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JUNE 1988 • $2.50

INTERVIEW
CHRIS STRACHWITZ

AKAI AD-93
DAT RECORDER
THE FUTURE
GETS CLOSER

HISTORY OF
SOLID-STATE AMPS

TESTED
OHM WALSH 5 SPEAKER
MASTERPIECE OF DESIGN

WHEATON
TRI-PLANAR II TONEARM
FIRST-RATE ENGINEERING

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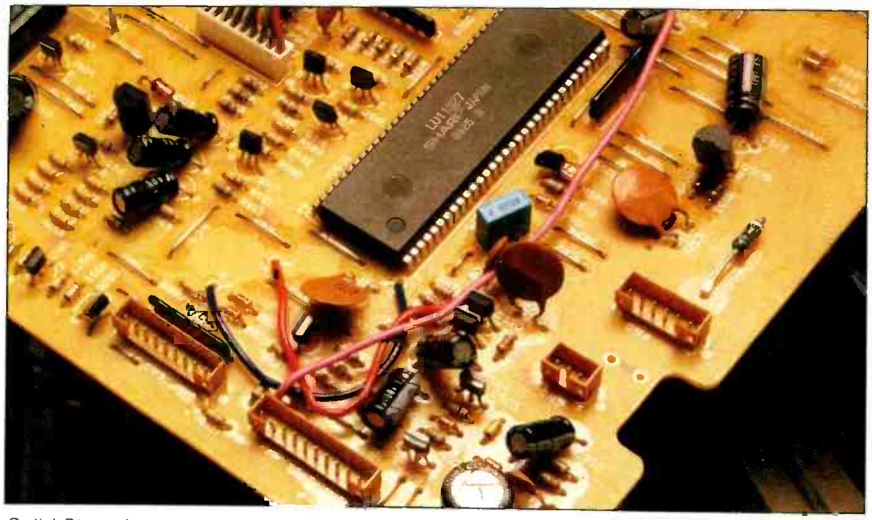
Sumo
TAPE COPY
INPUT
VOLUME - BALANCE
athena
STEREO
MONO
NORMAL
BYPASS

Audio

JUNE 1988 VOL. 72, NO. 6



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DEPARTMENTS

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MPA

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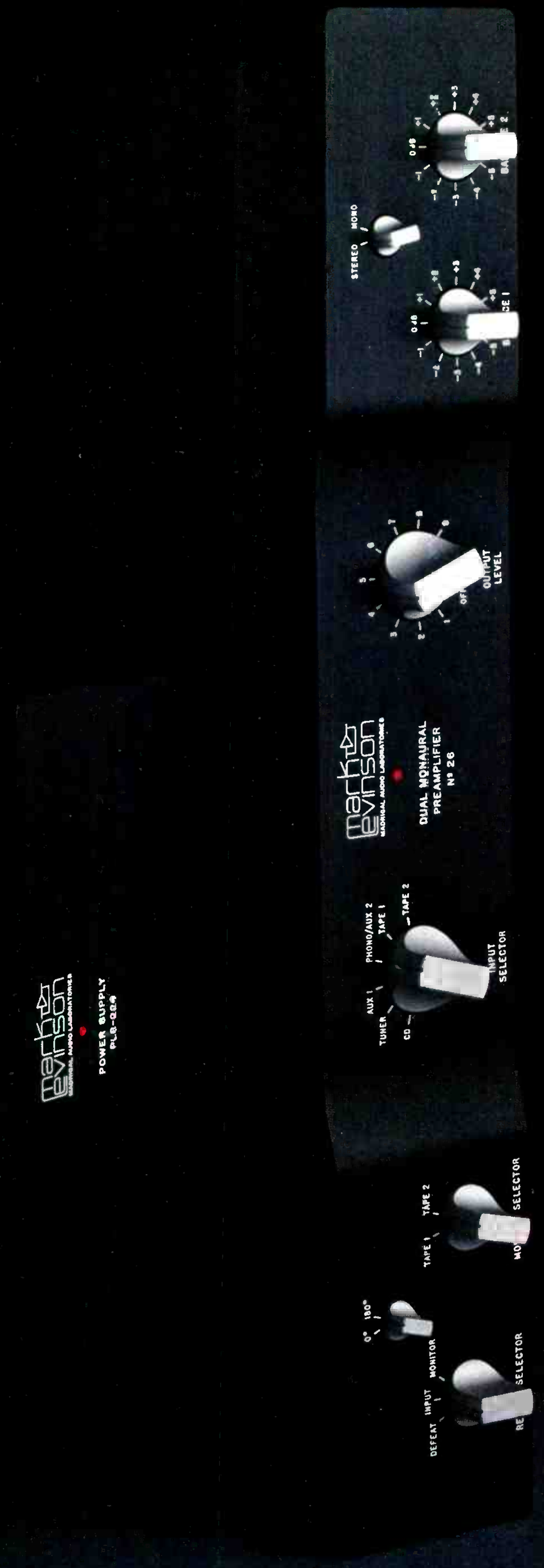
THE SHAPE OF THINGS TO COME



Products recognized for their ability to reproduce music and to advance our perception of high fidelity emerge from unique companies. The community of individuals dedicated to the production of Mark Levinson components has established an unequalled tradition of excellence and accomplishment, while accepting the responsibility for refining the state of the art in music reproduction within the boundaries technology and imagination allow.

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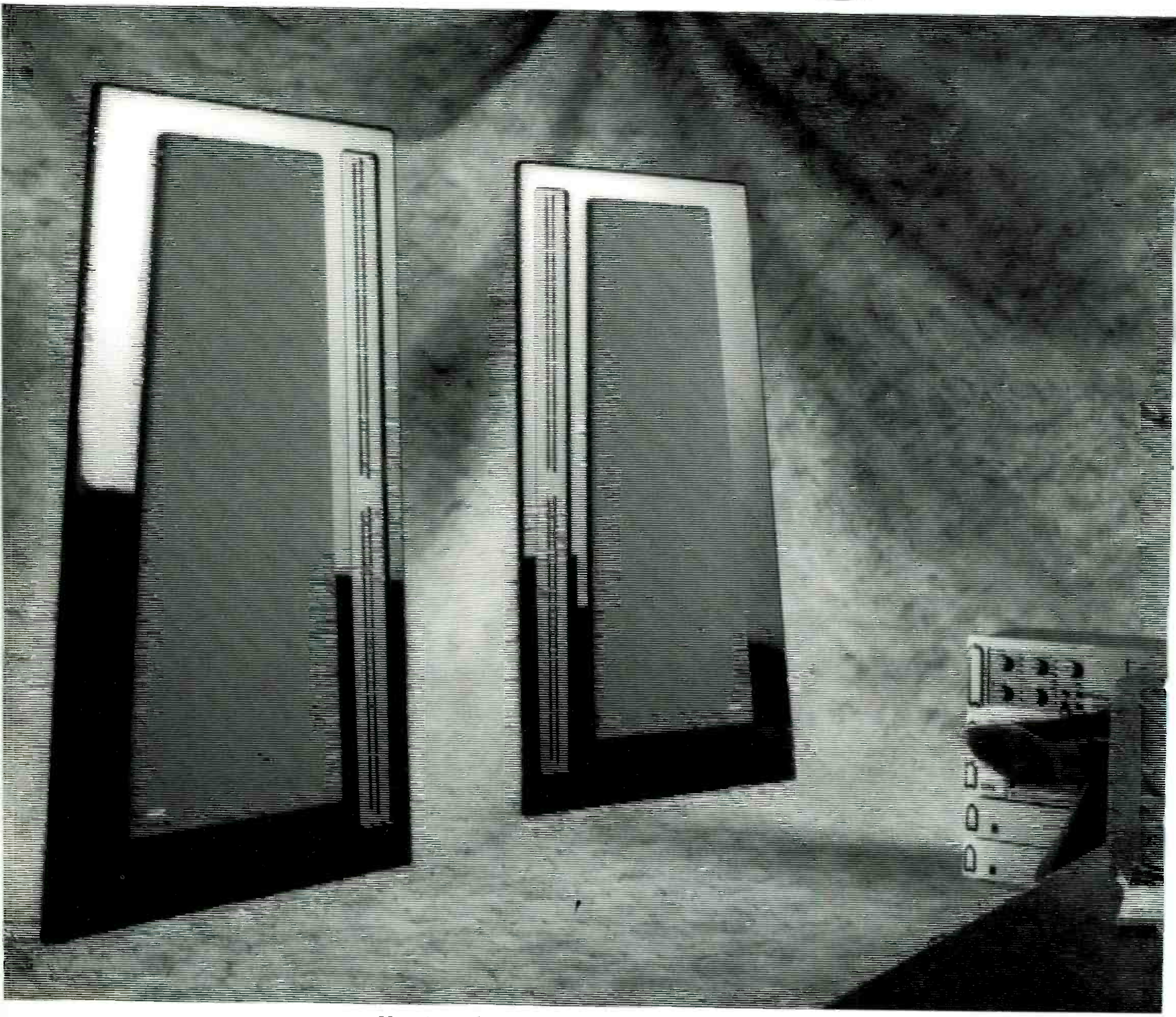

How it works.
A brief conversation with Bob Carver.

Q. How can The Amazing Loudspeaker put out so much powerful, extended bass?

A. Brute force. A total of 8 subwoofers, each with 4 times the excursion of regular bass drivers for a total displacement (area times excursion) of almost 2000 cubic inches. The low frequency 3dB point is 18Hz!

Q. Why use a ribbon driver?

A. Because the sound of a ribbon is nothing short of glorious! Free of individual driver anomalies and crossover problems, the Amazing Loudspeaker's extended line source driver delivers a majestic sonic image that literally floats in 3-dimension acoustic space. Simultaneously, it reproduces an amazing amount of musical detail that's simply unmatched by any point source driver.

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But aren't ribbon drivers inefficient?

Not when designed with enough magnetic field strength. Each Amazing Loudspeaker ribbon uses 30 feet of high energy magnets in a special focused field gap. At 82dB efficiency, that's almost twice as efficient as any other ribbon that goes down to '00Hz. Our M-1.0t power amplifier yields peak SPL's exceeding '06dB; up to 110dB with an M-1.5t! More than ample to deliver a symphonic orchestra's sonic power, fifth row center.

This is not a typical speaker ad. Because The Amazing Loudspeaker is anything but a typical speaker.

This isn't even a typical *Carver* ad.

True, the Amazing Loudspeaker breaks so many conventional speaker rules — and succeeds so spectacularly at it — that we're tempted to fill this ad with a litany of hertz, watts and exotic buzz words the way our competitors' ads do.

"Its overall sound is spectacular, its bass performance surpasses that of almost any other speaker one might name."
STEREO REVIEW

Because there's bound to be quite a story behind a speaker that's 5½ feet tall and yet just 1½ *inches* thick. Especially when Bob Carver has a hand (or rather two hands, both feet and a year or so of lab time) in its creation.

But ingenious design is only our means to an end. The beginning of a dramatic awakening that will re-define for you the very essence of music.

"The image is as wide, deep and multi-layered as I have ever heard. Only Infinity's $35,000 Reference Standard impressed me more."
Henry Hunt
Hi Fidelity Editor
HOUSTON POST

The Amazing Loudspeaker can etch a sonic image so detailed you can almost see rosin drift from a bow onto the polished surface of a violin.

It can brighten your listening room with the sheen of a #4 drumstick on a Ziljan hi-hat cymbal. Or darken it with the smokey midnight growl of a battered baritone sax.

It can stun your senses and rearrange your furniture with thunderous salvos of tight, perfectly controlled low bass.

"It solves certain design problems and achieves certain sonic results with a simplicity and flair that can only be called, well, amazing."
Peter Aczel
THE AUDIO CRITIC

It can meticulously separate every instrument and vocal on a dense, multi-track mix and project each in sharp relief at precise points across the sound field.

In short, the Carver Amazing Loudspeaker restores what time and reading too many speaker ads often takes away.

Sheer wonder.

We have merely touched on the highlights of this truly amazing loudspeaker. We'd be happy to send you more information including reprints of several great reviews.

"It's price is ridiculously low for what it does and... what comparable products cost."
Julian Hirsch
STEREO REVIEW

However, if your immediate interest is the sensation of a listening room melting away to reveal the crystalline clarity of pure music, you need only visit your nearest Carver dealer.

Your amazement will begin when you discover just how affordable the Carver Amazing Loudspeaker really is.

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SIGNALS & NOISE

Still Grooving

Dear Editor:

Thank you for reviewing our record mat in the April issue ("Mats & Clamps: By the Numbers"). We found Edward M. Long's article to be very interesting, and we were satisfied to see that his findings corroborate our own views about the neutrality of the Groove Isolator Mat and its ability to provide the vinyl disc with adequate immunity against the energy travelling through the playing system. In his article, Mr. Long states that the mat is no longer available. However, the Groove Isolator Mat has been, and still is, sold as an accessory through our dealer network.

Marcel Riendeau, President
Oracle Audio
Sherbrooke, Que.
Canada

What I Did for Sound

Dear Editor:

How many times do you have to tell us stubborn readers not to sacrifice quality when it comes to sound reproduction? Still, we never listen.

I became very excited when I finished Neknnaml Hop's article on the Auditory Bypass System developed by the Lirpa Foundation ("Digital Ptomaine," April 1988), and I immediately started calling around to do some price shopping. Many of the high-end audio dealers in the Dallas area offer this system, but their prices are outrageous. I found a dealer that installs the system using a gold drill bit (#61) and a Q-Tip, but their price is more than $7,000 and they have a two-month waiting list. Finally, I came across a place that could get to me as soon as their installation specialist got out of jail. I had my system installed three days ago. The pain was excruciating because they used no deadening device of any sort. The RCA connectors were tapped into my skull in unison with the cannon shots of "The 1812 Overture," which blared in the background.

Now, not only have I lost the whole left channel, but I can't use my left arm either. All food tastes like solder to me, and when I drive past a hospital, I pick up their paging system—in my head, I can hear doctors being called to surgery. When confronted, the dealer told me that my eight-hour warranty had expired. Please continue to warn your readers that there is still no cheap substitute for quality. Congratulations to all at the Lirpa Foundation.

Steve Foss
Arlington, Tex.

Return to Greatness

Dear Editor:

I applaud your February 1988 issue, in particular the article "Understanding Common-Mode Signals" by Richard N. Marsh.

I hope that I detect a renaissance in the content of *Audio*, as evidenced by this article and the previous article by Walter Jung dealing with the sonic improvement of Magnavox and other CD players ("The Magnavox 16-Bit Series: Making Good Players Better," June 1987). Both of these articles compare very favorably with the two-part article "Picking Capacitors" by Jung and Marsh which appeared in the February and March 1980 issues of *Audio*. Incidentally, "Picking Capacitors" is still considered to be a landmark, watershed article by audiophiles across the nation, and it is still commonly cited.

It seems that this signals (I sincerely hope) *Audio*'s return to greatness and preeminence in the field, as typified in the past by the construction articles by W. Marshall Leach, Jr. et al. I am still running Leach's wide-band preamplifier, his head amp, and his low-TIM amp. The latter is still considered by audiophiles to be one of the very best amplifiers available today.

Once again, congratulations, and *please* continue and expand this trend.

Paul T. Kelly
Fort Wayne, Ind.

Editor's Note: Many thanks, Mr. Kelly, for your warm letter. I hope it's a renaissance, too, but I have to emphasize that, from my side of the desk, such articles as you cite are extremely hard to come by. I can only encourage the authors you mention; they don't respond to threats or bribes. Perhaps the publication of your letter will have a favorable effect.—*E.P.*

Erratum

In "Inscriptions: Miles Davis on CD" in the April issue, we misidentified drummer Jo Jones as Philly Joe Jones. Sorry 'bout that.—*E.P.*

Audio

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AUDIOCLINIC

JOSEPH GIOVANELLI

Fan Guidelines

Q. I am trying to choose a small a.c. fan to cool components inside a rack-mount cabinet. My main concern is to avoid inducing electrical noise into my system. I have a couple of 3-inch fans (115 V, 50/60 Hz, 5 watts, input-protected) which I obtained as surplus from a disk-drive maker. It seems to me that, because computer peripherals require "clean" power, these fans would be suited to my needs.—Andrew David, Minneapolis, Minn.

A. By taking a few simple steps, you can make sure there will be no problem using the fans you describe, nor any other small fans. Fan motors do not employ brushes and commutators as they did many years ago. Motors of that kind could introduce noise, especially when listening to AM. The only way I can see how today's fans could introduce electrical interference into an audio system is by way of induced hum, either into tape playback heads or into phonograph cartridges. This should not be a concern, however, as long as the components to be cooled are located far enough from the phonograph or tape recorder so that the fan will be well clear of these sensitive items. If the amplifier (or other equipment employing large power transformers) is located too near the phonograph or recorder, its power transformer will probably cause more hum than the fan. As with all power cords, keep the fan's cord well clear of the phono interconnecting cables.

More About Cable TV Hum

I read with interest the item in the June 1987 "Audioclinic" regarding hum in TV audio. I, too, like reader Pat Yacques, had experienced the problem for more than a year, and the solution—after trying everything—was very simple. One or more components (most likely power amplifiers) in my audio system have three-prong a.c. line cords, with the third prong used as a ground for protection against shock hazards. With the ground from the cable drop (the point of attachment of the cable to the home), audio grounds, etc., the addition of this three-prong grounding scheme produces many different possible ground loops within the audio system. A very pronounced 60-Hz hum may result.

Sometimes there is no ground at all, or a very poor one, at the cable drop. Thus, a voltage is developed between the audio and cable system grounds. This voltage finds its way into the audio system and is heard as hum. I suggest two solutions.

First, an isolation transformer can be created by using two 75-ohm to 300-ohm baluns; connect them together by tying the 300-ohm leads of one unit to the 300-ohm leads of the other unit, and then feed the main cable to one balun's 75-ohm side. Connect the TV set to the second balun's 75-ohm side. This circuit isolates the TV ground from the a.c. line ground with no appreciable video signal loss. However, because of the lack of r.f. shielding, this system may cause r.f. interference with the desired cable signal.

Also, by removing the audio system a.c. ground, the entire audio system floats above ground but at a level constant within the system, and no hum results. So the second alternative is to use a three-prong to two-prong a.c. adaptor plug in the a.c. line cord of any three-wire, three-prong audio equipment. Do not connect the pigtail to the outlet grounding screw. I use this method with my amps; it isolates the a.c. ground from the system and eliminates any trace of hum. The grounding protection can be obtained by installing a ground fault circuit interrupter (GFCI), which can be found in duplex-outlet form at hardware stores. Place this ahead of all a.c. line cords which have been adapted from three- to two-prong. This GFCI will provide better and faster shock protection in the event that the protected piece of equipment should develop a problem connected with the a.c. line.

I also suggest that a surge protector, of the type used for computers, be placed in the a.c. line ahead of all audio and TV electronics.—Andrew J. Megna, Jr., Emmaus, Pa.

I should add just one thing: Be sure that the baluns used employ isolated windings, or the scheme proposed by Mr. Megna will not work.

If you have a problem or question about audio, write to Mr. Joseph Giovanelli at AUDIO Magazine, 1515 Broadway, New York, N.Y. 10036. All letters are answered. Please enclose a stamped, self-addressed envelope.

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And a CD Direct selector allows you to bypass less crucial preamplifier circuitry so you can fully enjoy the clarity of digital.

Extensive video capability complements the audio performance. Remote control using Onkyo's new RI (Remote Interactive) system is standard, too. And the programmable remote transmitter means that you need just one control for all your components!

In short, the Onkyo TX-850 proves that you don't need to sacrifice sound quality for convenience. And stands as one less barrier between you and your music.

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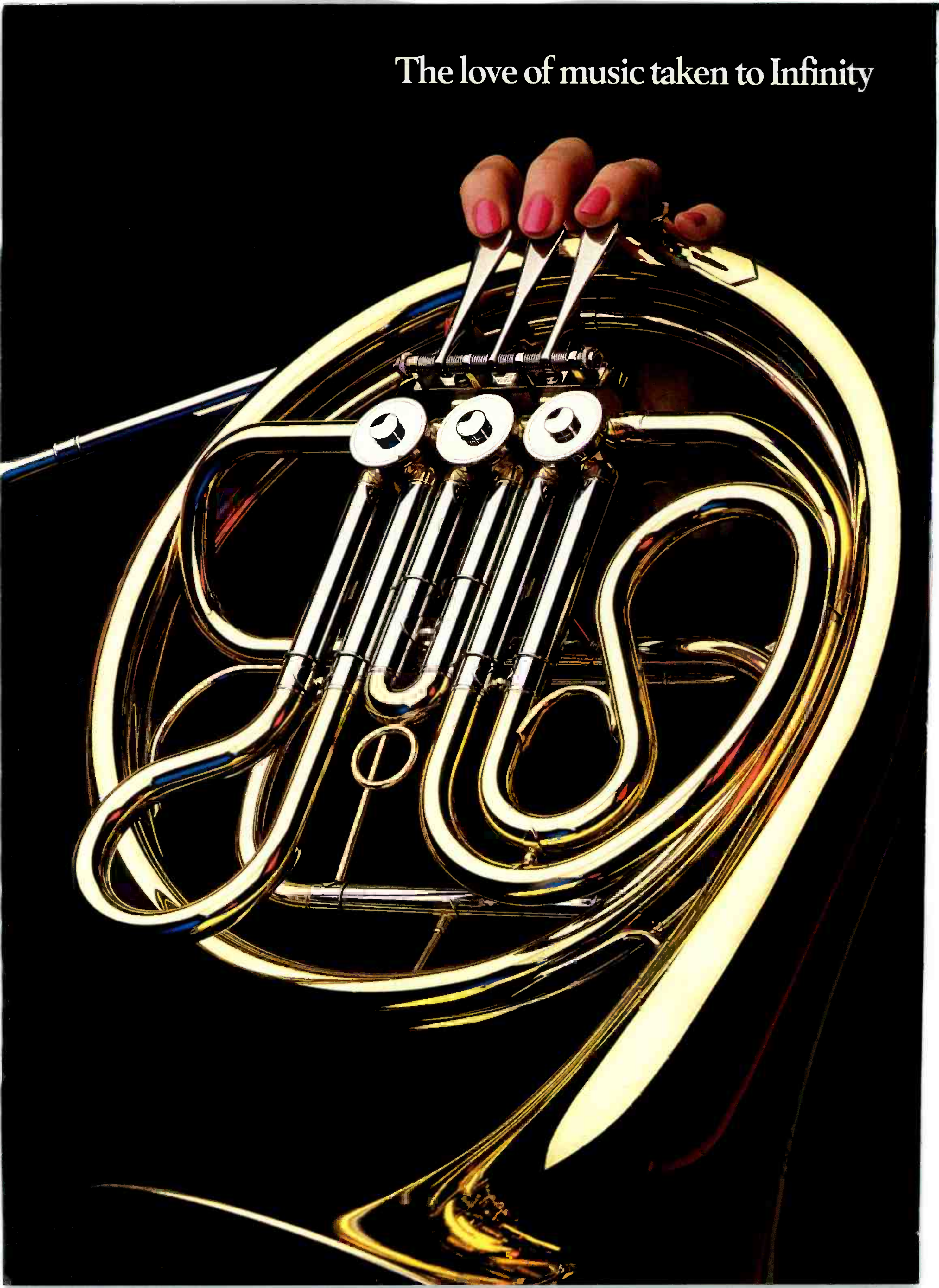
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TAPE GUIDE

HERMAN BURSTEIN

Proper Calibration

Q. I understand that matching of record and playback levels in taping a cassette is important for proper tracking by a deck's Dolby circuits. If I correctly match levels, using the adjustments provided in my deck for this purpose, will the tape that I have recorded on my deck be tracked properly when played back on another deck?—Timothy Donovan, Lexington Park, Md.

A. If, for a given tape, two decks are properly calibrated with respect to Dolby level—based on a Dolby-level test tape employed by the manufacturer or a technician—a Dolby-encoded tape made on one deck will play correctly on the other. If there is miscalibration, treble response will tend to be affected adversely, usually in the form of treble loss. Fortunately, there is about ±2 dB of latitude in matching levels before adverse effects become serious.

Complaint Department

Q. I would like to know if you share my viewpoint concerning the quality of today's cassette decks. It seems we have gone backwards. Mid-priced decks have more wow and flutter, and weigh less, than those of five years ago. They have a cheap feel, and I find a lot of them actually sound worse than the earlier ones. It bothers me that companies are all too willing to focus attention on features which do nothing to improve the sound or increase reliability; in fact, they often detract from performance. Manufacturers always look for ways to keep costs down, but unfortunately it's the bells and whistles that catch consumers' eyes. Why do major companies focus their attention on auto reverse and double wells? Why do they offer $200 or $300 decks which have auto reverse, programmability, electronic tape counters, microprocessor this and microprocessor that, but which also have high wow and flutter, terrible frequency response, muddy bass, Permalloy heads reminiscent of those used a decade ago, poor transports, etc.?—Steve Medel, New York, N.Y.

A. I have to agree somewhat with your observations; while there are companies making very good cassette decks, others are not. At times it seems there is almost an inverse relationship between price and number of features. It appears that in some companies the factory makes what the marketing department believes it can sell, rather than the other way around. In this and other ways, it seems that we are in the age of hype fidelity.

Thin May Be In

Q. Your September 1987 column recommended against using tapes thinner than 1 mil for open-reel decks. I once owned a Tandberg open-reel deck; Tandberg's great claim to fame at the time was that their decks made good recordings at slow speeds. At 3¾ ips, my deck made tapes that were flat to well beyond 18 kHz with just about any brand of tape, provided the bias was adjusted properly. For me, the biggest problem was not hiss or distortion, but dropouts. I noticed that thinner tapes had considerably less of a dropout problem than thicker ones. Tandberg was aware of this and recommended tapes that were 1 mil and thinner. *It appears that the greater flexibility of thin tapes allows more intimate tape-to-head contact. If I wanted to use the 1⅞ ips speed of my deck, 0.5- or 0.75-mil tapes were the only ones I could use satisfactorily.*

I agree that using thin tapes on professional machines is asking for trouble. But on home-type transports designed for 7-inch reels, thin tapes will not stretch if reasonable care is used. True, there is a bit more low-frequency distortion and reduced S/N, but as for print-through, at the slower speeds the primary printing frequencies are moved into the upper bass and therefore are not that much of a problem. As far as I'm concerned, 0.5-mil tapes are quite suitable for high-fidelity recordings, so long as reasonable care is taken and limitations are understood.—Steve Graham, Ann Arbor, Mich.

A. My own experience with thin tapes (less than 1 mil) for open-reel machines has been negative. Also, the NAB Standards, at least in the past,

If you have a problem or question on tape recording, write to Mr. Herman Burstein at AUDIO, 1515 Broadway, New York, N.Y. 10036. All letters are answered. Please enclose a stamped, self-addressed envelope.

With only few exceptions, makers of CD players and cassette decks have failed to address the problem of distressing dynamic range.

have stated that thin tapes are not recommended. However, all this is well in the past, and doubtless thin tapes have improved over the course of time, along with all other tapes. This even applies to very thin cassette tapes, the C-120s. Not long ago, several readers pointed out to me that some makes of C-120 tapes provided satisfactory results; until then I had been very negative about them.

While I am not prepared to heartily recommend extra-thin tapes to home recordists, I shall keep in mind that some people, like yourself, have found them satisfactory and even advantageous, and that they are worth trying.

Unkeyed Cassettes

Q. *I have come across several prerecorded CrO_2 cassettes that will not register as such in my deck. Although the cassette labels say CrO_2, Type II, the shell does not have the required depressions to activate my deck's automatic sensing system. Don't the tape manufacturers know that many modern decks incorporate sensors which switch the deck automatically to proper bias and equalization according to tape type? If they do know, why don't they at least leave tabs that consumers can punch out?*—Timothy Eckert, Madison, Wisc.

A. There are two possible reasons for the absence of this notch. The first possibility is carelessness or indifference on the part of the suppliers of the prerecorded tapes in question. This includes the chance that proper keying was accidentally omitted. The second possibility is that the omission of CrO_2 identification notches from these tapes is *not* a mistake at all. Many prerecorded cassettes are recorded with Type I (120-μS) equalization even when they are made on Type II tape. This is done to ensure compatibility and proper Dolby NR tracking on those decks which do not have equalization selector switches of any kind. By omitting the notches, the tape duplicators are probably preventing your deck from automatically selecting the wrong equalization, rather than preventing it from using the right one.

Some of the blame for problems of this nature also attaches to those deck manufacturers who fail to provide for manual as well as automatic selection of bias and equalization in accordance with tape type. In a world where Murphy's Law operates, I don't think that deck manufacturers should assume that cassette shells will always be properly keyed.

Excessive Dynamic Range

Q. *I have a dynamic range problem: There's too much of it in the tapes that I make. They are beautiful tapes, but in my car the road noise and engine noise mask all but fairly robust sounds. The result is that I must either give up the softer parts of the music or put up with excessive climaxes. I have achieved some success with dbx NR encoding and playing back without decoding, but the frequency response then sounds thin. Any ideas?*—Norm Strong, Seattle, Wash.

A. Check the section on Signal Processors in *Audio*'s latest Equipment Directory (October 1987), and you might find a compander within your price range. Such a unit would permit several user-selectable degrees of compression rather than the fixed and severe amount provided by a dbx noise-reduction unit.

Alternatively, you might continue to use your dbx encoder (compressor), but with equalization in recording to produce a final result that is more or less satisfactory for car use. Equalizers are available today at fairly modest prices.

A third course would be to ride gain when recording. This assumes you have very good prior familiarity with the material so that you can accurately anticipate loud passages and reduce recording level temporarily.

With only one or two exceptions, manufacturers of CD players and cassette decks have failed to give attention to the problem of excessive dynamic range—understandably, because great dynamic range is one of the boasts of the CD medium. This problem can exist in the home as well as in the car. I have at least one CD which requires a volume change in mid-course if I am to avoid distressingly loud sound yet hear the softest passages. To some extent, the makers of CD equipment are only doing what they should, in capturing the widest possible dynamic range. But this can easily cause a dubbing problem.

Prism Effect

What has prism effect, a refractive phenomenon, to do with audio equipment?

Nothing, except that it is the simplest analogy to describe what our sophisticated XM-3* Mobile Electronic Crossover does to audio signals.

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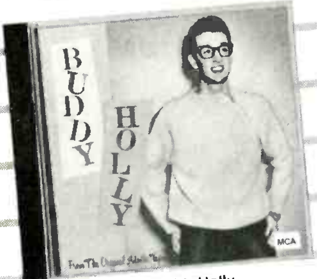
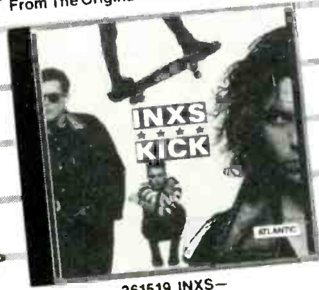
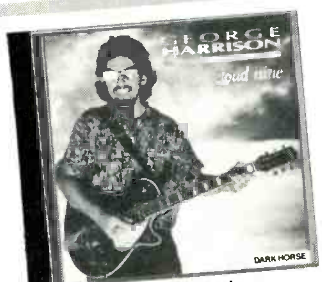
From Buddy to The Boss



348110. Buddy Holly—From The Original Master Tapes. (MCA)



361519. INXS—Kick. (Atlantic)



365494. George Harrison—Cloud Nine. (Dark Horse)

361402. Tiffany. (MCA)

364695. Wynton Marsalis—Baroque Music For Trumpets. (CBS Masterworks)

362079. Michael Jackson—Bad. (Epic)

366443. Good Morning Vietnam. —original motion picture soundtrack. (A&M)

346957. Steve Winwood—Back In The High Life. (Island)

360016. Spyro Gyra—Stories Without Words. (*Digital*—MCA)

334607-394601. Carpenters—Yesterday Once More. (A&M)

339226. Gershwin: Rhapsody In Blue; more. Thomas, Los Angeles Phil. (*Digital*—CBS Masterworks)

339903. The Cars—Greatest Hits. (Elektra)

342097. Barbra Streisand—The Broadway Album. (Columbia)

336396-396390. Billy Joel's Greatest Hits, Vol. 1 & 2. (Columbia)

343715. Vivaldi: Four Seasons— Maazel cond. (*Digital*—CBS Masterworks)

344184. Copland: Billy The Kid/Rodeo Ballets — Slatkin, St. Louis Sym. (*Digital*—Angel)

344622. Anita Baker—Rapture. (Elektra)

345199. Beethoven: Overtures— Bavarian Radio Orch., C. Davis. (*Digital*—CBS Masterworks)

345827. Bob James and David Sanborn—Double Vision. (Warner Bros.)

346544. Kenny G—Duotones. (Arista)

347492. Glenn Miller Orchestra—In The Digital Mood. (*Digital*—GRP)

354449. U2—The Joshua Tree. (Island)

347567. Gershwin's Song Book & Other Music For Piano Solo— Leonard Pennario. (Angel)

347955. Huey Lewis & The News—Fore! (Chrysalis)

348318. The Police—Every Breath You Take—The Singles. (A&M)

348458. Dvorak: Cello Concerto— Yo-Yo Ma; Maazel, Berlin Philhar. (*Digital*—CBS Masterworks)

348649. Pachelbel Canon & Other Digital Delights—Davis, Toronto Chamber Orch. (*Digital*—Fanfare)

348987-398982. Linda Ronstadt—'Round Midnight. (Asylum)

349134-399139. Beethoven: Sonatas Piano & Violin, Vol. 2—Stern, Istomin. (*Digital*—CBS Masterworks)

349985. Johnny Mathis/Henry Mancini—The Hollywood Musicals. (Columbia)

350587. Kathleen Battle Sings Mozart. (Angel)

351601. Mozart: Requiem— Malgorie, Grand Ecurie. (*Digital*—CBS Masterworks)

352534. Holst: Planets — A. Davis, Toronto Symph. (*Digital*—Angel)

352633. Dolly Parton/Linda Ronstadt/Emmylou Harris–Trio. (Warner Bros.)

353771. Bolling/Rampal: Suite #2 for Flute & Jazz Piano Trio. (*Digital*—CBS)

354902. Fleetwood Mac—Tango In The Night. (Warner Bros.)

360974. Squeeze—Babylon And On. (A&M)

354472. Expose—Exposure. (Arista)

354514. Jody Watley. (MCA)

354951. Mozart: Flute Quartets— Rampal, Stern, Accardo, Rostropovich. (*Digital*—CBS Masterworks)

354985. Billie Holiday—From The Original Decca Masters. (*Digitally Remastered*—MCA)

355362. Whitesnake. (Geffen)

355115-395111. Prince—Sign 'O' The Times. (Paisley Park)

355164. Vladimir Horowitz Plays Favorite Encores. (CBS Masterworks)

355172. Ravel: Rapsodie/Valses/Pavane/Alborada/etc. Previn, Royal Phil. (*Digital*—Angel)

355578. Hanson: Symphony No. 2 ("Romantic"), Barber; Violin Concerto. Oliveira; Slatkin, St. Louis Sym. (*Digital* Angel)

356667. Heart—Bad Animals. (Capitol)

357087. Grateful Dead—In The Dark. (Arista)

356279. Gloria Estefan And Miami Sound Machine—Let It Loose. (Epic)

356287. Suzanne Vega—Solitude Standing. (A&M)

356329. Randy Travis—Always & Forever. (Warner Bros.)

356501. Benson/Klugh—Collaboration. (Warner Bros.)

357079. Michael Brecker. (*Digital*—MCA/Impulse)

Classics of the 50's, 60's & 70's

138586. Bob Dylan's Greatest Hits. (Columbia)

219477. Simon & Garfunkel's Greatest Hits. (Columbia)

231670. Janis Joplin's Greatest Hits. (Columbia)

244459. Santana's Greatest Hits. (Columbia)

260638. Chicago's Greatest Hits. (Columbia)

269365. The Band—The Best Of The Band. (Capitol)

286914. Fleetwood Mac—Rumours. (Warner Bros.)

287003. Eagles Greatest Hits 1971-1975. (Asylum)

291278. The Doobie Brothers—Best of the Doobies. (Warner Bros.)

291526. Emerson, Lake & Palmer—Brain Salad Surgery. (Atlantic)

292243. Jackson Browne—The Pretender. (Asylum)

293597. Led Zeppelin—Houses Of The Holy. (Atlantic)

308049. Creedence Clearwater Revival Featuring John Fogerty/—Chronicle. 20 greatest hits! (Fantasy)

319996-399998. Motown's 25 # 1 Hits From 25 Years. (Motown)

341073. A Decade of Steely Dan. (MCA)

342501. The Byrds Greatest Hits. (Columbia)

343657. Chuck Berry—The Great Twenty-Eight. (Chess)

345157. Jethro Tull—Aqualung. (Chrysalis)

346445. Beach Boys—Made In U.S.A. (Capitol)

350645. Rolling Stones—Sticky Fingers. (Rolling Stones)

351957. Yes—Fragile. (Atlantic)

353102. Jimi Hendrix—Are You Experienced? (Reprise)

357616-397612. The Best Of The Doors. (*Digitally Remastered*—Elektra)

358887. Grateful Dead—Workingman's Dead. (Warner Bros.)

364430. Cat Stevens—Classics Volume 24. (A&M)

364935. Traffic—John Barleycorn Must Die. (Island)

365361. The Who's Greatest Hits. (MCA)

367102. Joni Mitchell—Court and Spark. (Asylum)

359075. Aerosmith—Permanent Vacation. (Geffen)

360107. Billy Idol—Vital Idol. (Chrysalis)

357350. Duke Ellington Orchestra—Digital Duke. (*Digital*—GRP)

357368. Hiroshima—Go. (Epic)

357640. Wynton Marsalis—Standard Time. (Columbia)

357657. Beethoven: Piano Concerto No. 5— Murray Perahia. (*Digital*—CBS Masterworks)

357871. Tchaikovsky: Waltzes— S. Comissiona and Houston Symphony. (*Digital*—Pro Arte)

357889. Copland: Billy The Kid; Appalachian Spring; etc.— Bernstein, NY Phil. (*Digitally Remastered*—CBS Masterworks)

358127. Kronos Quartet—White Man Sleeps. Volans; Ives; Bartok; etc. (*Digital*—Nonesuch)

358663. The Art of Alfred Brendel Volume 1 —"Virtuoso Pieces." (Vanguard)

358929. Elton John Live In Australia. (MCA)

358937. Handel: Royal Fireworks Music— Menuhin, Royal Phil. (*Digital*—MCA Classics/RPO)

359018. Pat Metheny Group—Still Life (Talking). (Geffen)

359695. Sarah Vaughn—Brazilian Romance with Milton Nascimento. (CBMA)

359711. Brahms: Piano Quartet, Op. 25— Murray Perahia, Members Of The Amadeus Quartet. (*Digital*—CBS Masterworks)

359927. Debbie Gibson—Out of the Blue. (Atlantic)

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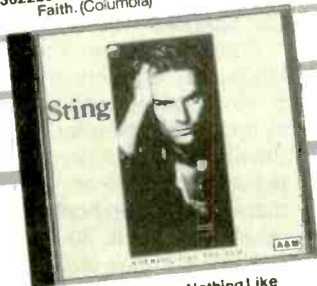
362228. George Michael—Faith. (Columbia)

360115. Bruce Springsteen—Tunnel Of Love. (Columbia)

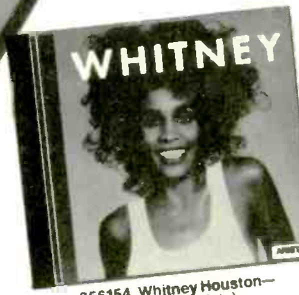


361675. Sting... Nothing Like The Sun. (A&M)

365130. David Lee Roth—Skyscraper. (Warner Bros.)

363648. The Manhattan Transfer—Brasil. (Atlantic)

366716. Robert Plant—Now And Zen. (Es Paranza)



356154. Whitney Houston—Whitney. (Arista)

366435. Tom Scott—Streamlines. (*Digital*—GRP)

361139. R.E.M.—Document. (I.R.S.)

361022. Tchaikovsky: Symphony No. 6—Claudio Abbado, Chicago Symph. Orch. (*Digital*—(CBS Masterworks)

361048. Diane Schuur and the Count Basie Orchestra. (*Digital*—(GRP)

361170. Yes—Big Generator. (Atco)

361147. Rodgers And Hammerstein's Carousel. Barbara Cook; Samuel Ramey. (*Digital*—MCA Classics)

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362251. Ahmad Jamal—Crystal (Atlantic Jazz)

362277. Neil Diamond—Hot August Night II. (Columbia)

362293. Andres Segovia, —The Segovia Collection (Vol. 1) Bach. *Digitally Remastered*—MCA Classics)

362343. Stevie Wonder—Characters. (Motown)

362541. Pretenders—The Singles. (Sire)

364018. Foreigner—Inside Information. (Atlantic)

362640. Linda Ronstadt—Canciones De Mi Padre. (Asylum)

362657. Madonna—You Can Dance. (Sire)

362665. Cher—Cher. (Geffen)

363051. Brahms: Piano Concerto No. 2; etc.—R. Serkin; Szell, Cleveland Orch. (*Digitally Remastered*—CBS Masterworks)

363655. Barry Manilow—Swing Street. (Arista)

363739. Branford Marsalis—Renaissance. Columbia)

363994. Lee Ritenour—Portrait. (GRP)

364257. Arthur Fiedler & The Boston Pops—Capriccio Italien; Capriccio Espagnol. (*Digital*—Omnda)

364885. Neville Marriner—The Sound Of The Academy. (*Digital*—Angel)

365189. James Taylor—Never Die Young (Columbia)

365247-395244. Verdi: Requiem—Muti, Phila. Or. (*Digital*—Angel)

365254-395251. Vladimir Feltsman's American "Live" Debut. Recorded live at Carnegie Hall. (*Digital*—CBS Masterworks)

365379. Miles Davis—Milestones (*Digitally Remastered*—CL Jazz Mast.)

365502. George Thorogood and the Destroyers Born to be Bad. (EMI—Manhattan)

365619. Beethoven: Symphony No. 9 (Choral) Norrington, London Classical Players. (*Digital*—Angel)

365825. Billy Ocean—Tear Down These Walls. (Jive/Arista)

366161. AC/DC—Blow Up Your Video. (Atlantic)

366393. Ricky Skaggs—Comin' Home to Stay. (Epic)

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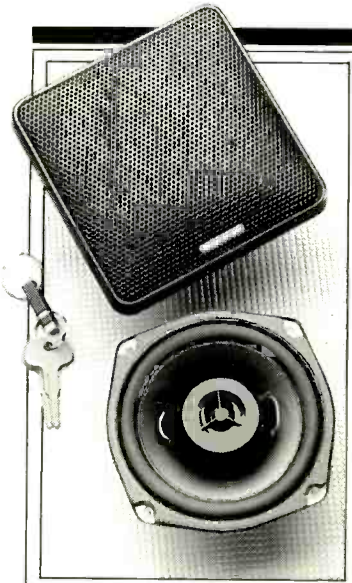
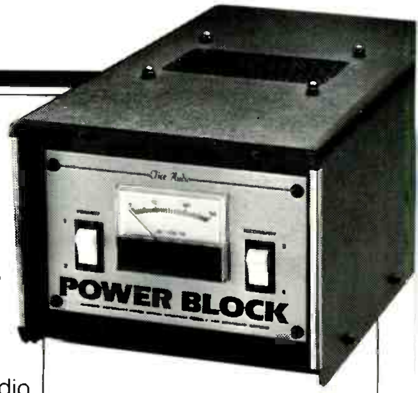


Boston Acoustics Car Speaker

A coaxial design, the Model 757 consists of a 5¼-inch woofer and a ¾-inch dome tweeter. Both drivers have weather-resistant copolymer diaphragms. Response is rated at 58 Hz to 20 kHz, ±4 dB, and power handling is 25 watts nominal, 50 watts peak. Price: $119.95 per pair.
For literature, circle No. 100

Cambridge Soundworks Speaker

The Ensemble is a four-piece speaker system consisting of a pair of satellites and a pair of low-frequency units. Designer Henry Kloss had as primary goals three parameters which usually conflict: Minimum visual and spatial intrusion into the listening room, extended bass response, and high accuracy of midrange and tweeter performance. A satellite measures 5½ × 8 × 4 inches, while a woofer is 12 × 21 × 4½ inches. Crossover is about 180 Hz, and recommended amplifier power is 25 to 100 watts. Sale will be factory-direct, at $499.
For literature, circle No. 101



Tice Audio Power-Line Conditioner

The Power Block is an a.c. power-line filter transformer specifically designed for use with audio equipment. The subjective result is stronger bass reproduction, less gritty high frequencies, and improved imaging and clarity. The overall circuit technique uses feedforward and feedback to reduce harmonics, r.f.i., power-line generated EMI, line hash, and spikes. Manually operated switches can be used to select from a variety of taps to compensate for overvoltage and undervoltage conditions, which can be diagnosed from the a.c. line voltmeter mounted on the front panel. The maker's tests show that all three types of automatic voltage regulators generate harmonics, hash, and harmonic distortion as a byproduct of their action. The unit incorporates grain-oriented, silicone-steel laminations in its transformer; uses 12-gauge wire throughout (including its own 10-foot line cord, which is double-insulated and terminates in a premium hospital-grade plug), and has six 15-ampere, nylon-face a.c. outlets for supply of power to preamps, amps, etc. The 60-lb. Power Block may also be used with video equipment. Price: $1,150.
For literature, circle No. 102

Denon Receiver

The tuner section of the DRA-425 features memory presets for 16 stations (FM or AM, in any combination) and auto scan tuning. Its amplifier section features variable loudness compensation, a liquid-cooled heat-sink, and electronic source selectors at the input terminals to reduce signal path length. The volume control is a motorized pot, allowing operation from Denon's Integral System wireless remote (included); the same remote also operates various Denon tape decks and CD players, either directly or via connections to the DRA-425. Rated power is 50 watts per channel into 8 ohms at 0.015% distortion from 20 Hz to 20 kHz. Price: $450.
For literature, circle No. 103

The Onkyo TA-RW490.
Technology with Imagination.

TO MAKE THE JOURNEY SHORTER—

For most people, the so-called dubbing cassette deck is an example of frustration in action. That's because the promised convenience is more often offset by poor results.

To correct this, the new Onkyo TA-RW490 is a fundamentally different design. Rather than follow the conventional approach of adding an inexpensive playback-only transport to an existing deck, Onkyo combined two high quality decks in one chassis. This gives the TA-RW490 performance advantages unavailable anywhere else. And gives you the benefit of uncompromised sound quality.

Each two motor, auto reverse transport can record either simultaneously or sequentially. So you can make two recordings at once. Or one continuous recording up to four hours long.

The TA-RW490 is the first dubbing cassette deck to feature Dolby HX Pro. This innovative system enhances a tape's ability to handle the extreme dynamic range that occurs when recording from today's demanding digital sources.

Two fully independent Real Time Counters show, to the second, elapsed and remaining time—particularly valuable when making dual recordings.

Additional convenience features include one touch, tape to tape standard or high speed dubbing with mic mixing, auto tape selection for proper bias and equalization, and, Onkyo's exclusive RI remote control.

The TA-RW490 proves once again that Onkyo designs components in which convenience complements quality.

It makes the journey to your music that much shorter.

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Sentrek Car Equalizer/Amp

The seven-band equalizer section of the SAQ 7200 can store up to four equalization curves in memory. A defeat switch allows quick comparison of the equalized and unequalized sound, and the display can be set so that the unit functions as a real-time spectrum analyzer. The amplifier section is a four-channel unit delivering 20 watts per channel at 1% THD. An IMX Dimensional Enhancement circuit can be switched on and off at will. Both speaker- and preamp-level stereo inputs are provided, to match all head units, and preamp-level outputs allow the amplifier section to be bypassed. Price: $184.95

For literature, circle No. 104

Blaupunkt Car Radio

The radio shown here isn't in the dash—its visible portion is on the control stalk, with its other circuits hidden. The stalk of Blaupunkt's Dallas SQM 88 can be bent towards the driver or passenger, and the pocket-sized control head can be removed. The design of the Dallas also leaves the dash slot free to hold a tape player (as shown) or a CD player. Features of the radio include 15 FM and 5 AM presets with preset scan, C-QUAM AM stereo, scan tuning, Dynamic Noise Reduction, inputs for two auxiliary audio sources, separate tone controls, and a clock. The four-channel amplifier that comes with the unit delivers 14 watts per channel at 1% THD. Price: $389.95.

For literature, circle No. 106

Recoton Cordless Speakers

The Wireless 100 speaker system broadcasts stereo sound from room to room via a.c. power lines. The system includes one pair of self-powered speakers which plug into any a.c. wall outlet, and a transmitter which connects to any audio system with output connections. Additional speaker pairs are available for multi-room listening. Designed by Larry Schotz, the system uses proprietary noise-reduction circuitry to reduce line-borne interference from other home electronics and appliances. Other audio facilities include 12 watts of amplifier power per channel, response-shaping equalization, a muting circuit that operates when no signal is being received, and a master volume control for each speaker pair. The speakers can be wall-mounted using optional brackets. Price: $269.95; extra speakers, $219.95 per pair; wall brackets, $19.95 per pair.

For literature, circle No. 105

EDWARD TATNALL CANBY

ONE-POINT OF VIEW

Ever since my visit to Denon's 1986 Gustav Mahler recording session in Frankfurt, Germany, I have been having second and third thoughts about stereo miking. There is an increasing new ferment in that area, indicating, perhaps, a slow reversal from the current and almost universal "one-point" or coincident stereo miking, which sacrifices the valuable musical perceptions of out-of-phase information between channels, in order to avoid a host of technical troubles that can plague us in just about any of the established stereo media. But there is technological change, some of it drastic, as we know. And the real values in the wider separation of stereo microphones persist and are remembered. Yes—there are the experimenters, too, the inquiring minds who will not let such a good thing, any *possible* thing, go untried. That's what I mean by a "ferment."

You may remember that Denon makes a big point of its "one-point" technique for Mahler's huge music, the main mike array abetted by "assistant" mikes rephased to eliminate the factor of distance. As I observed this setup in a very large hall, I thought that I saw not a single compound mike but, rather, two units mounted perhaps a foot or more apart. I may have misjudged this, but in such a large hall, a foot-wide array could be called a "point," as a basketball in a stadium. Nevertheless, even a foot of noncoincident separation could have an interesting impact on the sound. Through phones, it would rate as hyperbinaural, wider than the spread of two ears. Through loudspeakers, it might add a lively touch of out-of-phase information. Hopefully, that was the intention.

As any audio man knows (and most consumers don't), there are two apparent types of perception in our stereo listening, volume and phase. The most basic of these is the perception of multiple phase differences, tiny differences in time of arrival at the ears, because this makes the other possible—the selective pinpointing of volume differences whereby we can sense directionality, right across our stereo "stage," from side to side. The volume proportions between each channel, selectively, element by element, are what does it. Switch to mono, and you can see how it works. The two speakers now radiate the same signal, no inner differences. You hear a central blob of sound, and if you slide your balance fader sidewise, that blob moves, too, from side to side and all points between. In coincident stereo, with two mikes (via various different arrays) essentially in the same place, but sharply aimed to each side in order to emphasize volume differences, we hear all those positions at once, and even the spread of liveness or room ambience which surrounds the music.

Photograph: David Hamsley

Why bother with recorded phase differences when the microphones are actually spaced apart so that arrival times at these two microphones are quite different?

Those multiple phase differences, if & when, do not really do much for specific directionality. It is the relative volume that does that job most exactly. So why discuss phase at all?

Well, very few of us do, in all truth. Phasing is the well-known sleeping dog to let lie, if you follow me. Forget it. Coincident by-the-volume stereo is remarkably good, and never more than now—nor can we forget that "one-point" has other important attributes going back to mono days. The theory even then was that in every hall or "venu," as they say, there is theoretically one ideal point, above and out in front of the (classical) music, that is optimal for balance between the musical instruments or voices and, even more important, between the direct sound to the mike and the surrounding reverberation or ambience. Indeed, once found, that point proverbially (and in truth) seems to jump out at you with astonishing realism. It was no old wives' tale but a real phenomenon (ask Bert Whyte!) which you may remember from the famous Mercury mono LP recordings.

Now, as Denon made very clear, that same effect is embodied in their "one-point" two-channel stereo mike array, and for the same good reason. (We all know about the contrary technique that swung away from the single mike, multi-mike mixdown. It had its values, too, and still has them, but that is another subject.)

What, then, does the stereo *separation* of microphones do for stereo listening? (Those tiny phase differences—tiny even though to a lot of audio equipment they are all too enormous.) Not specific directionality. *Ambience*.

That is the memorable result, and once heard it is not forgotten. An instantaneous, startlingly realistic room sound that is, in fact, essentially what you hear in a live situation. You can almost move your head quickly and follow the bouncing reverberations, this side, that. Not easy to describe in words! But it is, in its own unique way, a priceless asset in the reproduction of sound.

We do get a bit of that direct phase ambience in many current recordings, but only because they are not rigorously one-point. Even a little bit helps; the recording simply sounds better, more immediate and realistic. Indeed, it is a tantalizing, tempting thing! Every re-

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**Did you know?
All out-of-phase stereo voice cancels when played in mono; the two signals simply combine.**

cording engineer wants his product to sound its best, after all.

With care, and good equipment all the way, you can indeed use a wide separation of stereo microphones, and, in fact, that sort of array was regularly employed in most early stereo and sporadically right on up through the years. You do risk trouble, in LP cutting, in playback, in broadcasting and so on. Ingenuity, all the way, can get around a lot of it if the will is there—and the desire.

We must understand that this business of liveness, reverberation, and ambience has been a part of most music for centuries and became very much a part of electrical recording around 1925, when sound engineers (and record producers as well) first began to realize that a "live" sound was musically nicer than the dead sound of acoustic recording. Minus electronics, the old recording horn could not hear ambience.

Performers were necessarily very close and very loud. Listen to any old disc of that sort, and you will see. Curiously, the early electrical recordings with microphone are *still* dead; it had not occurred to anybody to try anything else. (Even the pictures show curtained and soundproofed studios, the normal rule of the time.) From the early recordings onward, the microphone was given an ever more "live" sound as the values of ambience were better understood. Even so, the best classical recordings of the 1930s sound to us relatively dead. The attributes of hi-fi—sharper, clearer definition, lower noise and so on—made still more ambience desirable. Well before stereo, with the "one-point" mono technique, we had reached an early optimum. So you can see that liveness, spatial ambience, is not *necessarily* dependent on two-channel phase differences.

Nature has a habit of being redundant, in the computer sense as well as digital coding for audio. Natural perceptions are always compound, different aspects of "signal" reinforcing each other, different senses working strictly together, rather than separately. You can believe that directional hearing is immensely sharpened by directional sight! You see it, you hear it, it's there. But, luckily for modern entertainment electronics, we can get along well even when some of the natural signals are missing, like the 1934 16-cylinder Cadillac running on 15 cylinders. Indeed, we seem to thrive. As per my recent comments, we can go even further. We can wonderfully learn to take contradictions between our senses, between what we imagine and what we *know*, as in the portable concert hall in your automobile. So we have, indeed, been able to appreciate the sound of musical ambience even without the benefit of stereo to enhance it. We really did wonders, and the realization that so much could be so well achieved without stereo (and hence without the technical phase problems) gave a great and much deserved boost to most high-quality recording. This is the background of coincident stereo.

What technical phase problems? Read the technical journals, please, if you are not familiar with them in your own pro audio experience. I give but two easily assimilated examples. On stereo LP, the out-of-phase information appears as vertical grooving. The mono or "same" elements between the two channels are lateral cut, just as in the old mono disc. There are all stages in between, of course, from zero difference to 180° opposite. A hefty, big bass note that is highly out of phase as recorded (from different points in space) can be lethal. Loud lateral (mono) grooves can be spread out to make room for violent sidewise stylus movements, but a whopping vertical cut, if it can be cut, has nowhere to go but up or down. Many a tortured stylus has thus bounced out of control, pushing the next groove at the bottom, hopping into the air at the top. Big sounds out of phase are anathema to the working disc cutter, and to heck with that wonderful ambience effect.

Moreover, as we all ought to know, a stereo voice recorded out of phase tends simply to cancel out when the two signals are played mono. What, you want the stereo Michael ("I'm bad!") Jackson faded to nothing on a million mono players and radios just because he's *out of phase*? A fine excuse *never* to explore the beauties of variable stereo phasing. Even though the microphones aren't bothered a bit, nor most of our separate circuitry, nor your loudspeakers nor, most important, your ears!

That's the psychology of it. In stereo, the coincident system offers the kind of rock-solid guarantee that big biz wants and needs.

The truth is that coincident stereo is actually multi-point mono. With all its virtues, it lacks the ultimate and best value of stereo sound, sacrificed as an all-out protection against problems that often *can* be solved.

I suppose that because radio has the most devious problems in respect to phasing between stereo channels—and because it has had the law after it, too, for so many years—it is the most institutionalized medium in respect to coincident stereo. After so long, since the '60s, the original necessity to do *something* about the phase problem has solidified like a layer of geological sediment into the hard sandstone of Procedure. On Public Radio, it seems, coincident stereo is mandatory for all its operators, and there are even work seminars for the engineers to make certain the rules are followed. (More on this later.) Recording companies, I suspect, follow the coincident route on a somewhat more aesthetic ground; they are convinced that it is the right answer for optimum sound, problems or no.

And yet, there are always those questioning minds, the experimenters, the gadgetmen, who want to try a thing just because it is *there*. Many audio people know that phasing effects can be intriguing in stereo, so why not try, just for fun? Moreover, technical advances have made this a lot more interesting in two basic ways: First, ever greater ingenuity gets ever closer to eliminating or reducing the familiar problems—witness Shure's series of "trackability" test LPs, each one getting more demanding than its predecessor. Second, the gradual retirement of the LP and, likely, the audio cassette (in favor of the much superior DAT)—the general advance of digital everywhere—goes a long way to deflate the problems' importance.

It's simple. We are closer, day by day, to being really able to use more phase contrast in our recording. And that inevitably means we will. Somebody will, anyhow. Multiple mono is just not *quite* good enough. **A**

KEN POHLMANN

CHOMPING UP THE BITS

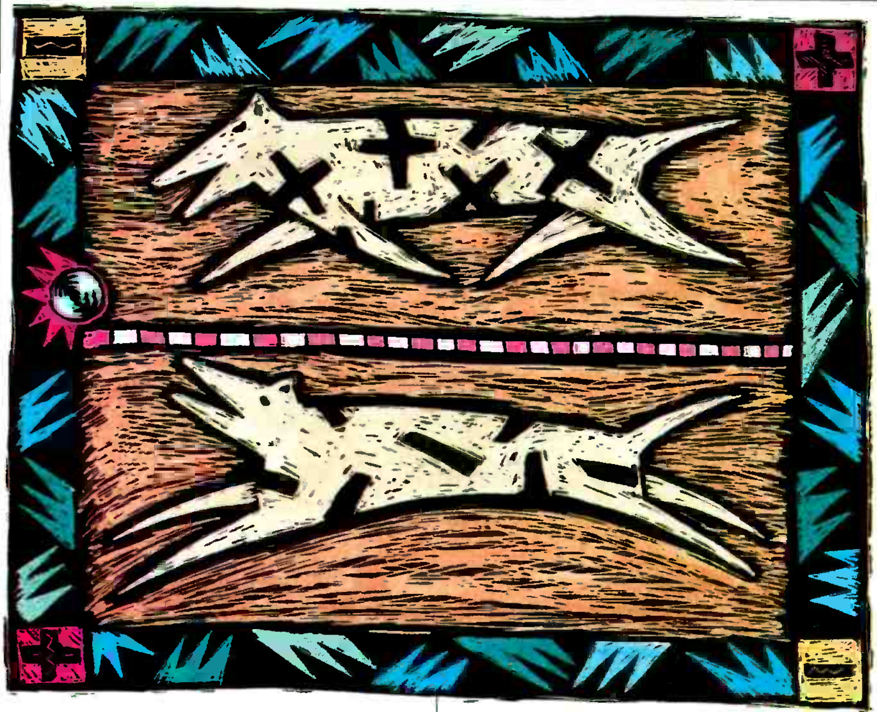


Illustration: José Ortega

Now that we've had conflicts in the Persian Gulf, Afghanistan, the West Bank, and the pool area of my condominium, it looks like the next trouble spot will be in CD player design. Specifically, the configuration controversy surrounding the digital-to-analog converter (D/A) is heating up fast.

However you configure them, D/As represent a weak link in the signal chain; they are not always good at generating the analog voltages which represent the digital words read from the disc. In particular, low-amplitude distortion is sometimes introduced because, simply, 16-bit converters are not ideal for reliably converting 16-bit data.

The problem is understandable. A 16-bit D/A must determine which of its 65,536 output analog voltages corresponds to the input digital word, and it has perhaps 20 µS to make up its mind. (This could make for a very challenging game show.) Several problems can interfere with that decision. For example, the distance between steps may not be exactly equidistant; that would lead to nonlinearity in the conversion. One solution is to use a D/A converter that can handle more than 16 bits. An 18-bit D/A, for example, would have 262,144 output levels, exactly four times as many as a 16-bit converter. Any nonlinearities from an 18-bit converter would therefore be correspondingly smaller, and the sound from a CD player using it would be theoretically better. In other words, an 18-bit converter would give a better 16-bit conversion. Out of this reasoning, the quest for more bits' worth of conversion was born.

Yamaha was the first to rock the boat, with a "Hi-Bit" system that offers 18-bit resolution using 16-bit D/As. The system, sometimes called quasi-18-bit, works something like this: Thanks to the multiplication going on inside a digital oversampling filter (which precedes the D/A), words longer than 16 bits are output at an oversampled rate. In the Hi-Bit system, 18 bits from the filter are wired through switches to two 16-bit D/A converters (one for each channel). When all 16 bits are being used to convey a signal (as is the case when signal amplitude is high), the upper 16 bits are applied to the 16-bit converters, as usual. When signal amplitude is low, the two upper bits from the oversampling filter are not being used to convey information; hence, the 18 bits are shifted upward so that the unused bits are ignored, and the 16 lower bits are decoded instead. Through bit-shifting, a 16-bit converter may thus handle an 18-bit input. When the lower bits are shifted up, the output amplitude increases. To compensate for the shift in amplitude caused by shifting bits, the gain of the signal is reduced whenever the lower bits are shifted in. An attenuator downstream of the D/A handles this chore. The result of all this: An increased S/N ratio.

Of course, Yamaha's competition wasn't far behind. Technics has stepped in with a CD player conversion system employing no fewer than four digital-to-analog converters. They call it their "4-DAC 18-Bit High Resolution System." It too is intended to provide a cleaner conversion of a CD's 16-bit output than any single 16-bit converter alone could provide.

As with the Yamaha system, digital oversampling filtering and 16-bit D/As are employed, as well as bit-shifting. However, in this design two D/As are used per channel, one for the positive half of the bipolar analog output waveform and one for the negative half. The reason for this (and the reason underlying any move toward more converters or more bits) is the desire to improve low-amplitude resolution. In this case, the design specifically addresses a problem known as crossover distortion.

This has always been an obstacle in reproducing low-level signals. Crossover distortion occurs at the zero-crossing point between the positive and negative halves of the waveform; as polarity changes, the converter must switch all of its digits instantaneously (from 0111111111111111 to 1000000000000000). To accomplish this, an internal network of laser-trimmed resistors must be switched, often with a slight crossover glitch. That glitch is particularly troublesome when the player is reproducing low-level signals because it's of fixed amplitude and is thus proportionally larger with respect to such signals. To remove the glitch, some manufacturers go to extreme lengths, such as the hand-tweaking of each D/A converter. Crossover distortion can also be alleviated by providing a D/A for each waveform polarity; in that way, the dreaded total switching of digits never occurs within a single D/A converter. Of

The AR Expert

Name: Alex Barsotti
Occupation: Teledyne Acoustic Research's National Service Manager
Years with Teledyne Acoustic Research: 21
Objective: To service the customer

(Editor's note: We interviewed Alex to find out how Teledyne Acoustic Research excels at serving their customers)

Q. Alex, what is your position at AR really about?
A. Customer satisfaction. I do everything I can to keep dealers and customers satisfied with AR products.

Q. You mean repairing speakers, electronics?
A. Yes, but there's more. It goes beyond the typical Service Department framework.

Q. Explain "goes beyond".
A. Actually, my day encompasses much more than the "fix-it" problems. I usually spend most of my time answering questions.

Q. Questions — what kind?
A. I think the most common questions asked by consumers are what amplifier should I use or how much power do I need or what speaker is best suited for my own listening.

Q. So what do you tell them?
A. What we try to do is to get a feel from the customer as to what kind of music he or she prefers, what kind of room environment the product will be used in, what kind of listening habits. And from that we try to give a guideline on how to choose an amplifier, what to look for in an amplifier according to what the listening habits are. Often they will call and ask which speaker should I buy. That's not an easy question to answer because there are so many different factors involved in choosing a loudspeaker.

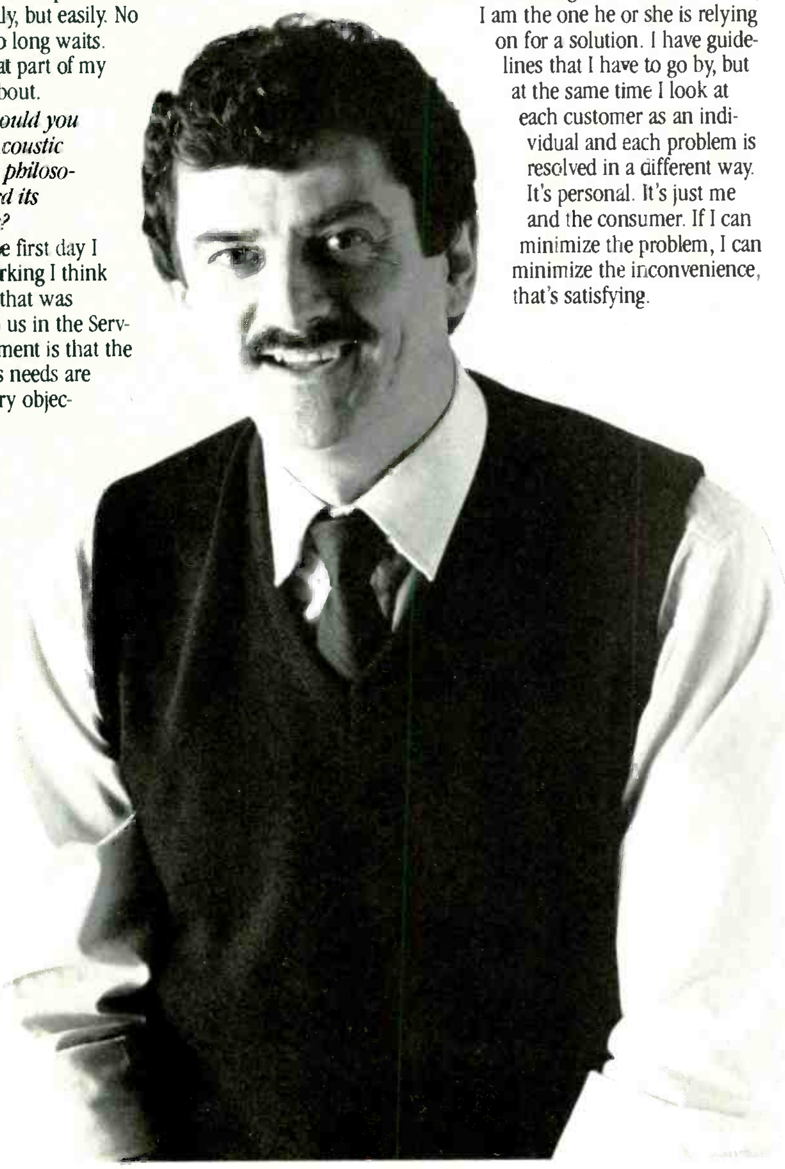
Q. So you help the customer think about the things he has to consider before he can make a decision?
A. That's correct. We really try not to suggest a specific amp or a specific loudspeaker, but give them options so that when they go into a store they know what they should look at. For instance, a floor model versus a bookshelf. Most customers have no idea that a loudspeaker designed to be on a bookshelf might not be suited to being on the floor and vice versa. We try to find out their listening habits — do they like mellow sound or more contemporary music? Do they listen at high volumes or background levels? From this information we can give accurate advice. Other questions asked are what the difference is between loudspeakers, not only within our own current line of loudspeakers, but also the difference between AR and some other company. You can look at specs and you can detail features of a product, but I think the bottom line is that you have to *listen* to it. We try to advise the customer to listen to a few types — two or three models. A loudspeaker is like anything else: you have to choose the one suited for your own listening criteria. We recommend how they should listen. If they have a favorite recording, to take it with them, something they are familiar with and use that to audition the different models of loudspeakers with the same recording.

Q. Aside from answering these questions, what is the most important thing you think you do for your customers?
A. Provide service — fast and easy. When you own a product and something goes wrong with it, you want it repaired not only quickly, but easily. No hassles. No long waits. That's what part of my job is all about.

Q. How would you describe Acoustic Research's philosophy toward its customers?
A. From the first day I started working I think one thing that was stressed to us in the Service Department is that the customer's needs are our primary objectives. In fact, Acoustic Research was the first company to give a 5-year "full" warranty on performance.

Q. What does the AR warranty cover?
A. The AR warranty for loudspeakers is a 5-year full warranty. Full warranty means that for 5 years from date of purchase, we not only guarantee our product will not fail, but will perform within ± 1 dB of the original specs.

Q. Alex, would you summarize what are the most satisfying parts of being Service Manager for Teledyne Acoustic Research?
A. In the morning, when I arrive at work, I never know what to expect. I have to deal with different problems; I have to deal with different situations. I think the most gratifying thing is when someone comes to me with a problem, I am able to solve that problem. Because when the customer gets in touch with me, I am the one he or she is relying on for a solution. I have guidelines that I have to go by, but at the same time I look at each customer as an individual and each problem is resolved in a different way. It's personal. It's just me and the consumer. If I can minimize the problem, I can minimize the inconvenience, that's satisfying.



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Using four converters and an extra two bits pays off with low-level signals, which make up the greater part of most music.

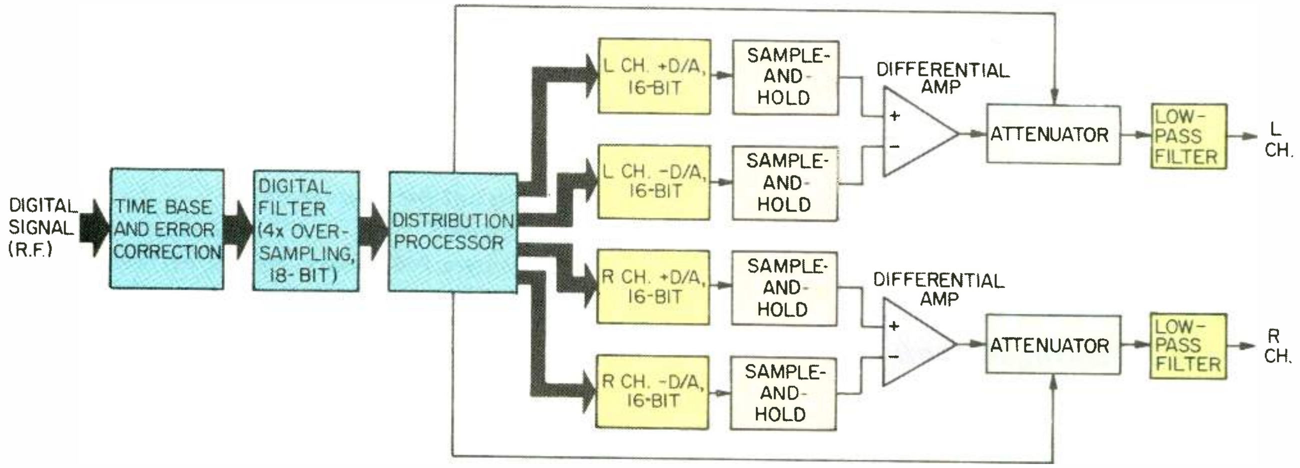

Fig. 1—Block diagram, Technics 4-DAC CD player. Note the use of separate D/A converters for each half of the signal waveform and bit-shifting (with subsequent attenuation) to get 18-bit resolution from 16-bit D/A chips.

course, this does mean that the digital signal must be split between the two D/As, but an upstream processor chip can handle the switching digitally, in glitch-free fashion.

Let's consider the circuit's signal flow, as shown in the block diagram of Fig. 1. A four-times oversampling filter outputs 18-bit words to the distribution processor, which directs the appropriate portion of the waveform to the correct D/A. A sample-and-hold circuit compensates for aperture error (a slight high-frequency roll-off) in the analog output. The two waveform halves are joined at the output by a differential amplifier. An attenuator compensates for the gain change caused by shifting, and a low-pass filter provides final attenuation of supersonic components.

The circuit operates similarly to Yamaha's bit-switching design. When the signal is of high amplitude, there is little motive to jump through hoops for greater low-amplitude resolution, so there is no bit shifting, and straight 16-bit conversion takes place. Both the positive-half and negative-half D/A converters in each channel reproduce the entire waveform, and their outputs are combined in a differential push-pull mode.

When the signal drops below −12 dB, the 4-DAC circuit gets serious. First, it reads the most significant bit (MSB). If the value of the bit is high, the word has positive polarity, and thus it is directed to the positive-polarity D/A converter. Likewise, if the MSB is low, the negative-half D/A gets the word. Also, when the signal is below −12 dB, the second most significant bit ceases to change; it will then always be low when the MSB is high, and high when the MSB is low. Because these two bits are spoken for, the word sent to the 16-bit D/As may be shifted down two bits. The D/As thus receive bits 3 through 18. Since the gain of the signal increases when bits are shifted, the attenuators are switched in to proportionally reduce gain.

Significantly, in this system the 17th and 18th bits from the oversampling filter have been utilized in reproducing the waveform, instead of being truncated and thrown away. Moreover, because dual D/As are used to convert the bipolar waveform, crossover distortion has been avoided. Together, these benefits pay dividends when reproducing low-level audio signals.

In fact, next time you listen to music, take a look at a VU meter. You'll observe that most music spends the greater part of its time below −12 dB. In other words, the benefits of the 4-DAC system are usually present. Straight 16-bit operation occurs only at high levels, usually of brief duration, when the amplitude of the waveform largely masks converter nonlinearities anyway.

In all, the 4-DAC design, used in tandem with quasi-18-bit technology, is a good approach to resolving the problem of nonlinearities in CD players' 16-bit converters. Of course, with recent advances in chip technology, true 18-bit D/A converters are now being produced and are appearing on the market in a growing number of CD players. All this activity is evidence of greater concern about this hitherto-overlooked weak link in the design of CD players.

So, how do CD players equipped with the 4-DAC system perform? Does this attention to two extra bits make any difference sonically? I'll leave the answers to those questions up to Len Feldman, *Audio*'s resident evaluator of CD players. I love it when he gets me off the hook.

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BERT WHYTE

RESEARCH AND YE SHALL FIND

The B & W loudspeaker company has always been research oriented, and they established one of the world's most advanced loudspeaker research laboratories at their Worthing and Steyning headquarters, in England. In 1979, after pioneering laser interferometry for motional and vibration analysis (plus advanced concepts in computer-assisted design), B & W introduced the Model 801 monitor loudspeaker.

The Model 801 was very well received, and it quickly gained widespread use as a reference monitor by most major record companies. Several years later, as a result of further research, the 801's original wooden housing for the midrange/tweeter drivers was replaced with Fibrecrete, a fiberglass-reinforced concrete that was extremely rigid and free of resonances. This version of the Model 801 became virtually the standard monitor for all classical music recording.

The Fibrecrete head assembly was a prime example of B & W's preoccupation with the degrading effects of resonance coloration in loudspeakers. No other company has so diligently pursued the demons of resonance, nor devoted so much research to its suppression and elimination. Years of research into anti-resonant loudspeaker enclosure construction peaked in 1986, when B & W introduced its Matrix System enclosure technology. (I described this in the September 1986 issue, and, after a visit to the B & W research laboratories, elaborated on it in the June 1987 issue.) Essentially, the Matrix construction uses a honeycomb structure made of lightweight—but extremely rigid—material, which is bonded to the interior panels of the enclosure. The interlocking vertical and horizontal elements of the Matrix honeycomb result in an enclosure of near monolithic rigidity.

At the 1986 SCES, B & W introduced the Matrix 1, Matrix 2, and Matrix 3. These three loudspeakers were the first to employ this new enclosure construction. And then in 1987, with appropriate fanfare, B & W debuted the Model 801 Matrix Series 2 loudspeaker. This was not just an update of the original 801 design with the Matrix enclosure, but a reworking and refinement that also incorporated new technology. Gearing up for production of the new loudspeaker was quite an undertaking—and quite time-consuming. After considerable pressure from professional users of the 801 Matrix, B & W is now in full production of the unit. The company is beginning to fill the dealer pipeline, and reviews of the 801 Matrix are starting to appear in various publications. I have been living with a pair of these speakers for some months now, and it would be putting it mildly to say that I am impressed with their performance.

The 801 Matrix is 39¾ inches high (about 4 inches taller than its predecessor), 17 inches wide, and 22 inches deep. Except for a vent port directly underneath the bass driver (some wags have dubbed it the "keyhole monitor"), the speaker looks almost identical to the original 801. The bass enclosure still has a volume of slightly more than 100 liters, but the acoustical foam that fills the internal honeycomb provides an acoustically larger volume. The Matrix is bonded to high-density particleboard panels that are over 1 inch thick. Doppler and speckle laser interferometry measurements of this bass enclosure reveal virtually no panel re-radiation. The 12-inch bass driver, the result of computer-aided design, is entirely new. The cone is a specially formulated homocopolymer, which provides good piston action without nodal breakup. The design of the speaker baskets are based on B & W's laser velocimetry and accelerometer studies. The design calls for a 13-pound magnet providing 13,000 gauss. As with all B & W drivers, these bass drivers are manufactured "in house."

In spite of CAD and other highly sophisticated measuring equipment, B & W engineers were unable to design a midrange driver superior to the 126-mm, Kevlar-diaphragm driver of the original 801. However, the 801 Matrix tweeter is an entirely new design. It has a 26-mm metal dome, the curvature of which was derived by finite element analysis. (A large number of short, curved finite elements of the dome were studied for various performance parameters, and the cumulative data was used to design this dome.) The new tweeter uses a large nickel-cobalt magnet, and its high-frequency response is stated as being −6 dB at 40 kHz. The crossover networks, also the result of CAD, are fourth-order Bessel, with crossover points at 380 Hz and 3 kHz. The crossover is designed to permit bi-wiring, thus reducing intermodulation arising from common ground paths between mid- and low-frequency filter sections. Biamplification is possible, but it is advisable to use identical amplifiers for the bass and midrange/tweeter inputs. Most high-quality power amplifiers do not have level controls, so using dissimilar amplifiers for bass and mid/

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Imaging and presentation of depth, strong points on the original 801, are considerably enhanced in the 801 Matrix.

high would be problematic, even if they had the same power output. All drivers are protected by Audio Powered Overload Circuitry (APOC), and an external bass-alignment filter is provided. With the vented system, this gives a sixth-order Butterworth alignment that affords a low-frequency response of only −3 dB at 19 Hz! The sensitivity of the speaker is listed as 87 dB for 1 watt at 1 meter (some 3 dB more efficient than the original 801), and it has an impedance of 8 ohms. At 95 dB SPL, third-harmonic distortion is rated at 0.5% from 20 Hz to 20 kHz. With the external bass-alignment filter utilized, frequency response is specified as 20 Hz to 20 kHz, ±2 dB. The speaker is rated for power handling of up to 600 watts, but this is academic with APOC protection. Obviously, the 801 Matrix is a high-tech speaker on the cutting edge of the art. It boasts some very impressive specifications. But the question, as always, is: How does it sound? In its reproduction of recorded music, how accurate is it, how close does it come to simulating the live listening experience?

There are several items to consider in auditioning the B & W 801 Matrix loudspeaker. First, always keep in mind that this is a monitor speaker. As such, the record companies which use it are principally concerned with its accuracy. For example, Decca Records, in London, has more than 30 801s which they use to monitor while editing, mixing, cutting, transferring tape, mastering CDs, and a host of other things—all of which demand repeatable accuracy of reproduction. The same holds true for Decca's classical recording sessions. The engineers want musical verity, not a "glamorized" sonic presentation full of euphonic colorations. The message for audiophiles or music lovers is the same—the 801 Matrix Series 2 is a highly accurate loudspeaker that will clearly reveal the good points of all the equipment and recorded source material, but it will likewise ruthlessly expose their shortcomings as well.

I can state emphatically that all associated audio components must be of the highest possible quality if one wants optimum performance from these $5,000 per pair loudspeakers. The 801 Matrix is absolutely intolerant of sonic artifacts. For example, a moving-coil phono cartridge with an exaggerated high-frequency response will surely assault the ears! It would be difficult to appreciate the well defined, extended, nonresonant bass response and the tremendous dynamic capabilities of this speaker with a low-power, low-current drive amplifier. Since distribution and marketing for the loudspeaker is fairly broad, it can be found in dealer shops that hardly qualify as "high end." In some cases, dealers will team the 801 Matrix with a receiver, preamplifier, or power amplifier of limited performance to offer a more "salable," less pricey package. But the 801 Matrix is unlikely to impress a truly discriminating listener under these circumstances.

My evaluation of the 801 Matrix was rigorous. I listened to a great many technically and musically demanding CDs and LPs. I auditioned the speaker with both tube and solid-state amplification. I also used the Sony CDP-705ESD and Denon DCD-3300 CD players, and a Sony DTC-1000ES R-DAT recorder. The digital coaxial output of these units was fed into an advanced digital processor, an American product which is the brainchild of scientists and engineers at Medea, Ltd. This processor, which will be demonstrated at the upcoming SCES in Chicago, is the breakthrough device that will finally make digital audio not merely acceptable to the "digiphobes" and vinyl aficionados, but actually their preferred medium for recorded music. It is an 18-bit linear system that permits sampling of CDs at 2,822,400 times per second and of R-DAT at 3,072,000 times per second. In other words, 44.1k and 48.0k, respectively, at 64 times oversampling! At these super-fast sampling rates, there is no analog filter. "Brick-wall" filtering is gone, so there are no measurable high-frequency spuriae. The increased resolution, transient response, ambience recovery and presentation, enhanced bass response, and dynamic range are something you simply have to experience to believe. (One example: A violent, high-level gunshot on a Compact Disc very obviously distorts the conventional 16-bit, 4× oversampling of the Sony and Denon CD players. With the Medea's 64× oversampling, the gunshot is clean, sharp, and free of distortion.) The Medea processor will not be inexpensive, but it will be a landmark product.

The Medea outputs unbalanced or balanced lines to the high-level input of a preamplifier. For my tube setup, I used conrad-johnson's Premier 3 preamp and Premier 5 monoblock amplifiers rated for 200 watts/channel. The solid-state electronics I used was Mark Levinson's Cello system (described in the March 1988 issue), which includes the Audio Suite preamp, the Audio Pälette, and Performance monoblock amps.

I bi-wired the 801 Matrix speakers (with Path cables) from a second set of output terminals on the Cello amplifiers. Bi-wiring necessitates the laborious removal of the crossover network cover on the bottom of the speakers and then removing a tiny pair of jumper wires from the bass and mid/hi sections of the network. Without the external bass alignment filter, the speakers reproduce bass frequencies fairly flat down to 28 to 30 Hz. Bass drums, tympani, contrabasses, and organ pedals are well reproduced but lack weight and impact. The bass alignment filter can be installed between preamp and power amp, or in a tape loop. I feel that the use of this filter is somewhat source-dependent and therefore recommend that it be installed in the tape loop. If you are going to play organ music, Gustav Mahler, or anything containing heavy bass drum passages, you can very easily bring the filter into action with a flip of the tape monitor switch. Otherwise, the filter isn't really necessary for a great deal of music.

The 801 speakers were set up about 8 feet, on axis, in my new listening room. This room was acoustically treated by Dr. Peter D'Antonio with Abffusors and Diffusors that use his Reflection Phase Grating techniques. I think I can safely say that I auditioned the 801 Matrix speakers with electronics of outstandingly high quality in an acoustically controlled environment.

My first impression of the 801 Matrix speakers was that none of the desirable characteristics which established the reputation of the original 801 have been in any way changed or compromised. Quite the contrary, imaging and


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With B & W's 801 Matrix, the direct sound reaches your ears without the time-smearing effects of panel radiation.

the presentation of depth—both strong points of the original model—have been considerably enhanced. Because of the solidity and anti-resonant properties of the Matrix enclosure, the new speaker has even more specificity of imaging.

One of the most admired qualities of the 801 was its nearly three-dimensional sound field. In the new 801, there is virtually no panel re-radiation. Therefore, the direct sound reaches your ears without the time-smearing effects of panel radiation. The result is incomparable stereo imaging. The 801 Matrix has an almost palpable, broadly panoramic sound field. A symphony orchestra is presented in layered depth, and with quite precise localization of instruments. On well-balanced recordings, the speakers seem to disappear. And in an RPG room, you have the uncanny effect of being in a performing hall, of sharing the acoustic space with the orchestra. The illusion of reality is further heightened by the ultra-clean, highly defined, and wonderfully articulate sound—a consequence of the lack of resonant coloration. The pizzicato of contrabass is notably clean, harmonically correct, and free of any overhang. Bring the bass filter into play, and you can easily ascertain the frequency to which the drum is tuned. You can feel its weight and impact, unsullied by boomy coloration. The new tweeter provides lightning-fast transient attack. Piano notes are never smeared, and all manner of bells, chimes, and cymbals are sharply delineated. With a suspended cymbal, heavily struck with a wooden stick, you can hear the metallic click of the stick just before it explodes in a shower of shimmering harmonics.

Needless to say, there is a distinct advantage in listening to one's own recordings. I played several of the recordings I had made for Everest: Aaron Copland conducting "Billy the Kid" and Leopold Stokowski conducting Shostakovich's Fifth Symphony. What a pleasure it was to hear all of the instruments properly localized, and to hear the distinctive acoustic signatures of the halls in which I recorded them. What a pleasure to be able to listen to the clear delineation of dense, complex, orchestral textures. The 801 Matrix did full justice to the thunder of the 32-foot pedals on my Virgil Fox organ recordings.

The spectral balance of the 801 Matrix is quite smooth, from top to bottom. A great recording with which to demonstrate this balance is the Nimbus CD of Mahler's song cycle, "Des Knaben Wunderhorn (The Youth's Magic Horn)." Recorded in 1966 by engineer Allen Stagg, it features the great mezzo, Janet Baker, and baritone Geraint Jones; Wyn Morris conducted the London Philharmonic Orchestra. The recording is analog, of course, and was highly praised in 1966 for its sonic realism and natural perspective. Listening to it on the 801 Matrix is a revelation. You are literally engulfed in the huge

When teamed with the best components, the 801 Matrix is unfailingly accurate; it will not falsify, degrade, or glamorize musical values.

sound field. The opening section of the first song, "Revelge," has a huge bass drum, tuned to about 32 Hz. On these new speakers, you can feel the wavefront rolling toward you, but it is not at all boomy, which you might expect from many loudspeakers. The voices of both the soprano and baritone are rock-solid, centered as a phantom image between the speakers. In the three-dimensional sound field of these speakers, these voices seem very real—their voices are at exactly the right height, as if they were standing right in front of you.

For demonstrating the accuracy of the B & W 801 Matrix and its ability to resolve very complex, harmonically rich musical textures, another fine recording is the Villa-Lobos "Bachiana Brasileira No. 1" (Delos DCD-3041). A veritable forest of 24 instruments, it features The Yale Cellos of Aldo Parisot. Here we have a rich, resonant sound along with superb ensemble playing, yet the timbres of individual cellos are easily discerned. The size of the recording space is clearly defined, and the placement of the performers in that space—laterally and in depth—is equally easy to perceive. The third movement of the Lutoslawski "Concerto for Orchestra" (Delos DCD-3070) opens with a barely perceptible pizzicato string bass. The ability of the 801 Matrix Series 2 to reveal low-level detail is shown in the timbre and tonality of this plucked bass. Conversely, the dynamic expression of the loudspeaker is dramatically conveyed by the visceral "whump" of the 48-inch concert bass drum that is heard at the beginning of Lutoslawski's moving work.

A very good idea when auditioning these speakers in a dealer's showroom is to take some London/Decca CDs with you. The majority of the classical music on these discs was recorded with the speakers used as monitors. Telarc also uses the 801 to monitor many of their overseas recordings. A good example is their wonderfully atmospheric recording of the Vaughan Williams "London Symphony No. 2," with André Previn conducting the Royal Philharmonic Orchestra (CD-80138). Note how well the 801 Matrix loudspeaker handles the very wide dynamic range and heavy bass transients of this work.

In general, these speakers are capable of handling the dynamic range of any CD you might encounter. I have deliberately played them at grossly larger-than-life levels without activating the APOC protection system. The 801 Matrix will play any kind of music in its proper scale and proportion. It is unfailingly accurate when teamed with the best associated equipment. It will also give you musical truth; it will not falsify, degrade, or glamorize musical values. All things considered, the 801 Matrix has to rate as an exemplar of uncompromised and honest speaker design—a most fitting memoriam for B & W's founder, that great and gentle man, John Bowers. ▲

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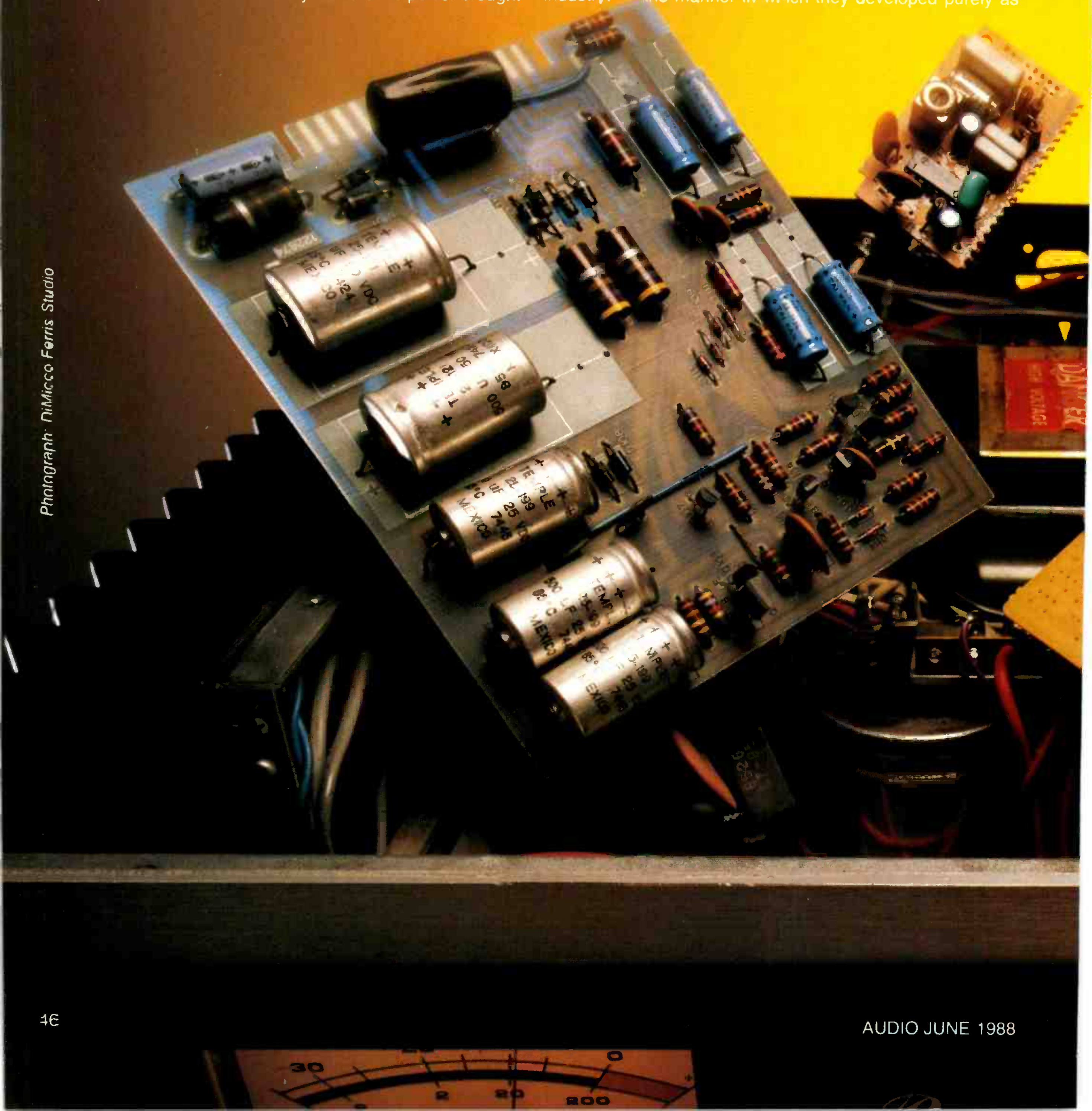
An Informal History

Daniel Sweeney and Steve Mantz

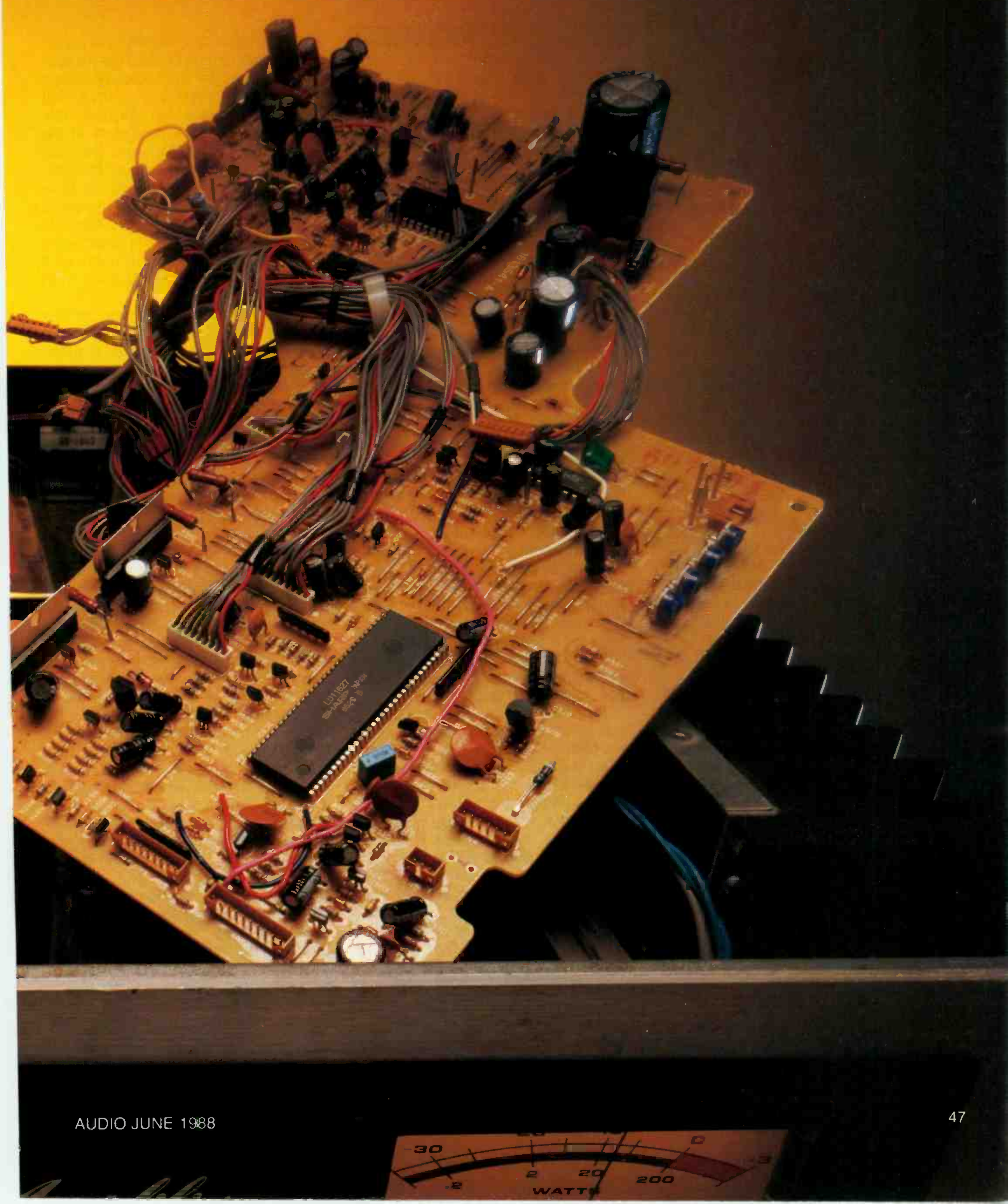
Approximately 20 years have passed since the solid-state amplifier gained ascendancy in the United States. Whatever our current preoccupation with digital audio, and our tendency to see the advent of the Compact Disc as the crucial event in audio history, the mass-market penetration of solid-state amps was a much more important development in the audio industry. Solid-state power brought serious component audio to the masses, brought the Japanese electronics industry to world dominance, and had countless ramifications in home entertainment and popular culture.

Because the introduction of solid-state domestic amplifiers in the early '60s produced so many side effects in the audio industry, the manner in which they developed purely as



Photograph: DiMicco Ferris Studio

Of Solid-State Amps



While transistors offer some real advantages over vacuum tubes, some designers don't believe that solid-state circuits sound very good.

equipment for replicating audio frequency waveforms has become obscured. Most of us recognize that present-day solid-state amplifiers are somehow different in their circuitry from the amps of 20, 15, or even 10 years ago, but how many of us know what changes have occurred, or why, or how? "Plug it in and forget it" is the slogan of solid-state designers—and we do. The amp sits, squat and swarthy on our shelves—untended, undusted, and always adequate to its task. Articles in some of the smaller audio journals fiercely debate the merits of various arcane circuit topologies, and manufacturers trumpet breakthroughs, but only the most engaged audiophiles follow the murky genesis of the amplifying circuits.

The very obscurity of this genesis can be attributed to the obscurity of amplifier design as it relates to audible performance. While designers themselves endlessly debate the consequences of employing a given circuit topology, a number of reviewers take the attitude that one circuit is very like another since most solid-state amps, old and new, have distortion ratings of a fraction of a percent. And yet the solid-state amp of today is no closer to its ancestors of 20 years ago than man is to Pithecanthropus. Clearly, something has been going on inside the chassis during the last two decades. This article is an attempt to analyze the tendencies that caused solid-state amplifiers to evolve and, we daresay, to improve.

First Glimmerings

After a long incubation in the 1950s, solid-state amplifiers emerged in the early '60s in very serviceable form. They immediately challenged or surpassed vacuum-tube amplifiers in a number of performance parameters.

The initial advantage that early solid-state amps evinced over their tube rivals was in price. Expensive when first introduced, the silicon transistor soon dropped far below the cost of the vacuum tube, and the new solid-state amps posed an immediate threat to the supremacy of the vacuum-tube designs in the mass market.

The second achievement of early solid-state design—and the one that chiefly concerns us here—was the low measured distortion of transistor amplifiers. Even in the mid-'60s, transistor amps rivalled tube amps in tests of static distortion. Although tube diehards insisted that transistor amps were audibly inferior, no one at that time could marshal a persuasive argument as to why this might be so. The digital analog debates in this decade are reminiscent of the controversy surrounding the rise of solid state, but the course the earlier controversy took was different: Vacuum-tube amplifiers were rather quickly dismissed by virtually the entire consumer electronics press. (The advocacy of tubes by the little magazines was still far in the future.) Thus, tubes lacked a forum.

The one indisputable advantage held by tubes over transistors in the late '60s was sheer power. In that era, no solid-state amp could come close to challenging McIntosh's 350-watt monos, though the market for these behemoths was limited. However, even before 1970, typical solid-state amps had begun to exceed tube amplifiers' power output norms of 20 to 50 watts. By the early '70s, several solid-state amps had been introduced whose rated power level exceeded 200 watts per channel with a THD of less than 0.1%. By the standards of the time, virtual perfection appeared to have been reached, and the evolution of solid-state amps should have stopped about 1972. But it didn't.

Why not? Largely because of the attitudes of the designers themselves. Whereas some equipment reviewers, at least in the United States, have taken the position that amplifiers of equivalent power ratings are sonically equivalent, the people who actually design amplifiers are more apt to think that these components are sonically distinct. The significant designers of the late '60s and early '70s were unhappy with existing designs on both theoretical and experiential grounds. In spite of the insistence of some reviewers that perfection had been achieved, the topologies of the mid-'60s kept being developed, and amplifiers underwent a continuous evolution that goes on to this day.

The typical transistor amp of the mid-'60s, the first generation, as it were, was what engineers call a quasi-complementary design with single-ended input and driver stages (Fig. 1). Most of these units, of which the English Leak Stereo 30 is an example, had four stages. The first two stages provided heavy voltage gain, the third stage split the signal into a pair of out-of-phase complements, and the final stage provided current gain. These amps used a single PNP transistor at the input, an NPN in the second (or driver) stage, an NPN and a PNP in the phase splitter, and two NPNs in the output stage. The output transistors were operated out of phase with one another, in a configuration known as a "totem-pole" or quasi-complementary output. A single positive power supply was provided, and the negative rail of the amplifier was at ground—0 V. The power supply was essentially unregulated. However, the Class-A driver had its collector tied to the positive rail via a bootstrap network which simulated a constant current source. A capacitor coupled the output stage to the speaker load and prevented d.c. from the power supply from reaching the speakers' voice-coils.

Crude though they were, these first-generation amplifier circuits could provide extremely low THD readings, though in the mid-'60s, designers were not yet aiming for the 0.01% distortion figures sought a few years later. At the time, the low distortion ratings attainable in solid-state circuits were often incorrectly ascribed to the purported linearity of the devices themselves. (Similar false claims are made today for the relatively nonlinear power MOSFET.) In actuality, the low distortion figures were due to the fact that more overall feedback could be employed in a transistor amp than in a conventional tube amp, where phase shifts engendered by the output transformer tend to cause oscillation problems if feedback values exceed about 30 dB.

Despite their low THD readings, these first-generation designs were perceived as problematic by some engineers. The single-ended, single-transistor input stage did not lend itself to direct coupling, and the totem pole had a tendency to "latch up" or stick to the negative half of the wave cycle at high frequencies. Defenders of the totem-pole output claimed that the high-frequency distortions were inaudible, but others maintained that such distortions could intermodulate and produce beat frequencies in the audible range.

Clever design work ameliorated some of the problems of the quasi-complementary output. Indeed, such schemes are still advocated by high-end designers John Bedini and Bascom King, but most designers eagerly embraced PNP silicon power transistors when they became available at the turn of the decade. Dan Meyer, Dawson Hadley, and John Curl began to experiment with dual differential input stages as early as 1968. Around the same time, John Iverson built fully complementary amplifiers using PNPs in every gain stage.

For several years, however, the power PNP remained in the laboratory. The first PNPs were substantially slower than their NPN complements and had intrinsic distortion levels up to three times higher. They weren't very well-matched devices, and the designers who used them were apt to create more problems than they solved. The second generation of solid-state amplifiers would remain single ended.

The Muscle Era

During the second generation of solid-state design, which began around 1969 and extended through the early '70s, two major advances occurred which led to the general acceptance of transistors in the high end as well as in the mass market. These advances really brought solid-state amplification out of the experimental era.

The first advance was the development of high-power output transistors

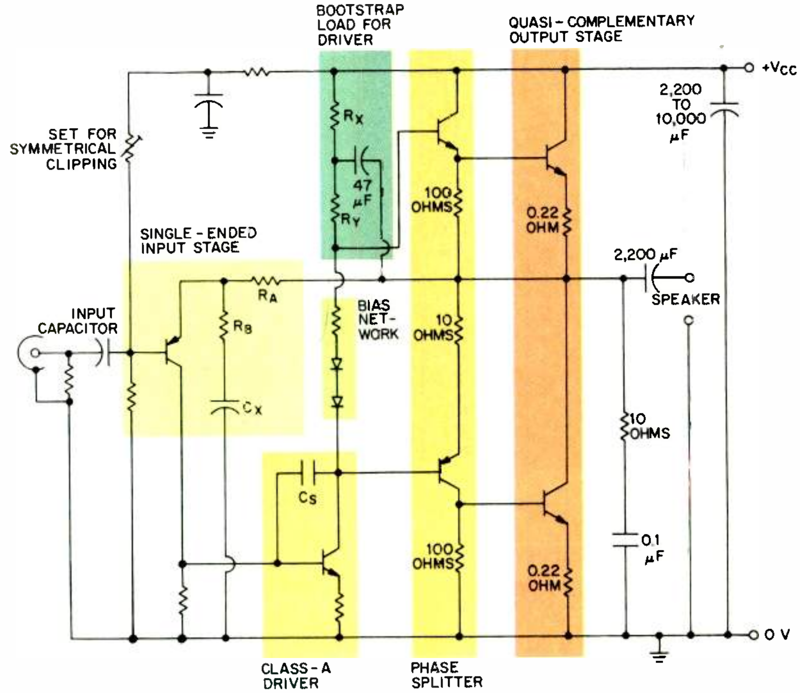


Fig. 1—The first generation of transistor amplifiers, which existed during the mid-'60s, used quasi-complementary designs with single-ended input and driver stages. Most had four stages; the first two provided heavy voltage gain, the next was a phase splitter, and the last provided current gain.

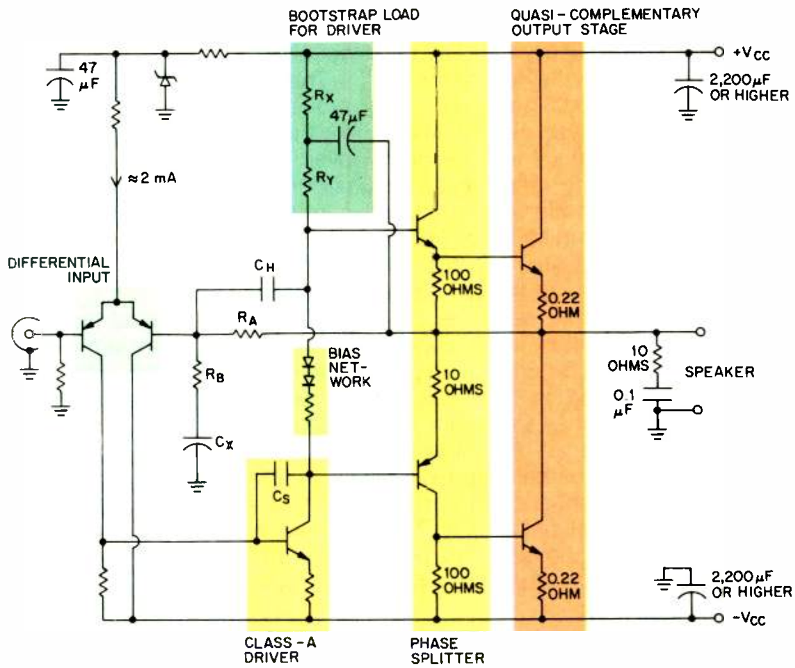


Fig. 2—The basic topology of second-generation amps, which appeared during the early '70s, included single differential input, constant-current sourced driver, a phase splitter, and quasi-complementary output.

The first-generation transistor designs did produce low distortion, but this was not due to any inherent linearity of transistor devices.

(all NPN devices, initially). Beginning with the 150-watt/channel Crown Model DC 150 in 1967, a rapid escalation in solid-state power ratings began, culminating in Bob Carver's 350-watt/channel Phase Linear Model 700 in 1971. Marantz, McIntosh, CM Labs, Dynaco, and Kenwood all joined in the power race. And though many of these amps were rather optimistically rated by current FTC standards, they definitely settled audio enthusiasts' questions concerning solid state's power potential.

The second advance, less heralded at the time, was the incorporation of differential inputs in high-performance power amplifiers. A differential (or difference) amplifier is a circuit that amplifies a signal equal to the difference in voltage potential between the positive and negative inputs in a balanced input configuration. Differential amplifiers had been used in tube circuits since the '30s, but they especially recommended themselves to solid-state designers by virtue of their thermal stability. Differential front-ends are practically universal in solid-state amplifiers today—a design cliché, so to speak. In the late '60s, however, they represented a startling innovation.

Yet another circuit refinement made in the '70s was the current mirror. It forms an active load on a differential front-end. The current mirror extracts the differential output from the differential pair and converts it to a single output referenced to ground. The circuit doubles the gain-bandwidth product of the amplifier compared to a constant-current active load. The provision of extra gain permits the designer to apply more feedback. The current mirror was extremely popular with Japanese designers of the '70s and early '80s, most of whom favored high feedback to achieve low static distortion; the circuit has found less acceptance among high-end designers in America and Europe. Among the relatively few non-Asian manufacturers which have used current mirrors are Mark Levinson, Apt, and Electrocompaniet.

Among the other refinements in the second generation was the split power supply—in effect, two supplies (one positive and one negative). The split supply provided d.c. stability and, consequently, a measure of loudspeaker protection. It also permitted the designer to dispense with the output capacitor, to the supposed sonic benefit of the amplifier. There was, however, one potential difficulty with the split supply; it increased the potential for harmful d.c. in the speaker if an output device shorted. The coupling capacitor in the earlier designs actually would not let the d.c. get through to the speaker.

The final major refinement was the provision of a constant current source for the driver stage. As the name implies, it insured that the driver operated under conditions of constant electrical current flow from the power supply. This allowed the driver to swing voltages independently of power-supply fluctuations.

A basic topology of single differential input, constant-current sourced driver, phase splitter, and quasi-complementary output characterized most of the high-powered amps of the early '70s (Fig. 2), and such circuits would be widely employed until the end of the decade. These high-powered, second-generation amps were ubiquitous in the better music systems of the early and mid-'70s, and they yielded impressive results driving the inefficient acoustic suspension speakers favored by audiophiles at the time.

Designers still were not satisfied. The tube camp—what was left of it—still insisted that transistor amps sounded harsh. Many solid-state audio engineers privately agreed and felt that a fundamental redesign of power amplifier circuitry was in order.

The Classic Era

Solid-state amplifier design came of age in the mid-'70s. Amplifiers from that era were the first transistorized components to attain the status of classics—that is, components with stable and enduring monetary value.

Jim Bongiorno's trend-setting Ampzilla from GAS was one of the first of these classics, and it possibly had the greatest influence on other amplifier designs of the period. Because this article is not a subjective report, we offer no opinions as to this amplifier's sonic attributes, but Ampzilla was widely regarded as the best-sounding solid-state amplifier of its day. Its introduction brought into focus discussions of supposed sonic differences among amps, discussions that had generally lapsed during the eclipse of the vacuum tube and the early solid-state power race. Bongiorno himself maintained that Ampzilla surpassed the competition sonically, and he credited the amplifier's sound to its then unusual circuitry.

That circuitry (Fig. 3) bears examining. At input, Ampzilla employed a matched complementary differential pair, a circuit pioneered by Dan Meyer of Southwest Technical Products (but which was very rare in a commercial product). The driver stage was also complementary, and each driver formed the load for the other. The power supply itself was split, and it featured a total of over 32,000 μF of capacitance, a very large value for the period. The power transformer was also massive and utilized square wire in a proprietary design. High current had not become a buzzword (and wouldn't be for at least another eight years), but Ampzilla provided it—and with pretty good regulation, to boot. Naturally, the outputs were truly complementary, not quasi, and the output transistors were connected in series rather than in parallel (the universal practice at the time). Such series connections vastly reduced the voltage swing over which the output transistors operated, which in turn increased their safe operating area. Series connection had been used much earlier in the germanium transistor amps of the early '60s, but Bongiorno brought the practice into prominence. Series-connected outputs subsequently appeared in

Nelson Pass' famous Threshold amps, among others.

Today, fully complementary design is commonly used in esoteric amplifiers made in the United States. (It is a rarity in Japanese amps.) However, the series output pioneered by Bongiorno has passed into disuse due to the availability of power transistors with higher voltage capabilities than those used a decade ago. Other aspects of the Ampzilla circuit continue to appear in contemporary designs. Ampzilla was one of the earliest designs with low global feedback. It achieved low distortion through complementary circuitry and by using local feedback loops around individual gain stages, a tactic used widely in present-day circuits and exemplified by the amplifiers of Threshold, Rowland Research, SpectraScan, and B & K among others. Copious use of local feedback combined with low values of global feedback (under 35 dB) is becoming increasingly characteristic of American esoteric and high-end design. Indeed, low or zero global feedback has become almost a matter of dogma among American high-end audiophiles and designers.

When Ampzilla appeared, the critique of global feedback was just beginning to penetrate the engineering fraternity, but it quickly gathered force in the second half of the decade and ignited a controversy that continues to this day. Not unexpectedly, the critique of feedback has had a profound effect on both the design and marketing of solid-state amplifiers. It has become as much a matter of ideology as of engineering.

The technical arguments for low values of global feedback are too involved to review in detail here, but they rest principally on two observations. First, global feedback reduces total harmonic distortion but increases the relative weight of irritating high-order distortions. Second, global feedback is ineffective in correcting for certain types of transient distortion. A more recent argument is based on the observation that amplifiers become effectively open loop under certain load conditions, and that amplifiers depending entirely on global feedback to control distortion will function poorly under such conditions.

The ideological arguments are harder to summarize, compounded as they are by subjective impressions and technical half-truths. Some of the objections advanced have dealt with the supposed relationship between negative feedback and slew rate limiting in an amplifier (see sidebar on TIM), and the purported ineffectiveness of feedback since it is applied "after the fact."

All of these arguments, technical and ideological, won adherents in the esoteric wing of amplifier design in the United States, Europe, and Japan, and were repeated by hobbyists patronizing such manufacturers. Audio equipment reviewers, for the most part, discounted such arguments. They assumed the position that massive amounts of global feedback were an entirely respectable way of lowering distortion, and that the distortion figures themselves were all that mattered, not how the designer achieved them.

In fact, massive global feedback is an easy way of getting low percentages of distortion. Although amplifier stability may be sacrificed in the process, you don't have to use precisely matched components, you don't have to resort to expensive and inefficient Class-A operation, and you don't need high-quality power supplies. All you need is high gain, and that's easy to achieve with present-day semiconductors. Indeed, most mass-produced power amps today, especially those found in receivers and integrated amps, use very high values of feedback to get the 0.005% THD readings typical of the industry.

In some respects, the continuing prevalence of massive global feedback is remarkable, since, as we will demonstrate in a moment, esoteric designs have, since the mid-'70s, tended to determine the form that mass-market designs take. Yet in this matter of negative feedback, the mass-market designers have persistently opted for high values. The ubiquitous THD specification is one that is perceived as important by multitudes of buyers, and there is no cheap way to manufacture an amp with very low THD without lots of global feedback. It is interesting to note that the cheapest receivers on the market typically boast lower rated THD than the expensive offerings of Mark Levinson. This disparity may be explained by the much greater use of global feedback in these receivers, but from a sales perspective, mass-market manufacturers really have no choice.

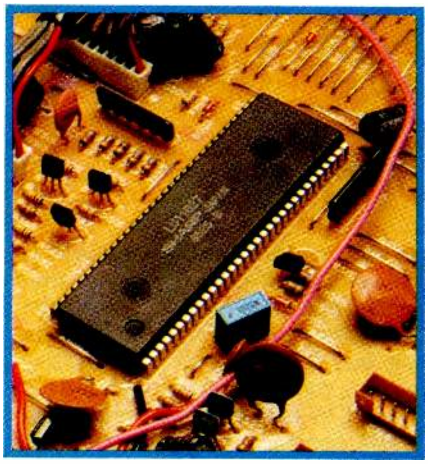
Marketing considerations aside, one of the earlier and more prominent critics of global feedback, Nelson Pass, claims to have conducted blind listening tests during the development of his Stasis amplifier circuitry. The tests indicated that zero feedback circuits could be distinguished from those employing global feedback and that they were judged more pleasing. Pass feels that the strongest evidence against the practice of using high values of global feedback can actually be seen in the marketplace itself. "Name an amplifier from the past with extremely low distortion obtained through high values of feedback that is still considered a classic," he argues. (We might add parenthetically that we could not, in fact, think of any designs with high global

Understanding TIM

Transient intermodulation distortion (TIM) is a type of voltage clipping. It occurs when an amplifier is forced to accept a sufficiently rapid change in input voltage within its initial gain stage that the gain devices cannot accurately pass the waveforms (that is, when the amplifier's slew rate is exceeded). TIM is directly related to the full-power bandwidth of an amplifier. An amplifier that can produce full power at 200 or 500 kHz has a very high slew rate and will be little subject to TIM.

Matti Otala, now a very prominent Finnish engineer, coined the term in 1975. He suggested that TIM resulted in audible differences between amps of equally good performance on static distortion tests. His ideas found ready acceptance among those in the audio community who believed that solid-state amps really did differ sonically. (Around the same time, engineers from an opposing school of thought were publishing results of blind listening tests. Their tests purported to show that most solid-state amps were indistinguishable from one another at any level below clipping.) Manufacturers themselves were much exercised by Otala's concepts, and amplifier slew rates increased by multiples.

From the perspective of the present, the whole issue appears passé. In 1975, many solid-state amps had slew rates in the 5-V/μS range—low enough to invite overload by moving-coil cartridges playing very dynamic material. Today, no high-end amp worthy of the name claims a slew rate of less than 20 V/μS—at least, no solid-state amp. In any case, no one standard procedure for measuring TIM has ever been accepted as necessary by the industry at large.



Two major advances helped second-generation designs: High-power output devices and input circuits which used a differential amp.

feedback going for big money on the used market. One could, however, argue that audiophile collectors have simply been brainwashed by the anti-feedback camp.)

At any rate, the course that solid-state amplifier design has followed from the early '70s to the present suggests that engineers who've designed no-compromise products have generally not relied on large values of global feedback to linearize their circuits. Instead, they have sought to reduce distortion by other means. Two distortion-reducing techniques have gained especially wide acceptance: Cascoding and Class-A operation.

Of the two, cascoding is much more common (if less publicized) in modern amplifier circuits. A cascode, not to be confused with a cascade, is a pair of devices acting as a single unit. (Tubes can also be cascoded, but that won't concern us here.) The bottom transistor is a common-emitter connection providing voltage and current gain; the top transistor is a common base providing high voltage gain. Common emitters are generally used to provide voltage gain in the input and driver circuits of a power amplifier. Transistors operating in the common-emitter mode are subject to the Miller effect, which may be described as a high-frequency roll-off due to collector-base capacitance. The Miller effect is exacerbated when high voltages are impressed across the transistor. The purpose of the top transistor's common-base connection is to shield the common-emitter transistor from high voltages and voltage changes because the common base is inherently a regulator. The cascode provides high gain, high linearity, and broad bandwidth. It is very widely used in contemporary amplifiers.

Cascoding (Fig. 4) first appeared in the early '70s in amps by SAE, CM Labs, Dynaco, Marantz, and, most remarkably, in the output stage of Nelson Pass' first Threshold amplifier. Pass still uses cascode outputs in the Stasis circuits of his current amplifier line. Cascode outputs also appeared in JVC's discontinued Model ML-10.

Since transistors are especially nonlinear when used to provide voltage gain, cascoding in the voltage gain stages must be counted as a major advance. Curiously, the cascode has never captured the attention of the enthusiast buyer, and its increasing use in modern solid-state circuits has passed almost unnoticed. Instead, the attention of the audiophile has focused on the output stage, where Class A-operation began to appear in a number of amps from the early '70s, creating a mystique among the cognoscenti rivalling that of the still fitfully alive vacuum tube.

Class-A operation had been used for decades in low-powered vacuum-tube amplifiers, and it was commonly used in the voltage amplifying stages of solid-state components. But power transistors proved difficult to operate in Class A because of their high susceptibility to thermal runaway, where destructive currents burn out the transistor as rising temperatures make it more conductive.

In true Class-A operation, a gain device will conduct electrical current at all times, from a no-signal condition to full rated output. Bias will therefore be set to about half of peak current, and electrical consumption and heat dissipation will be prodigious. Class-A operation eliminates switching distortion in transistors, and it forces the transistors to function within the most linear portions of their operating region. Furthermore, the transistor is kept quite stable thermally, so its gain characteristics are relatively invariant.

Class-A operation has other characteristics as well. In a complementary Class-A amplifier (virtually the only kind produced today), idling current is about half the peak current into a rated load, so idling power dissipation in the output stage is about twice the available maximum output power. The amp, therefore, has a massive power supply, with all the advantages that this provides. Many of the most prized solid-state amps have been full Class A, or close to it, including the Mark Levinson ML-2, the Stax DA-100, the Krells, and the Electro Research 75.

The first Class-A transistor amp that we know of was the little English Sugden, circa 1968, a single-ended design producing only about 10 watts per channel. It was followed after a lengthy interval by the Stax DA-300 in the early '70s, the Mark Levinson ML-2 in 1975, and the Electro Research 75 at about the same time. The Levinson unit is still made today, and a handful of other Class-A amps are available from such firms as Threshold, Krell, Luxman, and Audire—all at premium prices. No true Class-A amp has ever been produced for the mass market. The requirements for extremely massive power supplies and extensive heat-sinks and/or fan cooling—as well as the very high shipping weights of these components—necessarily relegate the prices of Class-A amplifiers to the market's extreme high end.

Nevertheless, the mystique of Class A began to reach into the mid-market beginning in the late '70s, creating a demand for a product that simply could not be delivered at a price conducive to mass acceptance. Determining the reasons behind the mystique is difficult, but at least two explanations suggest themselves.

Class-A operation is literally a textbook method for reducing distortion, albeit one that is difficult to implement in solid-state amplifiers of more than about 20 watts output. In an engineering sense, Class A is noncontroversial, though it's very debatable from the perspective of price versus performance.

Another factor contributing to the mystique is the ability of most early, true Class-A amps to control certain difficult speakers, notably electrostatics. At the time that the first Class-A amps reached the market, electrostatics (such as the Koss Model One, the Beveridge, and the Dayton Wright) were enjoying enormous acclaim. Class-A amps, with their enormous current capabilities, could handle the low impedances presented by such speakers and make them perform at their best. This fact put Class-A amps in an exclusive category. Because Class-A amps had a way of turning up in the most ambitious music systems, they became the preferred design. But they were still prohibitively expensive.

Enter pseudo-Class A or, if one is more charitable, quasi-Class A. This was another design from the fecund imagination of Nelson Pass, first surfacing in his Cascode amplifier in 1974. A number of variants of pseudo-Class A now exist, but the first and most widely used version consisted of a dynamic biasing circuit—also called a sliding bias—that varied the bias of the output transistors according to the strength of the input signal. On an instantaneous or cycle-by-cycle basis, bias will be very high during strong-signal conditions but will be low at all other times; at no time will the output transistors shut off and generate notch distortion. Unless the amp is run very hard, power consumption and heat dissipation are only slightly greater than in Class-AB designs.

Nelson Pass no longer uses the sliding bias circuit—nor does any high-end American manufacturer. However, this circuit has become almost standard in mass-produced Japanese amplifiers, appearing in units from Pioneer, Technics, Denon, Onkyo, JVC, and Fisher. Whether or not the eclipse of pseudo-Class A in the high end is based on performance factors, we don't pretend to know. Pseudo-Class A does not offer all of the benefits of true Class-A operation: It does not provide the same degree of thermal stability, and it does not linearize transistors to the same degree. Thus, it simply results in more open-loop distortion.

Class-A output operation has remained the perfectionist approach in the United States and Japan, but several other means of linearizing outputs—all of which can be discussed in a few words—have been attempted. Class-D operation is one such method. Class D is an operational mode whereby the audio signal modulates a high-frequency pulse train and varies the duty cycle, or width of the pulses, with-

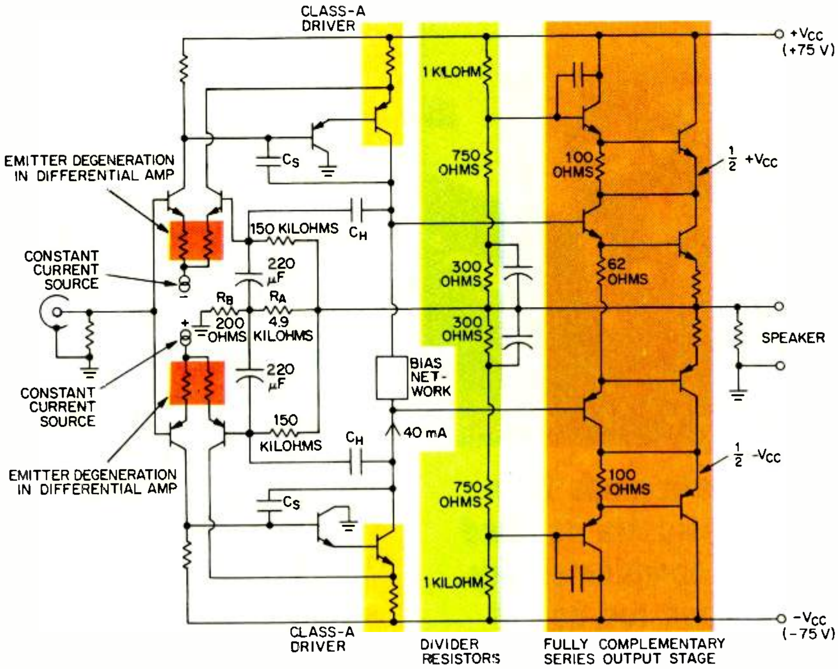


Fig. 3—Great American Sound's Ampzilla was widely regarded as the best-sounding amp of its day. It used a matched complementary differential pair at the input, and the driver stage was also a fully complementary series output.

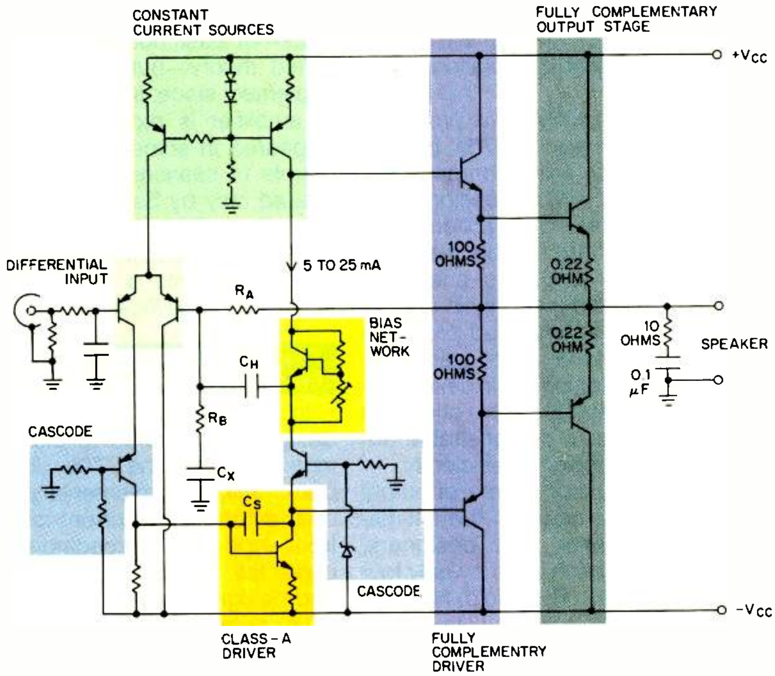
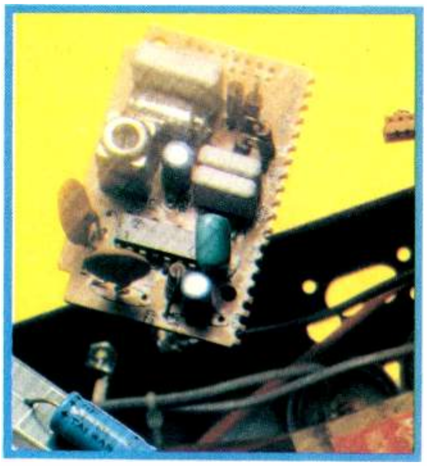


Fig. 4—Cascoding first appeared in the early '70s, and it provided high gain, high linearity, and broad bandwidth. Used fairly widely by designers, cascoding should be regarded as an important circuit technique, even though it has not been faddishly sought after by high-end buyers.



Solid-state amps from the classic era ushered in fully complementary output and the use of local feedback around individual stages.

out affecting their amplitude or frequency (which are held constant). An output filter is used to strip away the carrier frequency and produce an audio frequency output. Class-D amplifiers are sometimes inaccurately termed "digital amplifiers," though the proper term is "pulse-width modulation amplifiers."

Sony and Infinity Systems produced Class-D amps in the late '70s, but neither they nor any other company has been successful with the design in the marketplace. Class-D amplifiers have proven to be far less reliable than conventional audio amplifiers and have demonstrated no superiority in specifications. They also have had problems in driving reactive speaker loads, because the speaker load is in series with the output filter and therefore affects its operation. The sole demonstrable advantage of the design is efficiency.

The current-dumping type of output circuit has fared better in the estimation of audiophiles and designers. However, it has been used by only four companies: Quad, Threshold, Nakamichi, and recently Technics. (Nakamichi is licensed by Threshold to use its Stasis circuit.)

In all these circuits, voltage gain and current gain are provided at output by separate gain blocks connected to the load in tandem. One block provides current gain, while the other produces voltage gain. The voltage-gain block is operated in Class-A mode; the current-gain block is operated in Class B or AB. Distortion characteristics of these current-dumping circuits are said to be determined by the smaller Class-A circuit, which in effect shapes the output waveform. (Threshold, incidentally, recently introduced a couple of current-dumping amps which operate in Class A in both the voltage-gain block and current-gain block sections. When interviewing Nelson Pass for this article, we asked what the point was of combining Class A and current dumping. "It provides for superior presentation of depth," he replied.)

Related to current dumping is an old technique called feedforward, which was recently resurrected after being developed back in 1927 (by H. S. Black of Bell Labs) and ignored by the audio industry for 50 years. In classical feedforward circuits, a small error-correction amplifier is bridged to the main output and corrects for its nonlinearities by injecting an out-of-phase error signal into the main amplifier's output. Feedforward does not produce the deleterious effects of negative feedback—at least, not according to established theory—but it is expensive to implement since, in effect, an additional amplifier is required. Feedforward appeared in some Denon amps for a couple of seasons, but it is currently offered only by Sansui (though Yamaha's Zero Distortion Rule circuit is somewhat related). Basically, feedforward represents a road not taken in solid-state amplification.

The Eighties: Electronic Scholasticism

In one sense, solid-state amplifier design has matured in the '80s. The innovations of the '70s—local feedback, fully complementary circuitry, dual differentials, current mirrors, FET front-ends, and cascoding—have become the standard ploys of the high-end designer. Low-end manufacturers have ceased to design at all—they simply plug in new power ICs and purchase ready-made circuits from a chip supplier.

Although the topologies of most high-end amps at mid-decade were in common use in 1980, the climate of high-end design is very much different today. The concerns of perfectionist designers have shifted from basic topologies to the arcana of passive components. Fierce debates rage concerning the audible differences between polystyrene and Teflon capacitors, the effects of placing laminated iron cores over power transformers, the improvements to be had by using oxygen-free copper wiring, and even the benefits of using sound-proofing cabinets to prevent microphonics in transistors. (Interestingly, most of these notions originated in the Japanese high end, but the components that the Japanese favor rarely spark much enthusiasm among American high-end designers and consumers.)

All of this attention to minutiae would augur that solid-state design has entered a late-Mannerist stage from which little significant innovation is likely to emerge. Indeed, this is our view. Unless radically new devices (such as the still-experimental gallium-arsenide transistors) find acceptance—or unless truly high-performance, pulse-width modulation Class-D amplifiers are somehow developed—we see little fundamental change for the next few years.

And yet, solid-state amplifiers have changed along some performance parameters, if not in basic design. Ideology, always a potent force in audio electronics, has fastened on a new controversy, and manufacturers and consumers alike have become preoccupied with the matter of current capability.

Matti Otala, who initiated the TIM controversy, was largely responsible for launching the discussion about high current as well. Some years ago, Otala called attention to the fact that crossover-induced impedance nulls in dynamic loudspeakers could present an amplifier with a load of less than 1 ohm, which would in turn place enormous peak-current demands on the amplifier. Subsequently, Otala participated in the design of a very high-current amplifier for Harman/Kardon, giving substance to his theories. To be sure, high-current amps were advocated back in the '70s by Bose, Crown, and NAIM Audio, but only in the early '80s did high-current capability become a selling point.

Otala's observations concerning amplifier-speaker interactions were correct and verifiable, though the presence of impedance dips in dynamic loudspeakers causes problems for amplifiers only over a relatively narrow range of frequencies and only at high playback levels. Electrostatic loudspeakers, whose impedances fall and become progressively more capacitive as frequency rises, present a much greater challenge to a solid-state amp's current capabilities than do the ordinary cones and domes of dynamic loudspeakers. The relatively few audiophiles who own such speakers have insisted on amps with massive current capabilities all along. The recently introduced wide-range ribbon speakers (made by such manufacturers as Apogee and VMPS), with average impedances of under 4 ohms, present similarly difficult loads to amplifiers.

The controversy surrounding high-current capability extends considerably beyond the owners of such esoterica as ribbons and electrostats. High current has acquired its own mystique (just as did Class A), and high-current amps are said by their defenders to sound more "open." High current has come to be regarded as a desirable attribute in an amplifier and not just as a means of coping with certain difficult speaker loads.

The advocacy of high current has an interesting corollary. Current limiters, used to restrict current flow and protect output transistors, have come to be seen as sonically undesirable in the high end. Many purists insist that power amps should be run with no protection other than that provided by overrated output transistors and, perhaps, a fast fuse. Accordingly, many American high-end amplifiers have no current-limiting protection of any kind. Curiously, this particular design trend has gained no acceptance in Japan, where designers (esoteric and otherwise) are united in their insistence that products should be foolproof.

Nevertheless, the Japanese have somewhat belatedly embraced high current, as it has become a general obsession in the audio community. Today several mass-market amplifiers from the Orient are selling components on the basis of their supposed high-current capabilities.

So what consequences has this quest for high current had on design? Primarily, it has popularized modulated power supplies. Classical amplifier design theory posits a ripple-free, low-impedance power supply that holds supply-rail voltages steady under all normal load conditions. Amplifiers following this theory have utilized large transformers and filter capacitors, and occasionally have used voltage regulators. They have also been characteristically expensive.

To achieve acceptable sound quality, such "brute-force" power supplies are an absolute necessity when operating a solid-state power amp into a broadband 2- or 3-ohm speaker. For loudspeakers where the load only dips to low impedances at certain frequencies, one can generally get by with an amplifier whose power supply will momentarily dump large amounts of current into a load. This instantaneous current capability can be achieved in a number of ways: By varying the voltage rails on the supply and allowing the power transformer to "load down" (à la Carver or Soundcraftsmen), by stacking dual supplies (in the manner of the NAD 2200), or by simply loading down a small transformer and letting the supply rails sag (as in the Apt power amp). Many designers maintain that such tactics seriously compromise sound quality. Certainly they go against classical principles of good power-supply engineering, but amplifiers employing such modulated power supplies generally perform quite acceptably on static distortion tests.

One must be cautious in predicting the future of solid-state amplification. After all, in 1970, few thought that vacuum-tube products would enjoy a strong specialty market 15 years later. We see several areas where research is likely to focus: Fully regulated power supplies, switching power supplies, Class-D operation, power ICs, and new types of transistors. In mass-produced amplifiers, ICs will almost completely replace discrete circuitry in five years; in cheap, high-feedback integrated designs, we see the addition of second-harmonic distortion generators (of the Aphex Aural Exciter variety) possibly being added to sweeten tone. Class-D amplifiers will certainly reappear in improved form, but will only succeed in high-power applications. And five and even 10 years from now, vacuum-tube amps will still be manufactured, cherished by a small contingent of loyalists.

FETs and MOS-FETs

Oskar Heil, an Austrian physicist who later gained considerable fame in audio circles for his air-motion transformer loudspeaker, developed a field-effect transistor in 1933—some 15 years before Bell Labs devised the bipolar. Heil did nothing with his invention, and field-effect transistors (FETs) were not seen again until the 1960s (and then, only in laboratories). It wasn't until the mid-'70s that FETs appeared in consumer audio products.

The major Japanese manufacturers pioneered the use of FETs in amplifier circuits. The first application was in the differential input stages of power amplifiers, and, indeed, such FET differentials have come to typify Japanese amplifier design.

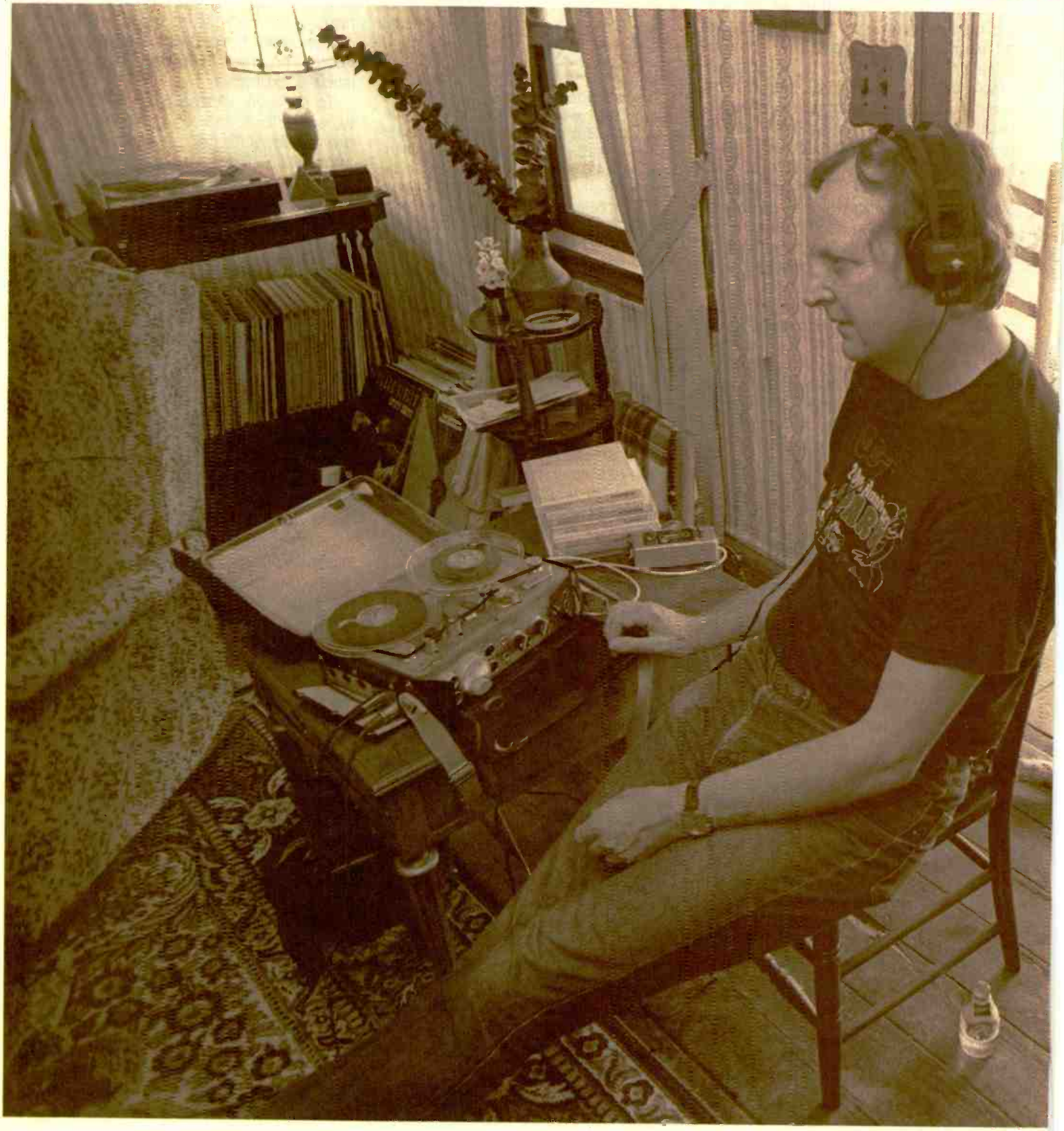
FET front-ends did not arouse much comment when they first appeared. In the late '70s, however, FETs came very much to the fore when the first amplifiers with FET outputs were introduced by Sony and Yamaha in Japan, by Peter Perreaux in New Zealand, and by Spectral Audio in the U.S. The Sony and Yamaha amps used power V-FETs; the other two employed the new metal-oxide semiconductor FETs (MOS-FETs). Today, the MOS-FET is the only FET in use in power output stages.

MOS-FET outputs recommended themselves for two significant reasons. First, MOS-FETs are high-impedance devices that require negligible current at input. Like vacuum tubes, FETs swing current as a function of input voltage (in contrast to bipolars, which swing current as a function of input current level). Second, FETs are square law devices in terms of their gain characteristics, and they tend to share the desirable distortion spectra of vacuum tubes. Audiophiles have been especially taken with the second attribute, and like to speculate on how the tube-like characteristics of MOS-FETs would lead to the marriage of tube amplifiers' sweetness and solid-state amplifiers' reliability.

Nevertheless, MOS-FETs have not come close to replacing bipolar transistors as output devices. Many high-end designers feel that MOS-FETs are highly problematic because of high gate capacitance, high intrinsic distortion, and increasing internal impedance with rising temperatures.

In mass-market integrated amplifiers and receivers, MOS-FETs are seldom used in output stages—nor are they likely to be. Because of their distortion characteristics, MOS-FETs are generally biased hard, to bring distortion down. Consequently, MOS-FET amps run hot. Heat is unacceptable in a mass-market design (particularly in one with an IC output stage), so MOS-FET amps are apt to remain in the high end.

CHRIS ■ STRAC



Photograph: Philip Gould

THE AUDIO INTERVIEW

HWITZ

IN THE TRADITION

Chris Strachwitz has never produced a smash hit record. In fact, if one of his records ever became a big hit, he'd probably wonder what he did wrong. His company, Arhoolie, is pleased when a record sells in the low thousands—or even in the high hundreds.

But Arhoolie's eclectic catalog of approximately 300 titles is far more important than the company's sales figures would indicate. Since 1960, Strachwitz has recorded some of the best and most important blues, country, regional, and ethnic music around. Whether it's country bluesman Mance Lipscomb, zydeco master Clifton Chenier (who died last December), the Yiddish Klezmorim, *Norteno* star Flaco Jimenez, or J. E. Mariner's Mountaineers, Strachwitz has pursued and then made available the most authentic and purest music to be found in America.

The distinctive music in the Arhoolie catalog has withstood the advances of popular music, and Strachwitz's effort over the years to preserve it can best be described as near-heroic. Moreover, although he doesn't profess to be much of a businessman, Strachwitz has managed to make Arhoolie a profitable business, at the same time branching out with his own distribution company, Bayside, and a wonderful retail store/mail order firm, Down Home Music. He even managed to back into a couple of minor hits when he recorded "Fixin' to Die Rag," by Country Joe and the Fish, and Fred McDowell's "You Got to Move," which was covered by The Rolling Stones.

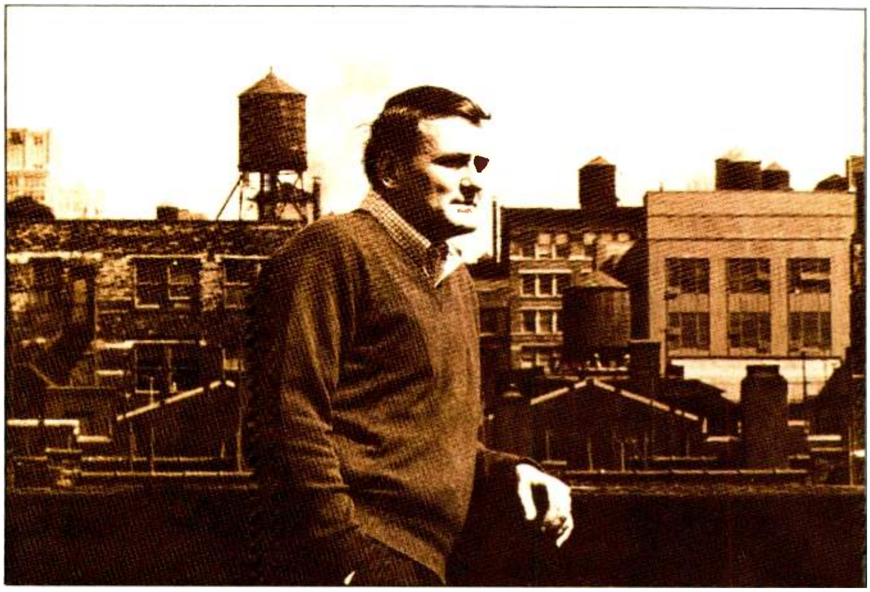
But the Strachwitz story really begins with his first wide-eyed trip down South, in search of his idol, Lightnin' Hopkins. *T.F.*

TED FOX

Lightnin' Hopkins

Michael Ochs Archives

Sam Charters



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Who inspired you to do your own recording?

Bob Geddins, who was making all kinds of rhythm & blues records. He recorded for Trilon, Downtown, Big Town, Geddins, Irma. He had more labels than you could shake a stick at. Whenever I went to visit him, he would be someplace else. There'd be a sign on his old place saying he done moved, try this address. I'd go to the new address and they'd be sawing away, building his studio all over again. I don't know how he ever got anything done.

The other man who really inspired me was Jaxyson. He put out records on the Jaxyson label. It was written "Jaxyson," but under it, it says, "Pronounced Jackson." He had a little repair shop next to the old Lincoln Theater on Seventh Street, in Oakland. That was the heart of the black ghetto in the 1930s and '40s. I was always hunting for records there. I was just a record collecting freak.

You were a teenager?

When I came to this country from Germany in 1947, I was 16. I went to school in Southern California until I came up here, to the Bay Area, in '53. So from about '53 on is when I got into the idea of making records. Those guys, Geddins and Jaxyson, probably had the most influence on me. I always thought that records were literally made in some huge factory where artists walked in one end, like mice in a cheese plant, and out came the records at the other end. I had no idea how they were made. But Mr. Jaxyson, he just had a record cutting machine. He literally recorded guys who came in off the street.

But how did you get the idea of jumping into your car and going down South to record?

I remember Sam Charters, in about '57, going down South and coming back with a trunk full of old records. Stuff I'd never seen before—like old scroll Victors. You know, Memphis Jug Band and stuff like that. Sam would come over to where I was staying and listen to Lightnin' Hopkins. I was totally addicted to Lightnin' Hopkins, ever since I heard his first records on the radio. We didn't know where Lightnin' was from. I saw an article in a French magazine saying that perhaps Lightnin' Hopkins was from Mississippi, but they weren't quite sure. Maybe it was Texas. We didn't have the sense to call up one of these guys like the Biharis (of Modern Records), which we could have done if we had had any ingenuity. Anyway, one summer I got a postcard from Sam saying, "I found Lightnin' Hopkins!"

It was like a revelation to me, like the Book of Moses [laughter]. I said, "My God, he actually exists." The next year, I believe it was in '59 . . . I have an older sister who was working in Albuquerque, and she needed her car driven down there. So I said, "Well, that's halfway to Texas." So I drove her car to Albuquerque and took a bus to Hous-

It never dawned on me that I could be exploiting the guys I recorded. I was just having fun, and they were having fun.

ton. In the meantime, Sam had also told me about a guy named Mac McCormack, who was acting as Lightnin's agent. He said, "Lightnin' is very suspicious; he's very hard to deal with." But Sam did record that first Folkways record with Lightnin' at that time, so I took a pilgrimage to Houston. I stayed at the YMCA. I met Mac, and he took me over to meet Lightnin'. It was just like meeting God.

This trip was made just as a fan, then?

Absolutely. I just wanted to hunt records and visit Lightnin' Hopkins. That year I didn't do any recording at all. I had made some tapes before—Jesse Fuller, in his house—and I had recorded John Hogg (he was a relation to Smokey Hogg), in Los Angeles, with a fellow named Ken Mills. Mills later started Icon Records in New Orleans. I was also a New Orleans jazz freak. George Lewis was my other idol. I used to tape record him. I used to go to The Beverly Cavern with Frank Demond, who is now a trombone player with The Preservation Hall Jazz Band, when we were at Pomona College. We used to go every night. I almost flunked out of that school [laughter]. That was before they had freeways in L.A., man. So I was already into taping stuff, but I don't think I had the idea of starting a label until I went to Texas.

Meeting Lightnin' Hopkins was the revelation?

Yeah. I had never heard of anything like Lightnin' in these joints. I knew all kinds of records had been made, but nobody had captured this man the way I saw him at Pop's Place. He was just moaning some blues about how he hardly could go to work that night because it was raining so hard, his shoulder was hurting, and the chuck holes were all full of water. He made it into poetry, all rhymed up. He saw us coming in, but he kept going with the same drone, with just a drummer behind him. And he sings, "Woe, this man come all the way from California just to hear po' Lightnin' sing." It was just a verse he threw in there, but rhyming it all the time. I had never encountered anything like that. Just making up this stuff. A real folk poet. That's when I decided I wanted to start a record label—to record Lightnin' Hopkins in those joints. Unfortunately, that never came about because I didn't have any money and I had shitty equipment. The next year, 1960, when I was teaching school, was the first time I took a tape recorder.

Let's talk about that first recording trip.

I decided to go down to Texas and record Lightnin'. I had bought a Roberts tape recorder and an Electro-Voice 664 microphone, I think it was. Bob Pinson, who now works for the Country Music Foundation, was working in a factory in the Santa Clara Valley. He came from Texas and wanted to catch a ride with me. I was teaching in Los Gatos, down near San Jose. I didn't have much money, but I saved what I could from that first year of teaching. I think I was making $7,000 a year, which was big money then. I think I had $2,000 saved up for the trip. I had an old '39 Plymouth, and it broke down in New Mexico. All the oil came out and the damn engine burned up [laughter]. I thought, "Man, we're getting the blues right here [laughter]." But we drove into Texas. It was very romantic. The whole country became like an opening up of the Pearly Gates.

Paul Oliver, who I had corresponded with, had sent me a long list of people he knew were from Texas—legendary old blues guys. Black Ace and a whole bunch of guys like that were on that list. We got to Dallas and Fort Worth, and Bob said he thought Little Son Jackson was from there. We looked in the phone book—I think his name was Melvin Jackson—but couldn't find him. Bob had the bright idea of going to the library and looking in an old telephone directory from the '50s. And there it was, Melvin Jackson, with an address. We called him up and asked him if he was the blues singer. He said yeah, so we went over. He was working at an auto parts place. He was a little, shy guy. I was really enthusiastic. But he was the first to throw a wrench at me with this money business. He'd made commercial records, so he was used to getting something like what Lightnin' got—$100 per song.

As an advance or as a flat fee?

It was a flat fee. To me it was a lot of money. For an LP, I needed 12 songs. I couldn't possibly pay him $1,200. I think I finally told him that this was just like one record. I must have been persuasive. He said, "Okay, I'll make some numbers for you."

And where did you first record him?

At his house, in his living room. I had one microphone, and I balanced it between the guitar and his voice. He had a very low voice, so it prepared me for what was to come with Mance Lipscomb. Jackson sang quietly, but he played very loud guitar.

Did you continue to follow the list you had?

Yeah, but they were just names. I don't think they meant that much to me. The people who meant something to me were the people I'd heard records by. There was a guy on a Talent 78 I had, his name was Little Brother. I remember I saw a bunch of black guys sitting on the curb, playing dominoes. I asked them, "You ever hear of a guy named Little Brother?" They just looked at me. I later found out that they usually think you're a bill collector or some government agent or some damn social worker. I said, "I have some old records by him." All of a sudden one of them said, "Yeah, he used to hang around with Black Ace."

I knew that Black Ace was on that list. I said, "Where can I find Black Ace?" The guy gave me the name of a tavern, and he said, "He comes in there every afternoon at five o'clock. You can't miss him because he's got 'Ace' written on his shirt." So I thanked them and went to that beer joint. This black man walks in with "Ace" written on his shirt [laughs], and I asked him if he was Black Ace. "That's what they used to call me," he said. He still had a steel guitar, but he didn't have any strings. I didn't record him then because he said he needed some time—he hadn't practiced.

Why had these guys not recorded for some time?

That music was fading very quickly. Little Son Jackson was almost a rhythm & blues artist, like Lightnin'. In the early '50s, that kind of low-down blues was selling really well to black people who came from the South. Especially out here in California, there's a lot from Texas and Louisiana. They were making pretty good money in the war industry, so they were willing to buy records and willing to pay to hear these guys. Bill Quinn, another inspiration to me, put out Gold Star Records, in Houston. His personal taste was schmaltzy German waltzes. Lightnin'

Mance Lipscomb

Michael Ochs Archives

Alan Lomax

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went to Bill and said, "Mr. Quinn, I need me some money." Whenever Lightnin' needed some money, he'd find a record man who'd record him. However, by 1960, black music was changing fast—it was going to soul music.

How many recordings did you actually do on this trip?

I did Black Ace, Little Son Jackson, Mance Lipscomb. I met Mance that same summer. There is actually a story to that. Lightnin' made a record called "Tom Moore," a very stark ballad about "there ain't but one thing this black man done wrong, but move his wife and family onto Mr. Tom Moore's farm." It's a really strong protest song about the mistreating of the field hands. So Mac said, "Let's drive up to Washington County. I think that's where Mr. Tom Moore lives." So we went to Navasota, and Mac walked into a feed store. He asked, "Does Tom Moore live here?" They said, "Yes, *Mr.* Tom Moore's got an office over the bank building." [Laughter.] Mac was pretty brash at that time, but I was scared. I didn't know what the hell we were getting into. Mac calls up Tom Moore, and he invites us up to his office. It was a nice, big office, and he had pictures of his plantation all over the wall. We talked to him for quite a while. Mac asked him if there was a black hand who played for his people. Tom Moore said, "Yeah. I don't know his name, but you can find out if you go down to the railroad station and ask for a guy named Pegleg." So we went and asked Pegleg, "Who's the guitar picker around here?" He says, "Oh, his name is Mance Lipscomb. You can find him out on the highway, cutting the grass." He also told us where he lived. And that's where we met Mance Lipscomb. He had just come off a tractor. I made a record that same evening. It became the first Arhoolie record—Arhoolie 1001.

That was quite a memorable trip.

Everything that happened on that trip was like that. I went from there to Louisiana. I had heard about Cajun music from Bob Pinson, who played me something by The Hackberry Ramblers, on Bluebird. So I asked for some Cajun music at a service station in Lafayette. They sent me to a bar. I remember there was a very attractive girl as a bartender. I asked her if she had ever heard of any Cajun music, and she just started laughing. She said, "Yeah, that stuff is crazy. My boyfriend and I went to this place, about halfway to Breaux Bridge, called the Midway Club." Sure enough, I got there and they were going full tilt. It was Aldus Roger and his band. They were playing a song I loved: "God Didn't Make Honky Tonk Angels," the Kitty Wells hit that J. D. Miller wrote. One singer would sing in French and the other in English. All these old couples were just two-stepping along, waltzing away. It was a neat sight. They were all really friendly. I didn't record Aldus Roger. I think I was sort of scared. I thought he

> **If I thought a song had commercial potential, I'd probably reject it. I only recorded something because I liked it.**

was too big-time for me. Also, I couldn't handle his amplifiers with my one microphone. I went to Hackberry, which is just south of Lake Charles, on a later trip because I figured that was where The Hackberry Ramblers were from. It's just a dinky town, maybe 50 people. I asked a lady in a little cafe there if she'd heard of The Hackberry Ramblers. She said, "Yeah, that's Luderin Darbone. He lives right back in Sulphur, on Darbone Street." So I walked in his house—I think the next day was Sunday—and he got all his boys together, and we made a tape in his house. I also loved New Orleans jazz. That was my other pilgrimage place.

Did you do a lot of work on the tapes before you put them out as records?

I didn't know nothing about that. What was on the tape was what would go on the record. I would take it to the guy who cut my masters, and he would fiddle with it sometimes. He'd say, "We can boost this a little or take some of that out." He just had a couple of tone controls. I don't think he did much. I didn't know what I was doing. I was kind of dependent on these people to know what they were doing.

How did you decide whether to record someone in his home or in a studio?

Money [laughter]. That was the big thing. I didn't have any money. Studios cost me $10 or $15 an hour at that time. That was a lot. I don't think I did any studio recordings at all the first year. The next trip, I did a couple in little, funky studios. Also, if it was acoustic stuff, I didn't really see any sense in a studio. The only time I needed a studio was if I had a piano player or something—or if there were several musicians.

So all you had in the field was your Roberts tape recorder?

Yeah. It was bad. In the second or third year, it started overmodulating, overrecording everything. One whole summer of stuff was wasted. There were some good piano players I recorded in Houston, and that's all useless. When I found out it couldn't be used, I looked up Jack Lauderdale, of Swingtime Records. I figured I had to get something out. He had some wonderful Joe Turner and Pete Johnson stuff that he'd issued on 78s—some Lowell Fulson, too. So I bought the masters. I picked the most uncommercial stuff. He sold them to me for $250. He said, "None of those ever made me no money."

Who was your most exciting, or satisfying, find on these trips?

Oh God, every time was something different. I guess Mance Lipscomb because it was so dramatic. But I'll never forget meeting and recording Fred McDowell in [Como] Mississippi. I believe I heard about him from one of Alan Lomax's records. He came out on that Atlantic series, "Roots of the South." Fred McDowell knocked me out. So I wrote Lomax, and he told me McDowell was from Mississippi. He gave me a route number. I went to the post office, and they said, "You go up Highway 61, make the third or fourth left turn, and it's the second ranch on the right." Lomax loved music, and he was such an open person. Fred told me later that Lomax didn't give him nothing but $5 and a couple of Cokes to play for him all night long. So I paid him a couple of hundred dollars, I guess. He thought that was great. I stayed in his house that night. He and his wife were so sweet. We made that record the day I met him. I had a Capps condenser mike. It was a nice sounding, omnidirectional microphone. You had to put it in a good place to catch both the voice and the guitar.

Did you have a new recorder by then, too?

Oh, yeah, I had the Magnecord by then. That was my war horse most of those years. That's the same kind that Bob Shad and the Biharis had, too. It gave out on me, but I still have it. I remember another trip I made to North Carolina. One of my favorite old time fiddlers was J. E. Mainer. I think I found out from Lomax that he was from Concord, North Carolina. I looked in the phone book when I got there, and sure enough, there was J. E. Mainer on Poplar Road. I drove out there and said, "I'd like to get your story." I didn't really know what to do with him—I just wanted to meet the man. Then I said, "I'd like to get a couple of pictures of you." He said, "Oh, that'll be $5, please." [Laughter.] Then he said, "You've got to buy me a bottle." So I went down the road to visit the lady with the bootlegged whiskey. The first year I just talked with him. The next year I went back with a German couple. They were making a film for German TV, and I made a record. I loved that record. It was a Sunday morning. I hung my microphone from the ceiling, and he had his son and daughter, a guy on bass, and a mandolin. I just lined them up in a circle under the microphone, with him in the middle because he was the fiddle and he did most of the singing. I figured he ought to be the loudest. That was LP 5002.

Some people might think you were exploiting these guys. Did that ever enter your mind?

No. Exploiting never entered my mind because they didn't seem to have any such feelings about it. Guys like Lightnin' and Little Son Jackson, who had made commercial records, wanted a lot of money, but I couldn't afford it. And I wasn't making any money, that was the other thing. Jac Holzman, of Elektra, once told me it took him seven years to break even. It took me a lot longer than that. But it never dawned on me that I could be exploiting them. I was just having fun, and they were having fun. It was just a mutual enjoyment thing.

How did you get the business going?

My format followed the Folkways label. They seemed to be a neat label, although they were very expensive. I couldn't afford many of their records. But I liked the way they were packaged. Wayne Pope, who did all the layout and art work, and his wife and I would sit at this table with sponges and wet those damn cover slicks down, all 250 of them. The pressings had come from the pressing plant separately. Mac had written the notes.

Who is the top-selling Arhoolie artist?

Clifton Chenier. He was the best-seller. I met him through Lightnin' Hopkins. I just liked to hang out with Lightnin' wherever he played. One night he said, "Chris, do you want to go see my cuz?" I said, "Who's your cousin?" He said, "Cliff, Clifton Chenier." The name rang a bell because I think I had a Specialty record by him, and maybe a Checker. To me, that was rhythm & blues. I wasn't all that enthusiastic, but if Lightnin' wanted to go. . . . I was just like his little dog. I said, "Sure, let's go over and see him." So we went over to Frenchtown, in Houston. I'll never forget. We walked into one of those little beer joints, with hardly anybody in it. There were two couples dancing.

Arhoolie Records

Clifton Chenier

Arhoolie Records

Fred McDowell

There was this man, with his accordion, and a drummer. He didn't have no band at all. He was playing these really low-down blues—mostly in French, but some in English, too. Clifton came up to me afterwards and said, "Oh, you making records? Come on, make me one!" He desperately wanted to have a single. This was three or four years after his Checker record and tour. It did okay, but he hadn't had anything since then. This was about '63 or '64. So we went to Bill Quinn's Gold Star studio the next day and did the single "Ai Ai Ai (Underneath the Evergreen)."

How did you come to do the first Clifton Chenier album?

I went back the next year, 1964. The Houston distributor had actually sold a few of the single—a thousand, I think, but at least I broke even on it. The next time I took him in the studio, he made several zydeco pieces. He also did a tune I called "Louisiana Blues." He came running out of the control room right after he cut it and said, "I gotta call my old lady." He said, "Baby, listen to this one." And the studio played it back for her over the phone. I remember during the recording, Bill Quinn said, "Chris, this thing will sell down here." And it did. It had this real low-down sound. I asked Clifton what he was going to call this number. He said something in French. I didn't know what the hell he was saying. I said, "How do you spell that?" "You can write it any way you want to," he said. I finally said, "Why not just call it 'Louisiana Blues'?" He said, "That's good enough." It had this phrase, "tous les jours les mêmes choses"—either every night is the same or every night is not the same with your old lady. It's a catchy phrase. I probably should have called it by that French title, except no one would have been able to say it, including me! That one sold pretty good, maybe four or five thousand. It got onto a lot of jukeboxes, and the black stations actually played it.

But the reason his records remained big sellers for you is the white audience, right?

Definitely. But at that time, he wanted me to get a single out so he could get some work. It did succeed in that.

Did you have him under contract?

No. I don't sign anybody up on an exclusive. I only agree to do one record. That's been my contract ever since I started. I always try to tell an artist, "I can only do so much for you. If somebody else comes along and offers you more money, go for it, but I wish you would let me know." Because if it's RCA or Mercury, I say, "Go." They'll make a lot of money, and they'll help me sell mine. But if it's my competition, like Delmark Records, then I must confess, I would try and tell them, "No, don't do that. Because they can't do any more than I can as far as getting your name out there." But I remember the record Fred McDowell made on Capitol. That put his name more places than I ever dreamed of.

You can make more money from owning copyrights than selling records, but I enjoy packing records more than filling out forms.

And he became a real going concert artist after that. *I Don't Play No Rock and Roll* was the name of the album.

But you did have a couple of artists who left for larger companies.

Yeah. Big Mama Thornton, after she recorded for me, recorded for Mercury and Vanguard. Of course, everybody was after Clifton. I remember talking with Jerry Wexler about it. He wanted Clifton for Atlantic, except it was just impossible for me to agree to it. But I learned something: I hate to be the middle man.

Why did Wexler come to you to get Clifton?

Clifton met Wexler at the Ash Grove, in L.A. Clifton called me and said, "This man wants to cut some records. Why don't you talk with him?" So I went over and met with Wexler. He wanted to sign Clifton up for five years and guaranteed him one record. I said, "Well, will you guarantee so many a year?" No, he wasn't willing to do that. I said, "Are you at least willing to pay him real well?" He said, "No, I'll pay him what you pay him." I said, "What's the point in that? And I'll have no guarantee that you will issue anything after that. What are we going to do if we want some local material? He needs to have jukebox numbers out there every year." He says, "Well, I'll let you do that." But he was totally noncommittal about it all. I told Wexler that Clifton had told me what he wanted. Clifton needed a new trailer and $3,000 or $4,000 worth of equipment. Wexler wasn't willing to give him that up front, so that blew that.

What about other Arhoolie artists?

About a year or two after I recorded Mance Lipscomb, this lady calls from L.A. She says she's from Reprise Records, Frank Sinatra's new record company, and they're interested in Mance Lipscomb [laughter]. I said, "Really, how come?" She says, "Well, he sounds like a very interesting folk artist." So we actually did make a deal. Reprise Records actually recorded enough material for three LPs. That was the biggest money Mance had ever made at the time. They didn't keep them in print very long, of course. They issued one, and then reissued it a couple of years ago.

What can an independent company do to keep its artists?

I'm not sure they should. See, I never really looked at it as a business. I only recorded something because I liked it. If I thought it had commercial potential, I'd probably reject it. I was anti anything that was really popular. Ralph Gleason always told me, "Chris, you don't have a record company, it's your hobby." And that's true. I never went at it as a businessman. When I first met Bruce Iglauer, he said, "I like your label, but you don't do anything for your artists." I told him that's not my forte. I record things that I like. I'm not going to be a manager or agent or booking person for somebody and get tangled up in their whole life. I don't like that part of the business. I hope they'll find somebody who can do that for them. Iglauer's been good at that. He's done a lot for his artists. I realized I'm not a good bargaining man. I leave that to the people who are good at it.

You were saying that Clifton has been your best seller. How many records did he sell a year?

Maybe 5,000 the first year, and between 500 and 1,000 the following years. But they keep selling.

Do most of your records continue to sell?

No. The country blues stuff is almost as dead as a doornail. Like that old stuff I did in Memphis, with Fred McDowell and Furry Lewis. That totally stopped selling. Maybe I'll sell about 40 a year. About two years ago, for the first time in my whole history, I withdrew about 50 items from my catalog. I felt they were clogging the pipeline. I still ship them to overseas distributors, but in this country I'm going to start selling them directly to stores who want them at a fairly low price. There's no money in them if you do it through distributors.

How many records are in the catalog now?

About 300. But in this country, it has about 250.

Isn't it expensive to maintain a large catalog of records?

It sure is. And it's becoming more so all the time. Just the simple fact of stocking them and having them on my shelves and the shelves of a distributor. Fortunately, I've gotten into all aspects of selling records. Not only making them, but wholesaling and retailing them as well. I'm not very good at learning what the problems are out of books. But I've found out it's very, very difficult to maintain items that don't sell.

Do you have a distributor for Arhoolie?

I have several distributors. The one I own, Bayside, is my West Coast distributor. For the rest of the country I use The House, in Kansas City, and then Rounder Records, back East. They're sort of a similar operation to mine, except they're bigger. They came along later than I did, but they've done a lot. I also have Floyd's, in Ville Platte, Louisiana, but he can only sell my Louisiana/French music.

Why are you unable to service the whole country through Bayside Distributors?

There are several reasons. The main reason is that the big chain stores depend on a salesperson coming in to do their inventory. They do not order on their own. If you don't have a local sales rep, you don't sell no records. My sales guys go to Tower Records—about 60% of our sales are through Tower—but they go in just like a big grocery store. The reps say, "You need this, you need that." As long as the store has a budget for the records that month, they'll put them in. If they don't sell, they come back.

Let's talk about selling records through stores versus mail order.

I started off in mail order. I started the International Blues Record Club before I had a record—from people who sent me $5 for a record. When the record came out, I sent it [laughter]. I made money to buy my first tape recorder by selling 78s through the mail. I did it through a British publication called *VJM*, which I think stands for *Vintage Jazz Mart*. I would advertise 78s, and people would bid on them. I would pack them up, send them the bill, they would send me the money, and then I would ship them. The first Arhoolies were sold pretty much to that same audience. They were collectors. At that time, there were very few blues LPs around.

What's the percentage today of mail-order sales versus store sales?

I do very little direct mail order myself. I get quite a few inquiries, because on all of my albums, it says send a dollar for a catalog. I'm going to have to up that to two. It costs me a dollar just for postage.

But you get full retail on a mail-order sale.


Arhoolie Records

Flaco Jimenez


Michael Ochs Archives

Country Joe McDonald

Yeah, but it's a lot of work, too. I'm still not sure whether it's worth it. But I am selling a lot now through Down Home Music, which is the store I own with Frank Scott. They specialize in selling not only Arhoolies, but every other blues record, old-time country—an enormous repertoire. Arhoolie itself sells very little, maybe $100 a week, through the mail. Down Home is separate. They're just like any other retail store. They actually buy from our distributing company. I keep it all very formal. I sell to my distributor, and Down Home buys from them. We give them a little deal, but that's about all.

How did Down Home Music come about?

I started it some years ago when an upholstery shop moved out of here and I had all of this space. I wanted a real record store. So I hired a guy and opened a little store. I had all kinds of records in there, but no customers. Frank Scott had a really good store in L.A., so I called him up. It was the right time and the right place. He's the man who really runs it. People can always find stuff here. If you want "The Bullfrogs of North America" on Folkways, we got it for you [laughter].

You must get customers from all over.

We had some guy from Germany come in with two empty suitcases. He filled them up with $1,500 worth of records. B. B. King bought over $1,200 worth of records the first time he came. Los Lobos has been in. When we opened the store, George Thorogood played. Ry Cooder will call up and want to know such and such.

Your catalog includes blues, country, Yiddish, Cajun, Polish, Hawaiian—everything. How do you get a record store, besides your own, to carry all of these different kinds of records?

There are very few record stores in the world that carry this kind of extensive repertoire. We were very fortunate on the West Coast that Russ Solomon started Tower Records. His philosophy right from the start was: If it's available through a domestic distributor, he'll carry it. And he's pretty much stuck to that until very recently. There's so much stuff that doesn't move—like bluegrass. The bluegrass section in Tower has really shrunk. But Tower is an unusual chain. I can count the specialty stores for the whole country on the fingers of one hand. It's very difficult. I'm amazed they sell anything at all. Who would put an Alex Moore or Black Ace out there?

Before we totally get the blues for Arhoolie, we should point out that a number of songs published by your Tradition Music have become hits. Tell me the story about Country Joe McDonald's "Fixin' to Die Rag."

I should tell you first that I didn't know anything about this aspect of the record business until I met Eddie Shuler, in Lake Charles, Louisiana. I've got to give that man credit. He was one of the record guys I looked up on one of my early trips. I knew he recorded Cajun music. I brought him some tapes, and

When you take ethnic music and try to make it popular, you grind out all the good stuff. What's left over is usually the mush.

he said, "What do you want these damn tapes for? Get their songs." I said, "What are you talking about, get their songs? I got their music, that's what I want to listen to." He said, "No, that ain't what I'm talking about. Get their copyrights." It still didn't click. He said, "Look, if some famous singer likes one of your guy's songs, you can make a whole bunch of money off the copyright." He explained that the song itself is worth some money. You have to publish it and let the world know you're the publisher. And if somebody records it, they've got to pay you—at that time it was 2¢—for every record they sell. Then you split that with the composer.

Now, Country Joe and the Fish. It was just before the big peace march, in Berkeley. Ed Denson, who was their manager at the time, called and asked if I had my tape recorder ready. I told him I was leaving to go to Germany the next day with one of the American Folk Blues Festivals. I said, "But bring them over and we'll make a tape." I hung the microphone, my good old Capps condenser, from the ceiling. In came this motley crew of characters—shaggy looking guys. I'll never forget it. I did it just like J. E. Mainer. I put them in a circle. They had a washboard beater and a guy with a guitar. "One, two, three, what are we fighting for? . . . Next stop is Vietnam." I thought it was sort of a catchy tune. They did it pretty fast. They did about two or three takes on each of their songs. I gave Ed the tape. Joe asked me on the way out, "What do we owe you for the tape?" I said, "You don't owe me nothing. Just let me have the publishing rights." He said okay. It was just a verbal deal. Well, the shit hit the fan when they went to that Woodstock thing. Some rock 'n' roll band didn't show up on time. And Bill Belmont, who was Joe's agent/manager, grabbed a guitar and said, "Joe, go up there and sing 'Fixin' to Die'." It became part of the movie and part of the record, and the money started rolling in.

Had you formalized the arrangement by then?

I'm not even sure. I guess we did have a piece of paper. I think Joe wanted to renege on it, but Ed Denson said, "I overheard that. You told Chris. That's a verbal agreement, and that's binding." So Joe agreed to that [laughs]. That's how I bought this building. I remember the money literally rolling in. I couldn't believe it. I put my down payment on this building. It wasn't just the record, but the movie, then overseas records. It came in from all directions—from BMI, from everywhere. It was weird. It was nice to have some money suddenly.

Joe would have said it was karma [laughter].

Well, he also said, "What did Strachwitz ever do for me?" [Laughter.] Actually, a couple of years ago, I gave it back to him. I don't have that copyright anymore. Unfortunately, it's been his only really big-selling song. The next time I made some money on a song was on The Stones' *Sticky Fingers*, "You Got to Move."

When did you first record the song with Fred McDowell?

It's on the second record I did with him. But I wasn't the first. Pete Welding had recorded it. But Pete was so nice, he didn't say nothing. I told him I made the copyright for Fred. The first money I took from Joe McDonald was used to copyright all of the songs I had recorded. It costs money. You've got to have somebody write the lead sheet for each of the songs. So somebody has to listen to the tape, write down the notes, transcribe it on the paper. That's going to cost you about five or 10 or 15 bucks per song. Then you got to send it to the Library of Congress and have the copyright registered. That costs you another $10 or so. That's a whole bunch of money when you're dealing with a whole bunch of songs.

And if nobody bothers to copyright a song?

Then you can easily lose them. I was lucky that a lot of these people said, "We know you and we know we should pay this, so we will." But if some cold, cruel business guys would have been at the other end, they'd say, "The hell with you guys, you didn't register. This is in the public domain now, and we ain't going to pay nobody." I think they could have easily done that with "You Got to Move." But Mick Jagger was really neat. The first record gave Fred McDowell composer credit. We later found out that their manager, Allan Klein, had a contract saying that every song The Stones sing and record is written by them, and that he is the publisher. The Stones told Atlantic to put Fred McDowell's name on the record. They didn't know who the original publisher was. They said, "We learned this from Fred McDowell. Put his name on it."

They did this on their own?

Yeah. So all hell broke loose. I started collecting money for it. Then I got a call from Manny Greenhill, a friend of mine. He said, "Chris, what are you doing!? You're stealing my song!" I said, "What are you talking about, Manny?" He said, " 'You Got to Move' is Reverend Gary Davis' song!" I said, "What are you talking about? It's not Fred McDowell's? I know and you know it's a public domain song, but The Stones say it's Fred's song, so it's Fred's song." So I asked Fred McDowell where he had learned the song. He said, "Man, I learned it out of a church-book, a hymn book." "Oh, God!" I said, "Do you have a copy of the hymn book?" He said, "Yeah, I got it right here." He sent it to me. I was hoping it would have a date on it. If it had a date, then he would be the arranger of a public domain song.

If the date was early enough.

Yeah. The book came, and there was no date in it. My lawyers finally told me to make a deal with Manny. Manny Greenhill is a sensible man. "Instead of fighting each other over a few dollars," I said, "let's get together and make both guys the composers of this song. The Stones do Fred McDowell's arrangement with that slide guitar. Reverend Gary Davis does not play slide guitar, he picks it." It's basically the same song, though. I suggested that if somebody records it the way Fred does it, Fred should get three-quarters of the money. And if somebody records Gary Davis' version, then he should get the bulk of the money. Manny said okay.

Didn't you have problems with Allan Klein, too?

Oh yeah. He had his name in there right from the beginning. The British society had already collected on his behalf. We had a hell of a time getting it back from him.

So you sued Klein and won?

Yeah, we did. It wasn't that difficult, but it was difficult collecting the money. It was Jagger's niceness that put Fred's name on that record and saved us.

I speak German, and I couldn't understand this weird-sounding singer. A friend finally said, "Oh, that's Yiddish!"

Just before Fred McDowell died, I went to Mississippi with a check for over $7,000. That was the most money he had ever seen in his life. There's more money in copyrights than in selling records, but I enjoy packing records more than I do filling out copyright forms.

Why is there so much great American music that the majors won't release here, but will license to foreign companies?

The biggies won't consider anything that sells less than 50,000 records. They just don't want to fool with it. At least they are willing to license now. This is in the last 15 years. Before that, if you wrote to them about licensing their material, you wouldn't even get an answer. They would sit on these things, like hens on their eggs. Now, in order to protect their ownership—I think that's one of the reasons—they are willing to license the material. It reinforces their ownership. Whether or not they are the legal owners is a whole other ballgame. Take the stuff that comes from the old Paramount label. Fantasy claims they bought the Riverside label, who claims they bought the Paramount stuff. Also, Jack Buck says, "I bought the Paramount stuff." Even if two people gave money for it, how are you ever going to prove it? There were no masters—they were all dubbed off of 78s. Or you're dealing with a small label that was owned by some disc jockey or some jukebox operator, who sold it to somebody down the line, who was bought out by somebody else. How can you ever tell who was the actual owner?

What about royalties?

I should say something about this business of royalties. It's not an old concept. I think it is fairly recent, since the '60s, or a little bit earlier. In the union contract, to the best of my knowledge, there is no mention of a royalty paid to the leader or to the sidemen. You pay session money, and that's it. There are several companies I know—Delmark is one—that say, "We go by what the union says. We pay union scale. We pay no royalties." So there are no royalty requirements if you are a union musician. I am not a union label, of course, because almost none of the musicians I recorded belonged to the union. But I feel an obligation if something is a big seller. I think that the people who created the material should share it. So I furnish artists with statements saying how much they sold. How much to pay? That's another difficult situation because it varies. When The Maddox Brothers and Rose first recorded, they said, "We made union scale, but at the end of the session, the man took it back from us!" Rose said, "I don't mean them any harm. They did more for us publicity-wise than anybody has. They got us on the radio and the jukeboxes. We made more money playing gigs behind that." But that was a common practice, especially in the Mexican field. Artists never got any money for it. My example when I started was Prestige, for which I did some sessions. They were paying 20¢ an LP, and I think that's what I used at that time. Now I pay roughly 50¢ per record royalty. And there's usually some advance that I pay. I think people ought to be paid for their time. On his best-seller, Clifton said, "Chris, I don't want no royalties. Just pay me five thousand flat." And I did. That's one he lost on, because it turned out to be his best-seller. But maybe I'd have just paid him royalties on it anyway since I'd covered my $5,000 advance.

Let's change the subject a little and talk about your personal tastes. At first it seemed to be mostly blues and country and jazz, but now you seem to be getting more into regional and ethnic music.

I had a liking for most of it right from the start. I heard Mexican accordion music when I was in high school. Kids in school called me the Crazy Mexican. I love the sound of the language. Spanish is still music to my ears, even though I don't understand much. Maybe it has to do with my European upbringing. I don't remember listening to much polkas and waltzes, but that's basically what Mexican music is—at least the music here in the North, *musica Nortena*. It's very Germanic, Central European. It took a lot from the Italians, Germans, Bohemians, Poles.

Is that how you got into the Yiddish and Polish music?

The radio has been my real educator. When I was going to Pomona College, I listened to a radio station in Los Angeles that had this weird-sounding German. I spoke German, you see, but I couldn't quite understand all of it. I finally asked a friend of mine what it was. "Oh," he said, "that's Yiddish!" [Laughter.] But I didn't like the music they played on that show. It was all squeaky clarinets and sort of hokey stuff. Jeff Alexson, the guy who runs Kaleidoscope Records, came over a couple of years ago and said, "Oh, Chris, you gotta hear this little band at the Freight and Salvage [a club in Berkeley]. They're just great." I went, and there was this band of two fiddlers, a flute, an accordion, and a bass. And they were playing this Central European stuff. It was the Klezmorim in their first incarnation. I thought it was a neat sound. To tell you the truth, what also really got me turned on was that I saw they were mostly young, Jewish people, playing their own music. I had met people of Jewish extraction who wanted to play blues or old-time string band music. I could identify with them, because I didn't want to play German music. But I thought, here are some Jewish kids who really want to play their own stuff. And the music was so wonderful. I just fell in love with it. I said, "Let's go make a record."

What about Polish music?

It was a similar thing. First of all, where I came from—it was Germany at the time, but it's now Poland. During the War, when I was a youngster, we had Polish stable hands. They were forced laborers in our village. The Nazis would round up whole blocks of them in Warsaw and bring them in to work the fields. They were the only people I really associated with—the only guys our own age we spent any time with as children. We spoke a pidgin German. They were really nice, down-home people. Dick Spotswood, who did that series of reissues of American vernacular music for the Library of Congress, played records of Polish and Ukranian music for me. Especially the extraordinary Ukranian fiddler, Pawlo Humeniuk. He had a wonderful country sound with just a bowed bass behind him. The Polish stuff was very much like it. I always did like polka bands. That was a very popular kind of music back in the '50s. Down in Texas, they have what they call Bohemian bands. They're Czech. They settled there in the last century and still play a fiery brand of European brass band music that has a definite Southwestern swing to it.

Do you feel that any of this could be commercial music?

I think Los Lobos is showing that *Norteno* music can be commercial if you mix it with rock 'n' roll. When Les Blank made that film with them on polka music, *In Heaven There Is No Beer*, one of the disc jockeys in the movie said, "I don't know if that'd be all that good. We would probably all sound like Lawrence Welk." That's true. When you take an ethnic music and try to make it popular for everybody, you usually grind out all the good stuff. What's left over is the mush. There's a lot of regional and ethnic music today, but I haven't touched a lot of it because I know I can't sell it. Like the Bohemian music from Texas, for example. The Yaquis and the Papago Indians of Arizona play a kind of *Norteno* music, but they don't sing. They just play instrumentals with saxophone and accordion, together with drums and bass. That's their dance music. That's going as strong as ever. It's all over the place. With the Mexican stuff. you have guys tell you, "The youngsters go to school with the Anglos, and in school they all want the Anglo music. But once they graduate and come back, they come to our dances again." Things are changing. There are very strong regional musics. It's a social music.

Tell me about Flaco Jimenez.

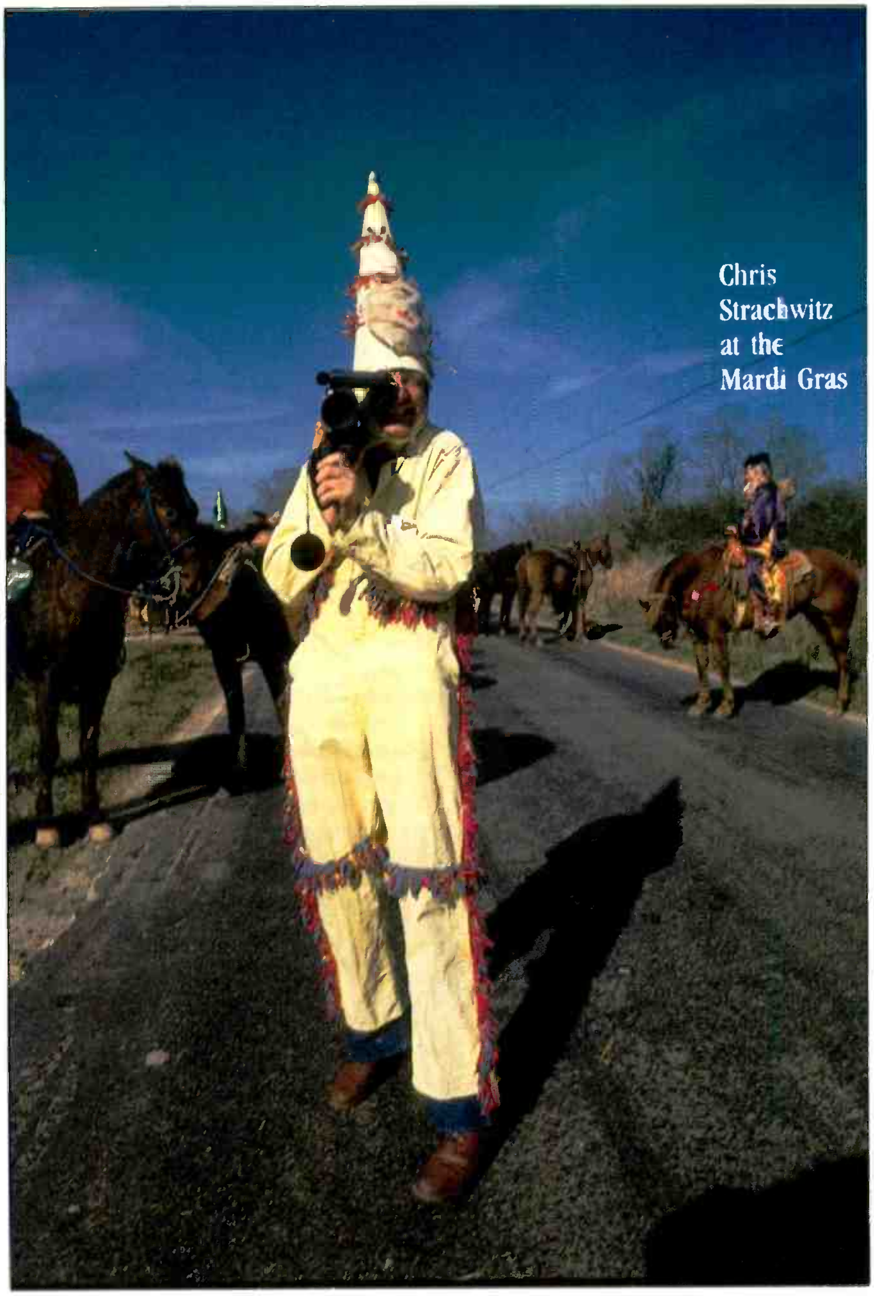
He's the parallel to Clifton, an extraordinary musician and charismatic person. Flaco really enjoys playing with Ry Cooder and Peter Rowan, where he is the sideman and has to listen to what they're playing. He doesn't depend on the bag of tricks he plays in the *conjunto* field. Ry Cooder took him along on the Chicken Skin Review for a while. They went all over the place. They went to Europe. Peter Rowan did something similar. Flaco was also on several records with Bob Dylan and Santana.

What's the difference between conjunto *and* Norteno *music?*

It's the same thing. *Conjunto* simply means "group," and it's used in a lot of Spanish-speaking, regional styles. In South Texas, the term usually means an accordion group with *bajo sexto*, drums, and bass. But the style is also called *musica Nortena*. In Mexico, they call it that because it comes from the north. It's popular all over Mexico, the Southwest, and in Chicago—wherever there are Mexicanos from Texas or from the north of Mexico. There's more money up here than in Mexico, so all the good musicians come up here.

What's been the greatest satisfaction for you?

I enjoy recording this music. I get such a pleasure from it. I think there must be others out there who will share that joy. When Flaco Jimenez was in Europe, it gave him great pleasure to meet a new audience. Mance Lipscomb and Fred McDowell had pretty harsh lives, but they really enjoyed their last years. I enjoyed those blues shows in Germany—it was amazing to see the reaction of the Europeans. These guys had never been anywhere except in beer joints where people threw bottles. All of a sudden, they were celebrated musicians! There's so much good music in this world. I just like to put some of it out there so people can hear it. The big music industry pushes the overdubbed, overproduced stuff they have an interest in. I figure somebody's got to fight it. Somebody's got to put some real good stuff out there.



Chris Strachwitz at the Mardi Gras

Photograph: Philip Gould

Editor's Note: Down Home Music, the retail store/mail order firm operated by Chris Strachwitz, is located at 10341 San Pablo Ave., El Cerrito, Cal. 94530; (415) 525-1494.

AKAI AD-93 DIGITAL AUDIO TAPE RECORDER

Manufacturer's Specifications

Frequency Response: 2 Hz to 22 kHz, ±0.5 dB.

Dynamic Range: Record, 90 dB; playback, 96 dB.

S/N: 92 dB.

THD: 0.005% or less at 1 kHz, 0 dB.

Wow & Flutter: Below measurable limits.

Analog Input Level and Impedance: 316 mV for 0 dB, 47 kilohms.

Digital Input Level and Impedance: 0.25 V peak to peak, 75 ohms.

Analog Output Level and Impedance: 2 V at 0 dB, 100 ohms.

Digital Output Level and Impedance: 0.5 V peak to peak, 75 ohms.

Headphone Output Level and Impedance: 30 mW at 32 ohms.

Tape Speed: 8.15 mm/S.

Search Speed: 200 times normal speed, maximum.

Fast Winding Time: 50 S for 120-minute tape.

Power Requirements: 120 V, 60 Hz. (Sample tested was 100-V, 60-Hz version.)

Dimensions: 18.1 in. W × 4.6 in. H × 15 in. D (46 cm × 11.7 cm × 38.1 cm).

Weight: 24.3 lbs. (10.9 kg).

Price: Not available.

Company Address: Akai Div. of Mitsubishi, 225 Old New Brunswick Rd., Piscataway, N.J. 08854.

For literature, circle No. 90

Photograph: Robert Lewis

Although DAT recorders are available in Japan and many European countries, as of this moment you still can't buy them from authorized dealers in the United States. Nevertheless, this situation is not likely to continue indefinitely, despite the attempts of certain record companies to stop audio technology from progressing along logical lines. That being the case, I was happy to be able to look at another DAT entry, Akai's Model AD-93. Its designers have taken advantage of just about every user convenience feature of the R-DAT Standard, which was created by 84 companies more than three years ago. Beyond convenience features, Akai has concentrated its engineering effort in creating an excellent, reliable tape transport system as well as digital and analog circuit topology that takes full advantage of R-DAT's recording and playback potential.

The AD-93 offers complete automatic subcode recording functions. When you make a DAT recording, start ID, program number and absolute time are automatically recorded as well. If you want to change the start ID codes, you can manually erase or record start ID points even after a recording has been made without affecting the audio program in any way. Renumbering of programs is also possible. Once a tape has the recording numbers encoded, you can program up to 60 selections for play from among a maximum of 39 numbered selections on the tape. Direct selection of program numbers is accomplished by using the number keys on the supplied remote control. Skipping one or more selections, either forward or backward on a tape, is possible by using appropriate keys on the front panel or on the remote. Fast cue and review, at 16 times normal play speed is available, as are the now familiar repeat play modes common to most CD players (and DAT recorders). A particularly attractive feature is "End Search," a function that quickly finds the end of all recorded material on a tape that's still partially blank. With a maximum recording time of two hours, I find that I rarely fill up a tape in one recording session. It's nice to be able to find the exact spot to begin recording the next time I want to add material to that tape.

Using an external timer, it is possible to set the AD-93 so that it will record a program in your absence or begin playback at a specified time. As if the microprocessors in a mechanism such as the AD-93 didn't have enough to do, this deck even displays nine different error messages if it encounters such problems as moisture condensation, broken tape, overly thin tape, transport motor problems, etc.

Less obvious but equally important are some of the AD-93's structural features. The capstan motor is a high-torque, direct-drive type, as is the head drum motor. Three additional d.c. motors are employed for reel drive, tape loading, and cassette tray drives. The tape head mounted in the spinning head drum is a spatter Sendust type, combining the magnetic properties of Sendust with the wear-resistant qualities of ferrite. The head drum itself uses a new silicon-enhanced aluminum alloy for reduced tape and head wear. The chassis features a thick upper panel (1.6 mm) and triple-layer construction of the side panels, and it is supported on large pedestal-type feet for reduced vibration.

Six power supplies are used in the AD-93, with the analog supplies completely separated from the supplies powering the digital circuitry. Separate digital and analog signal-handling circuit boards are used. Audio amplifier circuitry is divided into four separate sections: Recording, playback, left, and right.

Unlike some of the very first DAT recorders I tested, this one offers two-times oversampling digital filtering and independent A/D converters on the recording side, together with four-times oversampling, digital filtering, and independent left- and right-channel D/A converters for playback.

Control Layout

The front-panel layout resembles that of some of the other DAT machines I have evaluated. A power switch, headphone jack, and headphone level control are at the extreme left. Along the top half of the panel are the smooth-gliding cassette drawer, a large fluorescent display area, and a pair of concentrically mounted record level controls.

The counter display shows either elapsed time, absolute time, or time of a given numbered program. If playback of a tape is initiated from its beginning, the elapsed and absolute display times will be the same. However, if you insert a tape that's partly wound onto the take-up reel in its cassette

The AD-93's analog and digital circuitry takes excellent advantage of R-DAT's recording and playback potential.

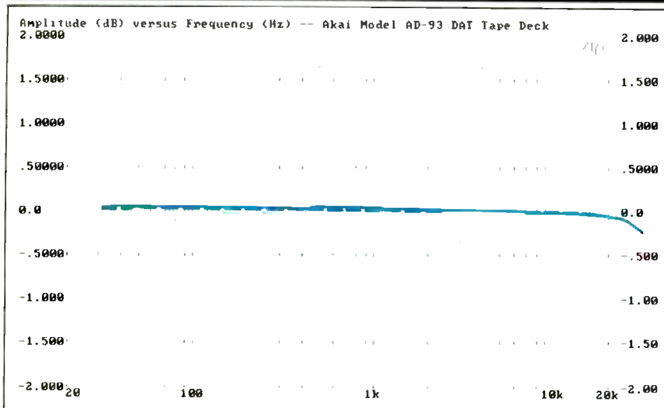


Fig. 1A—Record/playback frequency response at 0-dB record level of left channel (solid curve) and right channel (dashed curve) using dub of CBS CD-1 test disc.

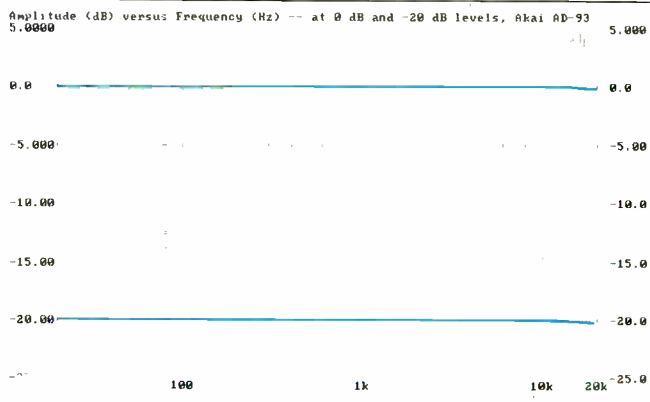


Fig. 1B—Record/playback frequency response at 0 dB (using dub of CD-1 test disc) and at −20 dB (using Japan Audio Society test tape).

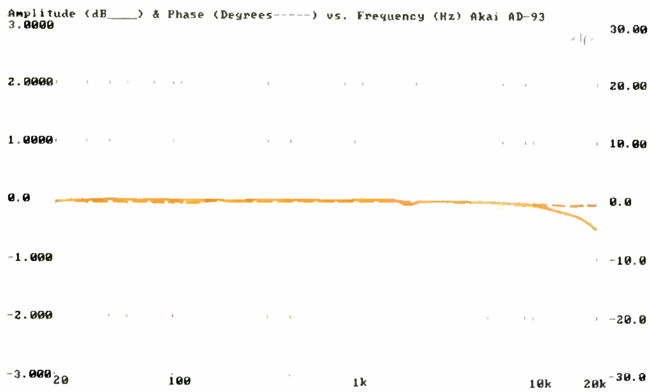


Fig. 2—Frequency response (solid curve) and interchannel phase response (dashed curve).

housing, the counter will read elapsed time starting from the new play point, but absolute time from the beginning of the tape. Program number, repeat play, tape-travel mode, and start ID indications are provided in the display area, as is a digital peak-reading recording level meter calibrated from 0 down to −42 dB. The metering system has a peak hold function that temporarily retains level indications above −21 dB. Overrecording—a situation to be scrupulously avoided with any digital recording system—is shown by a bright red indicator at the right end of the peak level meter. Other indicators in the display area show that the deck is in record mode, when "digital direct" mode has been selected, and the record or playback sampling frequency.

Remaining controls are arranged in two rows along the lower half of the front panel. A "Tape View" button in the upper row, when depressed, illuminates the cassette area during playback or recording so that you can see how much tape is left. This is a handy feature, but in my view it does not replace the accurate tape remaining indicators that some other DAT machines have. Other buttons along this upper row include "Counter Mode," "Counter Reset," forward and reverse program skip controls, and fast forward and rewind controls that also serve as cue and review buttons when the recorder is in play mode.

Controls and switches along the bottom row include "Timer Start" (used in combination with an external timer), "End Search," cassette tray "Open/Close," "Repeat," and "A-B" repeat. There are four subcode handling buttons: "Erase," to erase unwanted start ID subcodes; "Auto," to select automatic or manual subcode recording; "Write," to record the start ID data at any point on a tape, and "Renumber," to change program numbers in order (from 1 upward). Other controls in the bottom row are "Audio Mute" (for creating blank sections on a tape), "Rec Pause" (to obtain record mode prior to moving the tape so that you can set levels), "Play," and "Stop." A "Loading Off" button moves the tape away from the head to prevent tape and head wear during pauses. The tape is automatically moved away from the head drum if no operation is performed for 10 minutes.

The rear panel is equipped with analog pairs of input and output jacks, a digital coaxial input and output jack, an optical digital input and output jack, and an "Auto Rewind" selector with which you can choose to have the tape stop or rewound automatically when the end is reached.

Measurements

There are very few prerecorded test tapes available for testing DAT recorders. I have one from Sony that contains only a few test frequencies at maximum recording level on both channels, and even fewer test frequencies for testing channel separation and distortion at −60 dB. Recently, I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A great benefit of DAT is that there's no such thing as tape saturation at high frequencies.

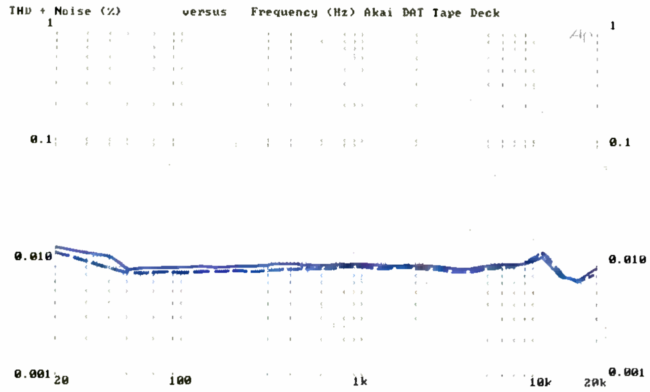


Fig. 3—THD + N vs. frequency at 0-dB recording level of left (solid curve) and right channels.

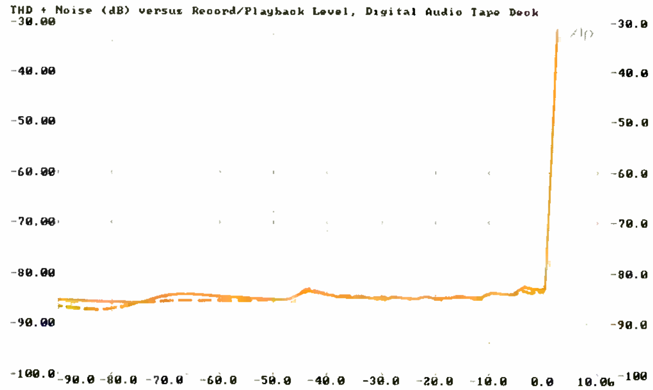


Fig. 4—THD + N vs. record/playback level of left (solid curve) and right channels.

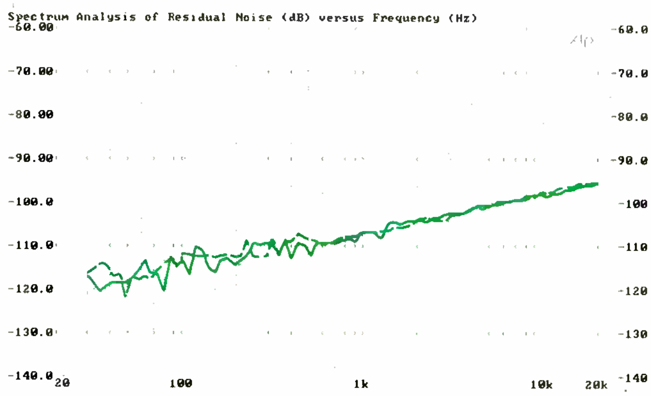


Fig. 5—Spectral analysis of residual noise, using ⅓-octave band-pass filters, left (solid curve) and right channels.

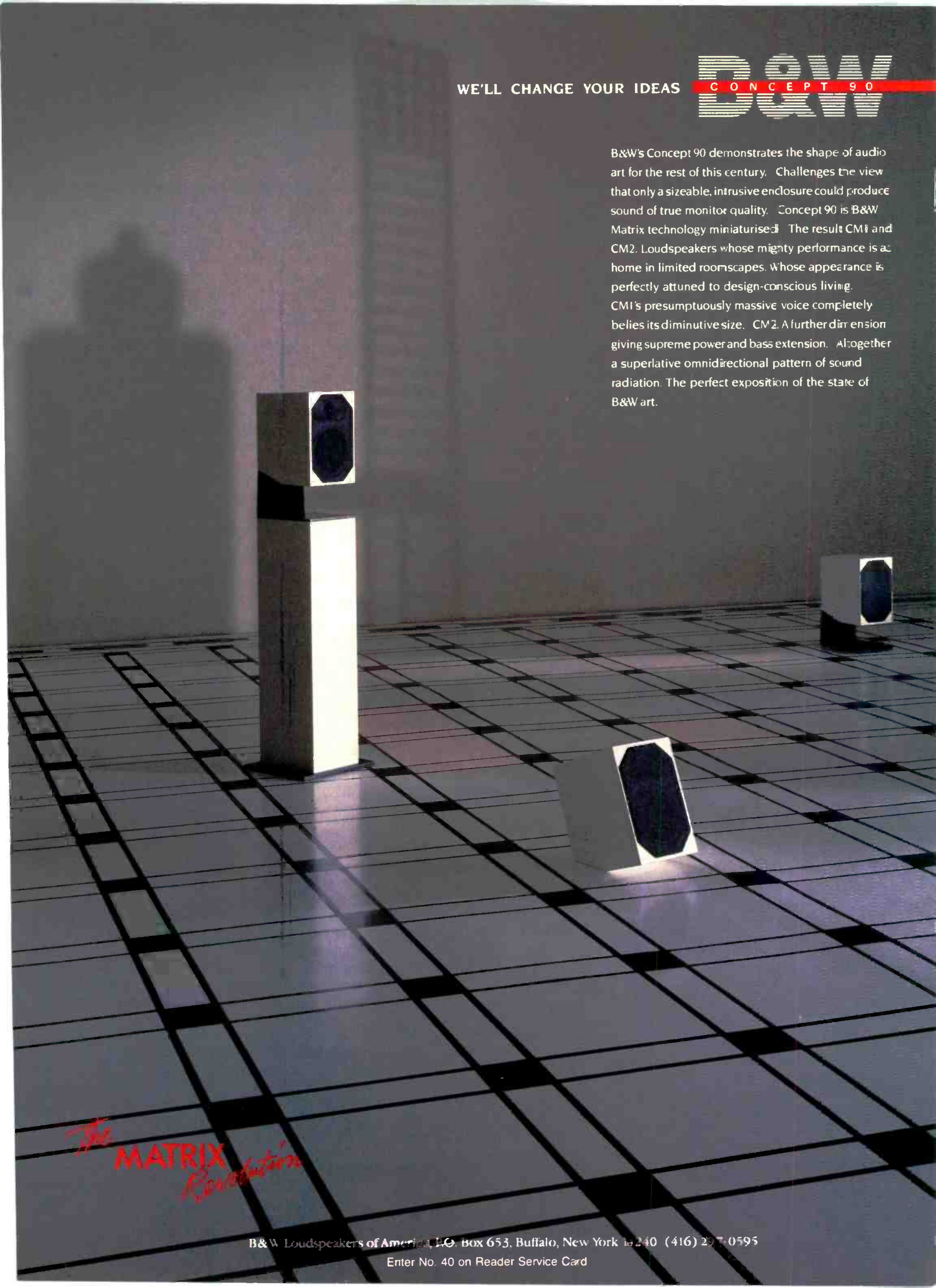
acquired a test tape issued by the Japan Audio Society (an active group which also produced an excellent CD test disc early on in the development of CD players). Though largely devoted to musical selections for subjective testing, this tape does contain a full array of spot frequencies as well as a sweep from 20 Hz to 20 kHz, recorded at −20 dB.

The AD-93 is the first DAT recorder I've been able to test using my recently acquired computer-driven Audio Precision System One test gear. With the aid of this programmable equipment, I was able to prepare some of my own test tapes, admittedly via the digital-to-analog-to-digital recording and playback route. Since this is the way most users will record and play back anyway, I felt that it was a fairly legitimate approach. Among the test tapes I prepared is a recording of my favorite (and EIA-approved) CD test disc, the CD-1 issued by CBS Records. Of course, the DAT Standard did not permit me to prepare this test tape by digital-to-digital recording either; digital recording in DAT decks is confined to a sampling rate of 32 or 48 kHz, whereas the CD-1 (like all CDs) has a sampling rate of 44.1 kHz.

Figure 1A is a graph of frequency response using the dub of the CD-1's frequency sweep. The level was adjusted for maximum (0 dB) as indicated on the AD-93's peak-reading meter. Response of both channels was plotted simultaneously and was identical over the range of frequencies measured. Response was down only −0.23 dB at 20 kHz—try accomplishing that with any analog cassette deck, using any grade of tape, at 0-dB recording level! Here's one of the great advantages of Digital Audio Tape—there's no such thing as tape saturation at high frequencies! When you are recording zeroes and ones at a fixed level on tape, the tape doesn't really care whether their patterns alternate back and forth 20 times a second or 20,000 times a second. Furthermore, when you use a DAT machine, what you put in during recording is what you get out during playback.

To further illustrate this point, I compared my homemade swept frequency tape's response with the −20 dB prerecorded frequency sweep supplied on the Japan Audio Society's test tape. The results are shown in Fig. 1B. To show both curves, I changed the vertical calibration of this graph (easily accomplished with the Audio Precision system), but it is clear that the curves are about as identical as any two frequency response curves can be.

In Fig. 2 yet another vertical scale was used, this time extending only ±3 dB about the 0-dB axis. In this graph, frequency response is shown once more (solid curve), but superimposed on it is the interchannel phase response of the system through the entire record/play process. Phase error at 20 kHz (indicated by the dashed curve and the right-hand vertical scale) was a mere −0.89°! Compare this with the azimuth of any accurately aligned cassette deck,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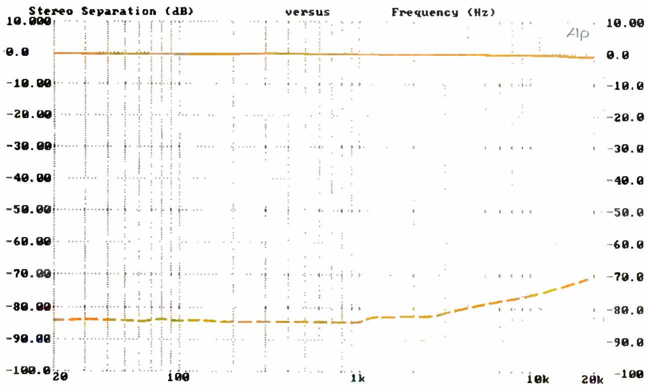
In terms of phase response, DAT recorders are clearly superior to analog decks. The AD-93's phase error was only −0.89° at 20 kHz!

and you'll see why DAT recorders are so superior in this regard as well.

Figure 3 shows how THD + N varied with frequency. The variation, in fact, was negligible. At 1 kHz, THD + N was approximately 0.008%. While this appears at first glance to be slightly worse than Akai's specification, I should point out that I measure THD *plus noise*, whereas Akai quotes only THD. The 87-dB A-weighted signal-to-noise ratio that I measured for this recorder (using the record mute feature of the deck to record a "quiet" section of tape) corresponds to a level of 0.005% all by itself, so the combined reading of 0.008% for THD + N is really not out of line.



A

B

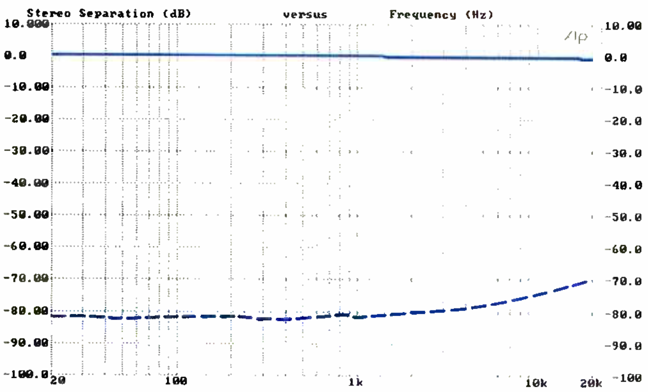


Fig. 6—Separation vs. frequency with signals passing only through the AD-93's electronics (A) and with sweep of frequencies recorded on tape, played back, and measured for one channel (B). See text.

Figure 4 is a plot of THD + N versus recorded level. Instead of expressing THD + N as a percentage, the vertical scale is calibrated in dB *below maximum recorded level*. This method of presentation shows that the quantization distortion, in absolute terms of amplitude, remains virtually constant at all recording levels from −90 to 0 dB. As might be expected, however, the moment the recording level exceeds the 0-dB mark, the distortion curve rises almost vertically. At a recording level of +2.0 dB, distortion has reached more than 2.0% (−30 dB corresponds to just over 3.16%). Learning to stay below that dangerous "0-dB" mark on a DAT recorder is going to take some practice for those who are accustomed to letting analog cassette deck meters go well above the 0-dB mark on peaks. On the other hand, backing down too much when making a DAT recording means sacrificing some of the dynamic range and signal-to-noise ratio potential of the digital recording process. Using the EIA's technique for measuring dynamic range, I obtained a figure of 94 dB for the complete record/play cycle. Using the EIAJ's method (THD at −60 dB, expressed in dB, plus 60 dB), dynamic range was only 84 dB. I believe that the EIA method is a more legitimate way of defining dynamic range and will therefore continue to use it when measuring this parameter on CD players as well as DAT recorders.

Figure 5 shows a spectral analysis of residual noise produced by the Akai AD-93. A ⅓-octave band-pass filter was used in making this analysis, and, as you might expect, noise tended to rise with frequency.

Figures 6A and 6B may appear to be identical, but they are not. Because a DAT recorder converts analog input signals to digital form, records that digital data on tape, and then, during playback, reverses the process, it has been suggested that the tape itself has little or no effect on the measured performance. If that were the case, it should be possible to test a DAT recorder without even using moving tape. One could simply apply a signal to the inputs and then monitor the output via the analog output jacks, since the input signals will have gone through the entire A/D and D/A conversion via the recorder's record and playback circuitry. Indeed, this proved to be true in nearly all of the tests I performed on the AD-93. I recorded all my tests onto tape and then played them back. However, I found that results were the same when I simply applied signals to the analog inputs and measured the signals at the analog outputs. One exception occurred when I measured separation. Figure 6A shows how separation varied as a function of frequency when I omitted the intermediate step of actually recording tones on the tape. Under these conditions, separation measured 85 dB at 1 kHz, yet when I actually recorded a sweep of frequencies on tape (for the left channel) and played the tape back, separation decreased just a bit (Fig. 6B). Now, separation at 1 kHz measured 82 dB, a difference of 3 dB. I can't tell you just what caused this slight decrease in separation. Theoretically, it should not have occurred, but it taught me a lesson: You can't always rely on theory. From now on, all DAT testing will be done through the full record/play cycle, theories notwithstanding!

I decided to check the AD-93's linearity even though I realized full well that using the analog dub of the CD-1's

When playing back musical passages, the Akai deck provided the same noise-free qualities I have come to associate with CD sound.

linearity test tracks was not a very rigorous test of this important parameter. Since no digitally prerecorded tapes involving linearity testing were available, I decided that using the analog copy would be better than nothing. The results, expressed as deviation from perfect linearity, are shown in Fig. 7. I was not at all surprised to see that the deviation was greater than what I usually measure for a CD player. I'm reasonably certain that most of the deviation is due to nonlinearities in the analog circuitry (both recording and playback) of the DAT recorder rather than with the A/D and D/A conversion processes themselves.

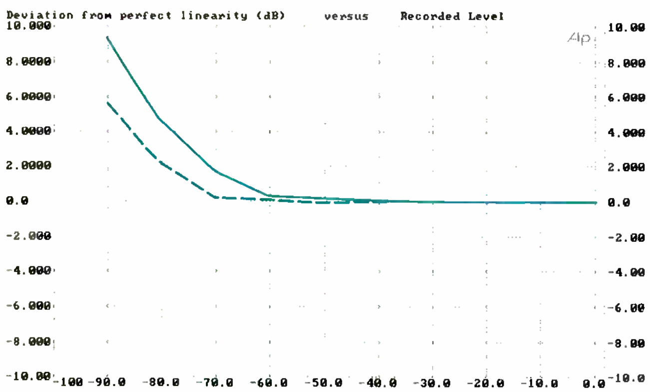


Fig. 7—Deviation from perfect linearity for left (solid curve) and right channels using undithered signal.

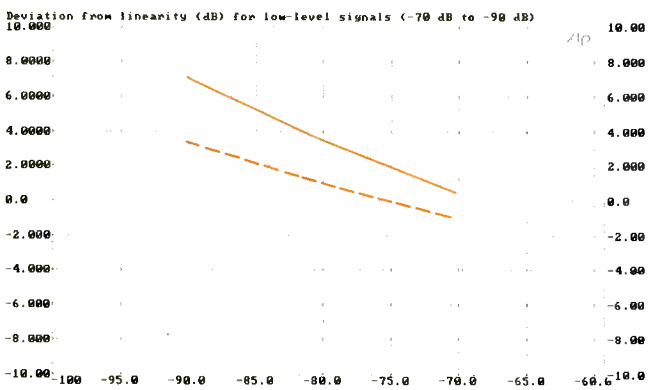


Fig. 8—Same as Fig. 7 but using low-level, dithered test signal.

I repeated the test, using a low-level dithered signal (again, recorded through the analog inputs onto a DAT cassette and then played back to make the measurement). This allowed me to compare results of a dithered signal (Fig. 8) with those of an undithered signal (Fig. 7). Sure enough, while the deviation from perfect linearity at −90 dB for the undithered signal was over 9 dB for the left channel and nearly 6 dB for the right, deviation at −90 dB measured only 7 dB for the left channel and 3.3 dB for the right using the dithered test signal.

Use and Listening Tests

The few prerecorded musical DAT cassettes that I own really don't contain enough material for me to be able to judge sound quality with the level of confidence I would like—especially since I don't have copies of the same material on CDs, LPs, or analog cassette tapes. Despite this, I can say that the musical numbers on the Sony and the Japan Audio Society test tapes were reproduced by the AD-93 with the same kind of noise-free, distortion-free qualities that I have come to associate with CD sound. Indeed, even when I recorded a few favorite CD tracks onto a DAT cassette using the analog inputs, the sound quality of the playback was barely distinguishable from the original CD. In one or two cases, I did seem to lose some of the dynamic range of the CD when it was transcribed to DAT, but I attribute this to my being a bit overcautious in setting recording levels.

I have one small criticism about the transport functions of this machine. The record/pause control enables the user to go into the record mode (without actually starting to record) when setting levels, but there is no similar function available when accessing a particular program during playback. Regardless of whether you are in play or stop mode, if you call up a given program number, the transport will rapidly zip through the tape to find the exact start of the program. Then it begins to play the program immediately, without pausing or stopping. I suppose this is really minor, but I would have liked to have had the option of reaching the desired program and pausing until I hit the "Play" button or of going right into play mode when the desired program start point was reached.

In terms of its circuitry, construction and features, I regard the Akai AD-93 as a "second-generation" DAT recorder. Its designers have obviously studied the first DAT units and have tried, with some success, to improve upon them. Perhaps our long wait for DAT in this country will have some benefit after all. By the time we can buy a DAT recorder at our local audio shop, maybe we will have reached the *third* generation of products. Remember that the first CD players were not all they were cracked up to be—at least compared with what's available now. Don't get me wrong! I think we, as audio enthusiasts, ought to be allowed to decide whether current DAT machines are good enough for our needs, rather than having the decision taken out of our hands by the major record companies and Congress. If you're planning a trip to Japan soon (of if you know a dealer bringing in gray-market DAT recorders directly from Japan), the Akai AD-93 is certainly one DAT recorder worth considering.

Leonard Feldman

Now you CD it...now you don't.

INTRODUCING THE PIONEER TUNER/6-DISC CHANGER WITH REMOVABLE CONTROLS.

Whoever said you can't take it with you obviously never owned Pioneer's DEX-M300/CDX-M100—the most versatile tuner/multi-CD changer system ever designed for a car.

The detachable tuner/CD controller snaps instantly in or out of the dash. Or it can be mounted on a cord that floats inside your car. Leave your car and you can take the pocket-sized controller with you.

And when you're ready for the road, slip in six discs, using the same 6-disc magazine as Pioneer's home CD changers, and enjoy conveniences like track search, track scan, random play and up to 512 track programmability. And of course the incomparable sound of Supertuner III.™

The DEX-M300/CDX-M100. When it comes to incredible digital sound, it's out of sight.

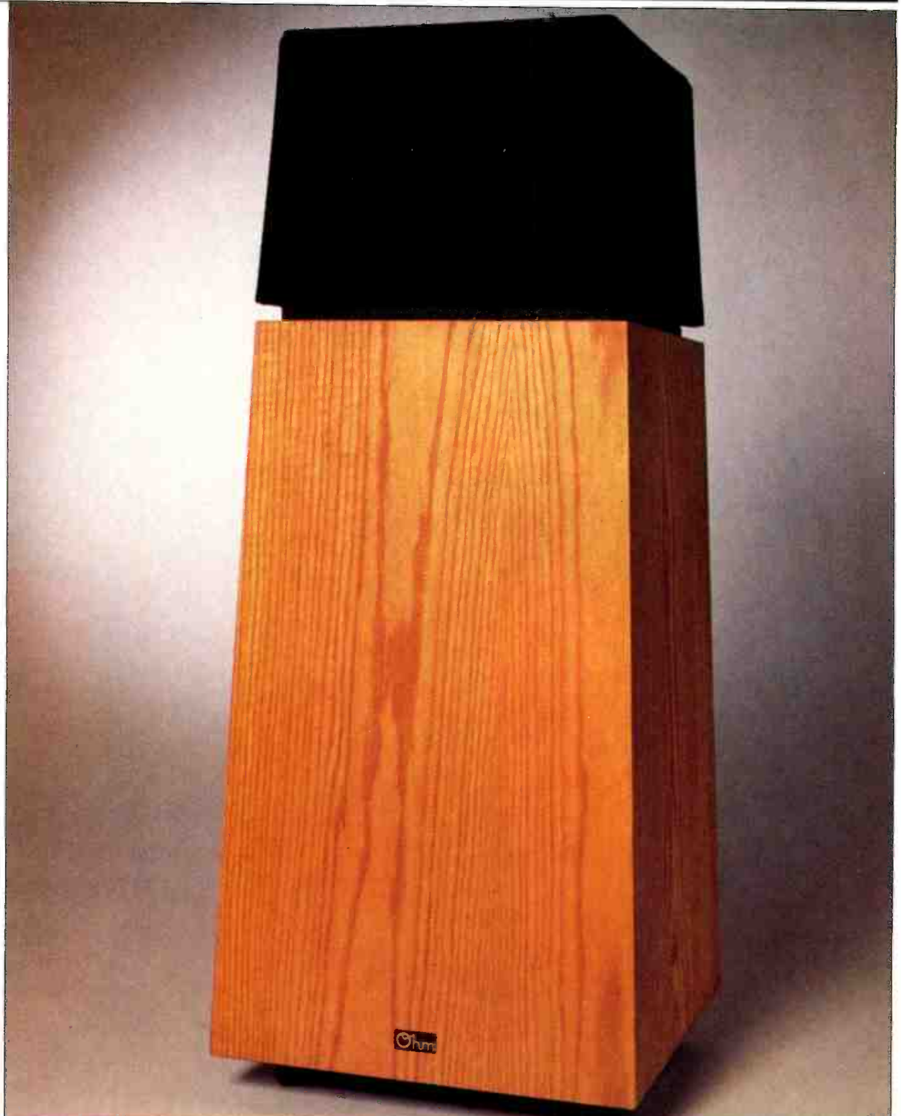
PIONEER®

 System shown: DEX-M300 (CD-M20 extension kit included) and CDX-M100 CD changer.

Enter No. 32 on Reader Service Card

2

OHM WALSH 5 LOUDSPEAKER



Manufacturer's Specifications

System Type: Two way, vented with Walsh woofer/midrange and dome tweeter.

Drivers: 12-in. (30.5-cm) woofer and 1-in. (2.54-cm) dome tweeter.

Crossover Frequency: 8 kHz.

Nominal Impedance: 4 ohms.

Frequency Response: 25 Hz to 25 kHz, ±4 dB.

Power Recommendations: 50 watts minimum, 500 watts maximum, 1 kilowatt maximum on peaks.

Dimensions: 17½ × 17½ in. at bottom, tapering to 15 × 15 in. at top; 43 in. H (44 × 44 cm at bottom, tapering to 38 × 38 cm at top; 109 cm H).

Weight: 95 lbs. (43 kg).

Price: $4,800 per pair.

Company Address: 241 Taaffe Place, Brooklyn, N.Y. 11205.

For literature, circle No. 91

In the Ohm Walsh 5's name, "Walsh" refers to a unique application of a cone-type driver which allows it to reproduce an extraordinarily wide frequency range. The special deep-cone driver, originated by Lincoln Walsh, is mounted face down on the top of the cabinet and is allowed to radiate in all directions from what would normally be called its back side. The result is a wide horizontal directivity pattern. There's no crossover until 8 kHz, where a titanium dome tweeter of controlled directivity extends the frequency response to 25 kHz.

The first Ohm Walsh speaker, the Model A, was introduced in 1970. The most famous and long-lived, however, was the Model F, a 12-inch, single-driver system which was produced for 15 years. The Walsh 5 is a limited-edition, top-of-the-line model that can be considered a descendant of the Ohm F. Five other Walshes extend the line down to the Sound Cylinder, at $549 per pair, and Ohm makes three conventional systems as well.

Extreme solidity of construction is evident in the Walsh 5's 6.5-cubic foot, oak-veneer cabinet. Four hand-tightened wing nuts secure the easily removed top section (which contains the Walsh driver, tweeter, and sound absorption within a cylindrical screen) to the cabinet. With the top removed, cross-bracing 2 × 4s can be seen through the opening. What cannot be seen are the 17 other panel stiffeners and 13 lead damping panels. The damping panels, composed of 1⁄16-inch lead bonded to quarter-inch plywood, are applied in specific locations to suppress resonances. The bottom opening vent is an unusually large 4 inches in diameter to allow maximum air volume velocity without restriction or turbulence noise. The large vent diameter requires an unusual duct length to tune the cabinet to 25 Hz. When I reached in, my arm disappeared to the elbow before my hand encountered a right angle bend.

A recessed area near the bottom of the finished rear panel contains gold-plated, five-way input connectors and three switches. The switches are labelled "Perspective," "Lows," and "Highs." Each switch has three positions, an average or middle position and two which offer small amounts of boost or cut in a particular frequency range. "Perspective," as the excellent, although nontechnical, owner's manual indicates, is a broad midrange control for changing one's "seat" in the concert hall.

The assembled system is topped off with a black grille cloth stretched over a wire frame. Casters allow moving the 95-pound speaker easily to experiment with placement. They also space the cabinet off the floor, providing an exit for the radiation from the down-firing vent.

The basic idea of the Walsh driver is to deal with the inevitable cone breakup at high frequencies, turning it into an advantage to provide cylindrical radiation. Breakup means that not all parts of the cone are moving in the same direction at the same time. A conventional speaker seeks to extend pistonic operation to as high a frequency as possible, and then it crosses over to a smaller driver whose breakup range is higher yet. The Walsh driver, however, encourages breakup in the form of controlled wave propagation downward and outward along its inverted cone. At high frequencies, the moving wave radiates the sound rather than the motion of the cone as a whole. The angle of the cone is chosen so that the outward or horizontal expansion of the supersonic mechanical cone wave matches the velocity of sound. Thus, as the wave approaches the bottom of the cone, it remains in phase with the acoustic wave radiated earlier near the top. Sound wave radiation is omnidirectional at low frequencies and approaches cylindrical at high frequencies.

In practice, science, art and black magic are required to make this happen. First, a Walsh driver must have a smooth transition from piston motion at low frequencies to wave motion at high frequencies. The transition occurs at about 1.6 kHz and is controlled by absorbing all wave motion within the cone before it reaches the outer suspension. The gradual absorption is provided by the modified polypropylene cone material and foam damping blocks affixed to its surface. If this were not done, the waves would reflect back up the cone from its edge and interfere with the new waves being sent down. This would produce the erratic response typical of conventional speakers in their breakup region.

The cylindrical radiation which comes about naturally from a Walsh driver must be restricted. The first Ohm Model F speakers were allowed to radiate into the full 360°. While it gave an airy sound, it proved to stimulate listening room acoustics too much. Experiments were carried out, over a span of years in different acoustical settings, with the Model F speakers fitted with acoustic absorption for the rear and sides. Eventually, a pattern maximizing radiation at a cross-fired 45° angle was chosen for best imaging and room compatibility. With Walsh drivers, such aiming does not necessarily compromise response flatness at other angles. Proper placement of absorption can evenly attenuate the entire upper frequency range, and in the Walsh 5, this absorption is located between the cylindrical screen and the driver. Toward the rear, a thin layer of felt is glued to the outside of the cylinder to further attenuate sound in that direction.

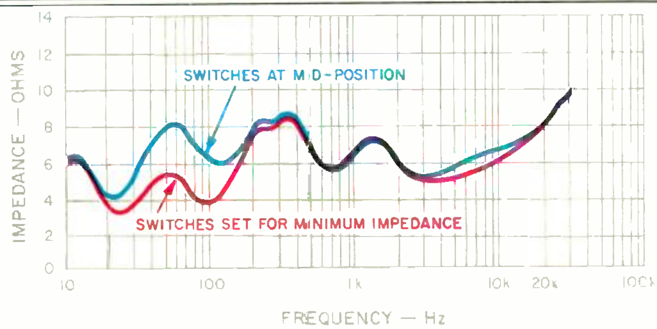


Fig. 1—Magnitude of impedance with rear-panel controls set to mid-position and set to produce minimum impedance.

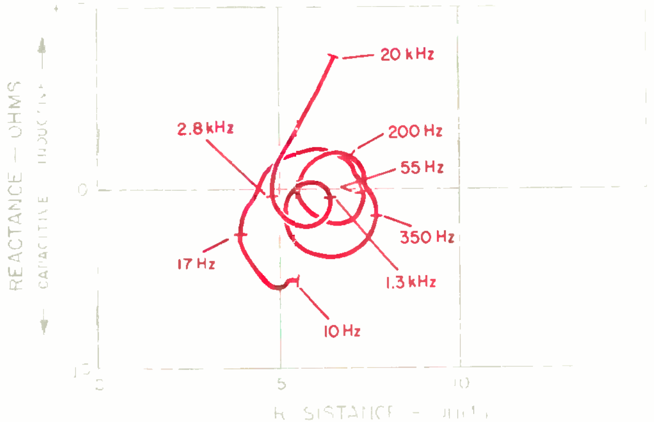


Fig. 2—Complex impedance.

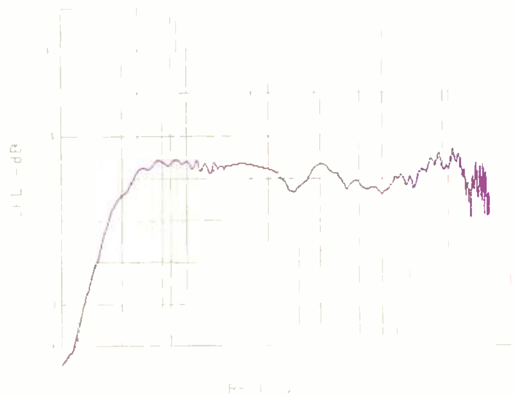


Fig. 3—One-meter on-axis anechoic frequency response, with an input of 1.0 watt into 4 ohms (2.0 V).

The Walsh 5's main driver has nearly cylindrical radiation, which needs to be aimed for proper imaging in a listening room.

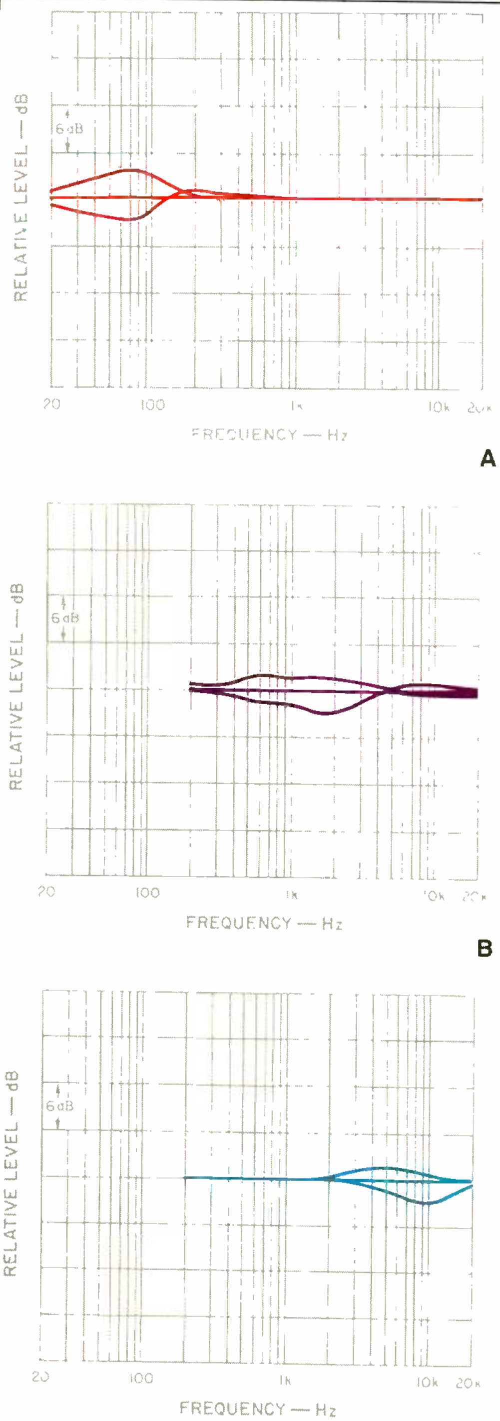


Fig. 4—Effect of rear-panel switches on frequency response, using "Lows" control (A), "Perspective" control (B), and "Highs" control (C).

Power handling capacity is another problem faced by any single driver that must cover the range from 25 Hz to 8 kHz. The voice-coil must be long-travel for the lows while being light and of low inductance for the highs. Expensive high-temperature materials and adhesives are, of course, needed. Ferrofluid is used in the magnetic gap of both the Walsh driver and the tweeter. This damping and heat-conducting oil has fine magnetic particles in suspension so that it does not fly from the gap. An automatically resetting circuit breaker further insures against overheated voice-coils.

Overexcursion of the Walsh driver on bass notes will produce harmonics of the fundamental, as is the case with any speaker. However, since mids and highs are also being reproduced by this driver, distortion—or modulation—of them will be produced as well. A long linear-travel voice-coil is employed to lower distortion. In addition, Ohm uses a large vented cabinet to reduce excursion requirements in the vicinity of 25 Hz. Perhaps most interesting, a patented crossover network consisting of two coupled inductors and two capacitors precedes the Walsh driver. These parts and two resistors are switchable by the "Lows" control, boosting where necessary and isolating the system from signals below its operating range.

Measurements

Input impedance, rated at 4 ohms, is shown as magnitude versus frequency in Fig. 1 and as reactance versus resistance in Fig. 2. Both the middle settings of the rear-panel switches and the settings yielding the worst-case load are shown in the magnitude plot. Impedance stays above 4 ohms and has little reactive component over most of the range, so the Walsh 5 will be a reasonable load for an amplifier rated for 4 ohms. Although it is not shown, impedance rises below 10 Hz as a result of the input filter network and is an open circuit at d.c.

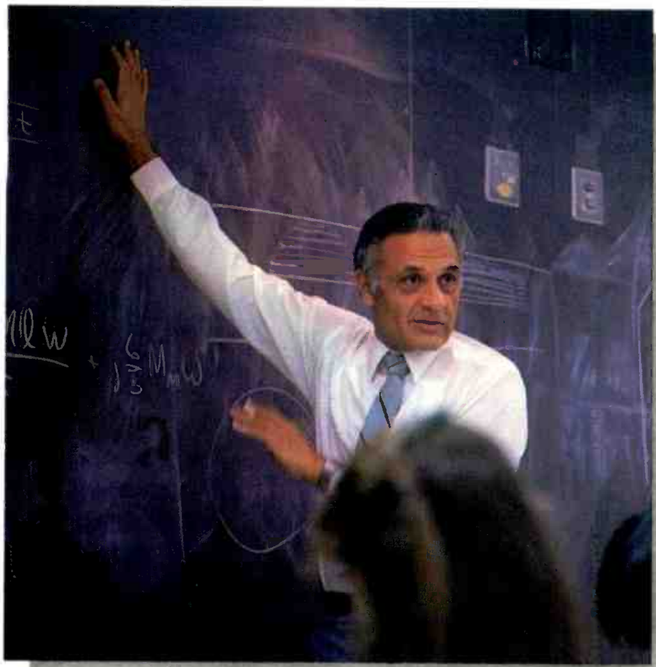
The 1-meter on-axis amplitude response is shown in Fig. 3. This is an anechoic or reflection-free plot except for the bass range, where the speaker is measured standing on a rigid surface and using the ground-plane technique (discussed in "Ground-Plane Acoustic Measurement of Loudspeaker Systems" by Mark Gander, *Journal of the Audio Engineering Society*, Vol. 30, No. 10, October 1982). Sensitivity averages only 80 dB SPL for 1 watt input; it would be higher with all controls switched to maximum. In a listening room, a pair of Walsh 5 speakers starts to catch up with conventional speakers having higher measured *anechoic* sensitivity because the Walsh 5's wider directivity puts proportionately more acoustic power into the room. Much of this power reaches the listener after reflection from walls. The Walsh 5 is still somewhat power hungry, undoubtedly due to high cone mass and losses in the damping materials.

The up side of Fig. 3 is that it is one of the most uniform and extended response curves that I have measured from a loudspeaker. If using a bigger power amp is the price for this performance, I am ready to pay it. The curve is slightly depressed from 400 Hz to 6 kHz. This is well within specification limits, but it could cause some of the recessed quality I heard earlier on vocals and on midrange solo instruments placed up front on the recorded soundstage.

Continued on page 89

The company, people, technologies, and products.

BOSE®
Better sound through research.



A company built on people–Above all, Bose is a company built on *people*. Our philosophy is simple: hire good people, create a good environment, and give those people freedom to grow. Many of the original MIT research team members are still at Bose. Our engineering staff has grown to more than 150, and includes specialists in metallurgy, electronics, acoustics, psychoacoustics, manufacturing, machine design, quality control, mechanical engineering and computer technology. Bose engineers have pioneered the audio technologies that have made Bose an industry leader for more than two decades.

What do you do when nothing sounds right?

If you're Dr. Amar G. Bose, you invent something that does.

For more than 20 years, Bose® Corporation has been regarded as a leading audio innovator. But the company *really* began in 1956, when a young assistant professor at the Massachusetts Institute of Technology decided to build a high fidelity system.

Although he was very careful to choose only components with the "right" specifications, everything sounded wrong once his system was playing. As a musician, he was disappointed. As a Doctor of electrical engineering, he wondered why there was such a huge discrepancy between the sound of live music and the reproduction offered by so-called "hifi" speakers. Ultimately, Dr. Amar G. Bose (top left) decided to find out. His simple question led to years of acoustical research at MIT (upper left)–and to the founding of Bose Corporation in 1964 (bottom left).

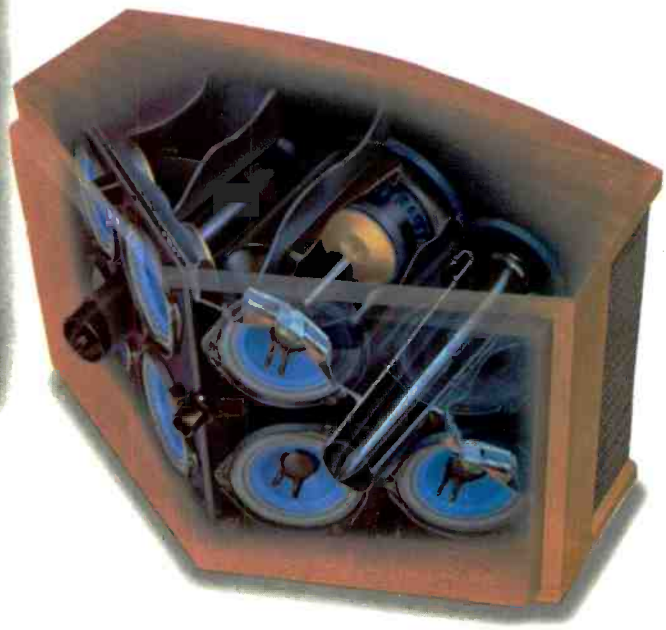
The Bose 901® Direct/Reflecting® speaker system: an audio breakthrough.

In 1968, Bose Corporation unveiled a speaker that incorporated the results of extensive acoustical research: the legendary Bose 901 Direct/Reflecting® speaker system. After 20 years, the 901 system is as popular as ever–a remarkable achievement in an industry where the average product's life span is five years. Now in its sixth series and incorporating some 350 research-generated improvements, the 901 system is the technological flagship of an entire line of products sharing the Bose reputation for quality and innovation.

Dr. Bose is currently the Chairman of the Board and Technical Director of Bose Corporation, as well as a faculty member at MIT. In 1987, he shared the "Inventor of the Year" award with Dr. William Short, one of his former MIT students, for developing Acoustic Wave® system technology. Working alongside Dr. Bose is another of his original MIT students, Sherwin Greenblatt (lower left). Originally Bose Corporation's first employee, he is now the company's president.

Many Bose products incorporate the advanced technologies pioneered and developed through Bose research. In fact, Bose has patented many of these inventions. Regardless of the technologies involved, our products share one goal: to provide listeners with the best sound possible in each price range.

The Bose 901® Direct/Reflecting® speaker system is based on the results of acoustical and psychoacoustical research. It's therefore not surprising that Hans Fantel of the *The New York Times* says it "... goes a long way toward accomplishing the ultimately impossible task of making an orchestra believable in the living room." *Now in its sixth version and with some 350 improvements made in the 20 years since its introduction, the 901 system remains Bose Corporation's technological flagship* as well as the top of a full line of Direct/Reflecting® speakers.



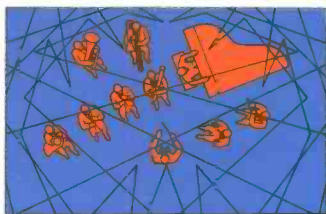
Better sound through research.

Bose® Corporation makes audio products that differ in form and function, because the people who use our products have a number of different needs. But regardless of its price, each Bose product incorporates the results of thorough research into sound, its reproduction, and its effect on the listener.

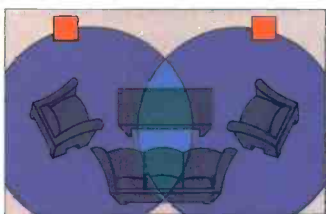
We started by learning as much as possible about the sound of live music, and how it is perceived by listeners. Next, we used that knowledge to discover and develop the various technologies that have the potential to improve sound reproduction. Finally, we turned these research-driven technologies into products that offer benefits listeners can easily hear. While our products continue to evolve and improve, many of their technological foundations remain the same—because the scientific principles behind them remain unchanged.

Over the past two decades, Bose has pioneered many unique technologies and innovations that improve the relationship between sound and listeners. *The following are just a few examples of "better sound through research."*

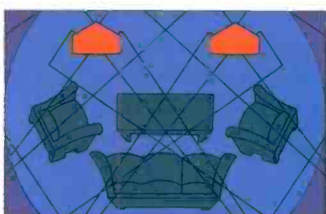
Direct/Reflecting® speaker technology.
By thoroughly investigating the physics of the concert hall, (opposite page, bottom right), it was discovered that live music in a concert hall is a combination of direct and reflected sound energy. What we end up hearing is mostly the *reflected* sound energy. Since conventional speakers are designed to reproduce mainly direct sound energy, they lose much of live music's realism.



Live Music is a combination of direct and reflected sound energy.

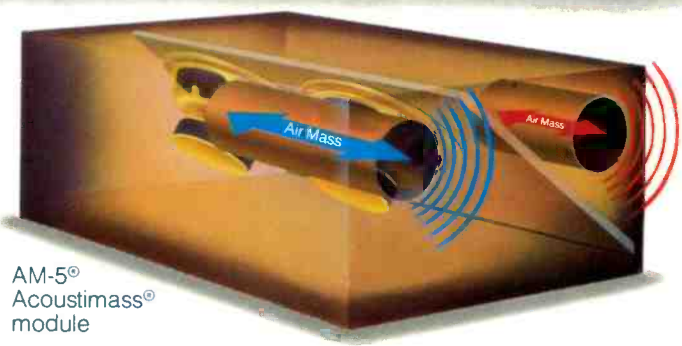


Conventional speakers reproduce mainly the direct energy. They miss much of live music's realism and impact—and let you hear full stereo only in a narrow spot (blue area).



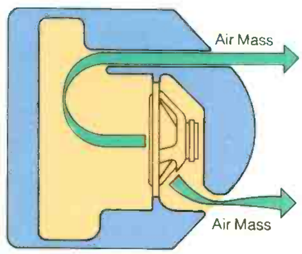
Bose Direct/Reflecting® speakers reproduce live music's natural balance of direct and reflected energy, bringing concert realism in full stereo (blue area) to your living room.

The complete Bose® line–Whether you need to fill a living room or stadium with sound, Bose makes products to fit your needs and budget. In any application, delivering better sound is a job for products that are *fundamentally different* from anything else. At Bose, that difference is provided by research.



AM-5® Acoustimass® module

Acoustimass Professional system (above) and operating principle (below)



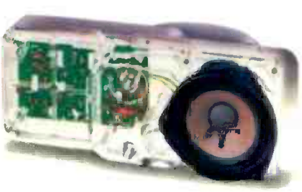
Acoustimass® speaker technology.
Acoustimass speakers operate on an entirely different principle from conventional ones. They launch sound into the listening area using *two masses of air*, rather than radiating sound directly from a vibrating surface. The benefits of this Bose-patented technology are profound: purer sound from a more efficient, compact system.

In the *Bose Acoustimass AM-5® speaker*, this technology enables a Direct/Reflecting® speaker to be nearly invisible. The system's heart–the Acoustimass module–can be concealed almost anywhere in the room, even under or behind furniture, delivering both the "superb sound and virtual invisibility" noted by *Stereo Review's* Julian Hirsch. The *Bose Acoustimass Professional powered speaker system* uses this technology to fill night clubs, theaters, concert halls and other areas with sound from a system that's a *fraction* of the size and weight of conventional professional sound equipment.

Acoustic Wave® system technology.
Acoustic Wave® system technology does away with conventional speaker enclosures altogether. Instead, an acoustic waveguide system produces low-frequency sound–making it possible to package true high fidelity performance into more compact, manageable forms.

The *Bose Acoustic Wave® music system* (AW-1) is a complete stereo the size of a portable typewriter, yet it delivers the sound of a full-sized component stereo system. Rich Warren of the *Chicago Tribune* called it "... the least intimidating quality sound system ever developed." The *Acoustic Wave® Cannon system* uses acoustic waveguide technology to generate deep, abundant bass (as low as 25 Hz!)

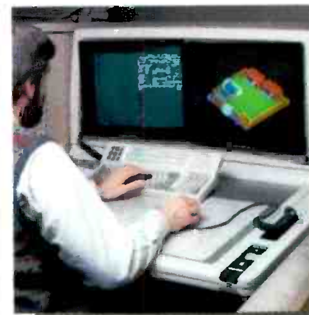
in professional sound applications without the bulky cabinets required by conventional designs. In the Bose Cinema Sound system, Acoustic Wave® Cannons bring film sound-tracks to life with full sonic realism. Bose also uses Acoustic Wave® system technology to bring the realism of high fidelity sound to some of the finest television sets available from leading TV manufacturers.



Switching amplifier technology.
Our patented Switching Amplifier technology enables us to push the benefits of our other technologies to their very limits. Unlike conventional amps, Switching Amplifiers are compact, efficient, and generate almost no heat while producing clean, low distortion high-fidelity sound. In the automotive music systems we design and build for leading car manufacturers, *Digital Mode switching amplifiers* are built right into the speaker modules (below left), taking up almost no interior space. In the Bose Acoustimass Professional powered speaker system, the *Two-State modulation amplifier* allows us to fit a 400 watt professional amplifier right inside the speaker.

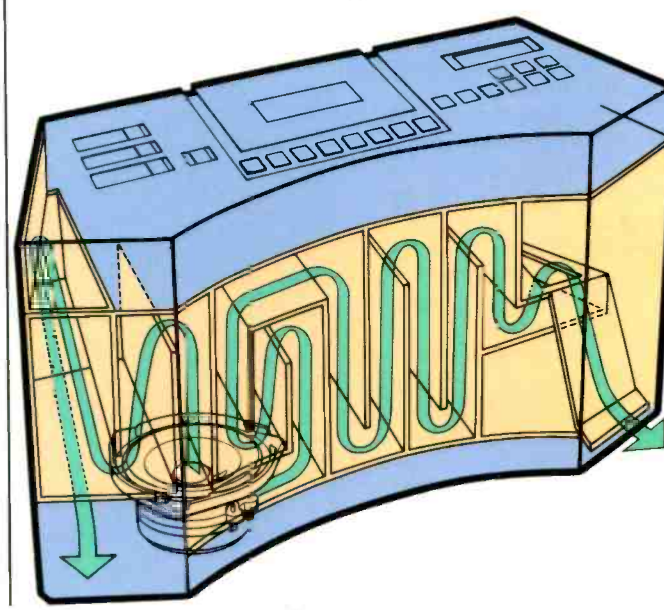
Advanced driver technology.
The loudspeaker driver is the heart of any audio system. When our products' performance requirements outstripped the capabilities of existing driver designs, we responded by developing the revolutionary patented *Helical Voice Coil (HVC) driver* (above). HVC drivers reconcile the need for speaker efficiency with the demand for high power handling. For example, while our 901® Direct/Reflecting® system can be comfortably powered by modest receivers, its power handling is *unlimited* in non-commercial applications. Our HVC driver's ability to withstand extremes of heat, cold and moisture is why it's found in dozens of Bose consumer, professional, automotive and commercial sound products.

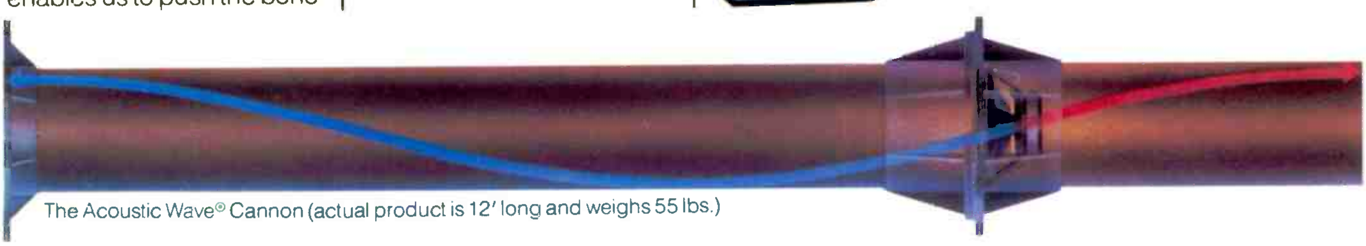
Psychoacoustics research.
In effect, the *listener* is the final component of the sound system. How sound affects listeners is critical in designing components that will better reproduce it. In the 1950's, Bose pioneered a more modern approach to a branch of acoustics called *psychoacoustics*, which studies the human end of the sound chain. Today, we've taken psychoacoustics to the point where the entire human hearing process can be taken into consideration during every phase of sound system design. For example, we simulate human hearing using an artificial head in conjunction with our AMS computer program to acoustically tune our automotive sound systems.



Computer-aided design (CAD)–A primary design tool at Bose that allows us to more efficiently and accurately design reliable, high performance products–and incorporate the latest technologies and improvements in them.

Acoustic Waveguide technology (below)–the complex acoustic waveguide inside the Acoustic Wave® music system. This invention by itself represents 14 years of research and development. The Acoustic Wave® Cannon system uses the same technology to provide deep bass in movie theaters and concert halls.

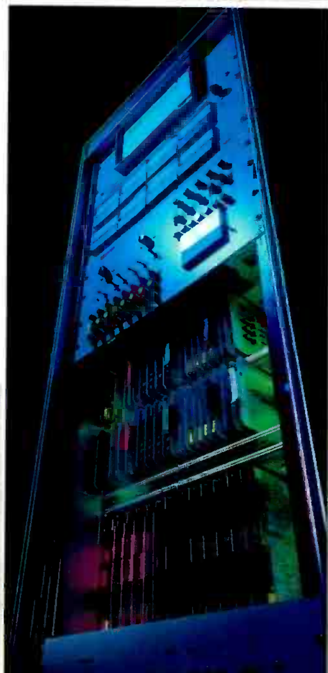




The Acoustic Wave® Cannon (actual product is 12′ long and weighs 55 lbs.)

Turning the benefits of technology into better sound.

Syncom® computer quality assurance program–To ensure that the Bose product you purchase delivers the same sound quality as our laboratory reference standards, we employ the Syncom computer quality assurance program. Developed by Bose, it represents an unprecedented commitment to quality control.



Turning Bose® research into actual consumer products demands manufacturing capabilities that are equally advanced. In the quest for these new manufacturing technologies, we took an approach similar to our acoustical research. The result is a line of products that establishes new standards of performance, value and reliability–because we made them using new concepts in design, materials and quality control.

The demand for Bose products has resulted in an expansion of our manufacturing facilities as well. In addition to our Framingham and Hopkinton, Massachusetts plants, we now operate plants in Ste. Marie, Quebec, Canada; Colebrook, New Hampshire; Hillsdale, Michigan; and Carrickmacross, Ireland.

Cabinet construction. We feel it's important for a speaker's exterior to reflect the level of the technology inside. That's why we make our own consumer speaker cabinets, incorporating much of the skill, technology and craftsmanship used in making fine furniture. Each Bose cabinet reflects a careful balance between acoustics and aesthetics, designed to complement its environment while filling it with lifelike sound.

Electronics manufacturing. The various applications for which we build sound systems demand very innovative electronics to complement them. At Bose, we build many of our critical electronic assemblies ourselves–something that's increasingly rare in American audio manufacturing. Our electronics plants use the latest and most advanced manufacturing technologies, including surface mounting, to produce electronics for use in consumer, professional and OEM (original equipment manufacturer) products.

Precision assembly–To obtain the performance objectives set by our designers, we manufacture many critical product components ourselves. Our automated driver assembly line, considered the most advanced of its type in the world, was designed in-house by our own engineers. We pay equally careful attention to the final assembly of each of our products and the processes involved. For example, some of our speaker assemblers have designed their own assembly systems to maintain better control over the end product.

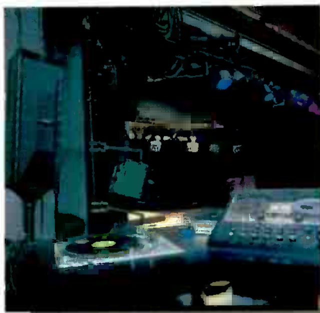
Environmental testing–We continually test our environmental HVC driver to make sure you can depend on it under the toughest conditions imaginable, including heat (+185° F), cold (–40° F), water, and exposure to dust, salt fog and dirt.

Wherever sound is important.

The flexibility, cost-performance ratio, environmental qualities and reliability inherent in all Bose® products are responsible for their appearance in some very prestigious–and diverse–applications. For example, installed Bose sound systems perform in the Hollywood Palace (a popular dance club that hosts a weekly national television show), the Boca Raton Hotel Resort, and Public Broadcasting System's *This Old House*.*

Now standard equipment for musicians, performers and concert system designers, Bose professional and commercial products provide sound in a host of applications: concerts, outdoor events, nightclubs, cruise ships, restaurants, movie theaters, churches, and nearly anywhere sound is important. As an original equipment manufacturer (OEM) of audio systems, you'll find Bose in many top-of-the-line U.S.-made and imported automobiles. Our OEM systems also bring the realism of high fidelity sound to some of the finest televisions and personal computers available–which is why manufacturers of other fine products increasingly turn to "sound by Bose." Our Acoustimass® Music System for the Home brings music lovers together with their stereo system at the ideal time: while their new house is being built. The new Bose Cinema Sound system brings the excitement of "sound by Bose" to an entirely new audience.

*Bose speakers were installed throughout one of the program's featured project houses



At sea and in the air–Cunard Line's *Queen Elizabeth 2* and Royal Caribbean's new *Sovereign of the Seas* (the world's largest cruise ship) feature Bose sound systems. So does the presidential yacht *Sequoia*. Bose noise-cancelling headphones flew around the world with *Voyager* (right) on its historic 1986 non-stop flight.

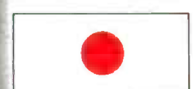
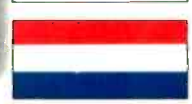
The *Official* Sound Supplier for the XV Winter Olympic Games, Calgary '88–Bose sound system designers and installers, equipped with the latest audio technology (including the proprietary Modeler® computer design program), created and supplemented sound systems for specific events that earned praise from athletes, spectators and news commentators.









International operations–Bose operates an extensive network of international subsidiaries and distributors to make the benefits of "better sound through research" available almost anywhere in the world. Our 12 wholly-owned subsidiaries are located in Australia, Belgium, Canada, England, France, Ireland, Italy, Japan, the Netherlands, Spain, Switzerland and West Germany.

The anechoic response is very uniform and extended, though the sensitivity is a relatively low 80 dB SPL for 1 watt input.

Continued from page 80

Figure 4 shows how the frequency response of the Walsh 5 is modified by the use of the rear-panel controls. These controls are appropriately subtle in their effect. Note that the measured midrange depression can be dealt with nicely, although I recommend setting the controls by ear, using music.

As I mentioned earlier, the axis of maximum radiation is 45° to the inside of the front direction. Anechoic response on this axis is shown in Fig. 5. It is very flat as well but is generally higher than the response in Fig. 4 in the upper midrange and above 10 kHz. When sitting well off the center line, this tends to be the response that arrives from the far speaker. This spectral tilt tends to recenter the images, which would otherwise move towards the near speaker because of the precedence effect.

Phase response is plotted in Fig. 6 for the on-axis direction. It is relatively smooth, resembling the curve of a 25 Hz to 25 kHz electrical bandpass filter. Usually phase shift found in loudspeakers is at the crossover, not because of the drivers. Since the Walsh 5's single crossover is way up at 8 kHz, the system's smooth phase response is not too surprising. Ohm's chief designer, John Strohbeen, feels that this is important to music reproduction.

The 3-meter room response test measures direct sound and reflections occurring within 10 mS from the speakers in my listening room at my listening position. Rooms differ, but not by very much during this critical, early-arrival time span. The 3-meter measurement is plotted for the Walsh 5 in Fig. 7. The on-axis curve was measured on the forward axis of the speaker, and the 30° curve measured the sound aimed inward towards a centered listener. Both curves show midrange interference notches caused by the floor reflection. The ceiling and the wall behind the speaker also create interference notches. We don't listen without a room, but some speakers do manage to avoid these early reflections.

"Three-dimensional" plots of directivity are shown in Fig. 8 (horizontal) and Fig. 9 (vertical). Neither lobing nor midband pattern narrowing is evident. Radiation is omnidirectional at low frequencies and quickly attains and holds the intended (and still very wide) directional pattern through the mid and high frequencies. Maximum radiation is to the front and inward toward the other speaker. The linear frequency display stretches out the high end and shows a regular pattern of peaks and dips above 10 kHz. From their spacing, it can be estimated that there is an interference about 6½ inches from the primary source. This effect is apparently due to a reflection from the cylindrical metal grille around the drivers.

Figures 10, 11, and 12 show the harmonics of test frequencies of 41.2, 110, and 440 Hz (musical notes E_1, A_2, and A_4) at power input levels of 0.1 to 125 watts. Bass distortion is exceptionally low, but it must be remembered that the Walsh 5 requires somewhat higher power and that distortion rises with increased power. However, even with other systems at matched sound pressure levels, the Walsh 5 is one of the cleanest speakers available. During my lab testing at lower power levels, the Walsh 5's low sensitivity resulted in a lower acoustical signal-to-noise ratio, with a measurement at the test equipment's noise limit. The random spikes are from room noise, not the speaker.

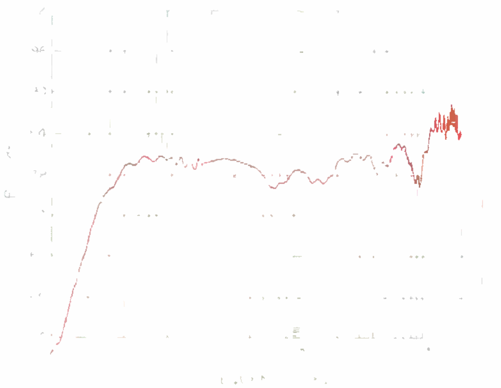


Fig. 5—One-meter anechoic frequency response measured 45° off-axis in the toe-in direction of maximum radiation.

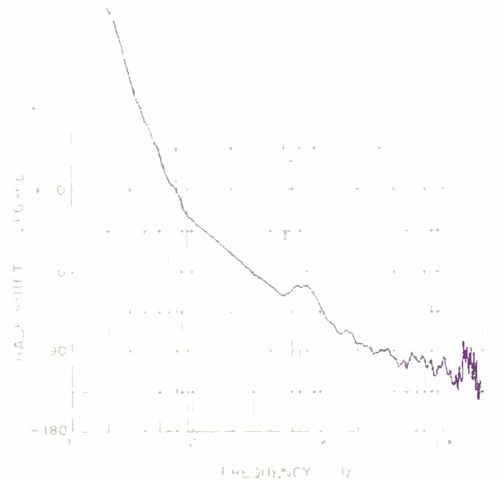


Fig. 6—One-meter on-axis phase response.

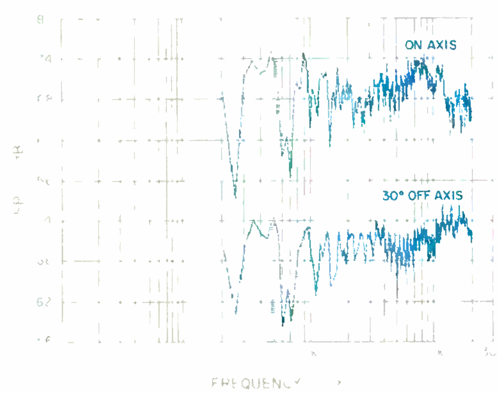
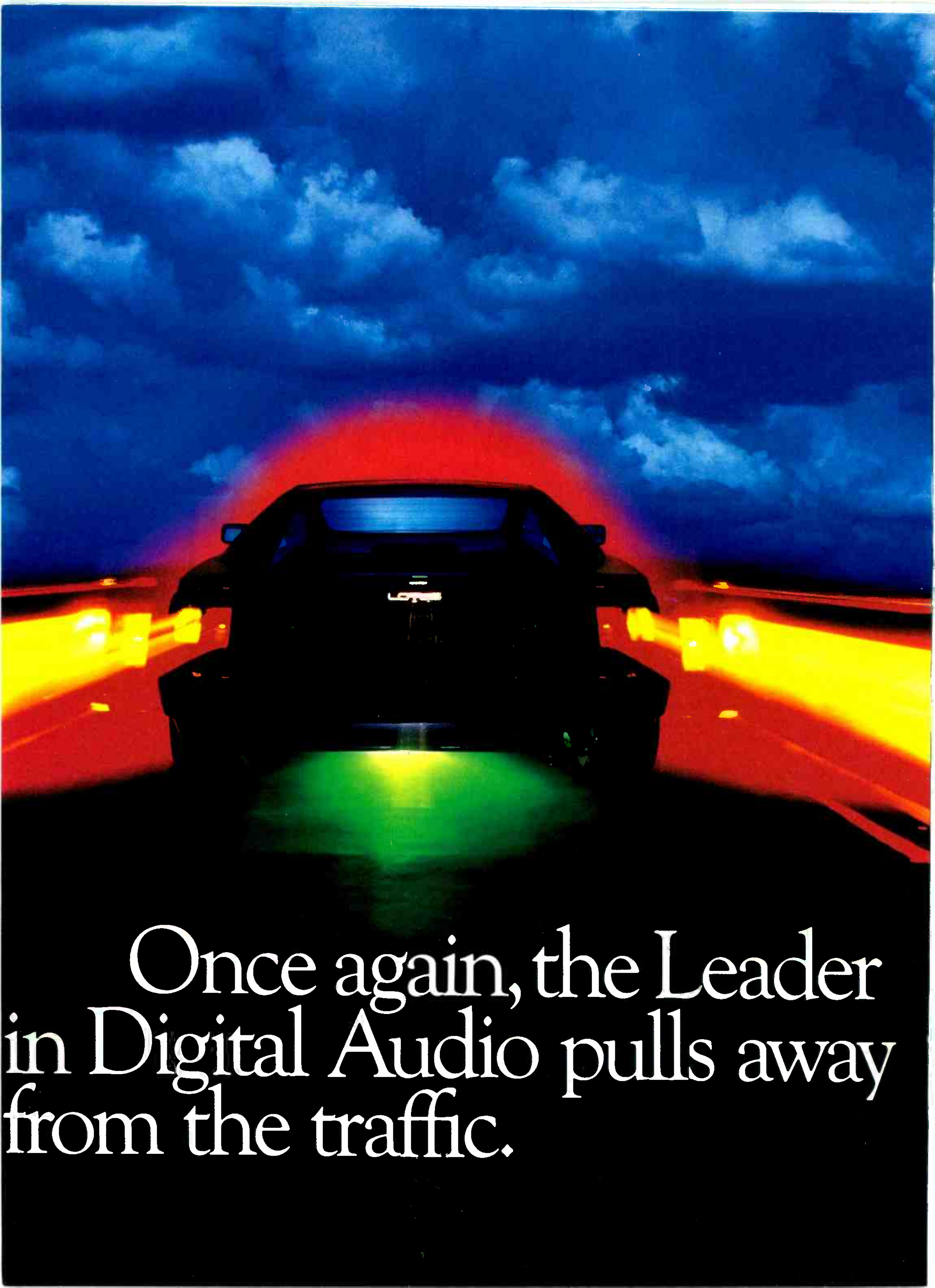


Fig. 7—Three-meter room response measured on-axis and 30° off-axis; for clarity, off-axis curve has been lowered.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Both horizontal and vertical directivity plots show no evidence of lobing or of pattern narrowing in the middle frequencies.

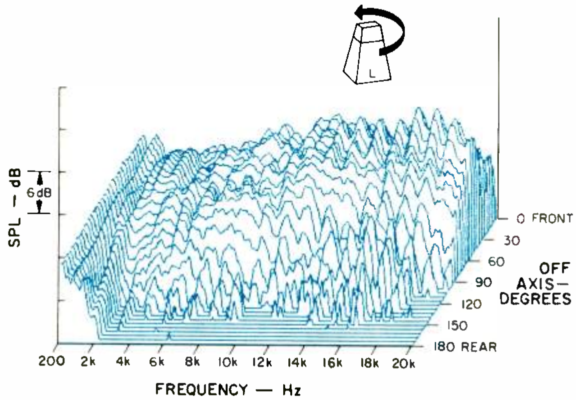

Fig. 8—Horizontal off-axis response plots taken from the front, around the maximum radiation side, to the rear.

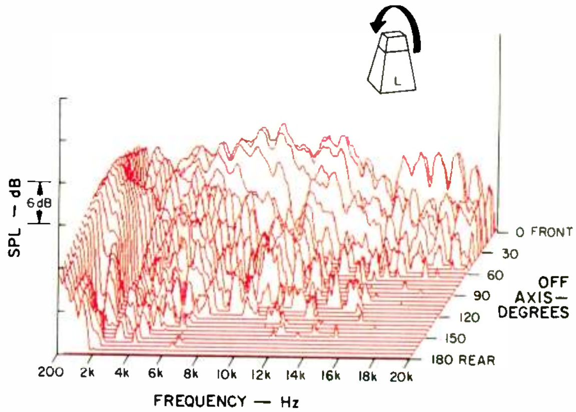

Fig. 9—Vertical off-axis plots taken from in front, over the top, to directly behind the system.

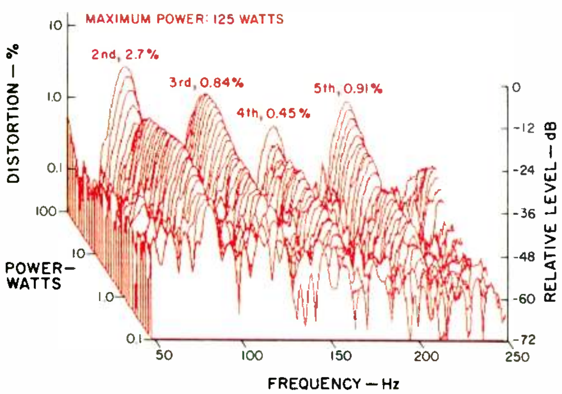

Fig. 10—Harmonic distortion products for the tone E_1 (41.2 Hz).

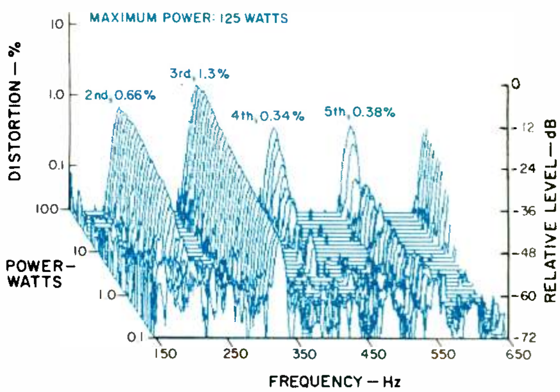

Fig. 11—Harmonic distortion products for the tone A_2 (110 Hz).

Nonlinearity was measured by the IM method, shown in Fig. 13. Here, a 41.2-Hz modulating signal is applied in equal level with a 440-Hz carrier frequency. Ideally, the carrier would remain unaffected by the presence of the low frequency. The Walsh 5 maintains very low modulation up to a higher than usual test level of 125 watts.

Testing power linearity is a direct method of determining how much power a speaker will handle. Frequency sweeps at progressively higher power inputs are applied. Acoustic output eventually fails to track the increase due to distortion or compression. Each frequency and power input where acoustic output fails to track within 1.0 dB generates a point on the plot of Fig. 14. The Walsh 5's results are outstanding. Power input above 100 watts causes only slight compression between 50 and 200 Hz, which increases above 8 kHz. The Walsh 5's ability to handle 200-watt sine waves between 20 and 40 Hz is so unusual that I reran the test several times before I was convinced there was no measurement error.

The energy-time response of the Walsh 5 is shown in Fig. 15. Energy in this test (from 20 Hz to 20 kHz) is concentrated in the upper range, so the tweeter accounts for 60% of the plot. The plot of the arrival of sound from a pulse is desirably tall and compact in time. A secondary arrival at 3.9 mS is the reflected wave or interference that causes the minor response ripples above 10 kHz.

Use and Listening Tests

I'm glad that the 95-pound Walsh 5 loudspeakers come with casters, because I needed to move them around to find out the best sounding location. My listening room is rectan-

Measurement of harmonic distortion was at the noise floor of the instrument, while IM distortion was also commendably low.

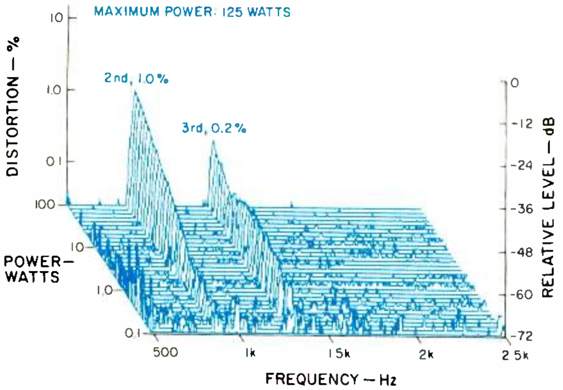

Fig. 12—Harmonic distortion products for the tone A_4 (440 Hz).

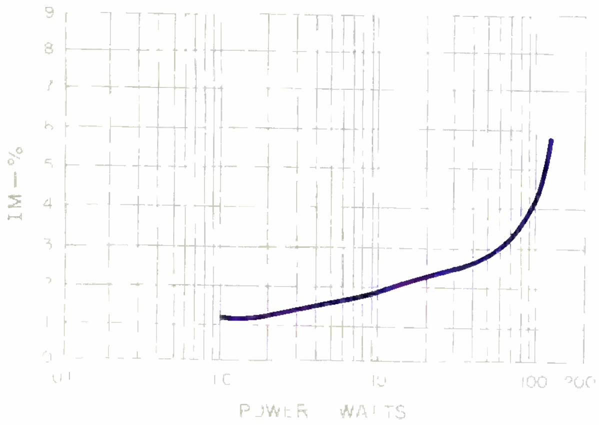

Fig. 13—IM distortion on 440 Hz (A_4) produced by 41.2 Hz (E_1) when mixed in one-to-one proportion.

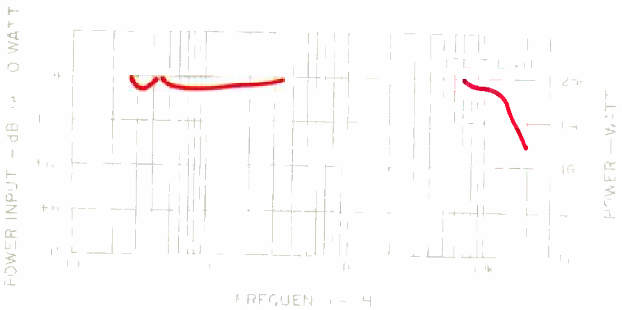

Fig. 14—Power linearity.

gular, and I usually place speakers near a short wall firing into the long direction of the room. When I placed the Walsh 5 systems there, about three feet out from the wall, I heard a disappointing "disembodied" effect. Spectral balance was very good, but depth imaging seemed to be in two places at once—at the speakers and way back behind the wall. Fortunately, repositioning the speakers corrected this condition.

Moving any pair of speakers around changes several aspects of their sound at once. Positioning speakers near walls increases the bass output of most models, but it is easy to end up with too much bass at certain room mode frequencies. Proximity to walls also encourages coloration from speakers with overly wide directivity because of interference from the reflected sound. Placing speakers away from walls, either behind them or to their sides, increases the reflected path length and can give a sense of air to the sound. This, however, may place the speakers too close to the listener, giving too much direct sound in relation to the room reverberation. In turn, it may produce a headphone-like quality and image-shift sensitivity to small movements of the listener's head. Eliminating room reflections by using soft, sound-absorbing material everywhere doesn't help, in my view, as I consider the listening room's acoustics a necessary part of the stereo record/playback chain.

My goal in relocating the Walsh 5 speakers was to achieve more solid lateral and back-to-front imaging without degrading the fine spectral balance. The switch controls helped here, because I could first position for optimum imaging and then trim the spectral balance. I ended up finding two excellent locations along the long wall: One was against the wall, with sound absorbing material behind the Walsh driver; the other was about four feet into the room.

The location against the wall gave a sound reminiscent of an excellent pair of forward-radiating, shelf-mounted speakers—except that I have never heard such strong and deep bass from bookshelf systems. Reducing the bass with the Walsh 5's "Lows" switch helped the balance while retaining the depth of response.

Bringing the speakers well out from the wall and removing the absorption behind them opened up the unique and spectacular Ohm Walsh sound. Listening on the center line between the speakers, I perceived remarkable depth and spaciousness to music well recorded in a concert hall. This spaciousness did not result in a vague mass of sound; image locations were sharply defined and accurately placed. I enjoyed symphonic music for many hours at a stretch with this positioning.

Thelma Huston's hot, up-front vocals in "I've Got the Music in Me" (Sheffield CD-02), however, were enjoyable but not as hot and up front as I'm used to. Backup voices and instruments which were supposed to be back in the soundstage were indeed there, as though it was real. Bass impact from this Compact Disc was stunning. There seemed to be no limit to the clean low end that these speakers could deliver.

Moving around the listening area makes one quite aware of the Walsh 5's crossfired directional patterns and their importance. When listening exactly on the center line between the speakers, it is best if they are spaced quite widely apart, say 30° to 45° away from the center line for each

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LIVE

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SURROUND 1
HALL TYPE A

STADIUM
SPACIOUS

These systems demand care in placement, but they are worth it—a true masterpiece of the speaker designer's art.

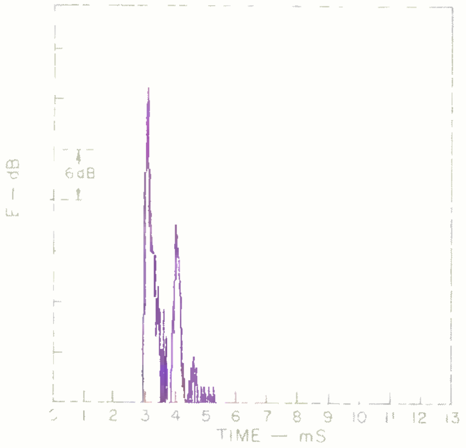

Fig. 15—Energy vs. time.

speaker. Listening off the center line is best with a spacing of less than 30°. Although spaciousness and sharpness of imaging are not as spectacular off the center line, the directivity patterns still provide the listener with a continuous soundstage image. I think it is important for a speaker to be able to provide decent listening when off center line. Indeed, such listening locations can provide a more relaxing experience, because it is the only position in which you can move your head without hearing image locations shift.

After extended listening to the Walsh 5s in their best position, out from the long wall, I felt most comfortable with the "Perspective" control switched to the forward setting and the "Lows" control switched to the reduced setting. Of the many discs I played, one segment serves best to illustrate the qualities of the Walsh 5. The segment is the old demonstration spectacular, the opening of "Also Sprach Zarathustra" by Richard Strauss. My copy is a Technics demo disc (SRCD-1003). First, the unusual low bass rumble at the beginning is heard clearly. Next, the horns announcing the fanfare are *way* back—say, 60 feet behind my listening room wall. The rest of the orchestra comes in, perfectly arrayed in space, with astounding crescendoes having just the right "splash" to the cymbals. The organ's pedal tones are effortlessly reproduced and join seamlessly with the enveloping spaciousness of the upper registers of the instruments. This speaker loves organs.

Perhaps the best way to sum up the qualities of the Walsh 5 is to list several more examples of the music it plays best and some that could be better. (We're talking shades of greatness here, not simple good and bad.) First, examples of the best. Stravinsky's "L'Histoire du Soldat: Suite" (Reference RR-17 CD) was reproduced with precise imaging and detail of the small ensemble. On the " Mefistofele: Prologue" (Telarc CD-80109-2), the combined forces of orchestra, organ, and chorus were dramatically rendered with mass and depth. Now the not so spectacular. In Joe Williams' Grammy-winning CD, *Nothin' but the Blues* (Delos DCD-4001), Williams' voice was not as intense and "in your face" as it might be. Close-miked saxophone lacked some of the "bite" I've heard before. The Joan Baez disc *Diamonds and Rust* (A & M CD 393233-2) is one of my favorites for judging vocal quality even though it is partially a result of studio production techniques. The recording's intent is clear when heard on certain systems, but over the Walsh 5, there was some lateral imaging vagueness and some missing sparkle and freshness. "La Grange," from ZZ Top's *Best of ZZ Top* (Warner Bros. 3273-2) was just not as funky as this rock classic should be

Interaction with the surfaces and acoustics of the listening room is where the Ohm Walsh 5 gets its strengths and its weaknesses. I suspect that in a different acoustical environment from mine, the Walsh 5s would be superb on close-miked music. Considering the investment, the prospective purchaser should insist on a lengthy home trial. I suggest listening to many kinds of music and moving the systems around. These speakers may be demanding of care in placement, but they are worth it. They are a masterpiece of the speaker designer's art. I particularly recommend them for the audiophile who has a large but not particularly reverberant listening room and who enjoys large-scale music productions.

David L. Clark

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3

WHEATON TRI-PLANAR II TONEARM

Manufacturer's Specifications
(Note: Measurements of arm taken when fitted with Accuphase Model AC-2 phono cartridge.)
Tonearm Resonance: Vertical, 7 Hz; lateral, 7 Hz.
Top Resonance: Vertical, 12 dB; lateral, 11 dB.
Tracking Ability: Left channel, 80 μm; right channel, 80 μm.
Price: $1,795.
Company Address: 11230 Grandview Ave., Wheaton, Md. 20902.
For literature, circle No. 92

The Wheaton Tri-Planar II is the latest version of the tonearm designed and handcrafted by Herbert Papier, who began making it in 1981. Various refinements have been incorporated to increase the level of performance, which was already considered by many experts to be excellent.

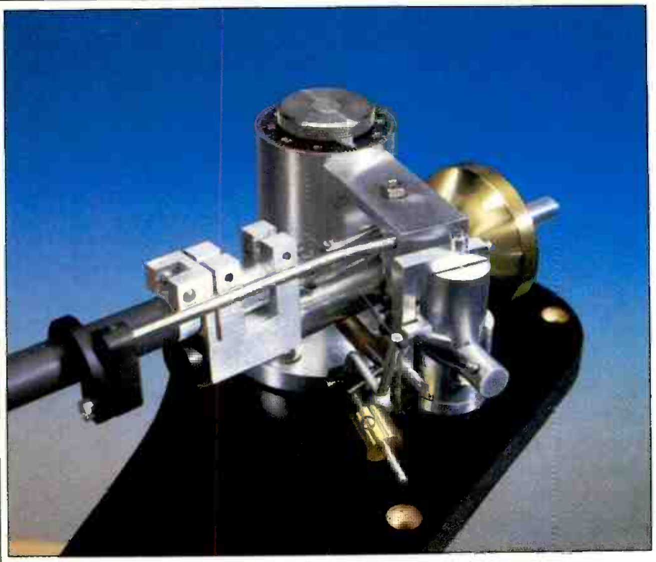
Wheaton Music is not a hi-fi store but a music store, the kind that specializes in helping people produce their own live sound by providing musical instruments and sheet music. Before starting Wheaton Music, Papier was a watchmaker. As such, he was used to working with tiny precision parts. When he retired a few years ago, Papier decided to design and build a tonearm for himself, and his experience in watchmaking gave him a definite advantage when it came to the most critical part of a tonearm, the bearings. When others saw and heard the results of his efforts, they encouraged Papier to produce the tonearm commercially.

With the collaboration of Steve McCormack of The Mod Squad (a company which specializes in custom improvements in high-end audio products), refinements were made in the tonearm. The name Tri-Planar was given to the tonearm because it reflects the design emphasis of allowing proper adjustment in three planes: The tonearm vertical bearings in relationship to the record surface, the vertical tracking angle of the phono stylus, and the azimuth of the phono stylus with respect to the side walls of the record groove.

The first things I noticed about the Tri-Planar II tonearm were the large number of machined aluminum parts (some of which are quite small) and the high quality of the natural finish. It is obvious that a great deal of hand work is involved in its production. The main or upper armtube is covered with heat-shrink tubing—a very clever touch that should help damp out resonances. The use of two armtubes, one above the other and connected by a machined block of aluminum, also caught my eye. While this is certainly unconventional, it was necessary if one of the design goals—to place the vertical bearings at the same height as the record surface—was to be achieved. A dial on the top of the tonearm pillar has 100 very clear, white-on-black markings, which are divided into groups of five and labelled every 10 divisions. A knurled knob in the center of the dial is used to set the vertical tracking angle.

When I grasped the armtube firmly in one hand and the main pillar in the other, and exerted force in different directions, I found that the bearings exhibited no looseness or play. They were, in fact, practically frictionless in the vertical and horizontal directions, which is as it should be. The designer's attention to detail is also apparent in the knurled-head ground screw on the base of the tonearm, which allows a separate ground wire to be attached if necessary. I was also very favorably impressed by the care taken in dressing the lead wires from the upper tonearm tube, through the bottom tube, and out to the connector block (which has gold-plated phono sockets and a gold-plated, five-way ground terminal). Mounting the Tri-Planar II tonearm is relatively easy. It needs no center hole for the pillar, and it is fastened to the turntable mounting board with three screws. Since the pillar does not extend below the mounting board, the Tri-Planar is ideal for shallow turntables. For this report, I decided to use the Shure V15 Type V-MR cartridge, which proved to be an excellent match with the Tri-Planar II.

Tonearm designers know that vertical bearings should be located on the same plane as the record surface, to allow for record warps. When the vertical bearings are above the record surface—as they are in most designs—the phono stylus will move back and forth in the groove as it follows the record warp up and down. This motion changes the wavelengths of the musical signals, making them shorter with forward motion of the stylus and longer with backward motion. Sonically, this translates as pitch changes which vary in direct relationship to the frequency and severity of the warps in the record. Vertical bearings in a tonearm are necessary, therefore, because all records tend to have some surface unevenness. It is interesting to speculate that



if records were perfectly flat and of uniform thickness, no vertical bearings would be required at all. Such a tonearm's pillar could be raised and lowered to allow records to be changed.

The vertical tracking angle (VTA) is the angle between the playback stylus and the record groove (as viewed from the side). It is the relationship between the playback stylus and the groove shape formed by the angle of the original cutting stylus. There is more involved in VTA than this, of course, but much effort was spent in the 1960s to try and standardize record cutting as much as possible. (In fact, Shure's

MEASURED DATA

Wheaton Tri-Planar II Tonearm

Pivot-to-Stylus Distance: 9.85 in. (250.2 mm).
Pivot-to-Rear-of-Arm Distance: 2.25 in. (57.2 mm).
Overall Height Adjustment: 0.75 in. (19 mm); 1/40 in. for each vernier rotation.
Tracking-Force Adjustment: Set by counterweight.
Tracking-Force Calibration: None (use external gauge).
Cartridge Weight Range: 4 to 20 grams.
Counterweights: Two main (99.9 and 112.8 grams) and five secondary (69.6, 85.7, 101, 118, and 136.5 grams).
Counterweight Mounting: Soft polyurethane insert.
Sidethrust Correction: Adjustable thread and weight.
Pivot Damping: Viscous.
Lifting Device: Damped lever and finger lift on headshell.
Headshell Offset: 22.0°.
Overhang Adjustment: Slots in headshell.
Bearing Alignment: Excellent.
Bearing Friction: Less than 40 milligrams.
Bearing Type: Hardened steel point and ball races
Lead Torque: Negligible.
Arm-Lead Capacitance: 35 pF for left and right channels.
Arm-Lead Resistance: 1.1 ohm for left and right channels.
External Lead Length: None supplied (gold phono jacks).
Structural Resonances: See Fig. 7.
Base Mounting: Three screws through base; no pillar hole needed.

Shure V15 Type V-MR Cartridge

Coil Inductance: 350 mH.
Coil Resistance: 875 ohms.
Output Voltage: 0.48 mV/cm/S.
Tracking Force: Without damping brush, 1.3 grams; with damping brush, 1.9 grams.
Cartridge Mass: 6.8 grams.
Microphony: Very good.
Hum Rejection: Excellent.
High-Frequency Resonance: 32.3 kHz.
Rise-Time: 18 µS.
Low-Frequency Resonance: Without damping brush, 5.5 Hz and Q = 7.9; with damping brush, 8.0 Hz and Q = 1.2.
Recommended Load Resistance: 47 kilohms.
Recommended Load Capacitance: 250 pF.

One of the first things that impressed me about the Tri-Planar II is the large number of machined aluminum parts.

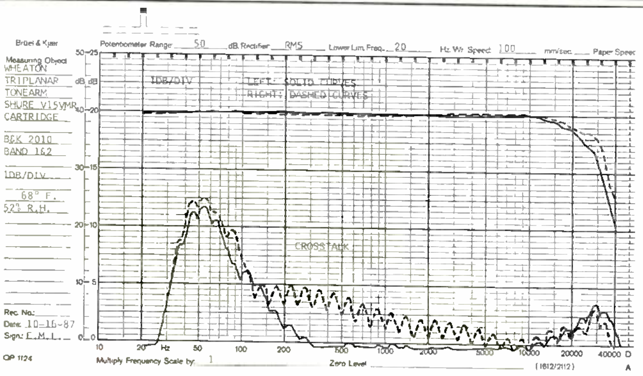


Fig. 1—Frequency response and crosstalk, Wheaton Tri-Planar II tonearm with Shure V15 Type V-MR cartridge, using B & K 2010 test record.

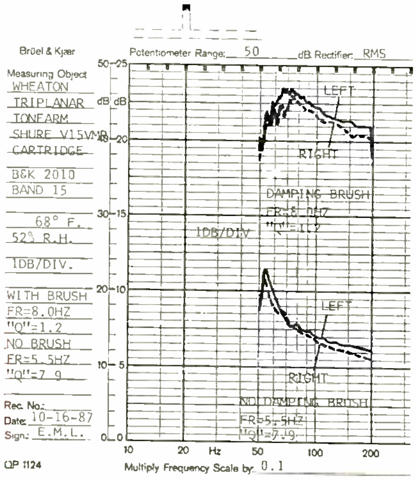


Fig. 2—Low-frequency resonance of the Wheaton/Shure combination. Using the cartridge's damping brush (top curves), resonance is at 8.0 Hz and Q = 1.2; without damping brush (bottom curves), resonance is at 5.5 Hz and Q = 7.9.

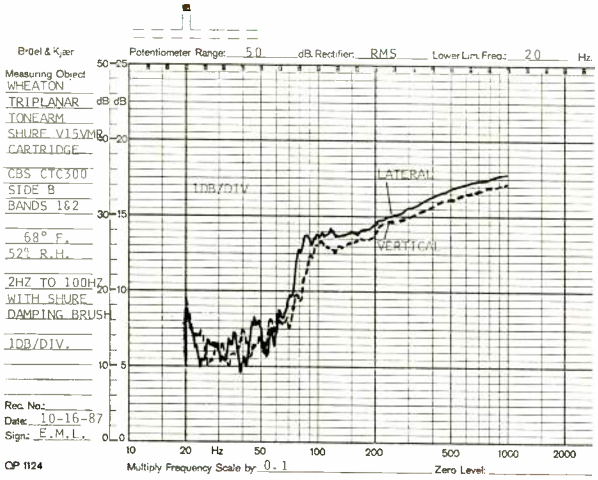


Fig. 3—Response to vertical and horizontal modulation from 2 to 100 Hz (slow sweep) with cartridge damping brush engaged and using CBS CTC-300 test record.

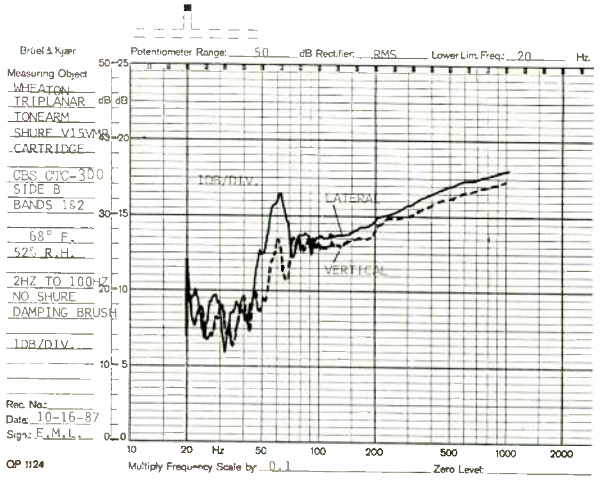


Fig. 4—Same as Fig. 3 but without cartridge damping brush.

series of V15 phono cartridges began in this era.) Many factors militate against an exact adherence to the desired 15° angle. Records are cut by many different companies all over the world, using different cutting systems and stylii as well as different blank lacquer master discs. It is difficult to measure the cutting angle exactly, and variations exist in the "spring-back" or "memory" variations of the different plastic formulations used in making records. Therefore, the vertical tracking angle should be adjusted to achieve the best results from each record.

The Tri-Planar II tonearm provides a calibrated vernier adjustment for this purpose. Turning the knurled knob on top of the main pillar will raise or lower the tonearm bearing, which changes the VTA of the stylus. The calibrations on the dial are arbitrary, but they allow settings to be repeated after the best VTA for each record has been found and marked on the record jacket.

Improvement in the stereo qualities of a record—such as the spread of the sound (stage width) or the ability of a listener to localize sound sources (imaging)—can be quite dramatic when attention is paid to setting the stylus azimuth angle correctly. Since the stereo information in a record groove is completely contained in the vertical component of the groove modulation, the interfaces between the stylus contact areas and the groove walls should be mirror images of each other. Any difference will shift the angle of the vertical component of the force exerted by the moving groove on the stylus. Such tilting results in distortion of the stereo information. The Tri-Planar II tonearm has a provision for setting the azimuth angle very accurately. It is a feature

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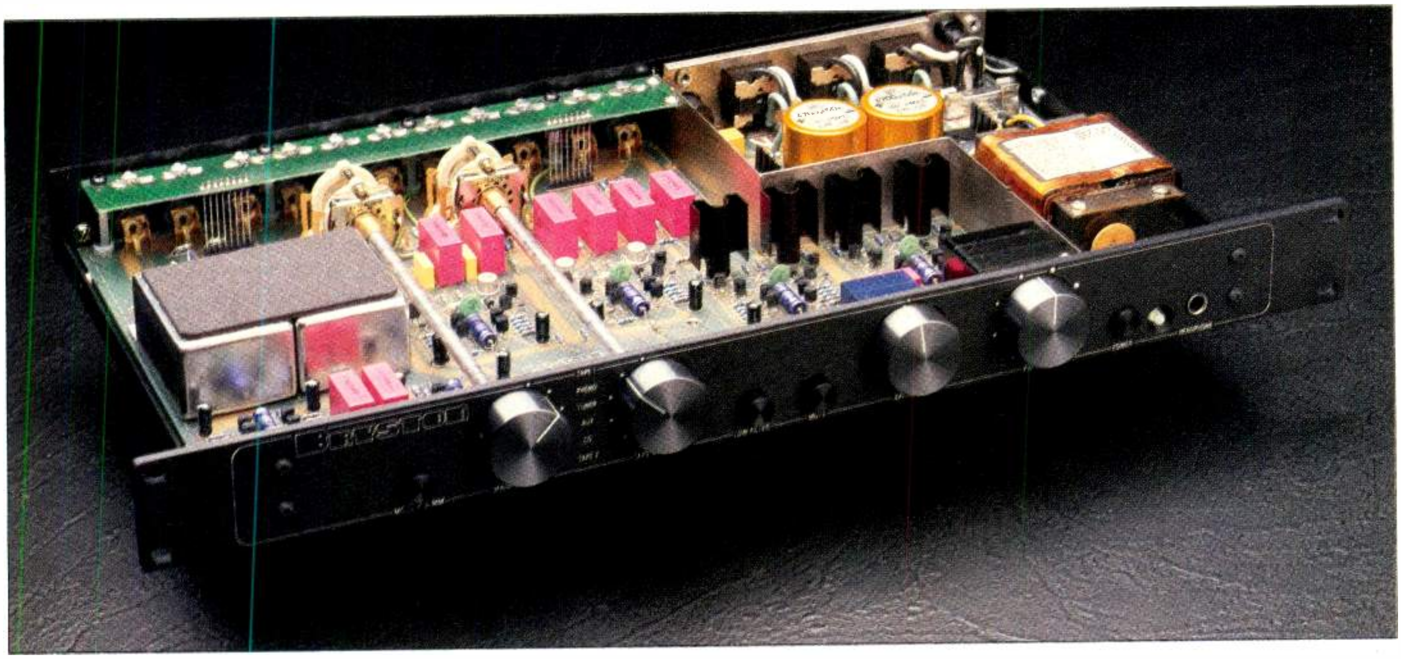

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The bearings show no play or looseness when the armtube and pillar are twisted, which is as it should be.

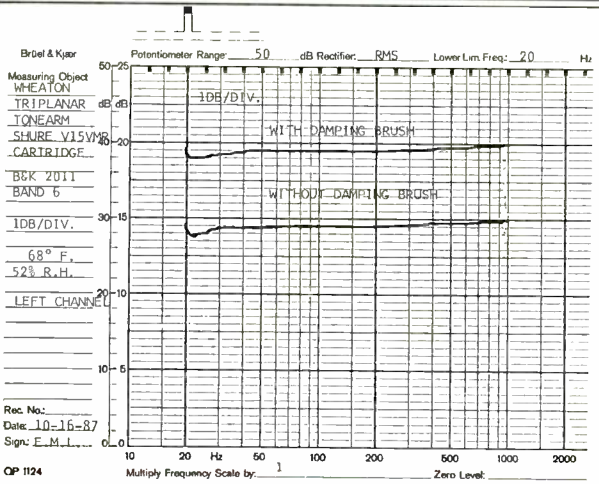


Fig. 5—Slow sweep from 20 Hz to 1 kHz. Note absence of glitches in this range; their presence would indicate artifacts which would color sound quality.

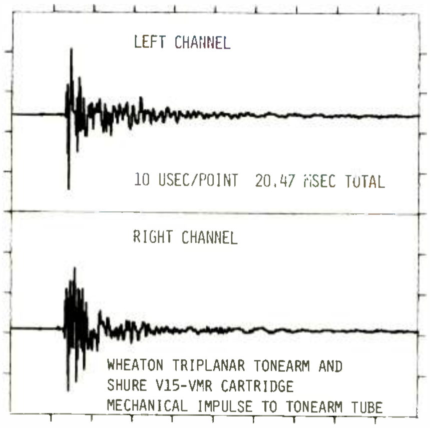


Fig. 6—Output vs. time of arm/cartridge when mechanical impulse was applied to armtube.

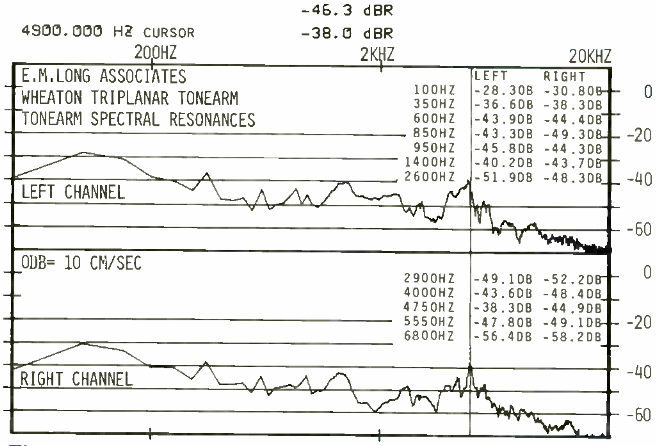


Fig. 7—Spectral output (averaged) of arm/ cartridge due to 16 mechanical impulses applied to armtube. Note the increase in output centered around 4.9 kHz.

which I find extremely valuable, because it allows for easily audible improvement over the more common method of making this adjustment with a mirror. A small hex-head screw is used to drive a pin on the top of the upper tonearm tube, causing the tube to rotate. Wheaton supplies a small screwdriver for this purpose, and the mechanical control that this provides makes exact adjustment relatively easy.

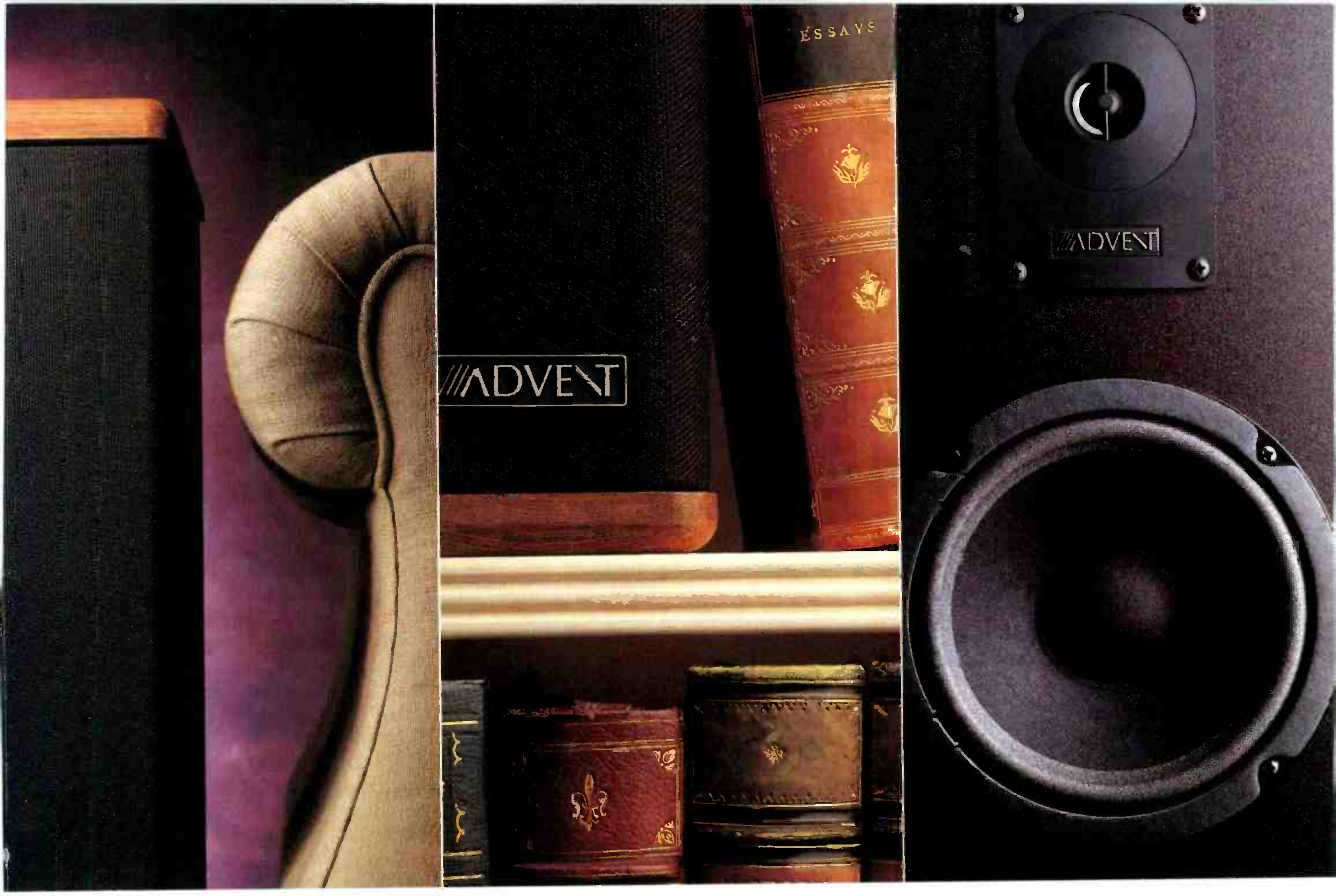
Wheaton recommends measuring the crosstalk output of the cartridge by using either of two commercial devices for making this adjustment—one of which they say is no longer available. I have neither device, so I used a different technique. The idea is to balance the vertical component of each channel, so I used a mono record (which, by definition, has only lateral modulation) and then connected the cartridge so that the channels were opposite in polarity. This yields a left-minus-right signal that is the vertical component of force. By turning the azimuth screw while listening to a mono record, the output can be cancelled almost completely, which means the crosstalk is balanced. Since all records are not exactly identical with respect to the VTA, I tried a number of mono records to see if variations among them would cause the crosstalk to vary. While variations were slight, the azimuth setting for minimum output—using the same cartridge—remained consistent, indicating that this technique is a viable alternative to the method recommended by Wheaton.

The machined aluminum headshell, which is firmly attached to the upper armtube, is supplied with a special dummy cartridge that includes a long, pointed shaft to simulate a stylus. I used this later to accomplish the preliminary alignment of the tonearm. A thin aluminum plate, with an extension formed as a finger lift, has two press-fitted nuts for the cartridge screws. The upper armtube is made of two concentric aluminum tubes with a damping layer between them, and the inner tube is filled with polystyrene cylinders, packed under slight pressure. Special mono-crystal wires travel down the center of the tube, terminating in gold-plated connectors that slip over the cartridge pins. Plastic and lead damping is strategically placed inside the armtube to aid in damping resonances. The sidethrust or anti-skate correction is not calibrated, but it was not hard to set it for the optimum amount of force by listening. The horizontal and vertical pivots are ball-race types, with six tiny balls and a hardened steel point. The damped cueing system is very good, and the plastic sleeve on the cueing bar prevents the tonearm from sliding sideways when it is carefully lowered to the record.

Measurements and Listening Tests

A listening panel was used to evaluate the subjectively perceived sonic qualities produced by the Tri-Planar II tonearm and Shure V15 Type V-MR cartridge combination. The panel was also asked to compare the combination with a high-quality reference tonearm and cartridge system.

Although many experts consider the reference system to be the best available, I choose not to reveal the names of its components. I do not wish to convey the idea that I think they are the best available. Its purpose is not to be viewed as the ultimate system, but rather to provide a consistent reference for the listening panel.



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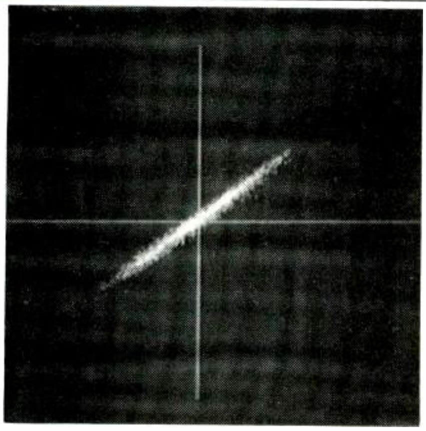

Fig. 8—Interchannel phase difference. Perfect phase response would be a straight 45° line; the Wheaton/Shure combination's response is close to perfection.

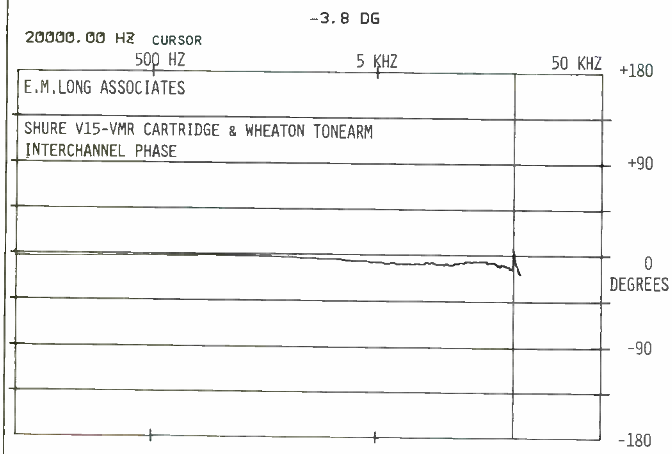

Fig. 9—Interchannel phase difference vs. frequency from B & K 2011, band 7, pink noise. Phase difference at 20 kHz is 3.8° (less than 0.5 µS).

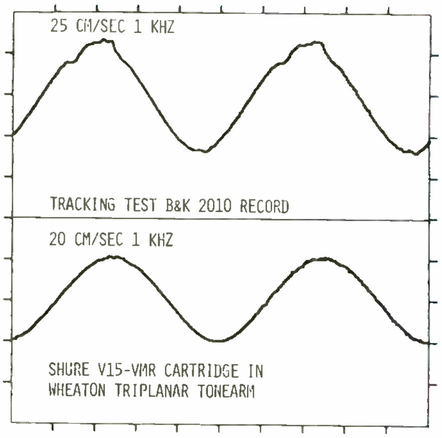

Fig. 10—Tracking test of Wheaton/Shure combination. Mistracking seen in the top curve is of the highest level on the test record, and this should therefore be considered good performance.

The panel auditioned a number of recordings of different types of music. Each member was asked to rate the Wheaton/Shure combination and the reference system on a scale from 0 to −5. They were also asked to write down comments about the quality of the sound that they heard. The listening panel's scoring for a total of 12 categories showed that the Wheaton/Shure combination tied the reference system in overall points. However, scoring and comments for each category showed that the preferences of the majority of panel members fluctuated between the two systems. Consequently, I've tried to correlate the panel's subjective impressions with the technical measurements to show the strengths and weaknesses of each combination.

Figure 1 shows the amplitude versus frequency response and the crosstalk of the Wheaton/Shure combination. The two channels show excellent balance from 20 Hz all the way to 20 kHz, and the low-frequency crosstalk is very good for this particular test record. That the Tri-Planar II tonearm allows for precise adjustment of the azimuth is certainly responsible for these results, and the comments of all panel members indicated that they rated the Wheaton/Shure combination superior to the reference system in spaciousness.

Figure 2 shows the low-frequency resonance caused by the mass of the the Tri-Planar II and the compliance of the V15 Type V-MR. The Q is quite high when the cartridge's damping brush is not used. The use of a less compliant cartridge would move the resonance up in frequency, from 5.5 Hz, but the cartridge mass should also be kept low or the Q could be higher than desirable for good low-frequency performance. The sound is much better when the Shure's damping brush is activated, but the low-frequency performance of the reference system was preferred by a majority of the listening panel. They found, for instance, that the sound of double bass was "well defined" and "clearer" and that drum sound was "deeper" and "tighter" with the reference system.

The shape of the response from 2 to 100 Hz, measured using the cartridge's damping brush and shown in Fig. 3, is a good indication that the Wheaton/Shure components are compatible at low frequencies. The effective lateral and vertical mass of the tonearm is matched almost exactly by the lateral and vertical compliance of the cartridge. The downward slope is due to the fact that the output from the test record is falling at a rate of about 6 dB per octave. Bearing this in mind, the rise at resonance occurs in the range of 8 to 10 Hz and is well controlled by the damping brush. Figure 4 shows the vertical and lateral resonances—without the damping brush—at about 7 Hz, with the highest Q in the horizontal plane. The lack of glitches in the range from 20 to 1,000 Hz (which can be seen in Fig. 5) is a good indication of the integrity of the bearings, the headshell-to-armtube connection, the counterweight mounting, and other mechanical factors. The presence of glitches would indicate resonances or delayed energy which would color the sound.

Figure 6 shows the amplitude versus time output of the Wheaton/Shure combination for a mechanical impulse applied to the main armtube. Although the trace shows that the ringing dies out in a uniform manner, it does extend visibly for at least 10 mS. Figure 7 shows the spectral

The combination of the Wheaton Tri-Planar II and Shure V15 V-MR gave the reference a real run for best-performer title.

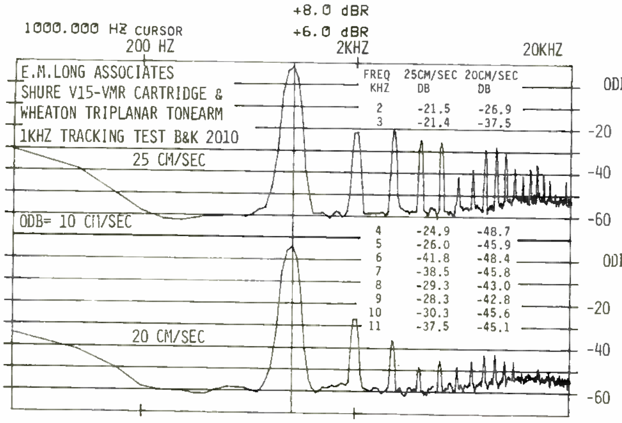

Fig. 11—Spectrum due to output shown in Fig. 10. Distortion at third harmonic is −43.5 dB or 0.67% at 20 cm/S. At 25 cm/S, the third harmonic is −29.4 dB or 3.4%, which is excellent for this high-level band of the B & K 2010 test record.

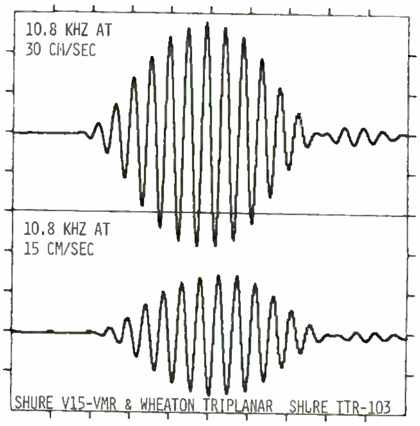

Fig. 12—Response to 10.8-kHz pulse on Shure TTR-103 test record. No compression is evident even at the 30-cm/S level, which is excellent.

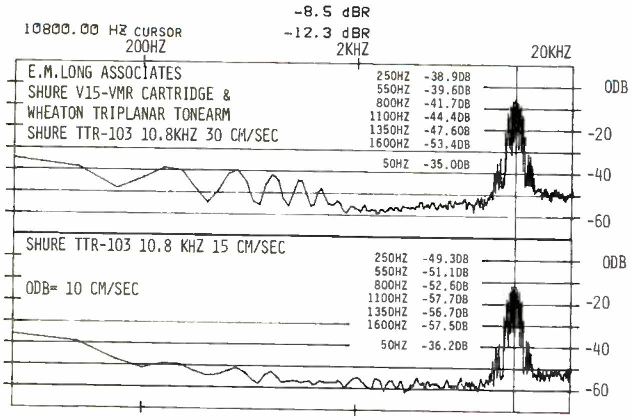

Fig. 13—Spectrum analysis for tone burst of Fig. 12. At the 30-cm/S level (8 dB above the reference level of 10 cm/S), distortion at 250 Hz is only 1.1%, which is quite good.

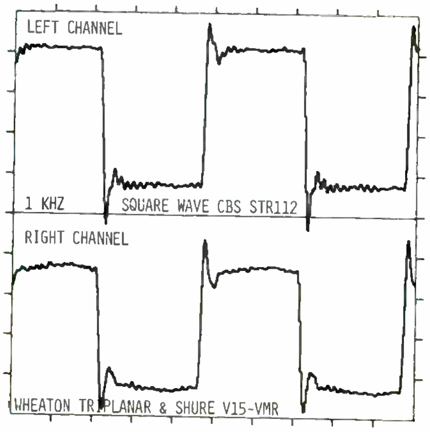

Fig. 14—Response to 1-kHz square wave on CBS STR-112 test record. Good performance is evident, although the Shure cartridge rolls off frequencies above 20 kHz.

components of the response averaged for 16 mechanical impulses. An increase of energy appears in the upper midrange (from about 3 to 6 kHz) and correlates with comments made by panel members. They seem to agree that, while the sound of the Wheaton/Shure combination was "brighter" and "very sonorous" in loud orchestral passages, it was also "less clear" or "less detailed" on staccato piano passages. The panel's scoring was close for both types of music, but the Wheaton/Shure combination was rated higher on orchestral music and lower on staccato piano.

Figure 8 shows the output of the left channel versus the right channel. It is close to being a straight 45° line, which indicates that the tonearm/cartridge combination has a near-perfect correlation of interchannel phase versus time. Figure 9 shows the spectrum of interchannel phase versus frequency. It, too, is almost perfect. This correlates well with the listening panel's excellent rating and their favorable comments about the spaciousness of the sound reproduced by the Wheaton/Shure combination.

The very good tracking capability of the Wheaton/Shure combination is indicated in Fig. 10. Even at the 25-cm/S level (the highest level on the test record), the stylus still maintains contact with the groove walls, albeit with higher distortion than at the 20-cm/S level. The spectral content of the distortion is shown in Fig. 11. The distortion is very low for the 20-cm/S level, but there are increases in output for the third, fourth, fifth, eighth, ninth, and tenth harmonics. The increase in output of the higher harmonics would tend to brighten the sound of high-level passages, and this was confirmed by the listening panel's comments. Herbert Pa-

This combination of arm and cartridge is as good as anything I've tested when it comes to imaging and stereo spaciousness.

pier has made improvements in the Tri-Planar II's bearings to improve its tracking capability, and he sent me another tonearm to check. I received this version too late to have the panel listen to it, but I did evaluate it. Although I don't like to rely solely on my own opinion, I can say that I noticed an improvement in the tonearm's tracking capability.

Figure 12 shows the output versus time for a tone burst test at 10.8 kHz. It indicates excellent tracking for high levels at high frequencies. Poor performance in this regard would tend to impart a leaden quality to the sound of bells, triangles, and cymbals, but comments by the panel indicated that the opposite was true for these instruments when reproduced by the Wheaton/Shure combination. The spectrum of the output versus frequency for this test signal is shown in Fig. 13; it represents excellent performance.

The square wave in Fig. 14 is indicative of good performance, but it also shows that high frequencies, above 20 kHz, are rolled off by the Shure phono cartridge. This correlates well with the amplitude versus frequency response shown in Fig. 1.

Conclusion

If you zipped right to this point of the report to find out who was vanquished, it wasn't the Wheaton Tri-Planar II/Shure V15 Type V-MR combination! This pairing gave the reference system a real contest and actually won many of the rounds. It reproduced certain types of music a little better than the reference system and some a little worse (but you will have to read the report to find out which). With regard to such stereo characteristics as spaciousness and image location, the Wheaton/Shure combination is as good as any I have tested—and better than most. *Edward M. Long*


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4

PHILIPS CD960 COMPACT DISC PLAYER

Manufacturer's Specifications

Frequency Response: 2 Hz to 20 kHz.

Amplitude Linearity: 20 Hz to 20 kHz, ±0.01 dB.

Phase Linearity: ±0.2°, 20 Hz to 20 kHz.

Dynamic Range: 96 dB.

S/N: 101 dB.

Channel Separation: 100 dB, 20 Hz to 20 kHz.

THD: 0.0015%.

Audio Output Level: 2.0 V rms.

Headphone Load Impedance: 8 to 1,000 ohms.

Number of Programmable Selections: 20 (see text).

Power Requirements: 120 V, 60 Hz, 30 watts.

Dimensions: 16-17/32 in. W × 3⅞ in. H × 14⅞ in. D (42 cm × 9.8 cm × 37.8 cm).

Weight: 22 lbs. (10 kg).

Price: $949.

Company Address: Philips Consumer Electronics, P.O. Box 14810, Knoxville, Tenn. 37914.

For literature, circle No. 93

This report marks the first time I have tested a Compact Disc player that bears the Philips name. Philips, as many readers know, is the giant electronics firm based in the Netherlands which was a co-developer of the Compact Disc. Though highly respected in just about every country in the world, the Philips brand name has had a mixed history in the United States. For whatever reasons, earlier attempts to sell products under the Philips brand name have had irregular success here. As a result, North American Philips (NAP), a subsidiary of the Dutch parent, marketed audio and video products under the familiar brand names of Magnavox, Sylvania, and Philco. A few months ago, this changed. Philips has now introduced a high-quality line of audio components under its own name; the Model CD960 is an excellent Compact Disc player, one that should do the Philips parents proud.

Thanks to its "FTS" feature, the CD960 can play tracks which the user has previously selected from many discs and then programmed into memory.

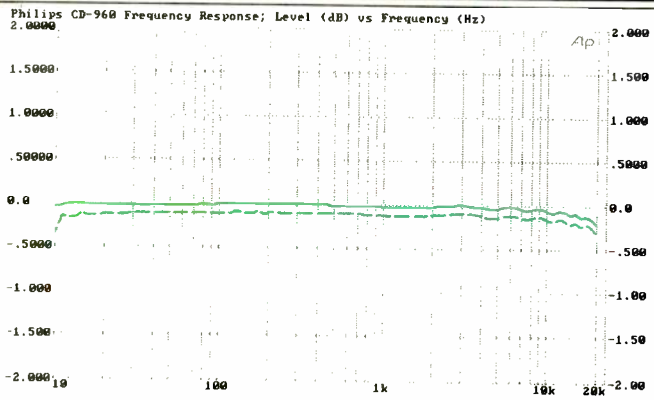

Fig. 1—Frequency response at 0-dB recorded level, using signal from CBS CD-1 test disc, for left channel (solid curve) and right channel (dashed curve).

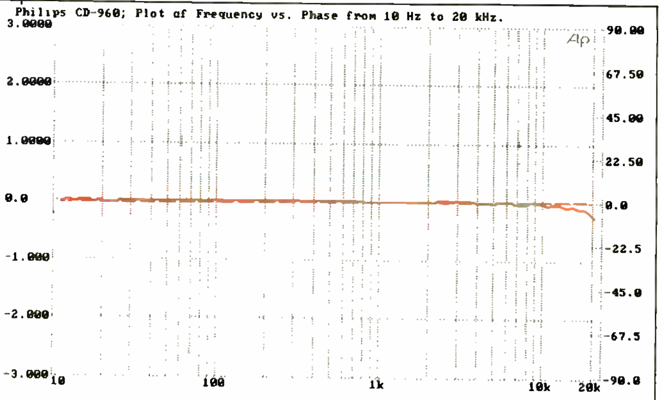

Fig. 2—Phase vs. frequency response indicates the use of dual D/A converters or accurate time compensation between multiplexed left and right channels.

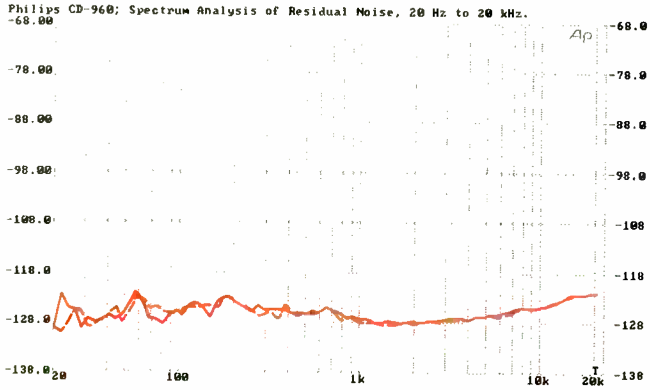

Fig. 3—Residual noise vs. frequency for left (solid curve) and right channels.

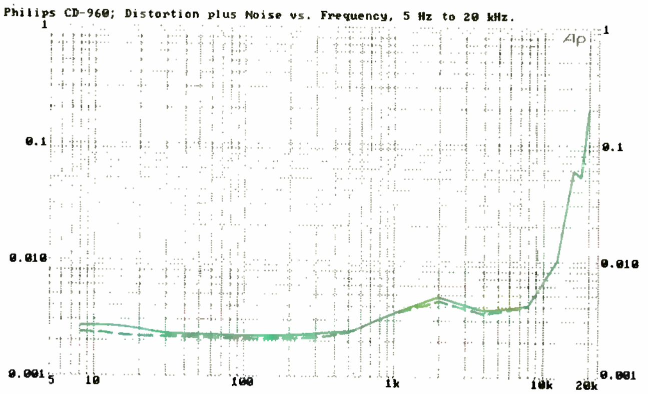

Fig. 4—THD + N vs. frequency for left (solid curve) and right channels.

Like a few of its Magnavox siblings, the Philips CD960 has Favorite Track Selection. This remarkably innovative feature allows you to store track numbers of many discs in a permanent memory. When you insert one of these discs and identify it by its FTS number, the CD960 will play only the tracks you previously selected for that particular disc. The player has enough memory for an absolute maximum of 226 discs, but the number of FTS programs that can be stored depends on the number of memory blocks being used. If you store five tracks per disc, for example, programs for 157 discs can be stored. The program for each disc—as well as any current, conventional programming for immediate play—may have a maximum of 20 memory blocks. Memorizing a track number uses one memory block, requesting an index point within a track uses two memory blocks, and requesting start of play at a given time (minutes and seconds into a track) uses five memory blocks. To simplify the task of cataloging discs that have been programmed using FTS, Philips provides a sheet of numbered labels which can be affixed to the label side of a disc or to its jewel-box case.

As is true of many top-quality CD players, you can advance to the beginning of any track, start play at any given particular index point, or start play at a specific time within a track. The unit allows repeat play of a disc or repeat of a continuous play loop (from one point on a disc to another). Forward or reverse searching is possible at three speeds, depending on how long the search buttons are pressed. Sound is audible during the two slower speeds. The scan feature allows listening to approximately the first 10 S of every track on a disc, in ascending order. During scan, you

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The overall unweighted S/N measured about 110 dB for both channels. When I added a filter, results went to 114 dB.

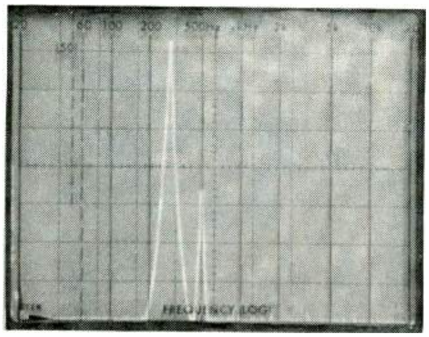

Fig. 5—Spectrum analysis of the CD960's output when reproducing 20-kHz test tone. Sweep is linear, from 0 Hz to 50 kHz.

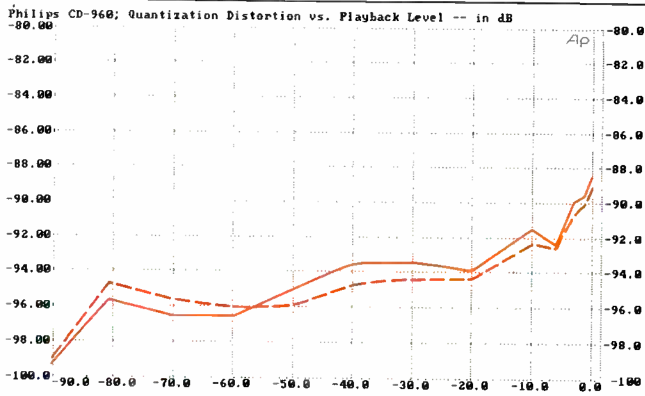

Fig. 6—Quantization distortion vs. frequency for left (solid curve) and right channels.

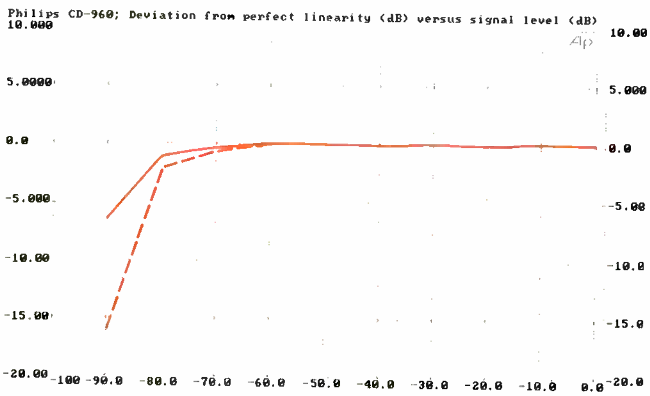

Fig. 7—Deviation from linearity as a function of recorded level for left (solid curve) and right channels, using undithered signal from CD-1 test disc. See text.

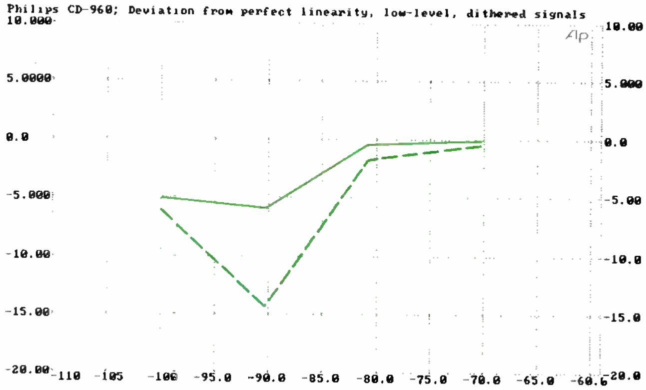

Fig. 8—Same as Fig. 7 but using dithered test signal.

can also program tracks you like for later play, but only if you want to listen to these tracks in the same order in which they appear on the disc.

Control Layout

The "On/Off" switch and stereo phone jack are at the left end of the front panel, adjacent to the disc tray. A slider control below the tray adjusts headphone volume. Major operating pushbuttons, including the fast-search keys, are at the right end of the front panel.

A display area is located directly to the right of the disc tray. A minutes and seconds readout shows total playing time of a disc, elapsed time for the track being played, remaining time of a disc or program, or a selected time position. Track numbers and index numbers are also displayed, as are a wide variety of word indications. The latter includes "Error" (if you have made a mistake during programming), "Disc" (after loading), "Program" (when a program is stored in memory), "A-B" (when playing a continuously repeating loop), "FTS" (when an FTS program is in operation), "Scan" (when the scanning function is in use), "Review" (when visually reviewing a previously assigned program), "Repeat," and "Pause."

Pushbuttons for programming or track and index selection are found on a lower section of the front panel. When this section is pressed, it moves forward, out of the front

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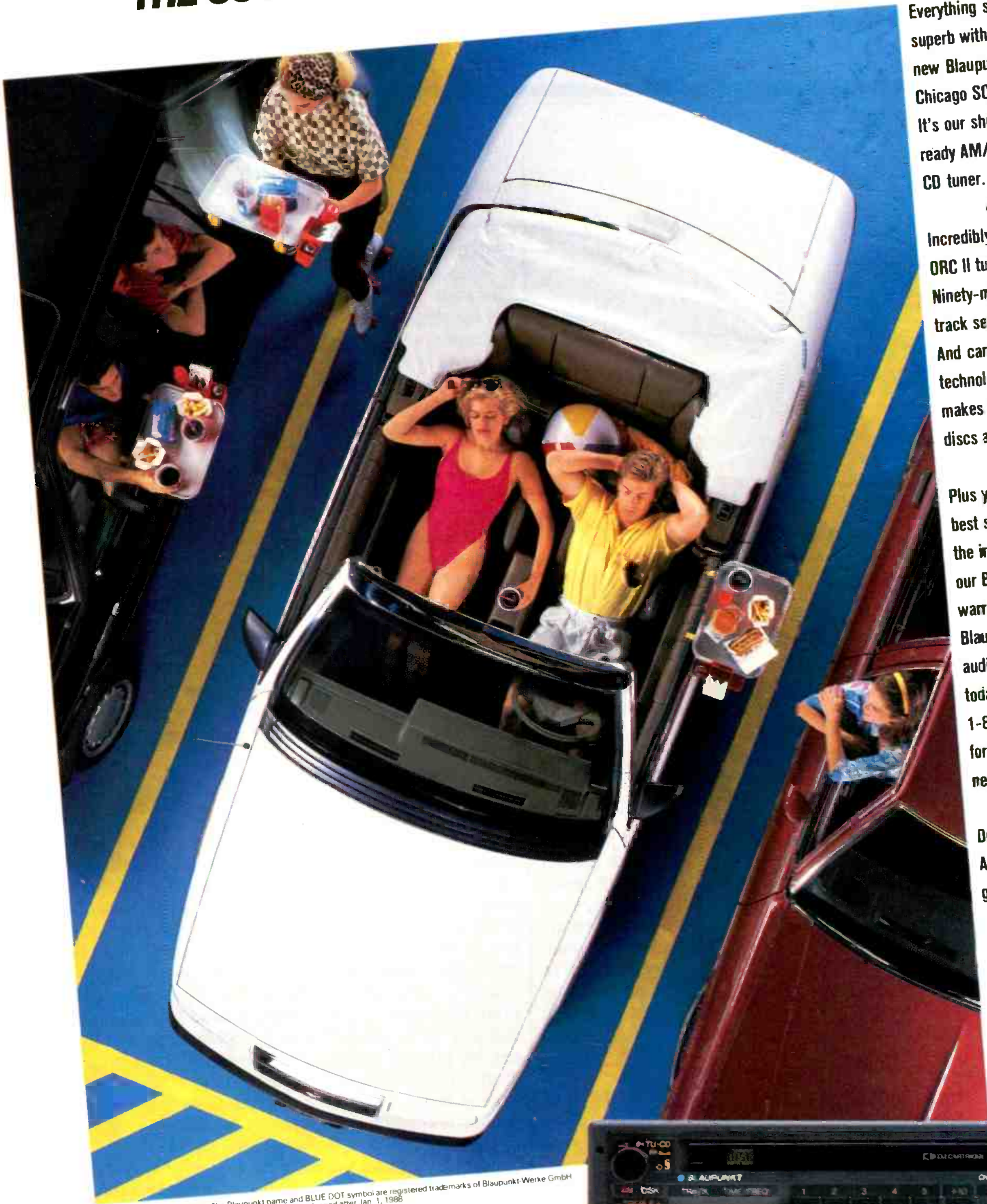

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Now that Philips is using true 16-bit D/A converters and four-times oversampling, players such as the CD960 offer even better sound.

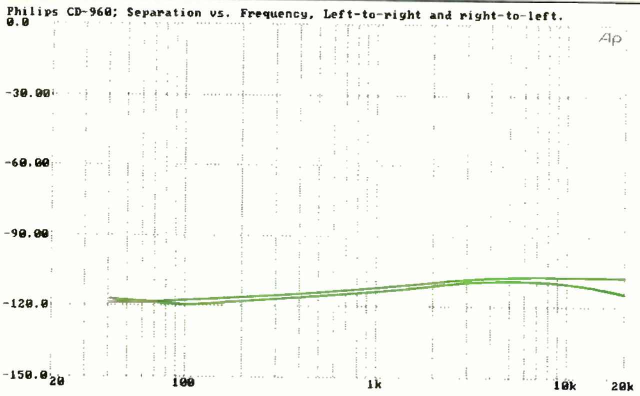


Fig. 9—Separation vs. frequency for left-to-right and right-to-left analysis.

panel, disclosing additional buttons for "Clear," "Store," "Review," "Scan," "Index," "Repeat," and "A-B." A mode switch selects "Normal Play," "Single Play," "Copy Pause," and "Auto Pause." The latter two settings are useful when tape recording CDs. They add either predetermined or automatic pause periods between tracks so that, if your cassette deck has track-seeking facilities, it will be able to find selections by these periods of silence between tracks.

In addition to the usual analog stereo output jacks, the rear panel is equipped with an optical output jack (for processing of the digital signal via a fiber-optical interface to a preamplifier or amplifier) and a digital output jack (for direct connection to a digital input on a preamplifier or separate D/A-converter unit). Remote-control jacks are for connection to either a remote-control sensor, which is available from Philips as the EM-2200, or to operate in a system configuration with other Philips components controlled by the RC-5 remote. A two-position switch selects between reception of signals from the remote-control transmitter or from an alternative remote receiver (used, for example, when the player is part of an audio system that has its own universal remote control).

Measurements

Figure 1 is a plot of frequency response from 10 Hz to 20 kHz. My new Audio Precision test setup is able to plot response of both channels simultaneously, using a glide sweep contained on the EIA-approved CBS CD-1 test disc. Output levels from the two channels were not exactly identical. The left channel measured 2.044 V (and was used to set up the 0-dB reference level), while the right measured 2.014 V. The difference between the two outputs, amounting to about 0.128 dB, shows up clearly in Fig. 1. Response for the left channel was flat down to 10 Hz and was off by no more than 0.23 dB at 20 kHz.

Figure 2 is a plot of frequency versus phase response between channels. Outputs from both channels were precisely in phase, with only a very slight phase displacement of a few degrees at 20 kHz.

Figure 3 is a spectrum analysis of residual noise versus frequency, referenced to maximum recorded output level. The overall unweighted S/N for this player was 109.9 dB from the left channel and 110.5 dB from the right. Adding an A-weighting filter in the signal path further improved the readings, to 114.5 dB from the left channel and 114.7 dB from the right.

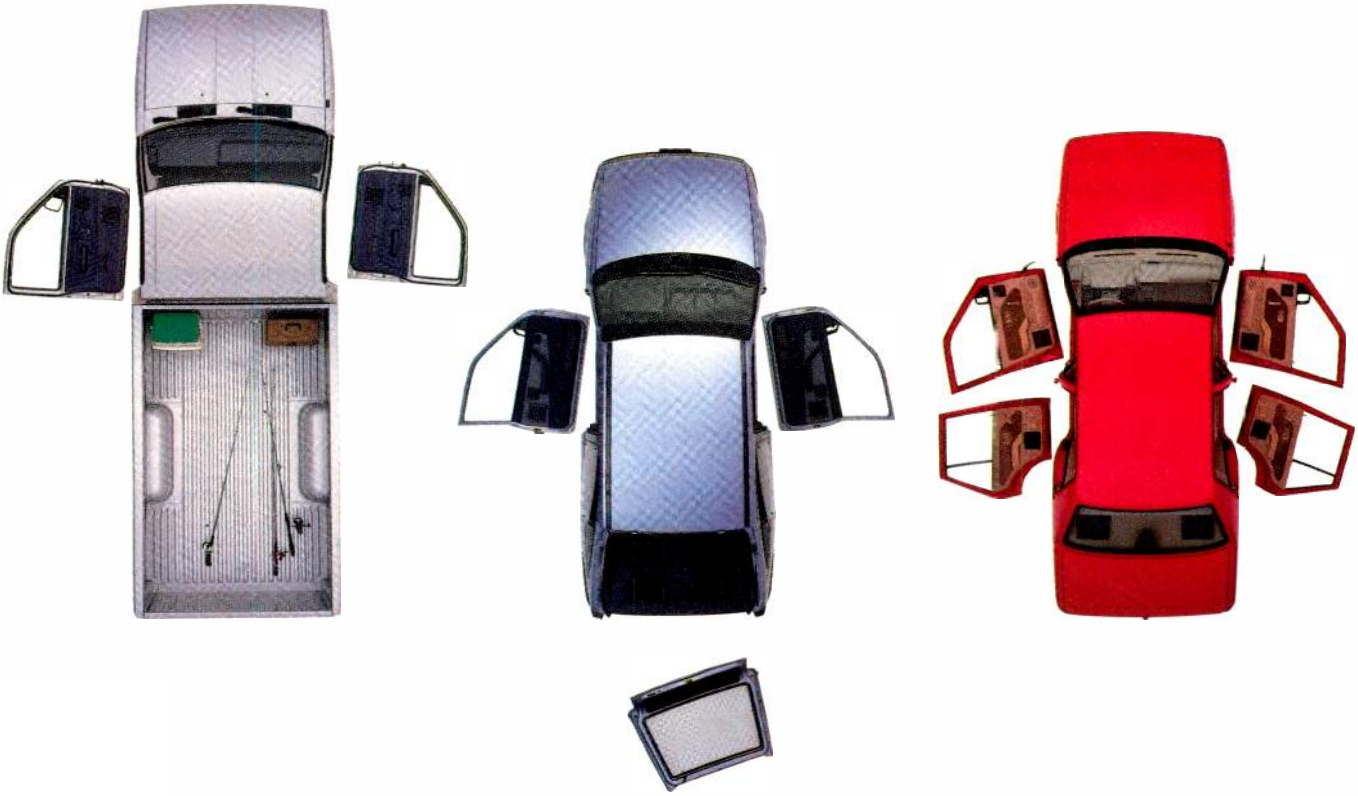
Figure 4 is a plot of THD + N versus frequency for both channels. At 1 kHz, THD + N was no more than 0.0035%, decreasing to still lower values at lower frequencies. The moderate rise at high frequencies was not so much an increase in actual harmonic distortion as it was the appearance of out-of-band "beat" components beyond the audible range. In Fig. 5, a spectrum analysis of the CD960's reproduction of a steady-state 20-kHz signal, one of these beat components is easily seen at 24.1 kHz. It is important to note that no such nonharmonically related beats appear in the audible spectrum.

CCIF (twin-tone) IM was 0.00095% on the left channel and 0.00136% on the right channel. SMPTE-IM distortion at 0-dB level was a mere 0.00434% on the left channel and 0.00384% on the right. Dynamic range measured just over 104 dB.

Figure 6 is a plot of the Philips CD960's quantization distortion—expressed in dB rather than percent—as a function of playback level. Interestingly, the quantization distortion was actually lower at lower recorded levels than it was at higher levels (although quantization distortion figures of −90 dB or better are hardly worth quarrelling about at any playback level).

Figure 7 is a plot of linearity *deviation* versus recorded level. From maximum recorded level down to −70 dB, linearity was virtually perfect. However, between −70 and −80 dB, linearity errors were evident, about 1 dB for the left channel and nearly 2.5 dB for the right channel. Severe nonlinearity was present from −80 to −90 dB; the right channel's deviation was far worse than the left channel's—more than 15 dB of linearity error at −90 dB. I suspect that one of the two D/A converters in the sample that I tested was the culprit here. Even though these tests were conducted using undithered signals on the CD-1 disc, I would not normally expect such a high degree of nonlinearity, especially in the negative direction. Nonlinearities of this type are usually positive (what should be a −80 dB signal reads *less* than −80, for instance). Using dithered test tones ranging from −70 to −100 dB, it was possible to plot deviation from perfect linearity below the limits supposedly imposed by 16-bit systems (Fig. 8). Here, too, it became obvious that something was wrong with the low-level signal D/A-conversion process. The deviation from perfect linearity at −90 dB is almost identical to that shown in Fig. 7. (The deviation should have been less, all things being equal, due to the dithering of the signals used in this test.)

Separation between channels is plotted in Fig. 9. Even at 20 kHz, separation exceeded 100 dB. Using my new test system's capabilities for spectrum analysis, I analyzed the nature of the SMPTE-IM distortion components in the range from 20 Hz to 1 kHz; the results are shown in Fig. 10. There appears to be a major contribution of IM at 120 Hz (which I would expect, considering that it is the second harmonic of



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Although the unit I tested exhibited some low-level nonlinearities, I detected no glitches at all during the listening sessions.

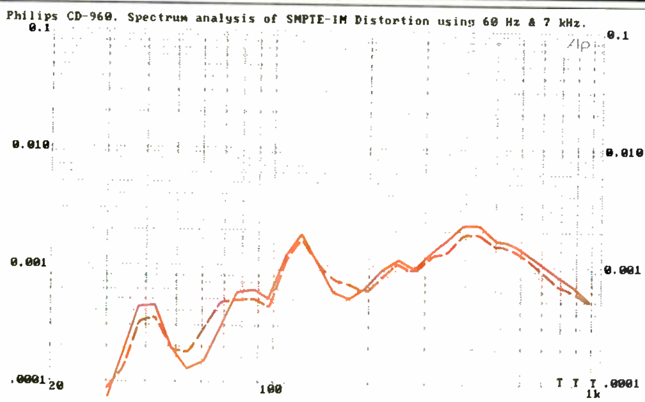

Fig. 10—Spectrum analysis of SMPTE-IM distortion for left (solid curve) and right channels.

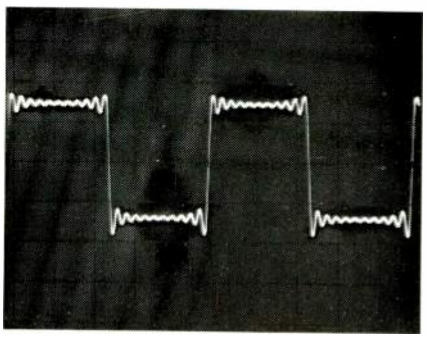

Fig. 11—Reproduction of 1-kHz square wave.

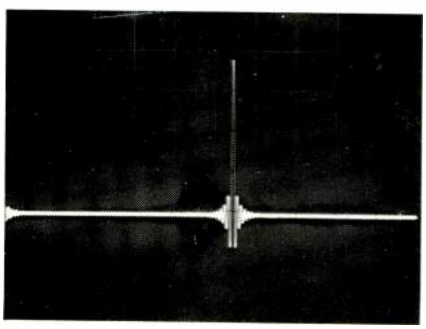

Fig. 12—Unit-pulse test.

one of the two frequencies involved in this test) and another "bump" at around 400 Hz.

Figure 11 shows how a 1-kHz square-wave signal was reproduced by the CD960, and Fig. 12 shows how it reproduced a unit pulse. The shape of the unit pulse in Fig. 12 shows that the analog audio stages of the CD960 do not invert polarity. The square wave in Fig. 11 is typical of those seen for CD players employing digital filtering and oversampling techniques.

Use and Listening Tests

Many of the earliest and best-sounding CD players were based on the early Magnavox (actually, Philips) players and mechanisms. There is a good reason for this: Philips technology is at the heart of all optically read media (such as CDs and videodiscs). Although these players did not employ true 16-bit D/A converters, they achieved the equivalent of 16-bit performance by using the innovative four-times oversampling technique, which has become almost standard in better units. Now that Philips has turned to true 16-bit D/A converters and maintained their four-times oversampling technique for reduced modulation noise beyond the audible spectrum, players such as the CD960 offer outstanding sound quality.

I listened to a wide variety of discs on this top-of-the-line machine, experimenting along the way with its FTS and other programming features. If you want to hear what a properly recorded disc can sound like on a well-designed player, listen to the CD960 reproduce Telarc's new release, *Hollywood's Greatest Hits, Volume I* (CD-80168). Try track 10, in particular, to hear how a good recording of a piano should sound. Several of this disc's other tracks will not only show you the kind of solid bass that can be reproduced digitally, but should put the rest of your system through its paces as well. Despite the low-level nonlinearities present in my sample (I suspect that this may not be the case in all production units), the CDs that I used for my listening tests sounded great. I did not detect the sort of glitches (akin to "crossover" distortion) that these nonlinearities might have been expected to produce.

Unlike units from Philips that bore the Magnavox label, the CD960's chassis construction is extremely rugged. Both the chassis and the laser assembly are of die-cast components and provide high resistance to external vibration and internal resonances. I couldn't resist opening up the unit to compare construction with earlier Magnavox models. The CD960 features four separate power supplies—arranged on separate modular p.c. boards—to drive the digital, servo, display, and analog circuits. Needless to say, not one of the defects on my Philips defects test disc was able to cause mistracking of the laser assembly. Access time from track to track was less than 1 S, while access from an inner track to the outermost track took about 3.5 S.

There are still CD players around that sell for considerably more than the CD960, but I haven't found one that sounds substantially better—or any that offers more convenience features. With personal CD collections in most audio-oriented households growing by leaps and bounds, the FTS feature, too, could not have come at a better time.

Leonard Feldman

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5

PHILIPS DAC960 D/A CONVERTER

Manufacturer's Specifications

Frequency Range: Fixed and variable unbalanced outputs, 2 Hz to 20 kHz; balanced outputs, 20 Hz to 20 kHz.

Amplitude Linearity: 20 Hz to 20 kHz, ±0.1 dB.

Phase Linearity: ±0.2°, 20 Hz to 20 kHz.

Dynamic Range: Greater than 96 dB.

S/N: Greater than 102 dB.

Channel Separation: Greater than 101 dB at 1 kHz.

THD: Less than 0.0015% at 1 kHz.

Input Levels: Systems 1 and 2 inputs, 0.5 V; optical input, from −15 to −23 dBm; digital tape input, 0.5 V.

Output Levels and Impedance: Fixed (100-ohm) unbalanced output, 2.0 V rms; balanced (600-ohm) output, 2.0 V rms; variable output, 4.0 V rms maximum; digital tape output, 0.5 V.

Power Requirements: 110 V, 60 Hz, 35 watts.

Dimensions: 16.5 in. W × 3.9 in. H × 14.2 in. D (42 cm × 10 cm × 36 cm).

Weight: 19.8 lbs. (9 kg).

Price: $950.

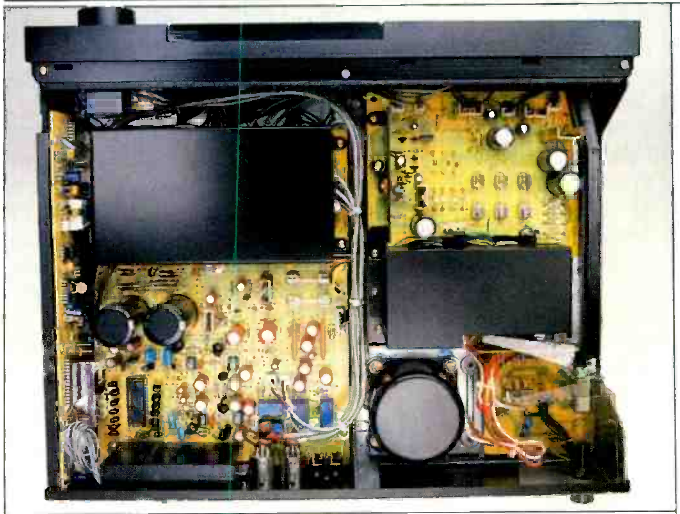
Company Address: Philips Consumer Products, P.O. Box 14810, Knoxville, Tenn. 37914.

For literature, circle No. 94

Testing and evaluating Philips' new stand-alone digital-to-analog converter presented quite a dilemma. Once before, I had compared a separate D/A converter with a high-quality CD player's built-in D/A conversion system and had found virtually no difference in sound quality between the two methods of digital audio recovery and reproduction. At the time that I made those tests, my lab equipment was insufficiently sensitive to detect measurable differences between the two approaches. Now I have the more sensitive, computer-driven Audio Precision System One test setup in my lab. Even if my ears failed to disclose significant sonic differences between a top-quality CD player and the digital output of that same player when connected to a separate D/A converter, I felt certain that measurements would finally "tell all." So, why the dilemma?

Simply because most low-cost CD players don't come with digital output jacks; indeed, Philips is perhaps the only firm to offer the feature in players retailing for less than $300. However, the people who might invest in a D/A converter will also want a full-featured CD player, and such a player will probably have D/A conversion circuitry that is fully as sophisticated and precise as the circuitry in a stand-alone converter. Would I have more success in differentiating between a high-test player this time? Read on, and you'll soon find out!

The Philips DAC960 converter can handle digital inputs having sampling rates of 48 kHz (used in DAT recorders), 44.1 kHz (used in CD players and PCM processors), and 32 kHz (used in European satellite digital audio broadcasting). Because one of several inputs can be selected, the converter resembles a preamplifier/control chassis. There are two wired digital inputs as well as an optical input. The DAC960 also has a tape monitor "loop," consisting of tape in and tape out jacks for connecting the digital output and inputs of a DAT recorder. The "monitor" designation is a bit of a misnomer, inasmuch as you can't really monitor results while in the record mode of a DAT machine. In fact, when recording with a DAT unit via the converter, the Philips



owner's manual (printed in *seven* languages) warns against pressing the "Monitor" button on the front panel. This button is used strictly for playback of a DAT recording—not for true monitoring in the sense that we normally think of that term.

Since I was still in possession of the Philips CD960 Compact Disc player (also reviewed in this issue), I had an opportunity to connect these components together using optical coupling cables. The accessory bag supplied with the DAC960 provided two kinds of optical coupling cables, each about three feet in length. When this unit was produced, the industry was still in the process of standardizing the type of optical connector to be used for this application. It is my understanding that such a standard has now been agreed to by major digital equipment manufacturers, and the type chosen is, in fact, the one that I found packed with both the Philips CD player and the D/A converter.

If you've never handled optical coupling cables, you should be aware that although they can be bent in a gentle curve, they should never be bent sharply. After all, a kink in these cables will prevent the light beam from travelling from one end to the other.

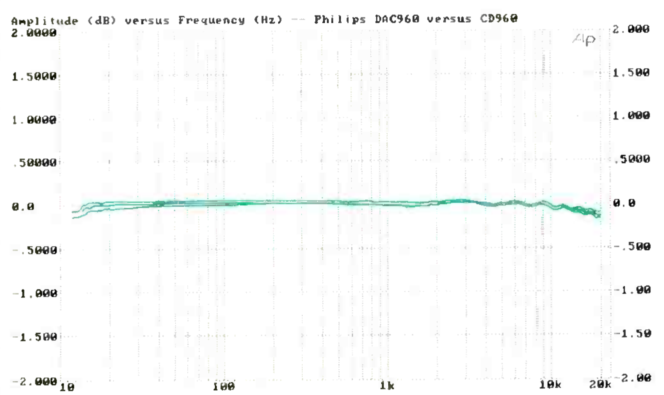


Fig. 1—Comparison frequency responses of Philips CD960 alone, CD960 and DAC960 coupled via optical link, and CD960 and DAC960 coupled via hard-wired link.

You can listen to the output of the DAC960 via headphones having any impedance between 8 and 1,000 ohms. Balanced outputs, using proper XLR connectors, as well as fixed and variable line-level unbalanced outputs, using ordinary phono-tip jacks, are provided; all digital inputs and the digital tape output employ phono-tip jacks. With the exception of the XLR connectors, all jacks are gold-plated for good, permanent, nonoxidizing contact. The optical input is protected by a removable plastic plug when it is not in use. As supplied, the tips of the optical cables are also protected with soft plastic covers at each end that must be removed before using the cable.

Control Layout

The all-black front panel of the DAC960 has a large, rectangular "On/Off" pushbutton at the left end. When power is applied, a soft blue indicator light illuminates along the top edge of the switch. The phones jack and its associated slider level control are at the lower left of the panel. Two pushbuttons adjacent to the slider control handle the "Monitor" function and invert audio signal polarity if, for some reason, an inversion occurs elsewhere in your signal chain and you want to restore correct absolute phase to your music (assuming you can hear the difference).

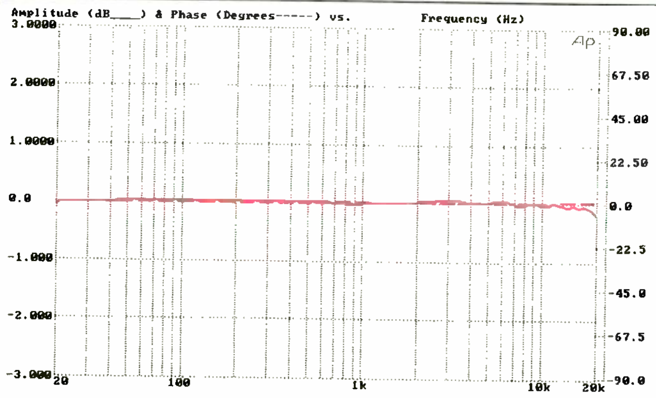
A very subdued display area near the center of the panel shows the sampling frequency of the digital program source currently selected. Decimals are omitted, so the readouts are "48 kHz," "44 kHz" (instead of 44.1 or 44.05), and "32 kHz." I rather wish that this display had been a bit brighter, as I found that the numbers were almost invisible in a well-lit listening room. Another pair of displays is to the right of the sampling frequency indicators. One lights up with the initials "DA"; the other displays the word "Monitor" when the "Monitor" button has been pressed. Three more illuminated displays further to the right show which input has been selected ("System 1," "System 2," or "Optical Fiber"). Three input selector buttons are at the lower right of the panel, below a large rotary "Output Level" control which adjusts the level appearing at the variable output jacks on the rear panel.

Measurements

Initially, I attempted to compare performance of the Philips DAC960—when coupled optically or digitally hard-wired to the Philips CD960's digital output—with performance of the CD960 using its own D/A circuitry and analog outputs. Figure 1 shows three frequency response sweeps superimposed on each other; there is not much point in attempting to identify which is which. Suffice it to say that one curve was derived from the left and right analog ouputs of the CD player, while the other two were measured at the left and right outputs of the D/A converter when it was connected, digitally, to the player (either optically or by hard-wiring of the digital-to-digital interface). Not only are the response curves identical (within about 0.1 dB) for all three sweeps, but, judging by the very slight ripple at the high end, it would appear that Philips is even using the *same* gentle analog filters after D/A conversion in both units!

To confirm this, I measured amplitude and phase response of the converter. Results are shown in Fig. 2A, and the dashed curve represents the phase response; it did not

The Philips DAC960 will handle all three digital sampling rates, has three types of inputs, and even offers balanced outputs.



A

B

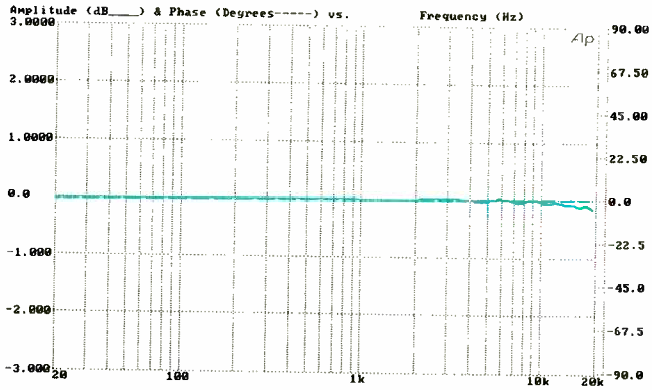


Fig. 2—Amplitude and phase responses for Philips DAC960 and CD960 combination (A) and for CD960 alone (B).

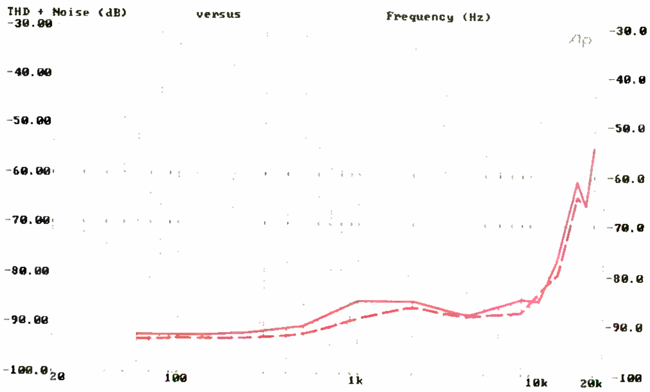


Fig. 3—THD + N vs. frequency; solid curve is Philips DAC960 and CD960 combination, dashed curve is CD960 alone.

deviate by any measurable amount from perfect in-phase relationship. Turning to the player for comparison, I repeated this test, and results are shown in Fig. 2B. Again, not the slightest amount of phase shift is evident!

At this point, frustration was beginning to set in. Surely the DAC960 must have *some* performance characteristics that are better than those of the CD960! So, next I compared THD + N versus frequency for both units, for maximum recorded signal levels. Results are shown in Fig. 3, with the solid curve representing the converter's performance and the dashed curve representing the player's. Again, results are so close that any difference must be attributed to small differences in each unit's reference output level. Even the shape of the curves is very similar.

I took a spot check of signal-to-noise ratios for the two units. Measured via the wired interface, using the DAC960 in combination with the CD960, S/N was exactly 112 dB (A-weighted) referred to maximum recorded level. Measured via the optical interface, the result was exactly the same. So much for the S/N benefits attributed to optical coupling, I thought. But then I decided to analyze the noise content itself, using spectrum analysis. Figure 4A shows the results. If anything, noise from the converter (solid curve) is actually a bit higher in overall level than from the player (dashed curve)!

By this time, I was about ready to scrap this whole project. Having invested a good part of a day so far, though, I decided to try one more experiment. I own a two-year-old CD player, a Sony Model CDP-650ESD which I regard as my "reference" player. Because it is two years old and has a digital output (albeit hard-wired, not optical) and because the state of the art moves relentlessly onward in the world of digital audio, I thought, perhaps, that a check of this "old" unit's noise spectrum compared to the new DAC960's might prove instructive. It did! As shown in Fig. 4B, I had finally found a CD player that could benefit from the use of a D/A converter. The dashed curve is an analysis of the Sony's noise, and you can see a distinct peak at 180 Hz that is not evident in the DAC960's noise spectrum!

When I measured THD + N as a function of signal amplitude (referred to maximum output, in dB) using the DAC960/CD960 combination and the CD960 alone, it was a tossup. At very low signal levels, from −60 dB downward, the DAC960/CD960 combination (solid curve in Fig. 5A) did a bit better than the CD960 alone (dashed curve in Fig. 5A). At higher signal levels, the CD960 measured alone produced lower THD + N. So, again, I introduced my "old" Sony player into the test scheme, and, again, the DAC960/CDP-650ESD combination performed measurably better than the CDP-650ESD alone (Fig. 5B).

Next, I looked at stereo separation as a function of frequency for the Philips converter and player combination and for the Philips player alone. The two pieces slightly exceeded the published specification of 101 dB (at 1 kHz), but the CD960 measured directly actually did *better*. As shown in Fig. 6, it yielded separation of more than 110 dB at 1 kHz and maintained a very high separation level out to 16 kHz, the highest frequency used for this test.

I've saved the really significant measurement differences for last. Using an undithered signal whose amplitude

Frequency response sweeps run in each of three operating modes are so close as to make their identification impossible.

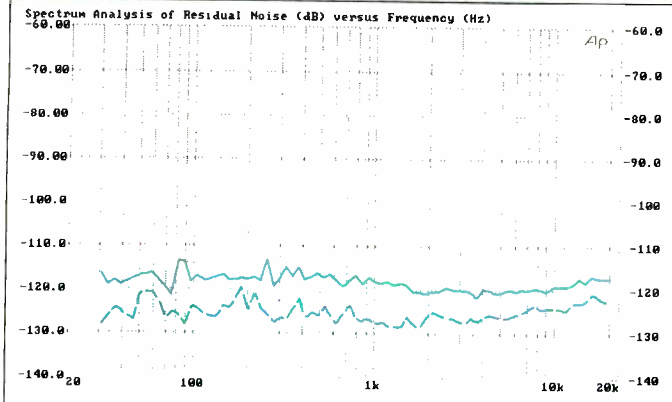


Fig. 4A—Spectrum analysis of residual noise; solid curve is Philips DAC960 and CD960 combination, dashed curve is CD960 alone.

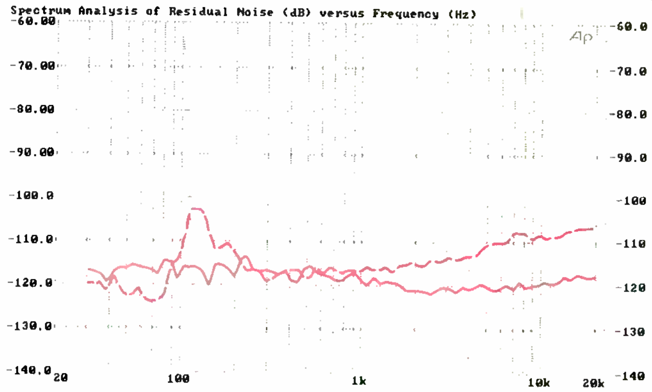


Fig. 4B—Spectrum analysis of residual noise; solid curve is Philips DAC960 and Sony CDP-650ESD combination, dashed curve is CDP-650ESD alone.

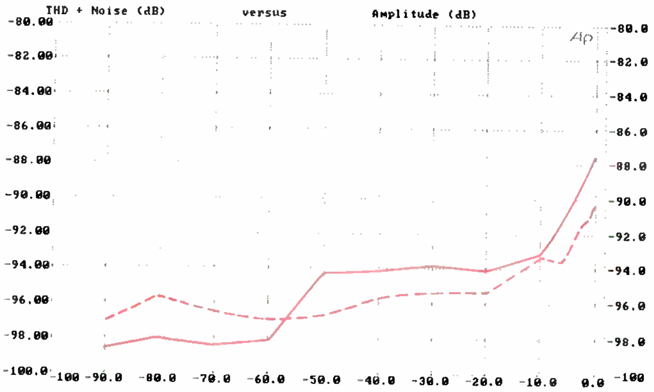


Fig. 5A—THD + N vs. amplitude; solid curve is Philips DAC960 and CD960 combination, dashed curve is CD960 alone.

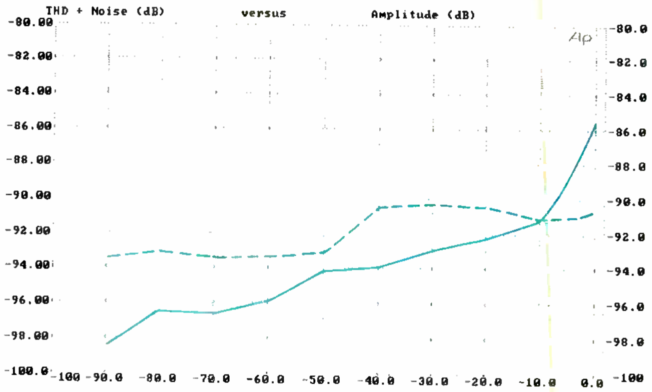


Fig. 5B—THD + N vs. amplitude; solid curve is Philips DAC960 and Sony CDP-650ESD combination, dashed curve is CDP-650ESD alone.

ranged from 0 to −90 dB, I compared deviation from perfect linearity for the DAC960/CD960 combination with the CD960 alone. In Fig. 7A, you can see that the combination's deviation at −90 dB was somewhat less than that of the player alone. The same held true when I compared deviation from linearity for the Philips converter/Sony CD player combination versus the deviation of the Sony player measured directly (Fig. 7B).

The EIA Standard Test Disc (CD-1, produced by CBS Records) also carries a low-level, dithered signal which extends downward from −70 dB. In this test, the DAC960/CD960 combination again yielded less deviation from perfect linearity than did the CD960 alone (Fig. 8). Yet, when I used the "fade-to-noise" track of the test disc (which offers dithered signal levels from −60 to −120 dB below maximum recorded level), the reverse seemed to be true. I observed somewhat greater deviation from perfect linearity at ultra-low levels for the DAC960/CD960 combination (Fig. 9A) than for the CD960 alone (Fig. 9B).

Somewhat more significant benefits of the separate D/A converter became obvious when examining the actual outputs from both setups, using a −80 dB test signal. The top trace in Fig. 10 represents the output from the D/A converter (driven from the CD960), and the bottom trace is the output waveform of the CD960 itself. Clearly, the top waveform is better defined; there is much more unwanted r.f. noise at the CD960's output.

The final lab measurement was conducted using the last track of the test disc. Dubbed a "Monotonicity" test, this track features a special square-wave signal. The peak of the waveform starts at "digital zero" and increases by 1 LSB (least significant bit) every five cycles, going to a maximum

It was only when I had switched to my reference CD player that I was able to find any measurable differences in operation.

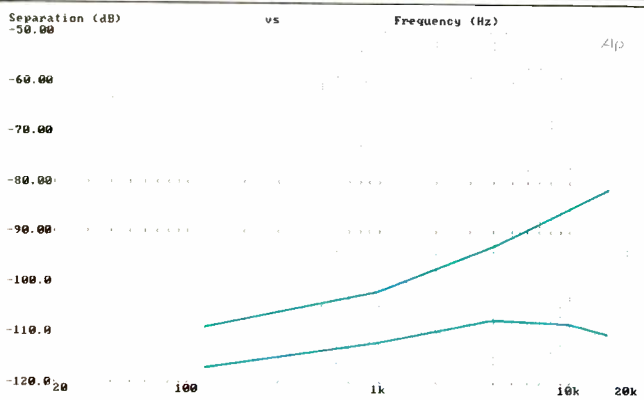


Fig. 6—Separation vs. frequency for the Philips DAC960 and CD960 combination (top curve) and for the CD960 alone.

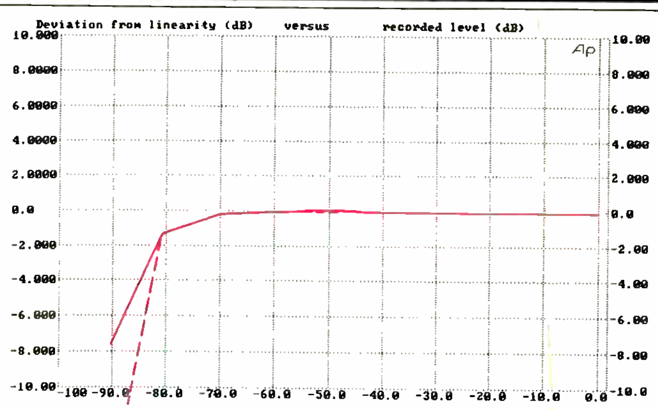


Fig. 7A—Deviation from perfect linearity vs. level; solid curve is Philips DAC960 and CD960 combination, dashed curve is CD960 alone.

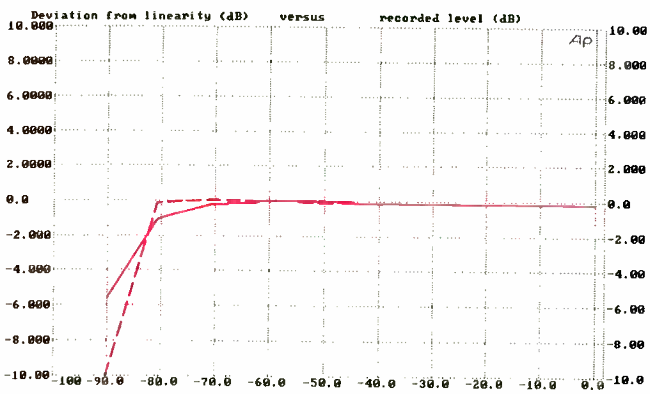


Fig. 7B—Deviation from perfect linearity vs. level; solid curve is Philips DAC960 and Sony CDP-650ESD combination, dashed curve is CDP-650ESD alone.

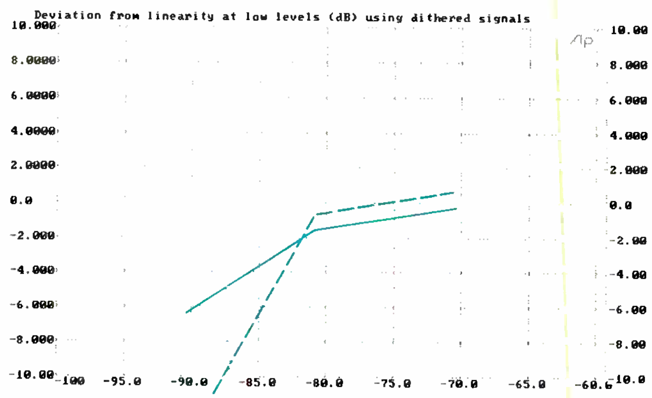


Fig. 8—Deviation from perfect linearity using low-level, dithered signals; solid curve is Philips DAC960 and CD960 combination, dashed curve is CD960 alone.

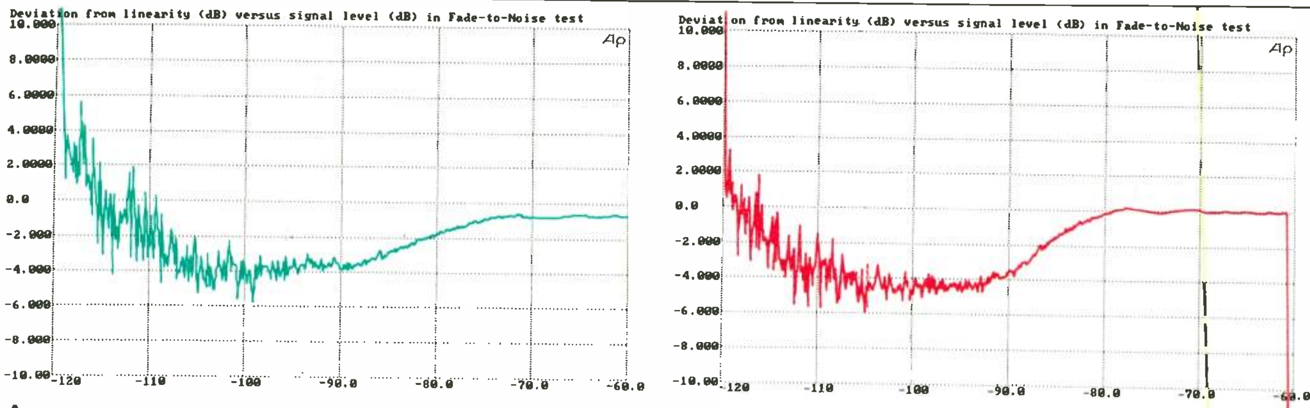
of 10 LSB. The frequency of the square wave is 1,102.5 Hz, exactly 1/40th of a Compact Disc's sampling rate. Ideally, the steps should always increase on the positive side and decrease on the negative side. The steps should also be equal in size; lack of uniformity in step size contributes to distortion in reproduced waveforms. It is clear in Fig. 11 that the DAC960/CD960 combination (top traces) comes closer to this ideal than does the CD960 alone (bottom traces).

Use and Listening Tests

The Philips DAC960 D/A converter is certainly easy enough to hook up to the digital outputs of a CD player or DAT recorder. Recovered analog outputs are, of course, equally easy to send along to your preamplifier, integrated amplifier, or receiver. I preferred using the fixed analog outputs rather than the variable ones simply because inadvertently setting the front panel's level control to maximum would result in an output of 4 V—perilously close to the overload point on some preamplifier input stages. If you need the convenience of a volume control (e.g., you've decided to go directly from the DAC960 outputs to the inputs of a power amplifier, to avoid further analog signal processing), then the option of using the variable output jacks would, of course, be welcomed.

For the listening tests, I went through more than a dozen of the marvelous little "pocket classic" 3-inch CDs recently released by Delos. Using the same setups as in the bench tests, I switched back and forth between the outputs of the DAC960 and the direct outputs of the CD960, after first

Using the DAC960 with the CD960 didn't produce any repeatable differences over the CD960 alone, but it helped an older unit.



A

B

Fig. 9—Fade-to-noise curves for the Philips DAC960 and CD960 combination (A) and for the CD960 alone (B).

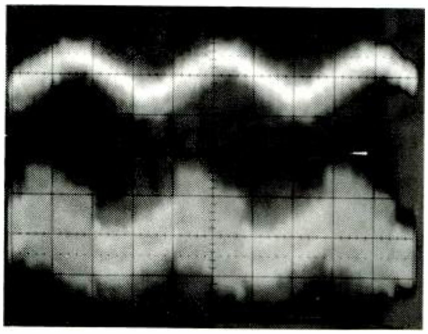


Fig. 10—Sine wave at −80 dB reproduced by the Philips DAC960 and CD960 combination (top) and by the CD960 alone (bottom).

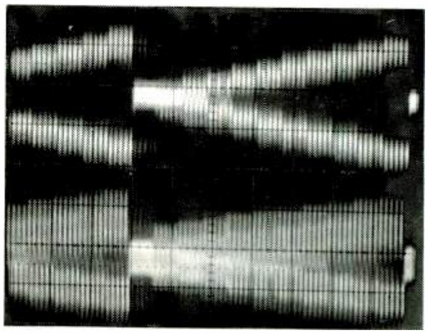


Fig. 11—Monotonicity test reproduction by the Philips DAC960 and CD960 combination (top) and by the CD960 alone (bottom).

making absolutely certain that levels were within 0.1 dB. I listened to everything from *A Sonic Odyssey* (Delos D/PC 2001, a potpourri of spectacular selections) to Haydn's "Trumpet Concerto" (Delos D/PC 2006), as well as to several of my favorite Telarc discs. In all honesty, I could not detect a sonic difference between the two setups. Every once in a while, I thought I heard a bit more graininess on low-level passages when I switched to the CD960 player alone. A few minutes later, when I repeated the test, the differences eluded me. It almost goes without saying that switching from optical to hard-wired interconnections did not yield different results.

When I added my older "reference" CD player to the equation and compared its sound with that of the DAC960/CD960 combination, I must admit that the improvement offered by the Philips combination was immediately apparent. It didn't take a whole lot of auditioning or program selection to detect it, either. Then again, comparing the Philips player alone against my older "reference" player also resulted in a consistent vote in favor of the Philips player. So, perhaps the conclusion is this: If, like me, you paid a lot of money for a CD player two or three years ago that you can't bear to part with, and if that player has a digital output, you may want to take it down to your local Philips dealer. Have him plug your player into a DAC960 converter, and see if you hear the kind of subtle differences that I heard. Listen in particular to very low-level music passages. On the other hand, if you are not that sentimental about your trusty CD player, you may do just as well by opting for one of the "new generation" players such as the Philips CD960.

Of course, if and when DAT becomes a factor, having a central component to which pure digital signals can be fed from both a CD player and a DAT recorder may be a convenience that we won't be able to resist. However, I am told that all-digital preamplifier/control units are on the way that will fill this requirement and provide additional flexibility besides.

Leonard Feldman

NEW RECORDING ARTISTS

For The Thom Rotella Band A Good Tune Is Never Too Far Away

Guitarist-songwriter Thom Rotella's kind of music, at least the variety played by the Thom Rotella Band on the Digital Music Products CD of the same name, is hard to classify. It's instrumental and, as DMP president and album co-producer Tom Jung notes, "jazz-oriented." Still, "the hardest damn thing is coming up with a label," Rotella remarks. "I just hope it's music that makes people feel good."

"We all have a basic jazz background," says Rotella of his four-man group (augmented by percussionist David Charles on the album). "We've all played our share of bebop tunes." Beyond that, the Niagara Falls, New York native explains, a number of influences filter in. "I listen to a lot of classical music. Mark [Minchello], the keyboard player, listens to a lot of fusion records. Wayne [Pedzwater, the bassist] tends to buy mainly pop records and Clint [deGanon, percussionist] probably listens to a little bit of everything."

If the album's diversity makes finding a handle to grasp for marketing purposes difficult, the very same quality has led to considerable airplay on radio stations with various orientations. "Patti Cake", the CD's lead selection, is being heard on rock stations while jazz programmers have responded to "Naima" (a John Coltrane tune and the album's only cover song; all other selections were written by bandmembers), Rotella's "Summer's End" and Minchello's brightly-colored "Song for Leah". At the same time, Wayne Pedzwater's "In the Wind", with its moody, minimalist attitudes, is being beamed out to New Age fans.

Along with other artists on the DMP label, Rotella is part of a circle of seasoned studio players whose versatility and experience with a wide range of musical styles do much to explain the heterogeneous mix on this debut album. His band arrived at their particular sound (or sounds) playing together on a regular basis at a now defunct New York City night spot called The Paper Moon. When asked about the evolution of the group's style, Rotella is anything but academic. "You do it and you do it and you do it," he shrugs. "It's kind of like being a sculptor. You just keep chipping stuff away until you start to see some kind of image."

The Thom Rotella Band: (from left) Mark Minchello, Clint deGanon, Wayne Pedzwater, Rotella

At its most basic level, the aural image most listeners will get from this first album is what has always formed the foundation of successful popular music—appealing melodies. Songs like "Never Too Far Away", a nostalgic tribute to Rotella's late mother, "The Immigrants", which began when the songwriter saw footage for a film on Ellis Island, the catchy "Come Down Easy" and others on the CD are simply good tunes. The band's skillful playing, along with the technological purism of co-producer Jung, who brings a battery of super-fi equipment to his live to two-track recording sessions, present these in the best possible light.

Rotella, who attended Ithaca college briefly before studying for two years at Boston's Berklee, has lived with music all his life and was first influenced by his grandfather and uncles. "There was always music—guitars and mandolins—around in our house," he recalls. At age 10, lessons began, and by the time he was 12, Rotella was playing in his first band.

After working as a successful session guitarist in Los Angeles for more than a decade, Rotella needed a change. So in 1984, after "commuting" between coasts for a couple of years, he moved to New York on a permanent basis. By 1986, he had his band together and was playing at The Paper Moon in Greenwich Village, and a year later, the musician-songwriter achieved a 15-year goal by doing the four-day session for his own debut album.

The Thom Rotella Band's current agenda calls for another DMP album and a debut tour. While the latter is still in its early planning stages, Rotella expects it will take him to 17 cities on both coasts as well as the Midwest, something the energetic artist admits he's looking forward to. "I want to get out and play my music for a lot of different kinds of people," he enthuses.

RETROSPECTACULAR

Crossroads: Eric Clapton
Polydor 835 261-2, CD.

Sound: A   Performance: A

Slice rock history with surgical precision at just the right angle, and you get a cross-section which both clearly portrays the growth of a major artist and reveals significant milestones in the development of pop music. That's what the new four-CD/six-LP 25th-anniversary Eric Clapton retrospective, *Crossroads*, manages to accomplish.

This is a stunning collection. Spanning Clapton's career from 1963 Yardbirds demos to his 1987 remake of "After Midnight" for Michelob beer, *Crossroads* paints a comprehensive and intimate portrait of a legendary musician who's been an enormous influence on rock since its early days.

Clocking in at more than 293 minutes for 73 songs, there's something here for both new and old fans and rabid collectors. Providing a useful historical context, about a third of the cuts are hits and standards such as "For Your Love," "White Room," "Layla," "Cocaine," and "She's Waiting." The remainder cover notable artistic performances (including one song requested by Clapton, who was not actively involved in this project—1975's "The Sky Is Crying"), previously unreleased material, and alternative takes. These alternative cuts include a 1970 horn-tinged "After Midnight," produced by Delaney Bramlett; a newly discovered acoustic slide duet with Duane Allman, "Mean Old World"; a '74 live version of mainstream rock's first reggae inspiration, "I Shot the Sheriff," and songs from the long rumored but unfinished second Derek and the Dominos album. Throughout the transition from British Invasion pop to psychedelia to countrified rock, Clapton's blues-based guitar style rings out with amazing continuity.

The assembly of this album unfolds like a detective story. "The youth-to-maturity concept began to crystallize after I stumbled on a copy of Ray Coleman's *Clapton: An Authorized Biography*," explains PolyGram catalog executive and producer Bill Levenson. Levenson then proceeded with the arduous task of tracking down literally *tons* of master tapes and getting licenses from a plethora of record companies (some of which were out of business) and other sources. Eventually, every master was located, except for those of the Cream cuts. They may have perished in an Atlantic vault fire, although Levenson has not given up the search.

Photograph: ©1987, Ebet Roberts

This brings us to "Layla," one of three songs newly remixed for this collection. After the two-track master for the *Layla* album was completed, the original multi-track masters disappeared. Now, *Layla* is universally regarded as horribly noisy—a fact attributable to fairly primitive multi-track recording, with layers of tape hiss build-up exaggerated by the lack of noise-reduction techniques. Plus, at least one track required speeding up, causing speculation that an interim tape generation may have existed between the multi- and the two-track masters. In any case, as the compilation progressed at New York's Sterling Sound, an engineer inquiring into what was happening pointed out a box in storage marked "Eric Clapton." Imagine Levenson's surprise when he discovered, sealed for 16 years, the original *Layla* multis!

This remarkable coincidence led to the decision to remix the "Layla" multis to see if the sound could be improved using modern technology. Basically, only gating techniqes were employed to remove noise on portions where no program material existed. The cut exactly reproduces the original mix; on the extended instrumental, the piano and strummed guitars were brought up slightly to fill out the sound and minimize the sourness of Allman's out-of-tune guitar. An A/B comparison with the original recording reveals an astonishing difference between the superior, cleaner, more open sound of the CD and the compressed, noisy LP. Because the original version of the song exists in so many places, Levenson felt *Crossroads* was an appropriate forum for this experiment. However, this raises the interesting issue of what sonic judgments guided this project. "We tried to be as pure as possible," says Levenson. He says he aimed for a middle ground, trying to achieve the best sound from the best masters while keeping the focus on the music. Only The Yardbirds demos were computer denoised.

FIFTEEN YEARS AGO BRITAIN THOUGHT THIS MAN WAS CRAZY.

Fascination with the way things work led Ivor Tiefenbrun astray from a very young age. But in the early seventies, the dark ages of hi-fi, things really took a turn for the worse.

It was a grim time all round. Cordless phones were hard to come by. People wore flares. And even the **experts** still believed that the hi-fi chain started with the speakers and worked down to the turntable.

This understanding dominated the way the industry as a whole designed new systems.

And it drove Ivor to distraction.

Because it was diametrically opposed to his own **opinion**. He believed that the turntable was the most important element.

As **crazy** as it seemed at the time – his reasoning was pretty straightforward. Commonsense really.

To pick up the music the needle follows the record grooves for information stored in the groove walls. What most people don't realise is how intricate an operation this is. Movements so minute, they are measured in microns.

Take a few minutes to watch closely while a record is playing. The process is hypnotic. Because you live in a world where things are measured in inches.

It's when you scale the 'groove world' up to inches that things start to get pretty **hair-raising**.

Suddenly you are in a deep crevice. The walls are undulated. Approaching at an alarming speed is a bobsled. As it hurtles through the passage it has to pick up tiny pieces of information.

The bobsled is, of course, the needle. And to pick up a deep organ note it has to swerve 10 feet 6 inches. For a high violin note it's less than an inch. A difference which may not seem staggering in itself. Until you stop to consider that the needle is travelling 6 miles per second. And that the pivot point of the lever controlling it is four **miles away**.

In these terms you can see how easy it is to miss out on critical information.

And how even the slightest, imperceptible movement can cause the needle to miss out on the more delicate notes.

Ironically, that which gives a piece its musicality.

No speakers in the world can bring back lost music. It must be dealt with at its source. The turntable.

A **painfully obvious** idea. Yet the entire industry ridiculed it. Because it pointed out they were wrong.

Ivor would have had more luck arguing that the world was round or man would fly.

So he did what Ivor always does when people tell him he's wrong. He ignored them. And quietly set about building a turntable.

The fruit of his labor, was the Linn LP12. And with it he **proved categorically** that the signal source is the most important component in the hi-fi chain. Apart from revolutionizing the hi-fi industry as a whole, the LP12 has served history well.

As a shining example of the time honoured truth

Ivor Tiefenbrun

that sometimes things are too **simple** for people to understand.

Because not only was it the undoubted industry leader in technical terms: it also sounded demonstrably better than any other turntable.

was in turmoil. Music lovers everywhere, long tired of worshipping false gods, listened to Ivor's turntable and were converted.

Up and down the country naive listeners began to confess. A Vicar here, a Member of Parliament there, even somebody's mother in Shropshire, all heard the difference. Because the Linn proposition is so simple to prove.

Anyone can hear the difference between good and bad hi-fi. All you have to do is listen.

This fundamental belief is at the root of everything we do. And it governs our retailing philosophy.

Comparisons, using a single set of speakers, are a matter of course at all our dealers. And have been ever since the dawn of Linn. No gimmicks. No obligations. Just a straightforward listen.

And whether you compare Linn to a similarly priced system, or one at ten times the price, the results are the same: Time and time again, Linn's superiority rings true.

By the late seventies, the LP12 reigned supreme, yet Ivor still would not rest. Having proved that the turntable was the **critical** component, he then applied his fanatical attention to detail to the problem of the hierarchy itself.

He tweaked and tested, designed and refined. And established that the correct order of the hi-fi chain is, turntable, tonearm, cartridge, amplifier, and speakers.

The rest is, as they say, history.

Now music lovers can choose between a variety of Linn components in the hi-fi chain. And with the recent introduction of the Axis turntable, starting to build-up a Linn system is more affordable than ever before.

Today Linn products are sold in thirty countries. In America Linn are the recognised leaders in

TODAY AMERICA THINKS HE'S CRAZY.

But for some mysterious reason the concept that one turntable might sound better than another was too much for some people to cope with.

Such was Ivor Tiefenbrun's dilemma. He was just a guy who wanted people to calm down and listen to the music.

And when they were too uptight to try it, he behaved in a slightly **deranged** manner. He called hi-fi reviewers who refused to listen 'cloth ears'. They called him a heretic. The score remained fairly even.

But the press love vocal crazies and Ivor was forever giving interviews.

Interviews in which he issued challenges to the hi-fi aficionados, calling on them to explain what the speakers can do about restoring music the needle has failed to pick up.

Their answers spoke volumes about their understanding of hi-fi. The industry leaders told Ivor he was **certifiable**. Out to lunch. **Looney** tunes. Living in Gagaland. Not to mention rather rude.

This upset Ivor. He doesn't like to be thought of as rude.

Alas these Board Room **diagnoses** came too late. Ivor's **insanity** had proved infectious. The industry

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specialist hi-fi. And worldwide Ivor is the undisputed protector of the faith.

While the problem of the hi-fi chain has been happily resolved, the larger question of Ivor Tiefenbrun's **mental status** still looms. What's your opinion? Just clip the coupon and send it to your nearest Linn dealer.

You owe it to humanity.

LINN
HIGH FIDELITY
YOU'VE NEVER HEARD IT SO GOOD.

☐ Yes, this guy is [illegible]

☐ He's probably **crazy**, but I'm reserving judgement until I get more information.

☐ If you promise he won't be there I'll come in for a listening comparison.

☐ He seems perfectly **sane** to me. (hee hee ho ho ha ha.)

Name

Address

Distributors ■ Audiophile Systems Ltd., 8709 Castle Park Dr., Indianapolis, IN 46256. Tel. (317) 849-7103 ■ Aldburn Electronics, 127 Portland St., Toronto, Ontario, Canada, M5V 2N4. Tel. (416) 863-0915.

See dealer list on page 140

Eric Clapton's stunning collection, *Crossroads*, portrays the growth of this artist as well as the development of pop.

"This was conceived as a CD project from the beginning," explains Rhonda Schoen, who digitally edited the music, "so we concentrated on painstakingly upholding the sound quality for CD." Songs were transferred flat to a Sony DAE 1100 digital audio editing machine, where they were individually equalized, edited (mostly clipping trailers, deticking and depopping), and then equalized a second time for continuity as they were compiled onto the new digital master.

The net result is that you will hear some noise (more evident when using headphones), especially on the older songs. Fortunately, there are no dramatic cuts from hiss to noiseless black between selections, which helps minimize discrepancies with the CD's low noise floor. You will also hear some memorable, pristine performances of both new and familiar music. Personally, I didn't find the noise distracting and feel the trade-off was worthwhile.

Eric Clapton's *Crossroads* represents an excellent testimony to the achievements of a great artist. It also raises some curious questions regarding how our historical archives should be treated now that, thanks to the arrival of digital audio, we have become more sensitized to sonic values.

Happy anniversary, Mr. Clapton, and thank you. *Michael Wright*

Into the Woods: Original Cast Album
RCA Victor 6796-2-RC, CD.

Stephen Sondheim's latest offering for the musical theater is, as was its immediate predecessor, his most accessible work to date. In *Into the Woods*, such fairy tale characters as Cinderella, Little Red Riding Hood, and Jack (of Beanstalk fame) enter an enchanted woods, each on his or her own mission. Ultimately, they stumble into one another's stories, encounter disaster together, become disillusioned, learn to cope, and emerge all the wiser for having realized that "No One Is Alone," the show's heart-stopping ballad.

Bernadette Peters plays the nasty but truth-speaking witch who ties these tales together, and it is the melody of her major song, "Stay with Me," that ties many of the numbers together musically: One verse is reprised entirely in

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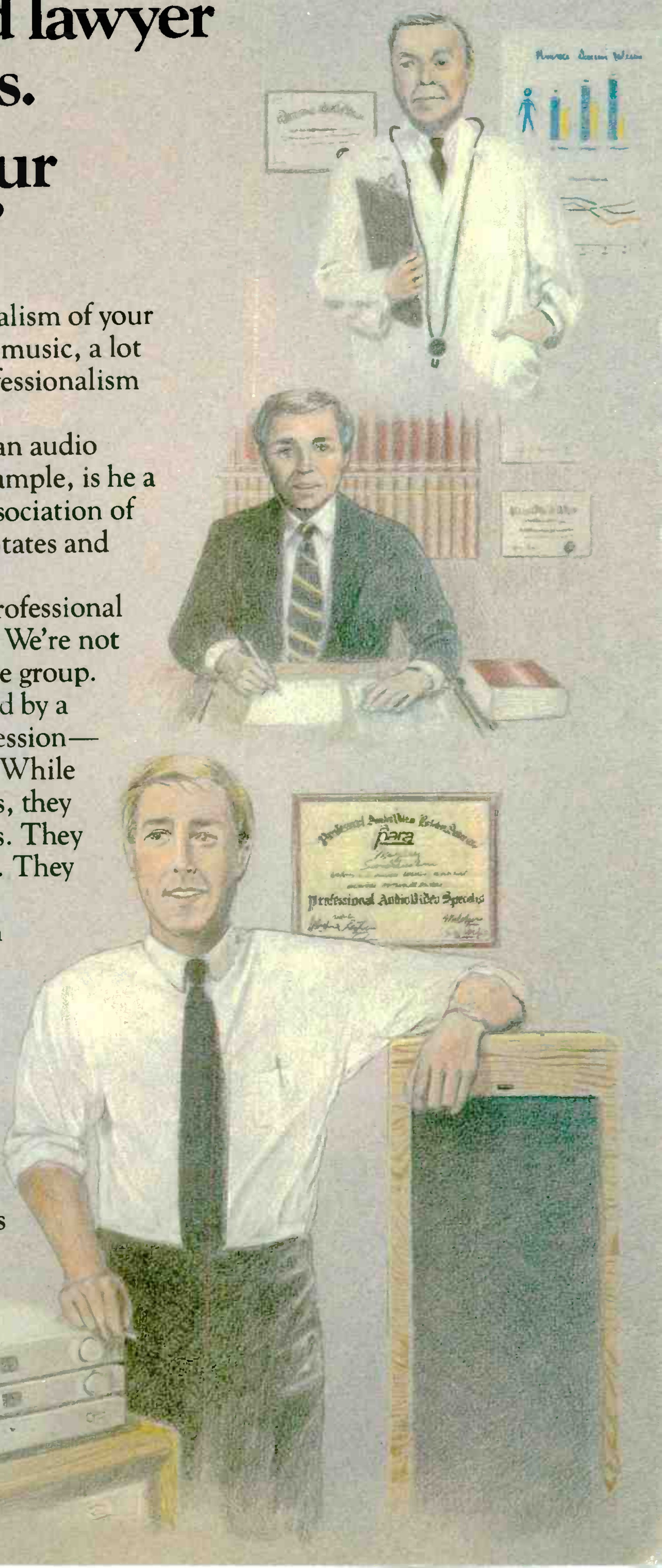

Much depends on the professionalism of your doctor and lawyer. If you truly love music, a lot depends on your audio dealer's professionalism as well.

Perhaps the easiest way to judge an audio retailer is by his affiliations. For example, is he a member of the only professional association of audio/video dealers in the United States and Canada?

That association is PARA, the Professional AudioVideo Retailer's Association. We're not ashamed to say it's a rather exclusive group.

Member dealers are distinguished by a genuine commitment to their profession— and consequently their customers. While they may not carry the same brands, they do share the same ethical standards. They employ knowledgeable salespeople. They back what they sell with service departments equipped to deal with today's high technology products.

If you're in the market for quality audio and/or video equipment, you really should visit a PARA dealer. To find the PARA stores nearest you, please refer to the dealer list on the opposite page.

Then stop in. You'll find doctors and lawyers aren't the only professionals around.

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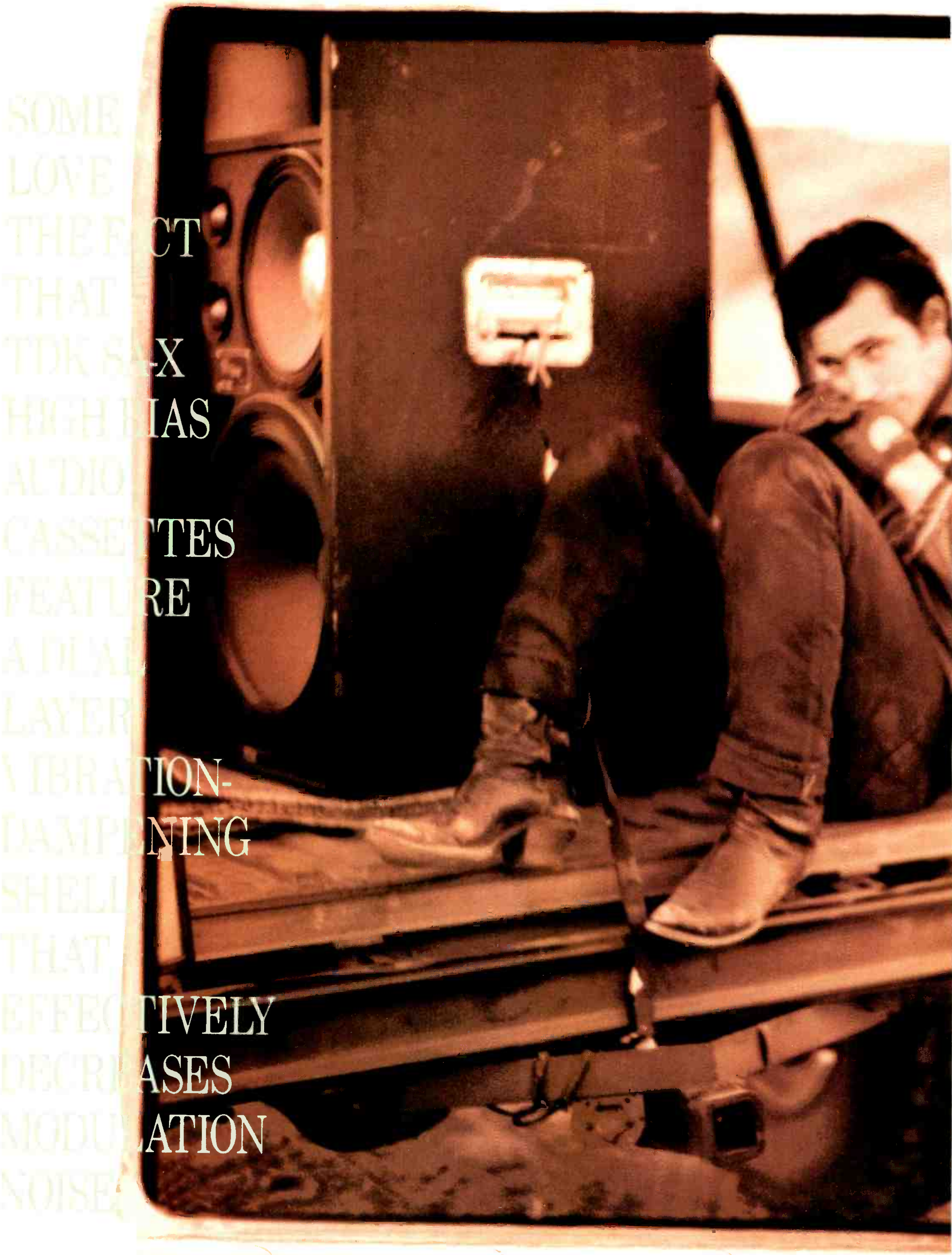
SOME
LOVE
THE FACT
THAT
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SHELL
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A
TYPE II High Position SA-X
TDK
SOME
JUST
LOVE
the
Music.
TDK SO REAL

The vivid performances by the cast help bring out the brilliance of Sondheim's *Woods* score.

Act 2's "Lament"; in "I Guess This Is Goodbye," "Giants in the Sky," and "No One Is Alone," it is a prominent countermelody. A variation of it becomes Rapunzel's cry from atop her tower, which in turn accompanies the melody of "Agony," a hilarious duet between Cinderella's and Rapunzel's respective princes. The witch's song, like her character, is everywhere.

The above is but one example of the Sondheim intellect at work with the Sondheim muse—a combination that has made the composer/lyricist the brightest creative light in musical theater today and earned him the 1985 Pulitzer Prize for *Sunday in the Park with George*, his first collaboration with *Woods* librettist James Lapine.

Woods appears to contain more traditional Broadway ballads than such tougher cored predecessors as *Company* or *Sweeney Todd*, and many of them give lie to the theory that Stephen Sondheim doesn't write hummable melodies. With the notable exceptions of "Stay with Me," beautifully rendered by Peters, and "No One Is Alone" (which bears more than a passing resemblance to "Not While I'm Around" from *Sweeney Todd*), the strongest numbers here are fast-paced, and lie somewhere between recitative and patter ("Your Fault") or between patter and rap (the witch's opening description of how her garden was dismantled).

The brilliance of any Sondheim score, this one in particular, lies less in its surface characteristics than in its surrounding and supporting structures. Melodic beauty, though considerable, is just the icing on a very rich cake. Sondheim provides the recipe in an elaborate piano score, and, in this case, Jonathan Tunick blends together the ingredients in stunning, string-rich orchestrations.

Musical director Paul Gemignani, like Tunick a frequent Sondheim collaborator, conducts some vivid performances by Ben Wright (Jack) and such Sondheim regulars as Peters, Danielle Ferland (Little Red Riding Hood), and Robert Westenberg (the Wolf and Rapunzel's prince). Joanna Gleason, who plays the Baker's Wife, has a noticeable break between her upper and lower registers but nonetheless provides a convincing character portrayal.

Voice placement in the spectrum seems quite specific to staging. This marks Jay David Saks' debut as a producer of original cast albums, and he has done a superb job. Headphone listening reveals a couple of audible splice points, but they are minor details in an otherwise clean, spacious, and careful production. *Susan Elliott*

Trapped in the Body of a White Girl:
Julie Brown
Sire/Warner Bros. 1-25634, LP.

Sound: C Performance: B

If you were expecting a female Weird Al Yankovic, forget it. Though Julie Brown came to starletdom with a comical, much-liked 1985 EP and an MTV-banned video for "The Homecoming Queen's Got a Gun," her first album is equal parts *opéra bouffe* and Belinda Madonnalauper.

I guess I was expecting more from the latest Hot Young Thing. *Trapped* is by no means bad, but the best stuff on it is from the EP: "Homecoming Queen," a hilariously dead-on pastiche of '60s tragic ballads and the movie *Carrie*, and "I Like 'Em Big and Stupid," a paean to male bimbos. A couple of the new songs can't decide whether they're supposed to be funny or not ("Shut Up and Kiss Me" and the disappointing title track), though the retro-'50s "Girl Fight Tonight!"—co-written by Brown with the "Like a Virgin" team, Tom Kelly and Billy Steinberg—is a hoot. (The songs, incidentally, are copyrighted by an outfit called Bitchen Tunes.) Sadly, the straight stuff is mostly so light, the LP is in danger of floating away. But boy, is "Homecoming Queen" good.

P.S.: My copy of the album came with a slip of paper that said "Inspected by #39." On the off chance that this is not some kind of joke, #39 should know that my LP had some crackles. Get with it, #39! *Frank Lovece*

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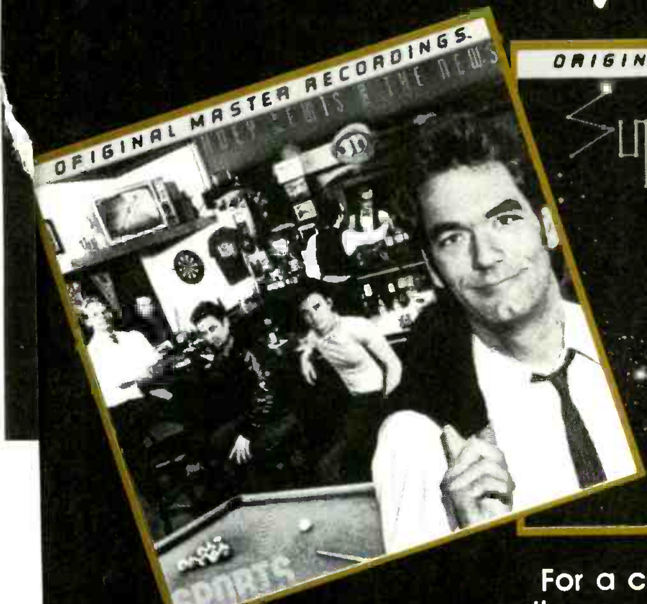

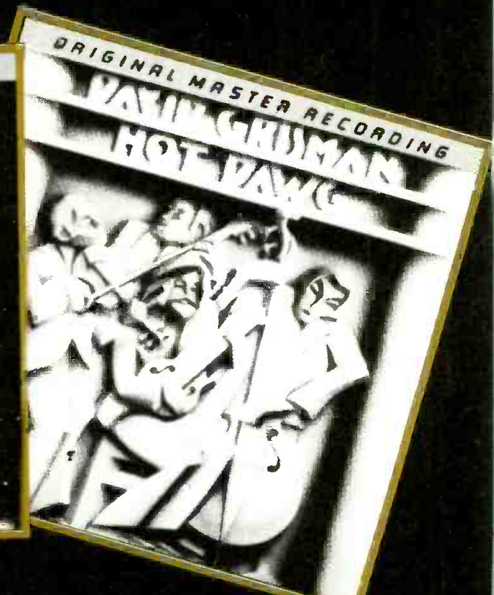

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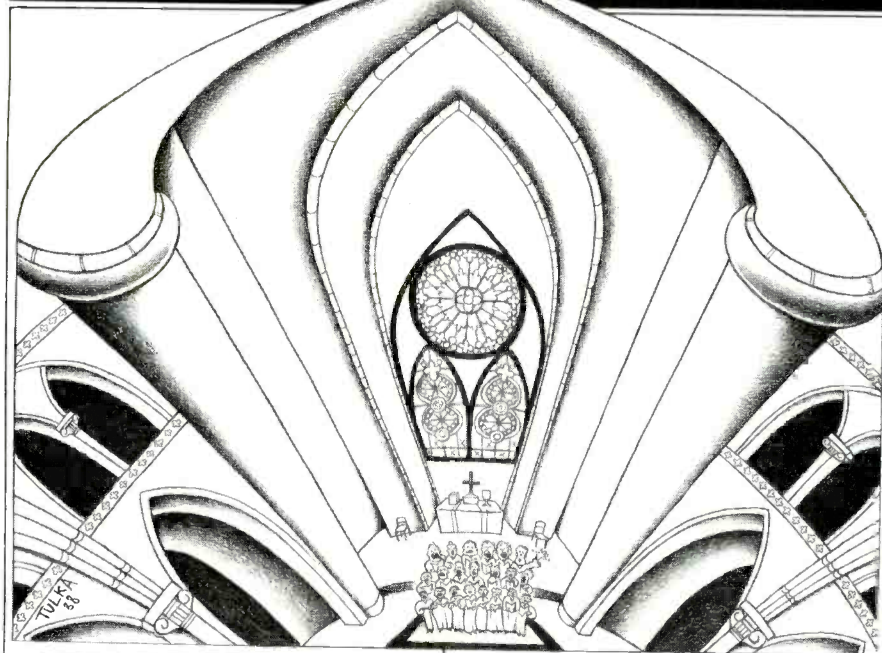


Illustration: Rick Tulka

Tomás Luis de Victoria: Requiem Mass; Alonso Lobo: Versa Est in Luctum. The Tallis Scholars, Peter Phillips.
Gimell CDGIM-012, CD.

For about 15 minutes after the CD was launched, it seemed that the new format was going to be mainly for big-show stuff, all kinds. The esoteric classics? Heavens no—not at *that* price! How wrong we were—for those 15 minutes.

Instead, the still expensive CD has assiduously brought a far greater number of the more unusual and interesting classical works than the LP did in its sensational early mono years. The CD lends itself to classical, its virtues emphatically the sort that favor a huge wealth of varied classical material.

Thus, the great and sometimes just-a-wee-bit-hammy Spanish composer de Victoria makes it onto CD, all digital. This is one of his more austere works, and rightly so considering the subject—death. The "Requiem Mass" alternates segments of the text between plain, unaccompanied chant and music set in parts, the composer's product. The music is rather long, almost the whole of this disc (the Lobo item is actually only a few minutes long), and the alternations are rigorous and continuous straight through. But in the CD format, the impact of this music is impressive, and the performance—very English—is impeccable. The traditional choir is splendid. The upper parts are sung by beautifully trained boys (and maybe some girls, too) and adult tenors and basses. The adult voices blend with the boys' without undue modern vibrato. This makes the listening easy—a maximum of intelligibility in words and harmony.

The tempi, the speeds, are a bit rigid and just a trace on the plodding side, but this is a minor problem thanks to the excitement, enthusiam, and excellent shaping of the musical phrases by these singers.

Odd to think when this music was written, the Spanish and English were the bitterest and most desperate of enemies, Empire against Empire, Catholic against Protestant. Time does heal, especially in music.

Edward Tatnall Canby

Virtuoso Guitar—Music of Falla, Ponce and Rodrigo: Manuel Barrueco
Angel/EMI CDC-49228, CD.

Sound: A– Performance: A

Alluring, Moorish-colored melodies and the sensuous rhythmic excitement of Spanish music undulate liberally throughout this Compact Disc, as Cuban-American virtuoso Manuel Barrueco plays works by the most significant members of the early 20th-century Spanish Revival to compose for guitar—Falla, Ponce, and Rodrigo.

Barrueco has chosen to assemble the best known—and most challenging—works of the concert repertoire, a conservative move certainly, but one that yields both a coherent and stimulating program. Most notable is the enthusiasm brought to Barrueco's arrangement of dances from Falla's ballet "The Three-Cornered Hat" (the only pieces not originally written for solo guitar), and especially note the astonishingly precise arpeggiation in "Night." Ponce's romantic, evocative "Sonatina Meridional" (known primarily through Segovia's treatment) displays Barrueco's typical balance between Latin expressiveness and classical control. To really hear Barrueco put his aggressive technique through its paces, check out Rodrigo's flamboyant "Invocation y Danse."

Soundwise, Barrueco provides an intimate, private concert rich in detail by placing his warm, round-toned instrument directly in the center of the mix, miked very closely, with just the slightest room presence at the edges. Even though digitally recorded, *Virtuoso Guitar* has an annoying hiss slightly audible at louder volumes. This doesn't detract from the performance, but you wouldn't expect to hear it on a CD.

On this recording, Barrueco continues to prove his stature as one of the finest guitarists of the post-Bream/Williams generation with a growing canon featuring mature interpretation and remarkable playing skill. *Michael Wright*

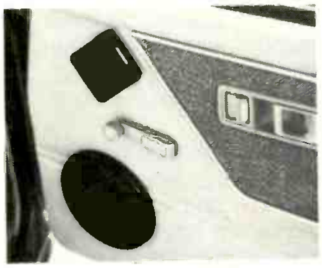
Manuel Barrueco

The **Boston** Acoustics

1988 Installation of the Month Contest

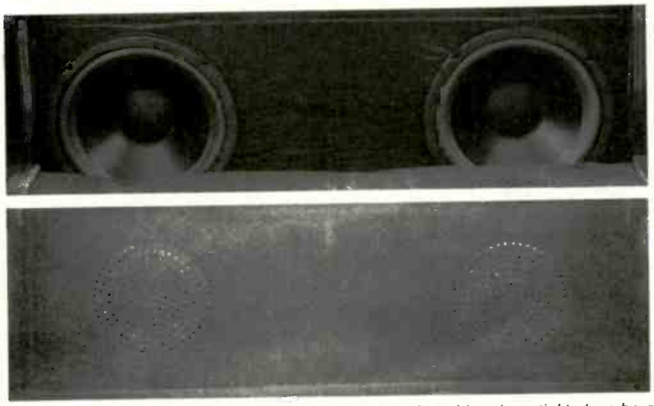
Selections from last year's winners: These photos show how easily and how well Boston speakers can be installed in a variety of vehicles. Send us several photos like these, including an over-all exterior view of your car, so we can select the four best to show here.

This unusual installation features three-way 763 component systems in front, with 6½" subwoofers installed in doors, Varimount® tweeters surface-mounted on doors, and 4" midranges in dash. 767 6½" two-way uniaxial systems in rear doors.



Boston 761 two-way component system in each door includes a 6½" woofer and angled Varimount tweeter.

Boston 751 two-way component system with 5¼" woofer in rear door; Varimount tweeter flush-mounted in rear pillar.



Custom woofer enclosure integrated into spare tire well provides clean, tight, deep bass from two concealed 780LF subwoofers.

(Left) 741 system in rear of pickup cab includes 4" woofer and Varimount tweeter, the latter concealed under headliner. (Right)

The challenge is on! If you are proud of your Boston Acoustics car system, you could be a winner.

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In last year's contest, we saw outstanding systems with Boston speakers in a wide variety of vehicles: 4x4s, luxury sedans, compacts, exotic imports, vans, and even boats. This enthusiastic response encouraged us to do it again.

"...its heritage is unmistakingly evident in its superb sound, practical size and proportions." Julian Hirsch, Stereo Review

The prizes. Each month from July through December, we will announce the winning Installation of the Month in *Stereo Review*. And each month's winner will receive a pair of our T830 tower design home loudspeakers. ($500 suggested retail value.)

What's more, the first 500 qualified entrants will also win a full year's free subscription to *Car Stereo Review*. (Newsstand value, $23.70.)

Good photos required. If you're proud of your Boston Acoustics car system, let's see it in photos showing installation details, like those shown at left. Black & white is preferred, though color is acceptable. Either way, we'll need the negatives as well as the prints. Please, no Polaroids or slides.

The fine print. Every contest must have its rules and requirements. We've kept ours simple:

(1) All speakers must be Boston Acoustics, of course.
(2) Send your photos and negatives plus the following information to Installation Contest at the address below: Your name, address and telephone number • Year, make and model of your vehicle • Dealer name and address • Salesperson and installer • Brands and models of all components in your system.
(3) All decisions will be made by Boston Acoustics and will be final.
(4) All material submitted becomes the property of Boston Acoustics.
(5) This contest is open to all residents of the U.S.A. and Canada, except employees of Boston Acoustics, Diamandis Communications, Inc., and their families.
(6) This contest is void where prohibited by law.

Formal entry blanks aren't required, but for your convenience are available at your Boston Acoustics car dealer, or from us. Good luck!

BostonAcoustics

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The Évora organ's peculiar arrangement of keyboards encourages a colorful musical dialog.

The Organ of Evora Cathedral: Bernard Brauchli
Titanic Ti-157.

This is Volume 2 of a fascinating sonic series (*The Iberian Organ*), now turned all-digital (DDD) for much enhanced presence, accurate pitch, and better reverberation—uncovered by the silence of the digital medium.

Spain and Portugal harbor numerous very old organs that have been left more or less unaltered over time, sometimes even to the man-powered wind-pumping system. But the pipes, the essence of the machinery, are durable, and when the whole is restored they do sound very much as they did centuries ago—perhaps more precisely so than any other existing musical instrument. The sound of these ancient music machines is rewarding because it makes so clear the sophistication, the strength, the subtleties of an art that might from our viewpoint seem crude. Not so!

The organ at Évora is the oldest in Portugal, dating from around 1545 or shortly thereafter. Restored by the famous Dutch firm of Flentrop, which used most of the original parts, this is a musical voice from the past if ever there was one. As one can hear, it has a peculiar arrangement, a single keyboard split at the middle, with different sets of pipes for the upper and lower halves. This encourages a colorful sort of musical dialog between top and bottom, as is evident in most of the Portuguese works here.

The recording is roughly chronological, from the time the organ was new on through the mid-18th century. Only the last few works are "modern" in a Baroque fashion. All the earlier pieces are in a free fantasia style of inspired "rambling," with constantly changing rhythms and colors out of the 16th century. As the record progresses, the registration becomes livelier and more colorful, with splendid "trumpet" reed sounds and the krummhorn-like squawk that adds a wonderfully raucous effect. The continuity really builds, until the last few items: Carlos Seixas' sonatas, in a Scarlatti manner, are predictable and standard Baroque. Perhaps the best work of all, running more than 16 minutes, is by the famous Anonymous, describing a hypothetical battle.

The recording is digitally excellent, if, in my opinion, miked just a bit too close. Not quite enough of the cathedral's fine long reverb is captured, for one thing. More important, notably in band 2, an effect occurs that I have often heard before: A set of mixture pipes at the twelfth (an octave plus a fifth above the base tone), which is supposed to blend indistinguishably into a color additive, instead stands out as a dissonant melody. This undoubtedly is an accident of mike proximity, not audible to the live listener at a distance.

I was so put off by the gimmicky packaging of *Beethoven or Bust*, I almost didn't play it. I'm glad I did.

Bernard Brauchli, a Swiss organist (via Cambridge, Mass.), is the thoughtful and well-versed performer.
Edward Tatnall Canby

Beethoven or Bust: Don Dorsey
Telarc CD 80153, CD.

This disc has a lot more to it in the way of thoughtful musicianship and first-hand knowledge of piano Beethoven than the somewhat corny publicity would indicate—it comes complete with a pair of dark glasses with ad stuff printed on the lenses! I was so put off by the gimmickry that I almost didn't play it. I am glad I did.

The well-known purists, who are always around, will be heard to object. Standard-type Beethoven pianists will probably be shocked and dismayed. But in spite of the fantastic array of enormously varied and expensive equipment used here—epoch-making, I would guess—the basic sense and shape of Beethoven's music has not been mutilated; it is all there. Indeed, to my mild confusion, the works are 101%, with a few emendations and additions and many of the optional repeats, plus several minor Beethoven-like idioms by Don Dorsey.

The synthesizing, too, is rigorously architectural, not grossly showy. A kind of piano-like sound is largely and intentionally present, keeping the original styling in mind even when it flies off into remarkably improbable effects including drums, bells, gunshots, auto horns (precisely in tune and unobjectionable), and even an auto crash. Actually, the sound is closer to the type produced by an early fortepiano with an elephant bass (and plenty else) attached. Remember, it's *not intended* to be a piano! But the keyboard thought (and even the period) is suggested.

Dorsey, in an interview, explained much. He actually plays these works, with his own fingers, but they go via Synclavier into a digital code, which can be replayed in infinitely various forms and shapes on other synthesizers. Wow! What an idea. My own first thought was Bach's "The Art of the Fugue," an abstract composition as this is an abstract performance in digital code.

I wouldn't mind a bit if this hit the classical charts. *Edward Tatnall Canby*

PARTY TIME!


Albert Collins

Tenth Anniversary Anthology—Volume 1: Various Artists
Antone's Records ANT004, LP. (Available from Antone's Records, 2928 Guadalupe, Austin, Tex. 78705.)

Sound: B Performance: B

Tenth Anniversary Anthology—Volume 1 is a celebration of the Austin, Texas club that has passed from local lore into legend as home to a burgeoning regional blues scene and a favorite stop of touring bluesmen. This set captures the party that erupted when a handful of well-known musicians gathered to honor Antone's.

The two most exciting tracks feature the extraordinary guitarist Buddy Guy, who's begun to fade from the spotlight because of a lack of current recordings. Guy has been cited as an influence by yet another generation of guitarists (such as Stevie Ray Vaughan) who have followed his music's evolution from a lyrical B. B. King-like style into a compressed, frenzied approach that creates a tidal wave of blues.

Albert Collins, the "Master of the Telecaster," backed by admirer Jimmie Vaughan of The Fabulous Thunderbirds, contributes a powerful rendition of "Cold Cold Feeling" that demonstrates why he's finally been able to break through to a larger audience in the '80s. Otis Rush, the dean of Chicago's West Side guitarists, is represented by a rare live performance of his minor-key classic, "Double Trouble."

Snooky Pryor offers a bouncy acoustic harp performance backed by a band of compatriots from the '50s: Guitarists Eddie Taylor (the architect of Jimmy Reed's sound) and Jimmy Rogers (member of Muddy Waters' best band) and piano-pounder Sunnyland Slim (who backed everyone), each of whom then takes a turn as bandleader.

Special honors go to James Cotton, whose work as a bandleader and sideman throughout this set reaffirms his position as heir apparent to Little Walter, the patron saint of amplified harp-blowers. Cotton's wailing behind Jimmy Rogers confirms that Cotton could have held his own against the giants of the '50s.

This anthology heralds the renaissance of a dying tradition: The recording of blues stars by the same clubs that helped bring them to prominence. On the basis of this set, let's wish Antone's luck.

Roy Greenberg

Together Again/One More Time: Memphis Slim and Matt Murphy
Antone's Records ANT0003, LP. (Available from Antone's Records, 2928 Guadalupe, Austin, Tex. 78705.)

Sound: B Performance: B

Loose, lively, and ever-so-slightly out of tune, blues brothers Memphis Slim (pianist Peter Chatman) and Matt "Guitar" Murphy are reunited after more than 20 years on this live, 24-track recording made at Antone's. Slim and Murphy swap licks on seven Chatman numbers plus Willie Dixon's "My Babe," with material ranging from the slow, augmented chords of "Havin' Fun" to the hot instrumental "Juggie Boogie." Slim's piano tinkles under his expressive vocals with the slinky arpeggios of boogie-woogie à la Albert Ammons, while Murphy's guitar wails with that raw, funky, '50s-Chicago feel. Filling everything out is some very cool sax by Mark Kazanoff and Joe Sublett.

The recording is generally pretty good for a live set, although the rhythm section is mixed back and lacks definition, with emphasis given to the soloists. But since they're the point of this reunion, you probably won't mind.

Memphis Slim and Matt Murphy do not offer a flawless performance on *Together Again/One More Time*, but they do manage to keep your body bobbing with their energy and enthusiasm. And they provide a mighty good time.

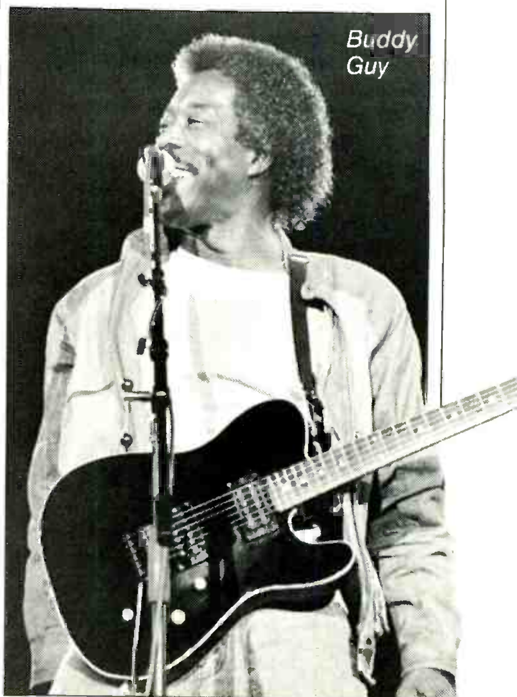
Michael Wright

The Gift of Time: Jean-Luc Ponty
Columbia FC 40893, CD.

Sound: A– Performance: B+

All of violinist Jean-Luc Ponty's melodic romanticism is intact on *The Gift of Time*. Ponty has been playing essentially the same music since his mid-'70s album, *Upon the Wings of Music*, using a style noted for its lyrical grace, propulsive rhythms, and a kind of modern perfectionism. He's a jazz violinist who really doesn't play jazz anymore.

If Ponty's music has changed at all in the past decade, it's been on the technological side. He's expanded his use of synthesizers over the years and now plays a Synclavier triggered by his violin. The technology brings a perfection of rhythm and a further streamlining to a music that has gotten increasingly sleek and occasionally slick. Ostinato sequences click away with computerized regularity on "New Resolutions," and Ponty's rhythm section,


Buddy Guy

Although Jean-Luc Ponty's sound has grown sleeker, his melodic romanticism is intact.

bassist Baron Browne and drummer Rayford Griffin, jump right in, lending an edge with their just-ahead-of-the-beat drive. "Metamorphosis" sounds like a computerized African village, with hand percussion and computer percussion percolating gently under Ponty's ascending violin lines.

The music benefits from the clear surface of the Compact Disc. Despite being an analog recording, it rings with clarity, from the electronic string drones of "Introspective Perspectives" to the sharply etched electroacoustic percussion of "Metamorphosis."

The Gift of Time, like most Ponty albums, is immediately compelling, with breathtaking vistas created by the wonderful arrangements and the lyricism of Ponty's playing. On its own, it is a fine album. But taken in the context of Ponty's career, it is barely distinguishable from any of his albums in the last 10 years. This artist has chosen perfectionism over growth.

John Diliberto

Transition: Peter Erskine
Denon 33CY-1484, CD.

On his new Denon disc, Peter Erskine, former drummer for Weather Report, finds imaginative musical ways to combine electronic and traditional instruments. The style is a logical extension of the Weather Report approach, with some beautiful sax solos added by Bob Mintzer and Joe Lovano.

Erskine employs a Macintosh computer to control his synthesizers, and what is especially notable about *Transition* is the way that he has integrated the contributions of the computer system with those of the live players. His "Suite: Music from Shakespeare's King Richard II," written for a stage production of the play, is a good example of this integration. Most of the music is for the entire jazz ensemble, but the "Sonnet" movement is arranged for an instrument that sounds something like a harp or a lute. Actually, it is played by Don Grolnick on synthesizers. What a refreshing contrast of color it is! Erskine slyly sneaks in a few stylistic mannerisms characteristic of the Richard II period, such as in the "Burgundian Cadence" section, where the melodic pattern at the ends of phrases is strongly evocative of 14th-century music. The final movement, "End Hymn," features brass-like sounds and multi-tracked French horns (played by Peter Gordon) in a beautiful chorale setting.

The sonic quality of this Compact Disc is razor-sharp, as you would expect from a direct-to-two-track, all-digital recording. Erskine as producer puts the ensemble into a neutral but slightly reverberant sound space, using reverb just enough to add life and color without obscuring detail. The result is a clearly focussed image with sharply etched instrumental colors. In "Corazon," featuring Joe Lovano and Bob Mintzer, the soloists seem to step forward out of the speakers when their turns come, and then step back to rejoin the group, just as they would in a live performance. Because of its imaginative approach and excellent performances, *Transition* is the kind of recording that makes you want to hear Erskine's next one—soon. *Steve Birchall*

Modern Drama: Jane Ira Bloom
Columbia FC 40755, LP.

Sound: B Performance: A–

This was obviously the right album for soprano saxophonist Jane Ira Bloom to make. For the last several years, this artist has been honing her technique, gaining critical credentials within the jazz community, recording albums on small labels, and playing with heavyweight rhythm-section pros such as drummer Billy Higgins and bassist Charlie Haden.

With *Modern Drama*, her major-label debut, Bloom begins forging her own direction, updating her influences—John Coltrane, Eric Dolphy, and Miles Davis—without selling them out. She's a deft improviser, using largely modal themes for twisting soprano excursions which are often augmented by electronic signal processing. Bloom uses delays, chorusing effects, and pitch-shifters to extend the range of her instrument, spontaneously punctuating a phrase, heightening the tension, or creating an atmosphere.

"Overstars" opens with a lovely soliloquy of delayed, overlapping soprano lines and then shifts into a modal rhythm, with vibraphonist David Friedman dancing through an echoing refrain. "Cagney" takes a more lively groove, with vibes, piano, and soprano tracking each other through the bop-like melody. "NFL" uses a football marching-band motif to explore a stormy, broken-field improvisation over a frenetic, shifting pulse supplied by bassist Ratzo Harris and drummer Tom Rainey. On "Race (for Shirley Muldow-

Jane Ira Bloom has begun forging her own direction and updating her influences without selling them out.

ney)," Bloom shows her rhythmic dexterity, overlapping fast on slow. As Harris downshifts into a slow-motion arco bass solo, Bloom's soprano rushes past in Doppler circles. "Rapture of the Flat" is a rousing album closer; it sounds like rock 'n' roll as interpreted by aliens. Fred Hersch runs variations

Irma Thomas is one of the great R&B singers around, but *The Way I Feel* is a record strictly for the already converted.

on Fats Domino piano lines while Bloom spins out melodies through a time warp of electronics.

It's difficult to inject electronics into essentially acoustic music, but this recording finds the perfect balance of ambience and art to make it work.

John Diliberto

The Way I Feel: Irma Thomas
Rounder 2058, LP.

Sound: C– Performance: B

Irma Thomas is one of the great R&B singers around. Unfortunately, she is out of fashion. But Irma stays true to her roots, and that's why, though she is an artist capable of delivering maximum emotion, she probably won't make million-selling records like Patti LaBelle or Tina Turner.

The results of *The Way I Feel* are mixed. Producer Scott Billington uses Paul Kelly, Allen Toussaint, and Jerry Ragovoy for new material (definitely the right sentiment), but he lacks the production technique to make the recording sound good in either a classic or a contemporary way. The equalization is very harsh, and the use of reverb particularly ill-advised. Irma also covers "Baby I Love You" and "Dancing in the Street"—these may work live, but they can't compete with the inspired originals. Someone else should produce Irma's next; this one's for the already converted. *Jon & Sally Tiven*

The Heat of Heat: Kevin Eubanks
GRP GR-1041, LP; **GRD-9552,** CD.

Sound: B+ Performance: B+

Since his jazz-guitar debut several years ago, Kevin Eubanks has been sending mixed signals to his followers, moving more and more into the pure pop vein. *The Heat of Heat* marks a step back; it's a George Benson-style compromise between jazz and pop—and guess who coproduced?

The instrumentals move from the electric pop of the title cut and the highly sweetened "Palace of the Seven Jewels" to the Earl Klugh-like acoustic swing of "In a Few." There is also a traditional jazz duet with the premier string bassist Ron Carter on Miles Davis' "Nardis," and on "Sojourn," Eubanks even engages in some fairly "outside" improvising.

The majority of cuts feature acoustic guitar (despite the electric on the cover), and Eubanks' talent on the instrument is amply demonstrated. Digitally recorded, the sound is impeccable, with clean instrumental separation.

The Heat of Heat has enough substance to please a fairly wide audience in the middle ground between jazz and pop. *Michael Wright*

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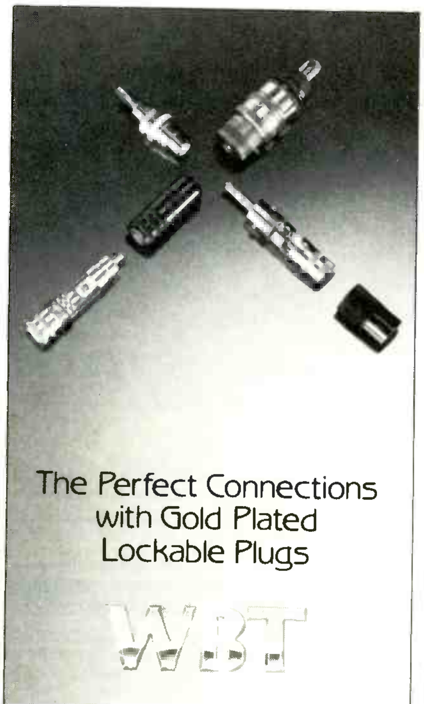

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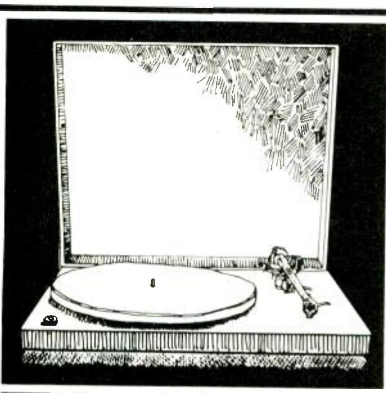

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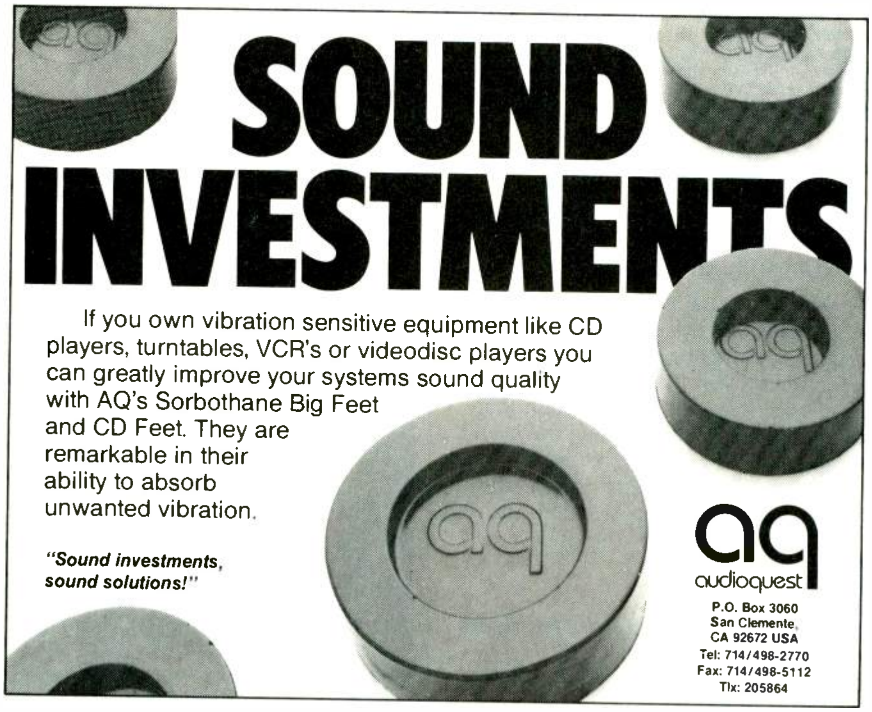

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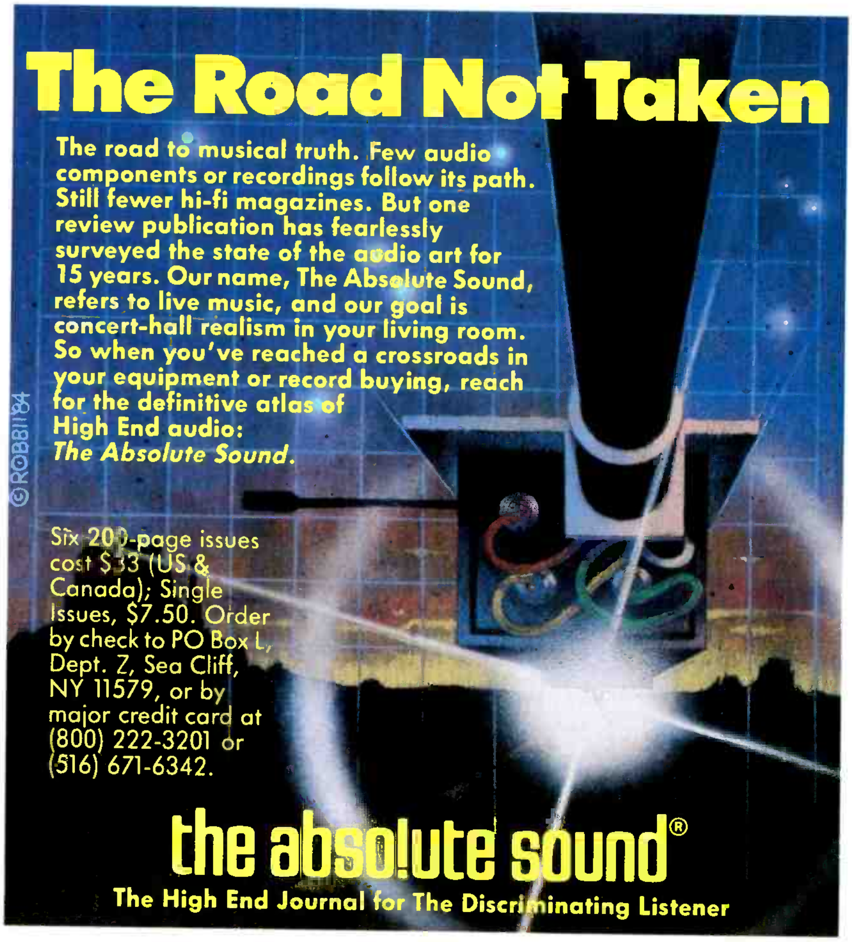

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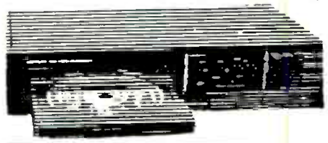

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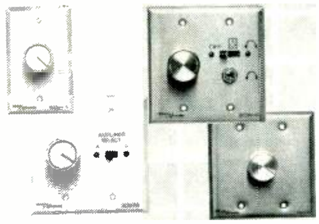

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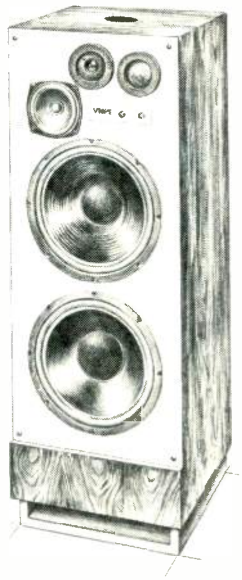

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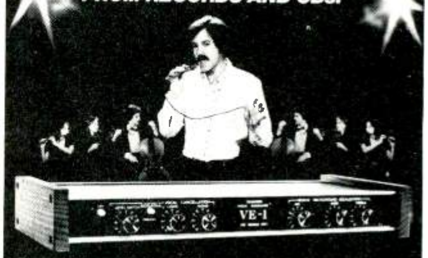

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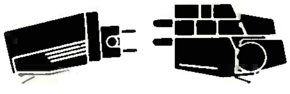

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—Dissipation factor @ 20°C: less than .01%
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—Insulation resistance @ 20°C: More than 100kMΩ/μFD
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—Leads: Tinned pure copper multistrand insulated sleeves, radial 4 inches
—Capacitance tolerance: ±10% (grading to 1% available)

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2μFD	.83D	1.9L	25μFD	1.6D	2.6L
4μFD	.98D	1.9L	35μFD	1.38D	2.6L
8μFD	.98D	2.6L	50μFD	1.38D	3.4L
12μFD	1.3D	2.6L	70μFD	1.62D	3.4L
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1.0μFD	$1.85 each	12.0μFD	$ 4.30 each
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4.0	2.50	30.0	8.90
4.7	2.75	35.0	10.00
5.0	2.75	40.0	11.10
5.6	3.05	45.0	12.20
6.0	3.05	50.0	13.25
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8.0	3.50	70.0	17.60
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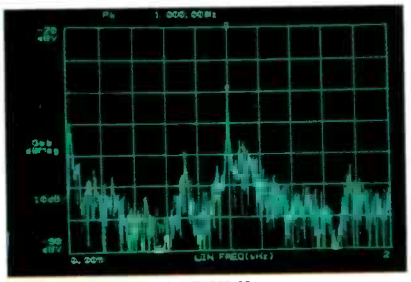
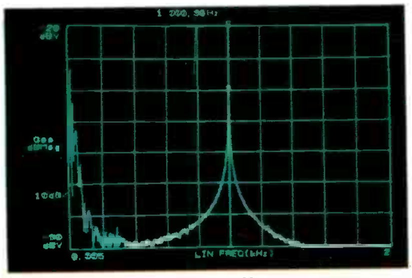
THE IDEA BEHIND OUR NEW CASSETTE DESIGN IS NO GREAT SHAKES.



OLD XLII



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