD format. From Esa-Pekka Salonen, the young Finnish conductor, this should prove a wonderful introduction to the world of contemporary concert music for many.

The seven works by four modern masters are intended to take one on "a voyage to where perception and instinct subvert actual experience." Music is seen as the "echo of the invisible world," seducing us into exploring our unconscious and imagination via our dreams.

Both Tōru Takemitsu works use guitar and are lush impressionistic trips into the metaphysical and poetic. The first two Olivier Messiaen excerpts are from his massive "Turangalila" Symphony, highlighting the spacey sounds of the Ondes Martenot in his familiar ecstatic style.

The single vocal work, Lutoslawski's "Sleep's Spaces," depicts the spellbound feeling of that space between sleep and consciousness, and the short excerpt from *The Rite of Spring* demonstrates that Stravinsky's wild rhythms and orchestral fury can still transport the listener. *John Sunier*

Dello Joio: The Triumph of Saint Joan Symphony; Variations, Chaconne, Finale; Barber: Adagio for Strings
New Zealand Symphony Orchestra, James Sedares
KOCH INTERNATIONAL CLASSICS
3-7243-2, CD; DDD; 63:17

Why this "able American composer of pleasurable music" (Slonimsky) doesn't have more exposure on disc is a mystery. Norman Dello Joio began his career as a church organist, and his music shows an affection for Gregorian chant and the Italian opera of his heritage.

The subject of St. Joan was a natural for Dello Joio. His symphony's three movements depict The Maid, The Warrior, and The Saint. Some of the harmonies may remind the listener of Copland, but Dello Joio has his own quite unique and identifiable style.

The composer studied with Paul Hindemith at the Berkshire Music Center and at Yale; neoclassical traditions are behind his music. The influence of jazz is subtly heard in the Variations, Chaconne, and Finale on a Gregorian Theme, showing Dello Joio's skills at development and variation.

The inclusion of Samuel Barber's elegiac Adagio for Strings is in memory of Andrew Schenck, the young conductor who made many recordings of Barber and others with this orchestra before his recent death.

John Sunier

Paul Hindemith: Kammermusik Nos. 1 through 7
Various soloists; Royal Concertgebouw Orchestra, Riccardo Chailly
LONDON 433 816-2
Two CDs; DDD; 1:38:04

This important group of chamber (Kammer) works has been referred to as the 20th century's equivalent of Bach's Bran-

denburg Concertos. Surprisingly, this is the only set of all seven chamber works on CD.

These works are from the German neo-classical movement of the 1920s. Paul Hindemith's music is a synthesis of many different styles held together with technical mastery, but in the Kammermusik he stresses polyphony and a baroque style. Atonal melodies are used, but Hindemith eschews strict serial methods.

The composer was a violist himself; one of the seven 13- to 20-minute works is for that instrument, and another is for viola

d'amore. The first is the only one without a soloist; it has an almost dance-band-like cheerful irreverence.

The other concertos are a highly rhythmic piano concerto (Ronald Brautigam is the soloist), an expressive cello concerto—one of the most frequently played of the seven (Lynn Harrell is the cellist), a rather serious violin concerto (Konstanty Kulka soloing), and a final concerto for organ and winds that achieves a feeling of grandeur (Leon van Doeselaar, organ).

The second Kammermusik is a bubbling little five-movement suite for woodwinds and is shortest of the seven. It brims with a similar sort of ironic musical wit as found in Prokofiev and Frank Zappa.

Some might prefer a more in-your-face sonic than heard here, but, being London, that's not the case; clarity of the individual instruments isn't lost with the more distant perspective. *John Sunier*

Gilbert & Sullivan: Overtures
Academy of St. Martin in the Fields, Neville Marriner
PHILIPS 434916-2, CD; 63:51

For dyed-in-the-wool Savoyards, this will be a special treat. Neville Marriner has a particular empathy for the music, and he provides well-crafted performances which are by turns dramatic and dynamic, then tunefully lyrical. His finely honed orchestra furnishes playing with fine string ensemble, responsive gutsy brass, very bright and clean woodwind intonation, and percussion of notable weight and impact. Recording at EMI Studio in London, engineer Mike Sheady has achieved good internal balances and a moderately "forward" projection of the sound, along with a pleasingly warm ambience.

Such favorites as "HMS Pinafore," "Yeoman of the Guard," "The Pirates of Penzance," "The Gondoliers," and "Iolanthe" are here, along with a particularly dynamic "Mikado" and such less-often played works as "Macbeth" and "Patience."

If you like Gilbert & Sullivan overtures, you will find this recording exemplary.

Bert Whyte

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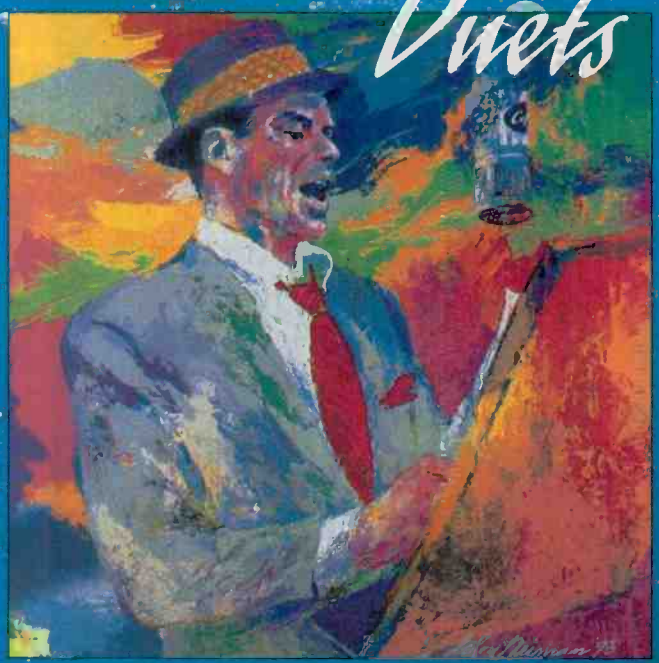

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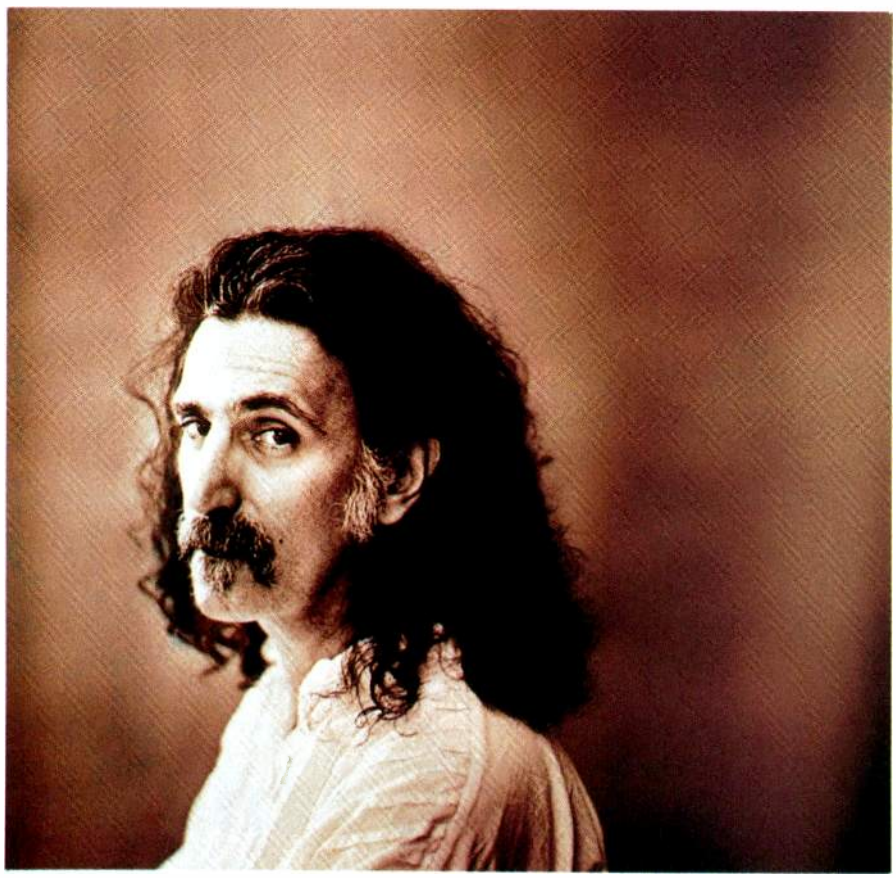


Zappa's Universe
Various Artists
VERVE 314 513 575-2
CD; 68:00
Sound: B+, Performance: B+

The Yellow Shark
German Ensemble Modern
BARKING PUMPKIN/
RHINO 71600, CD; 72:00
Sound: A, Performance: A

Modernist composer, acid satirist, and guitar god Frank Zappa stood alone as a pop star with greater ambitions who inveigled three decades of rock fans to laugh at teen lust and status issues. He also brought the influences of Boulez, Stravinsky, and Varèse to greasy '50s songs, and free-jazz-like improvisation to amplified-for-arena bands.

Zappa died last December; his final illness limited his involvement with the ambitious and well-received concerts of '91 and '93 documented in *Zappa's Universe* and *The Yellow Shark*, respectively. He did, however, participate in their elaborate preparations, and his sensibility suffuses these CDs.

On *Zappa's Universe*, Joel Thome conducts an expert studio rock sextet—combined with two a cappella groups (The Persuasions and Rockapella), The Orchestra of Our Time, and such guests as guitarist Steve Val—through his arrangements of repertoire that the Maestro selected for two nights at the Ritz in New York. The edited tapes' live sound has a lot of surface presence; all vocals, electric solos, and emphatic ensemble passages are focused and hot, so that both Mothers of Invention classics and mid-period Zappa rudenesses retain their raunch.

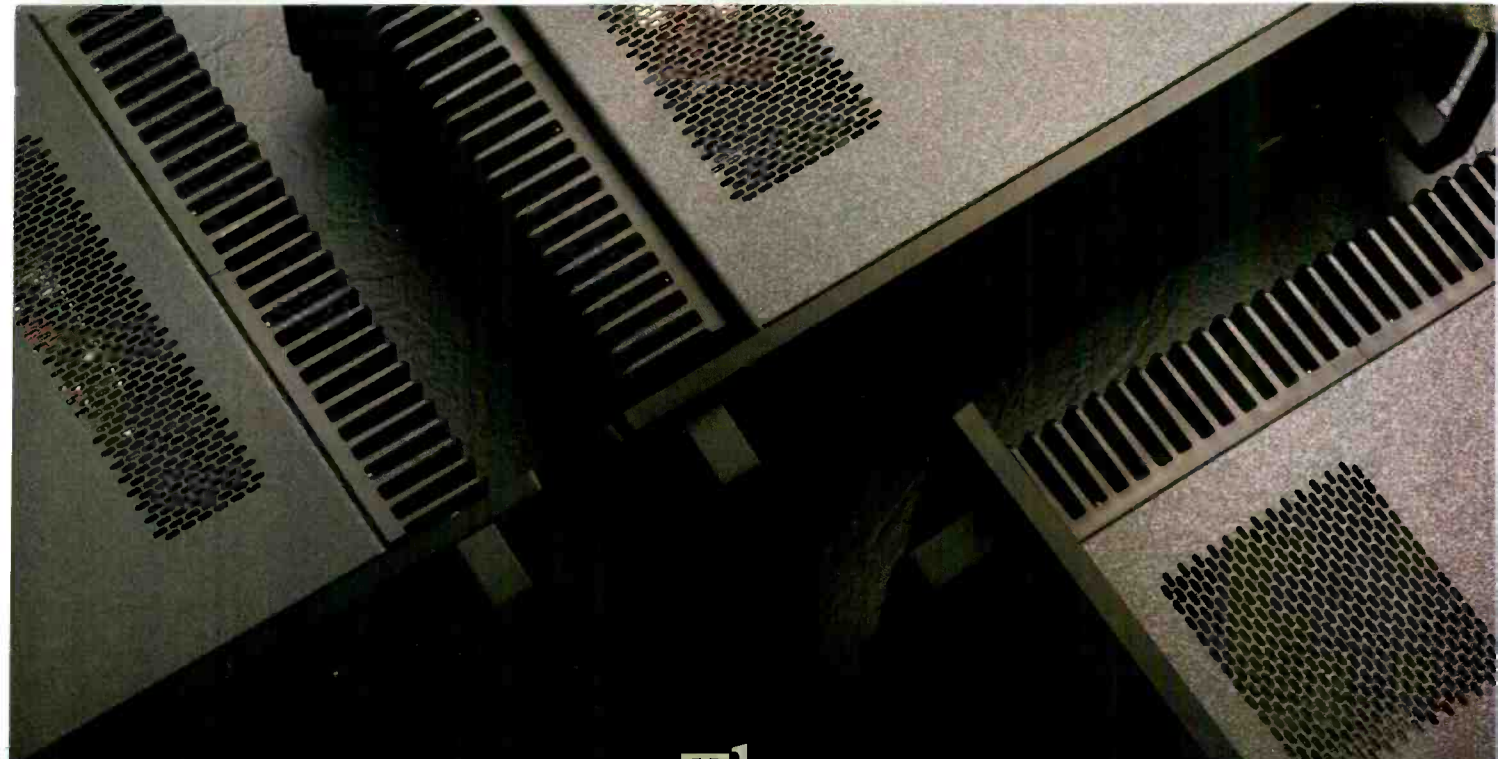
Yet *Zappa's Universe* celebrates only part of his genius; the symphonic details and depths of the composer's so-called "serious" efforts are not served in the mix. For this, *The Yellow Shark* truly is a revelation.

The Yellow Shark's 18 mostly unknown works, originally scored by Zappa on Synclavier, were adapted with great care for the 22-member German Ensemble Modern under the baton of Peter Ruder. Piano duets, woodwind and string sonatas, chamber orchestra pieces—all present Zappa in glory hardly hinted at by 1967's *Lumpy Gravy* or other previous large-scale recordings. Innovative "surround" instrument placement is preserved by faultless recording technique, and the handsome CD booklet provides information with which we can begin to reevaluate the man most often associated with the scathing humor of *Freak Out, Absolutely Free, Ruben and the Jets,* and *Hot Rats.*

Howard Mandel

THE YELLOW SHARK EXPLORES GALAXIES OMITTED FROM ZAPPA'S UNIVERSE.

Editor's Note: Scheduled for release in April is *Civilization: Phase III*, an orchestral work performed by Zappa on Synclavier and considered by him as the sequel to the *Lumpy Gravy* recording.—*M.B.*



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Four-Calendar Cafe
Cocteau Twins
CAPITOL CDP 7 99375-2, 37:19

There's no mistaking the mesmerizing affected guitars and layered vocal landscapes of Robin Guthrie and Elizabeth Fraser, Scotland's Cocteau Twins. Historically, the group has gone for "feel and flow," not clarity and structure, or so says the Twins' multi-instrumentalist Guthrie. But *Four-Calendar Cafe*, their 11th release, has vocalist Fraser actually annunciating real syllables and words, and the soothing "Oil of Angels" and "My Truth" almost fit the radio mold of Adult Contemporary. Could the "Cocks," as they refer to themselves, be the Renaissance of the '90s? Fret not, because more traditional tracks—such as "Bluebeard," "Summerhead," and "Pur"—conjure up the group's past. By no means a breakthrough record, *Four-Calendar Cafe* is a new direction and a nice addition to the Twins' already expansive career.

Tom Ferguson

Otis! The Definitive Otis Redding
RHINO R71439, four CDs; 4:41:47

It's difficult to find fault with any of Otis Redding's work, and certainly a four-CD package with this much music delivers quite a bit of value for the money. Redding was a perfect performer whose every take spoke of greatness, whether in any of his well-known hits, his earliest singles ("Shout Bamalama," for instance), or even an unaired radio spot for Coca-Cola. There's a bit too much duplication of *The Otis Redding Story*, which Atlantic released in 1987 and which was in itself a fine and comprehensive anthology. But *Otis! The Definitive Otis Redding* offers better mastering. A little more variance would have been nice ("Think About It," "Scratch My Back," or "Louie Louie" have never found their way onto a Redding anthology), but all said, you won't be disappointed by this one.

Jon & Sally Tiven

October Project
EPIC EK 53947-2, 50:09

There hasn't been a voice in pop music like Mary Fahl's since the '60s folk stylings of Mama Cass Elliott. It's a powerful alto with an earth-mother caress that infuses the lyrics of non-performing songwriter/member Julie Flanders, who has apparently found in Fahl a Roger Daltrey to her Pete Townshend. Flanders' songs of lost connections, fading memories, hidden forces, and a metaphysical love that seeks the

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spiritual are enlivened by Fahl's voice and the lush melodies of keyboardist Emil Adler. October Project is a young band, but the folk harmonies are right out of the '60s, including a startling reference to "Wimoweh (The Lion Sleeps Tonight)" on the chorus of "Always." Flanders' lyrics tend toward the artfully abstruse, but Fahl pulls them off, making some uplifting music for introspective minds. *John Diliberto*

Strange Cargo III
William Orbit
I.R.S. 27703 29, 65:53

William Orbit doesn't make music so much as create a sound design. This producer and mix-master for artists like Prince, Madonna, and The Cure turns into a sonic Cuisinart on his own projects, throwing together techno-beats, ambient

Rhythm, Country & Blues
Various Artists
MCA MCAD-10965
CD; 48:12
Sound: B+, Performance: A–

The intertwining of the roots of country music with those of rhythm and blues goes back beyond Elvis Presley to predecessors like Hank Williams, Bob Wills, and Jimmie Rodgers. From the R&B perspective, consider the crossover success, at the time an eye-opener, of Ray Charles with Hank Williams' "I Can't Stop Loving You" and before that with Hank Snow's "I'm Movin' On."

This album celebrates these connections with a collection of duets

between country and R&B stars. Performances throughout are delightful and ingenuous, and ringing with mutual respect. That many of the songs have been hits in both genres only adds resonance.

There's country boy Tony Joe White's "Rainy Night in Georgia," a hit for Brook Benton and Hank Williams, Jr., here done by Conway Twitty and Sam Moore of Sam & Dave. The standard "Since I Fell for You" is beautifully rendered by Reba McEntire and Natalie Cole. Allen Toussaint sings his "Southern Nights" with adornment by Chet Atkins' guitar. The Band's "The Weight" is ably turned by Marty Stuart with The Staple Singers, who have previously recorded the song twice. Perhaps best of all is the Al Green/Lyle Lovett duet on Willie Nelson's "Aint't It Funny How Time Slips Away." Even Clarence Carter's hopelessly hokey "Patches" is a gem in the hands of George Jones and B.B. King. The Eddie Cochran rocker "She's Something Else" is a delight in the hands of Little Richard and Tanya Tucker, and Trisha Yearwood does her best Linda Ronstadt impression in a sweet duet with Aaron Neville covering the Patsy Cline classic "I Fall to Pieces."

The only songs that leave me cold are the opener "Ain't Nothing Like the Real Thing" by Vince Gill and Gladys Knight, which feels too glossy, and the Patti Labelle/Travis Tritt take on Sam & Dave's "When Something Is Wrong with My Baby," a country hit for Sonny James and Joe Stampley.

It's all excellently played and sung from end to end. Producer Don Was has assembled a stellar backing band that on various tracks includes keyboardists Benmont Tench, Billy Preston, Barry Beckett, and Nat Adderly, Jr., along with drummer Kenny Aronoff, bassist Willie Weeks, and the Memphis Horns of Wayne Jackson and Andrew Love.

Thankfully, nothing's too deep here except the roots.

Michael Tearson

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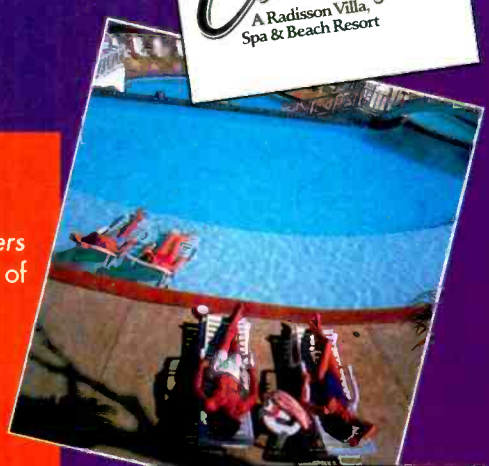

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atmospheres, reggae bass lines, African and Middle Eastern percussion, and fragmentary vocals. *Strange Cargo III* is a trippy collage centered by the groove. Orbit's got all the right signifiers, mixing the cosmic imagery of space music with the eroticism of disco, suggesting everything but saying nothing beyond the lurid shades of his kaleidoscope patterns. But it's a kaleidoscope that mesmerizes. *John Diliberto*

This Is Acid Jazz, Volume Three
Various Artists
INSTINCT EX-251-2, 67:29

Acid jazz is supposed to be a merger of hip-hop and jazz—jazz soloists, jamming on top of drum machine grooves, and turntable scratches. But *This Is Acid Jazz* is a collection of groove-intense songs that sounds like nothing more than early '70s soul music. Tracks like "Trash Jazz" sound as if they were lifted from old Average White Band albums.

That's not a criticism so much as a point of reference. *This Is Acid Jazz* offers up psychotic grooves on Secret Society's "Are You Listening" and soul torch singing by Diana Brown and Barrie K. Sharpe on "The Masterplan." There's not a name jazz soloist in the bunch, and the players roped into this project—pianist Adriano Pennino, sax player Topaz, and vibraphonist David Ylvisker—trade in on the soul-jazz clichés of

Roy Ayers and Lonnie Liston Smith. No doubt, this is a poppin' album, but it promises more than it delivers. (Instinct Records, 26 West 17th St., #502, New York, N.Y. 10011.) *John Diliberto*

Blood Music
Chapterhouse
DEDICATED/
ARISTA 7822-18742-2, 55:24

A marked interest in progressive house music (the influences are obvious) permeates this British pop group's second full release. The creative center of Andrew Sheriff and Stephen Patman integrate synth-driven dance melodies and yearning guitars within a trance-like state. Check out the cold groove of "Everytime" and the swirling guitars of "Love Forever," which best illustrate the band's knack for the art of the mix. A big backbeat drives "We Are the Beautiful" and "She's a Vision." On *Blood Music*, Chapterhouse exhibits far more diversity than cohorts like The Soup Dragons or Charlatans U.K. Although this effort

The Hellecasters
The Return Of... Album of the Year –Guitar Player Magazine

Smashing Pumpkins
Siamese Dream Platinum Selling Alternative Album

Cracker–Kerosene Hat
The band the L.A. Times described as "An American Treasure"

Brother Cane–Brother Cane
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Taj Mahal–Dancing The Blues
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Ann-Margret-My Story
Read by Ann-Margret
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Tori Amos–Under The Pink
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Holly Cole
Don't Smoke In Bed
A voice that dances toward your soul

King's X–Dogman
Produced by Brendan O'Brien (Stone Temple Pilots, Pearl Jam)

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lacks the youthful wonder of 1991's *Whirlpool* (recorded at an average age of 24), Chapterhouse nevertheless finds interesting terrain to explore. *Tom Ferguson*

FAST TRACKS

The Hendrix Set: *Paul Rodgers & Company* (Victory 383 480 014-2, 22:04). This EP, recorded live last summer, is more in the spirit of The Jimi Hendrix Experience than any of the heavily hyped tributes of late. Rodgers, one of rock's premier tenors, delivers with emotion that works for this material, and guitarist Neal Schon is one of the few guys who can mimic Jimi without sounding stiff. **J. & S.T.**

dōs: *Altered State* (Warner Bros. 9 45406-2, 73:20). Less random noise, more progressive rock melodies, and metal-cum-industrial guitars help make this L.A. trio's second effort akin to a *Dark Side of the Moon* for the '90s. Intelligent and emotive, Altered State is a band to keep an eye on. **M.W.**

Thirteen Years: *Alejandro Escovedo* (Watermelon CD 1017, 51:07). Escovedo's second album is a haunting work. As he did on his debut *Gravity* (Watermelon CD 1007), he sets his songs, a heady lot, in diverse styles. The rockers are sinewy, but most astonishing is his deployment of string quartets throughout. (Watermelon, P.O. Box 402088, Austin, Tex. 78704.) **M.T.**

The Calm Comes After: *Kate Jacobs* (Bar/None A-HAON-031-2, 48:50). This was previously on Kate's own label; the reissue adds three newly recorded songs. Jacobs is a wry yet warm country/folk artist with a disarmingly friendly and optimistic attitude. The title song, "My Siberia," and "Safe As Houses" are all standouts, laced with wisdom. (Bar/None, P.O. Box 1704, Hoboken, N.J. 07030.) **M.T.**

Dogman: *King's X* (Atlantic 7 82558-2, 59:19). Long a fave with critics, musicians, and progressive metalheads, King's X continues to rely on a formula of Fab Four-esque melodies and harmonies with a dense "low-metal" foundation. It was innovative six years ago, but on *Dogman*, their fifth, it's become samey. This band needs a revamping, an overhaul, something, but they're too good not to deliver a masterpiece eventually. **M.B.**

JACKIE McLEAN

The Complete Blue Note 1964-66 Jackie McLean Sessions
MOSAIC MD4-150
Four CDs; 4:07:02
Sound: B–, Performance: A–

The Jackie Mac Attack—Live
Jackie McLean
VERVE 314 519 270-2, CD; 55:50
Sound: B, Performance: B+

Jackie McLean plays alto saxophone with the grace of an arabesque and the authority of a machine press. You can hear it in his titles: Slam! "Cancellation," slam! "Action," slam! "Right Now." Mosaic's four-CD set captures a narrow 20-month, six-session slice of McLean's protean work for the Blue Note label in the mid-1960s.

Musicians were looking at new directions in 1964, but McLean, already a bop veteran, wasn't ready to throw tradition away. Instead, he integrated the changes along with musicians who would lead the charge into the next decade. Among those on these sides are drummers Roy Haynes and Billy Higgins, who played with John Coltrane and Ornette Coleman, respectively, and future Miles Davis drummer Jack DeJohnette. Cecil McBee is heard on bass, and a very young Herbie Hancock plays piano on material from *It's Time*. Hancock's terse, unadorned solos sound like Morse

code. Engineer Rudy Van Gelder's piano sound, unhappily, sounds unusually tinny.

These discs show that while McLean was recording hard-bop quartet dates like *Right Now*, he was also taking things further out on *Action*. With Bobby Hutcherson's vibes replacing Hancock's piano, musicians were freed of chordal structure, making every instrument melodically vertical rather than chordally horizontal. It's an innovation borrowed from Coleman.

Trumpeter Charles Tolliver appears on four cuts on this collection, and although this undersung hard-bop player lacks McLean's finesse, he contributes several of the more

riveting compositions. But the late trumpeter Lee Morgan was the only soloist who could stand toe-to-toe with McLean. Morgan brought lightning-fast technique, slurring, stuttering, and flutter-tonguing on tracks like the barn-burner "Consequence" from the album of the same name.

It's on the final session, *High Frequency*, that McLean's most exploratory sounds are heard. The title piece, written by pianist Larry Willis, has a modern-classical sense of drama, with rhythm shifts that only drummer DeJohnette could negotiate. The Coltrane influence is most evident here, with long raga-like lines that seem to call out in spiritual release. Like Coltrane, McLean is searching, but with a daunting sense of purpose. Even at the edge, he didn't neglect the roots, concluding with a funky get-happy number, "The Bull Frog."

McLean, who has only recently begun recording again after 20 years, doesn't have to worry about backhanded compliments like "Jackie McLean may not play with the fire of youth, but he brings the wisdom of

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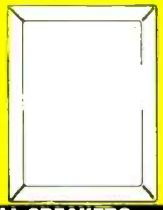

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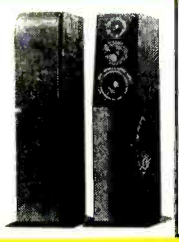

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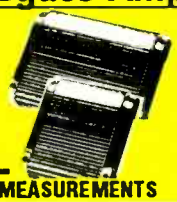

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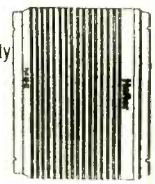

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age to his solos." Forget it! His latest album, *The Jackie Mac Attack—Live*, was recorded when McLean was just shy of 60, but he's still playing balls-to-the-wall alto, dancing through changes with dazzling lines and overblown effects. It may be a "Mac Attack," but this isn't fast food.

The complex harmonies of pianist Hotop Idris Galeta and the popping rhythms of bassist Nat Reeves and drummer Carl Allen clearly inspire McLean to some of his most energized playing. The album lacks the discovery and film noir atmosphere of the Blue Note sides, but this is the place to go for a quick shot of hard bop from someone who virtually invented it. (Mosaic, 35 Melrose Pl., Stamford, Conn. 06902.)

John Diliberto

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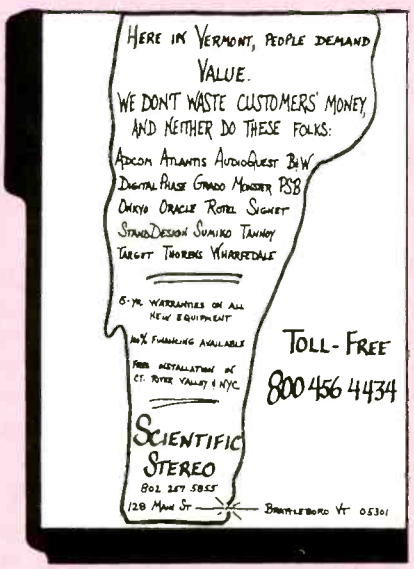

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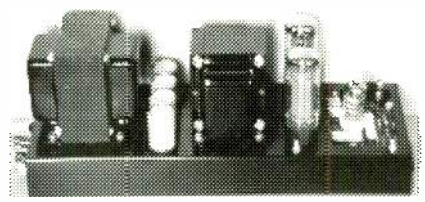

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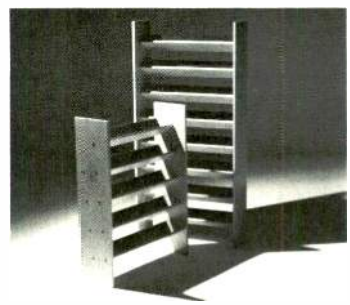

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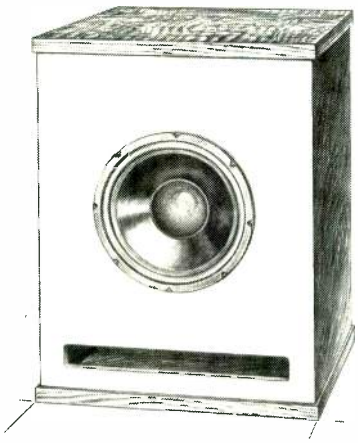

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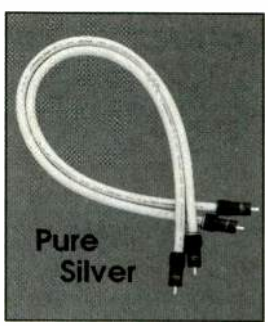

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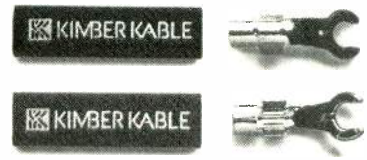

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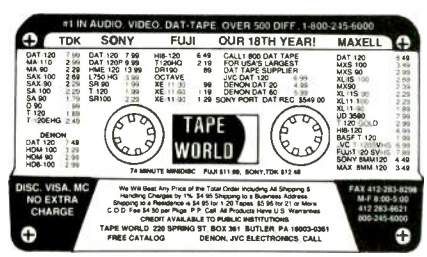

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The One and Only...

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

And what a front loader! The tray is made entirely of machined aluminum for maximum mechanical integrity. Of course, the front panel and all switches are also of machined aluminum, enhancing its spectacular slimline appearance. Special suspension techniques are used for optimizing acoustical isolation.

Using the Latest Technology...

High-speed asynchronous FIFO memory assures that the necessarily varying input and output data signals do not modulate each other—which otherwise would interfere with the "beat" and rhythm of the music—and each digital integrated circuit has its own regulated power supply—an absolute requirement for high-purity digital data. But we've not forgotten the Real World: each DA-11 offers SC ("TosLink") plastic optical, *two* BNC electrical outputs—one floated and one direct—and an AES/EBU balanced output and an optional ST glass optical.

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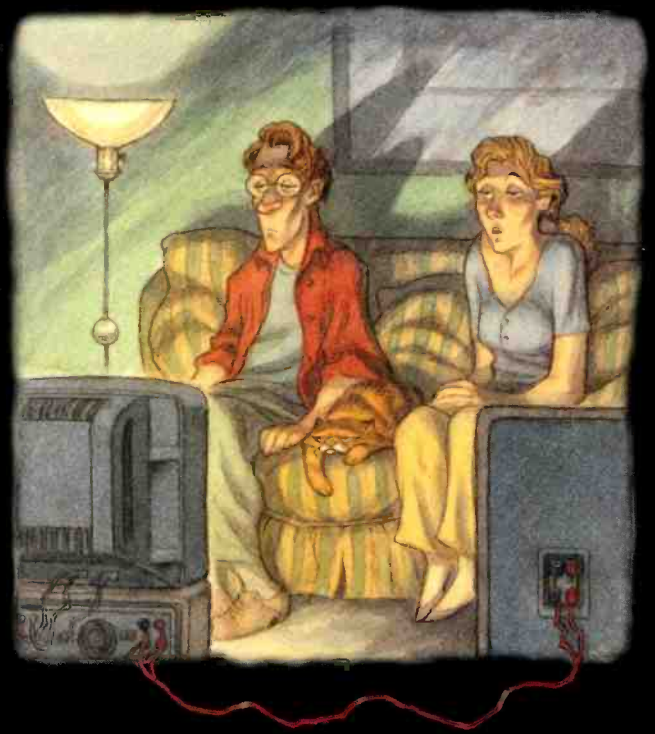

Which scares you more, a horror film with the sound turned off, or a horror show on the radio? The answer is easy because it is the movie's soundtrack which carries the pathos and emotion. You can enjoy sound without pictures, but who wants pictures without sound?

It's What You Don't See That Counts.

It doesn't cost more to do it right! AudioQuest offers a full range of cables, but the biggest improvement you'll hear is going from big fat stranded cable to the least expensive cables from AudioQuest. For the complete story, please call or write for our *Cable Design* booklet – or better yet, visit an AudioQuest dealer and listen for yourself.

It just so happens that cables are the part of your system which can help or hurt the performance the most... and for the least money. Whether you have two-channel stereo or multi-channel stereo, you have to have cables. You can't completely fix a bad system with good cables, but you can seriously degrade a good system with badly designed cables.

You won't see the cables and you won't see the sound – but you will experience the difference!

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