Audio

DECEMBER 1986 • $2.25

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LEIBER & STOLLER

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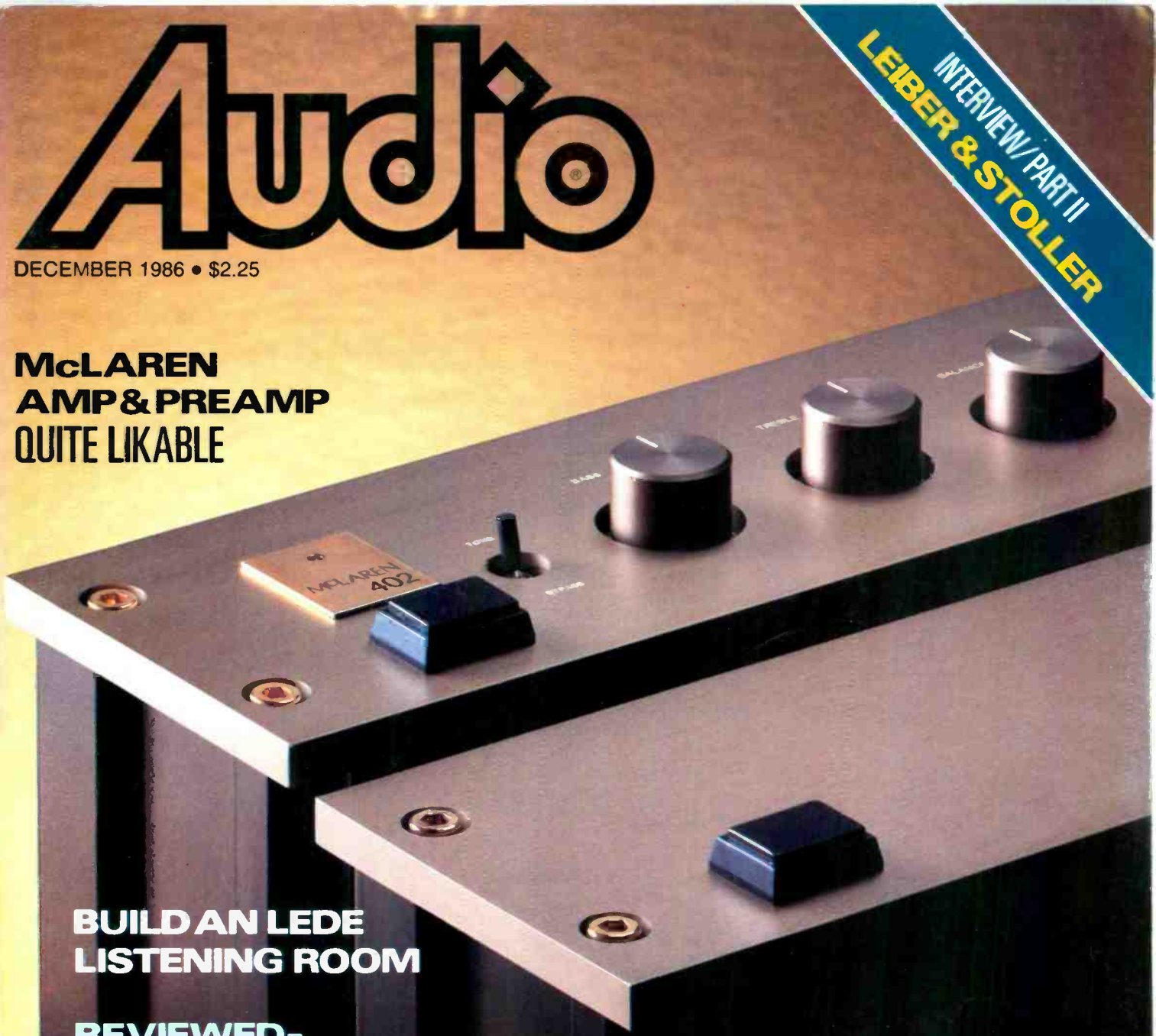

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NEC CD-650E CD PLAYER-
EXCELLENT PERFORMANCE

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POLARIS. The promise of delicate tube-like performance is part of the allure of MOSFET amplifiers. But the promise remained largely unfulfilled, until now, because of transconductance error. In Polaris, Sumo employs proprietary active bias output circuitry to correct the problem. Dedicated servo circuitry also reduces crossover notch distortion to levels found in the very best Class A amplifiers. And the elimination of protection circuitry ensures the purest possible reproduction of music.

The power is 100 watts RMS per channel into 8 ohms at 0.05% THD. There is no current limiting. Polaris is a conservatively rated amplifier capable of driving 4 ohm, even 2 ohm, loads comfortably.

Audiophile analog pressings reveal new nuances of sound. Compact Digital discs display dynamic range without high end pain. Loudspeakers are driven to new highs. Subwoofers to new lows. There is finesse for the subtlest shading and power for the most explosive rock-and-roll.

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SUMO PRODUCTS GROUP, 21300 Superior St., Chatsworth, CA 91311 Tel. 818/407-2427
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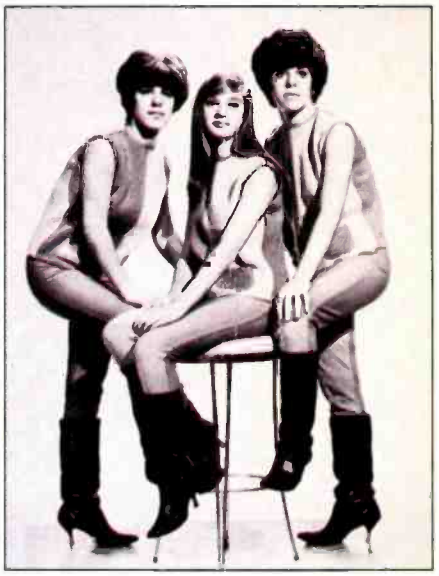
Audio

DECEMBER 1986 VOL. 70, NO. 12

See page 62



See page 54

See page 140

FEATURES

EQUIPMENT PROFILES

MUSIC REVIEWS

DEPARTMENTS

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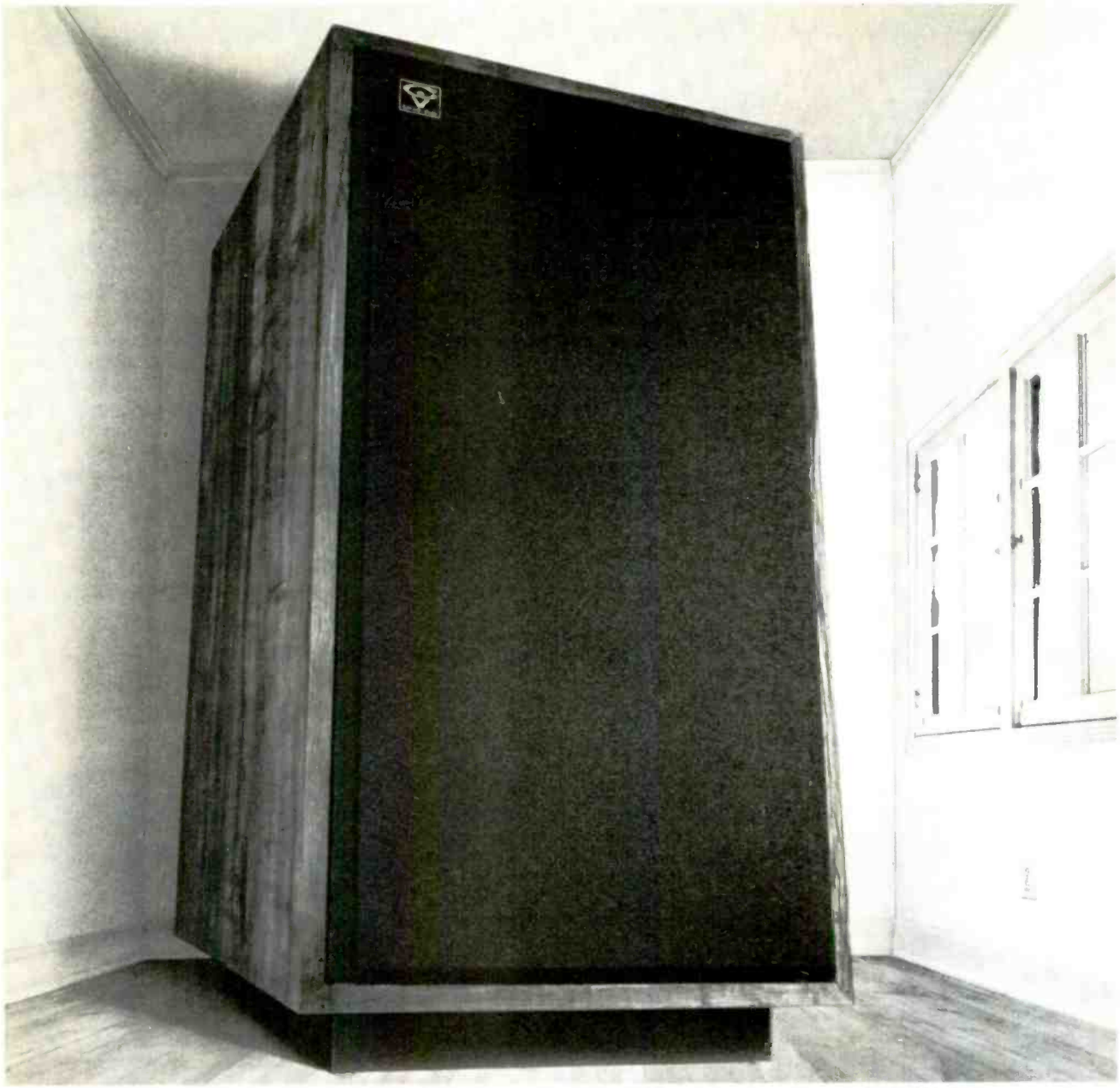

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A Digital Series loudspeaker from Cerwin-Vega is accurate, sensitive and extremely clean. And the first piece of audio equipment to be included in the hierarchy of needs.

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Mirage Loudspeaker

Unlike most dipole speakers, the Mirage M1 uses cone drivers. One of the two ¾-inch tweeters, one of the two 4½-inch midrange units, and one of the 8-inch woofers fire to the rear; the other 8-inch woofer is front-firing. Frequency response is rated at 25 Hz to 22 kHz, ±2 dB, and power-handling is rated at 300 watts maximum. The speakers measure 60 in. high by 19 in. wide by just 9 in. deep. Price: $3,000 per pair.

For literature, circle No. 100

Hitachi Portable CD Player

Hitachi's entry into the widening field of portable CD players is a little larger than most, but fills that extra space with extra features. The DAD-P100 has a battery pack (for six AA cells) and an a.c. power supply built in, plus an input for external 9-V d.c. power. A scan function plays the first 10 S of each track automatically. Price: $299.

For literature, circle No. 102

Quad Power Amplifier

A new protection circuit in the Quad 606 is placed at the amplifier's a.c. line input, in order not to interfere with the signal path. The circuit senses current drawn over time, rather than instantaneous current, so that brief power demands will not trigger it unnecessarily. The "current-dumping" amplifier circuit uses feed-forward error correction, and delivers approximately 135 watts rms per channel into 8-ohm loads. Price: $995.

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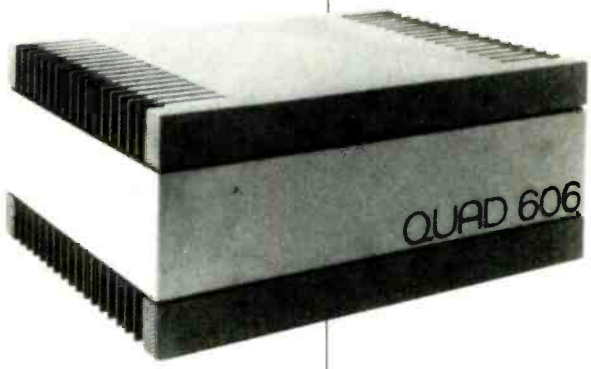

AudioSource Audio/Video Controller

The AV-Four combines a five-input video/audio switcher with several audio-enhancement circuits. The latter include DNR noise reduction, a stereo synthesizer, a surround-sound synthesizer, and a seven-band equalizer with spectrum analyzer display. A built-in 30-watt stereo amplifier can be used to drive front or rear speakers. Other facilities include one set of front-panel audio/video inputs, antenna switching that allows viewing telecasts while dubbing tapes, and an r.f. modulator for direct connection to TV-set antenna inputs. Price: $199.95.

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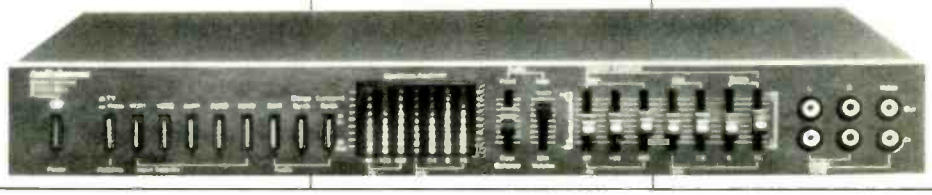

MORE GUTS, MORE GLORY.

The guts:

Look inside an ADS CD player and you'll know it's not a machine for novices.

The laser transport floats on a tuned, four-point rubber/spring suspension. The transport chassis is rigid cast alloy rather than stamped sheet metal or plastic. The player housing is made of thick, steel plate and extruded aluminum. This massive (and expensive) construction makes the ADS CD3 and the new CD4 virtually immune to physical and acoustic vibration.

For error correction, ADS uses a proprietary variable correction window. Instead of correcting large, fixed clumps of data, the ADS system constantly adjusts to the exact size of disc errors. Error correction is far less intrusive. Performance is far more accurate.

Ordinary CD players use one power supply. The CD3 uses five. The CD4 uses three. Shielded and regulated, they protect the audio signal from high-speed digital noise and dynamic limiting.

Further refinements include dual 16-bit digital-to-analog converters with double oversampling, digital plus analog filtering and an ultra-precise, linear-drive three beam laser.

The glory?

Waiting for you at your ADS dealer.

An audition will prove that all CD players are not created equal. Some are created perfect.

For a free buyer's guide, "CD Players: Differences That Matter" and the name of your local ADS dealer, call 1-800-345-8112. In PA. Call 1-800-662-2444.

A.D.S.

Right: The critically acclaimed ADS CD3. Consistently rated as one of the top players in the world. Left: The new CD4. Slightly fewer control functions, identical audio performance. Watch for the reviews.

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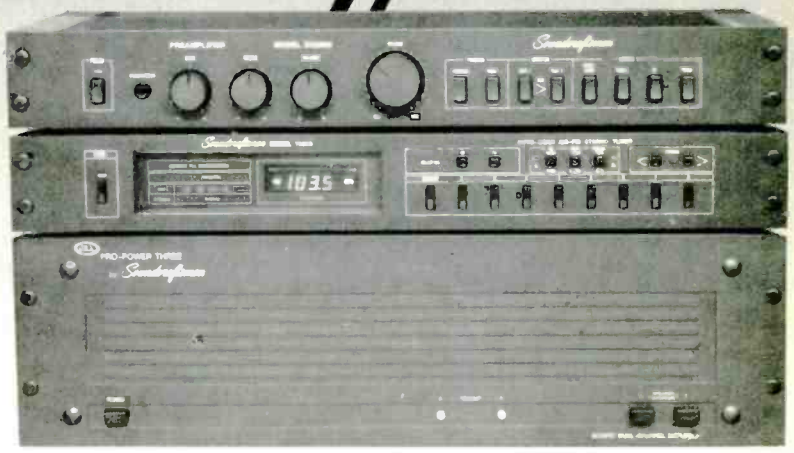

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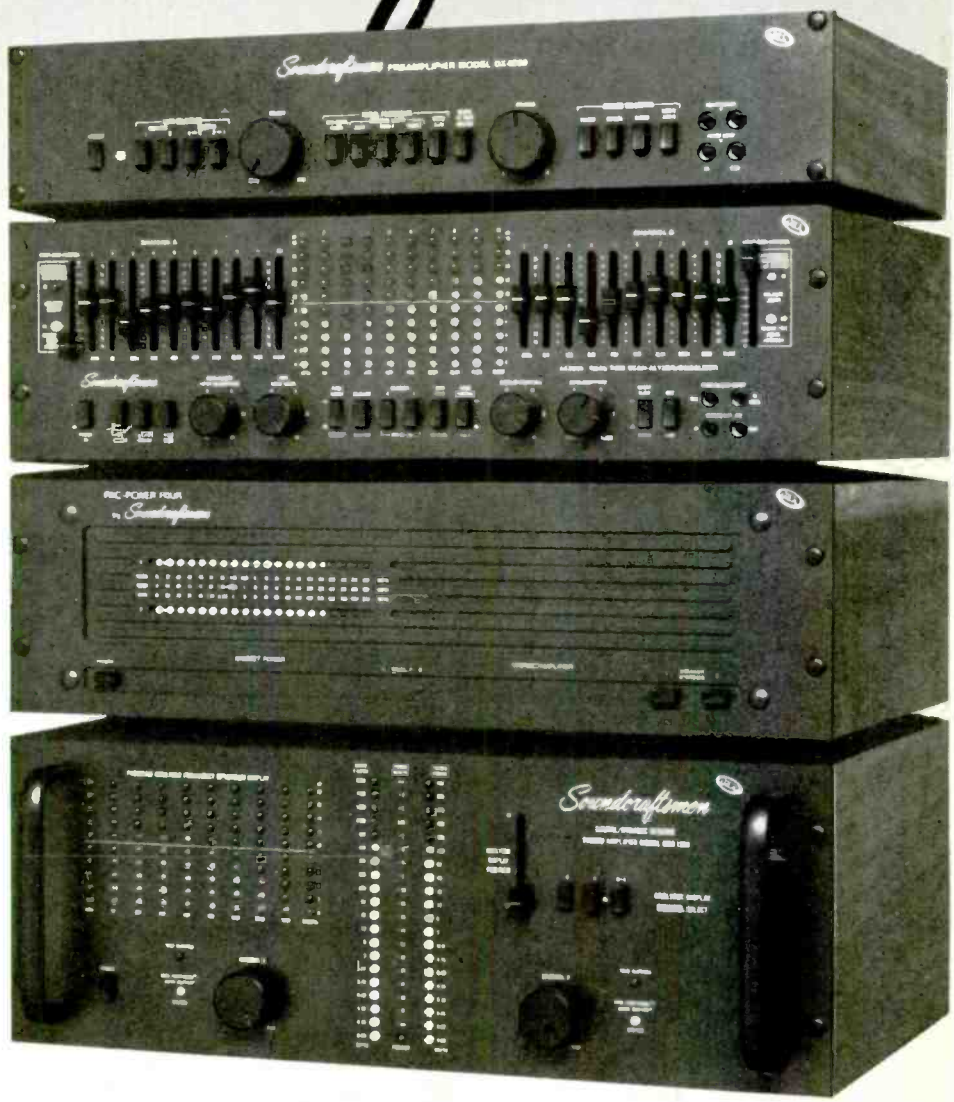

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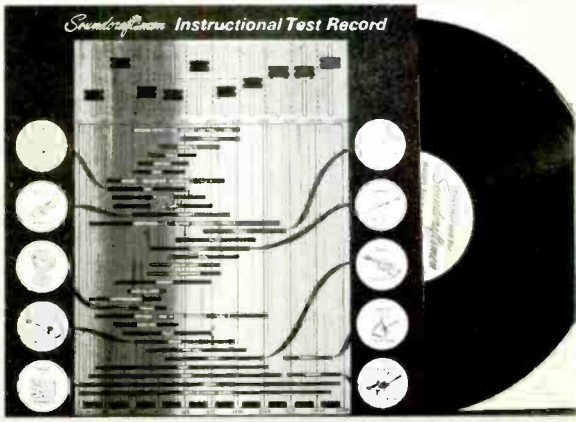

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And now—just as we announce general availability of RE71s—someone *has* put them to a test. The February '86 *Car and Driver* reports on their comparison of ten 50-series radials. And the RE71 did so well, we recommend a quick lap of the public library to check out the results.

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*Tires shaved to racing depth.

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For literature, circle No. 104

JVC Car Stereo

The elaborate radio facilities of JVC's top-of-the-line KS-RX605 head unit include presets for 20 stations; seek, scan, and preset-scan tuning, and both local/distant and stereo/mono switches. In addition to an auto-reverse tape transport with Dolby B NR, the unit features a five-band equalizer, switchable loudness compensation, and a CD-player input. The slide-out chassis can be removed for theft protection. Price: $479.95.
For literature, circle No. 105

Monster Cable
MC Pre-Preamplifier

A dual-mono design, the Alpha Plus has totally separate circuitry (inclucing rechargeable-battery power supplies) for each channel. Its battery-charge circuits operate only when the unit is off, thereby avoiding potential hum and noise problems. Input impedances at 10, 30, 80, 800, and 47K are selected by pressing front-panel buttons; intermediate impedance values can be obtained by pressing two buttons at once. The unit's enclosure is made of wood. Price: $475.
For literature, circle No. 107

Yamaha
Audio/Video Amplifier

The AVC-50 stereo amplifier mixes audio and video features in nearly equal proportion. Six of its 10 selectable stereo inputs are for audio only, and the others (including one input repeated on the front and rear panels) are for audio and video. The amplifier section delivers 45 watts per channel, and has separable amp and preamp sections for use with external processors, crossovers, and higher powered amps. A four-speaker surround system, with both delay and matrix circuits, is compatible with Dolby Surround video software, and can simulate stereo or surround sound from mono sources. Video features include variable control over detail, sharpness, and video level, with independent record-out selection of audio and video, plus provision to monitor one audio or video program while recording another. The remote control can also command other new Yamaha audio components. Price: $449.
For literature, circle No. 106

IVAN BERGER

FROZEN OUT

Cultural Conflict

Car makers know at all times what they'll be making three years down the line. Their designs have been frozen, the tooling to make them is on order, and the marketing plans have already begun to jell. Electronics companies have more short-term plans and faster reflexes; some of the products they'll offer three years from now may not even have been invented yet.

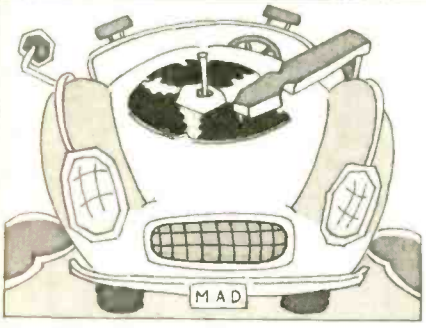
This cultural gap, I hear, recently lost a major audio company a sizable chunk of business. They had almost gotten a contract to supply car-stereo units to one of the world's biggest car makers when the auto company asked, "Is this a finished product?"

"Well," said the audio company, "we'll keep making improvements as we go along, so we always produce the best possible product."

"No deal," said the car company. "We only handle finished products. We can't put our name behind something that hasn't even been developed yet." So the people who buy that car three years from now will get some other supplier's product, one whose design is frozen now—and will be three years out of date then.

News & Notes

- Now tube-amplifier enthusiasts can get tube amps for their cars too. Milbert Amplifiers of Germantown, Md. offers a dual 30-watt model, the BaM-230, designed by David Berning.
- Matsushita is planning to begin manufacturing car-stereo equipment in the U.S. in May of 1987 at a new plant in Peachtree City, Ga., near Atlanta. Eventually, U.S.-made car-audio gear will replace nearly half the company's current exports to the U.S.
- Japanese car manufacturers are shifting to the DIN-sized radio slots used by European manufacturers. Toyota and Honda adopted the DIN standard in 1982, and Nissan began switching over to it in 1985. This should broaden the selection of car-stereo equipment available to owners of European and Japanese cars alike, by freeing stereo dealers to carry more models that differ in substance rather than in size and shape.



Car Disc Player, Cheap

Compact Disc players for the car are priced at about $600 to $900. Portable CD players, which can be hooked into car-stereo systems with low-priced adaptors, cost about $200. But there's an even cheaper way to play discs in your car . . . different kind of discs, however.

For just $29.95 (plus shipping), the H & R Corporation has a 12-volt Matsushita record changer. It wouldn't track well over bumps, of course, and you'd have to build a base for it, then find a place to install it. The good news is that its ceramic cartridge would probably interface well with the AUX inputs on some car-stereo head units.

New Dawn for AM?

The coming of AM stereo has not yet had much effect on AM broadcast practices or receiver design. Car-stereo makers have added stereo decoders but have not done much else to improve their tuner sections, and broadcasters seem to be transmitting stereo with the same old limited response as their former mono transmissions. I've heard only one really good AM section in a car in the last 30 years. Though it was only mono, I didn't much mind that; better good mono than so-so stereo.

Now, however, tuner makers will have an even better excuse than stereo to redesign their products. The U.S. and other countries in this hemisphere have agreed on a plan to extend the AM band to make room for more stations (300 more in the U.S.). The FCC plans to take applications for these new frequencies in 1989. Presumably, radios that can receive these new stations should reach the market about then. And it seems likely to me that some radio manufacturers will take advantage of this redesign to improve the AM performance of their deluxe models. At least, I hope so.

Equal Is . . .

There are two ways to alter the sound in your car with an equalizer. One way is to put an equalizer in your car. Another is to use your home system's equalizer to make tapes that are pre-equalized to sound best in your car. However, finding the right EQ curve to use will take a lot of trial and error. Most car systems I've heard could use a bit of boost at the low end, some cut at around 150 to 250 Hz, and perhaps some boosting in the lower treble. Yamaha makes a tape deck, the K-600 ($369) with a switchable car-tape record EQ curve built in; it gives an 8-dB boost at 60 Hz and a 4-dB cut at 200 Hz.

As usual with equalizers, you should first cut back any over-emphasized frequencies. Then boost the frequencies which are hard to hear in your car—those which your system cannot reproduce, and those which are cancelled by your car's acoustics or overwhelmed by road noise. Boost cautiously—otherwise, you can cause distortion in your original recording or drive your system's amps and speakers into overload.

Illustrations: Michael A. Donato

If you can't afford it, spare yourself the heartache of listening to it.

We are all aware that, money aside, it is an easy matter to upscale our quality of life, but difficult to lower it. In this regard, ignorance is bliss, and strict abstinence is sometimes better than a taste of something finer that we can't have. So it is with the concord HPL-550 Tuner/Amplifier/Tape Deck. One listen could ruin you.

Concord's performance engineering over the years has resulted in a list of mesmerizing characteristics that, as you become aware of them, will change your perceptions of car radios.

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Superb stereo imaging, wide band frequency response, and very low distortion levels are just some of the qualities of Concord's exclusive Matched Phase Amorphous Core Tape Head.

A cleaner sounding FM than you ever believed possible, thanks to the exclusive Concord FNR FM noise reduction system.

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High powered inboard amplifiers—rated at 25 watts per channel.

Dolby B,C + DBX Tape noise reduction systems.

Lighted panel switches, electronic memory with 24 preset stations, signal processor circuitry, a two-way/four-way amplifier, automatic Music Search Scanner, and a Bass EQ Switch.

One listen to all of this and you will be exhilarated. But then, if you can't afford it, you will be depressed. What will it be? Exhilaration and depression, the full human gamut? Or blissful ignorance? The trouble is, if you have read this far you are no longer blissfully ignorant.

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In the past, car-sound amps were all measured at 10% THD. But there was no intent to deceive, because customers rarely saw any specs at all.

Illustration: Rosalind Ivens

The Ten-Percenters

In the May issue, an article on car stereo (adapted from my book) said that if a car amplifier's power rating didn't specify distortion, power had probably been measured at a distortion level of 10%. A reader recently called to ask what made me say this. Was I a cynic? "No," I told him, "more of a historian."

Back when I first got interested in better car sound, virtually *all* car-sound amplifiers were measured at 10% THD. There was no intent to deceive customers, because the customers rarely saw any specs at all. If people didn't demand much in the way of specifications for their console radio-phonographs, why would they want them for a car accessory? Within the car and car-accessory trade, power specs were sometimes mentioned, but everyone in the trade knew the distortion level was implicitly 10%, so nobody was fooled. (Why 10%? It was probably picked at a time when that was a respectably low distortion level, at least for car use.)

Even in home audio, where power was publicly specified, some power specs included implicit distortion figures. Radios and phonographs carried "EIA Power" ratings, measured at a standard 5% THD, with the distressing word "distortion" left discreetly off the spec sheet. Only audio *components* specified both power and distortion. When the FTC began formulating a standard power-rating rule for home components, the EIA testified that their implicit 5% system was easier on consumers, who would just be confused by additional numbers. (To be fair to the EIA, some consumers would be.)

When home-audio manufacturers such as Pioneer and Sanyo entered the car-audio field, they measured and specified performance in the same terms for both kinds of equipment. Soon, many other manufacturers were following their lead. This led to a two-tier spec system, with old-line car-sound manufacturers still specifying power the old way, and converts from home audio specifying it the new way. Today, a lot of companies do both, so their power ratings can be compared to those of all their competitors, no matter what system they follow.

Delco-GM/Bose Revisited

When I wrote about the Delco-GM/Bose sound system for our December '82 issue, it was the only factory-installed car-stereo supersystem. Now that I've had a chance to evaluate the Ford/JBL system (see June '86 and November '85 *Audio*), I wanted to refresh my impressions of the Delco-GM/Bose.

My second go-round with the system left me with most of my 1982 impressions intact. The cross-fired speaker design still impressed me with its ability to provide good balance on both sides of the car at once, obviating the need for a balance control. I continued to feel that the system could benefit from a subwoofer option, which GM still does not offer (though they do make a subwoofer available with another sound system in some other cars). And I still thought that the four station-preset buttons in Delco's head unit were not enough, at least in metropolitan areas.

Some of my impressions did change, though, and all slightly for the better. The bass no longer seemed heavy to me, except on AM; and even on AM, dialing in about half the available bass cut made the sound very good—far better than the AM on most car or home systems. The lack of separate tweeters still bothered me a trifle, but not as much as it had the first time I auditioned this system.

On the head unit, Delco has added one feature and changed another. The new feature is a music-finder system. The change is in the method of entering stations into the preset memory. On the original head unit this was done by pulling and pushing the preset buttons; on the new one it's done by pressing a properly inconspicuous memory button. The control panel does not indicate that you must press the volume knob to reverse the direction of tape play; labelling the fast-wind knobs "Fwd." and "Rev." just adds to the confusion. The manual for the system now includes a list of FM stations by location, frequency and program format, a nice touch for travellers.

Imaging was sharper than I remembered it but a bit overblown, as if one were listening through headphones. The headphone effect was particularly noticeable when I played "Walk on the Wild Side" from the Lou Reed album of the same name—the chorus, after sticking in the back for the first few bars, seemed to advance toward and then *around* me.

Some day, I'd like to get a chance to compare the Delco-GM/Bose and Ford /JBL systems more directly. I know I prefer the former's spatial qualities and the latter's frequency balances, but overall I find them so closely matched that whichever I've heard more recently is the one I like better.

It may be a matter of opinion which of the two is more worth buying (I'd pick the car before the system, in any case), but there's no question that GM's is the less worth stealing. The head unit, while good, will only fit GM cars; the amplifiers are built into speaker systems that will only fit specific GM models. Since the amplifiers and speakers are effectively unstealable, thieves may decide the head unit by itself isn't worth stealing. Delco-GM/Bose system owners who do lose their head units, however, might consider a new one that has more features and hotter performance.

IVAN BERGER

BACK TO THE FUTURE

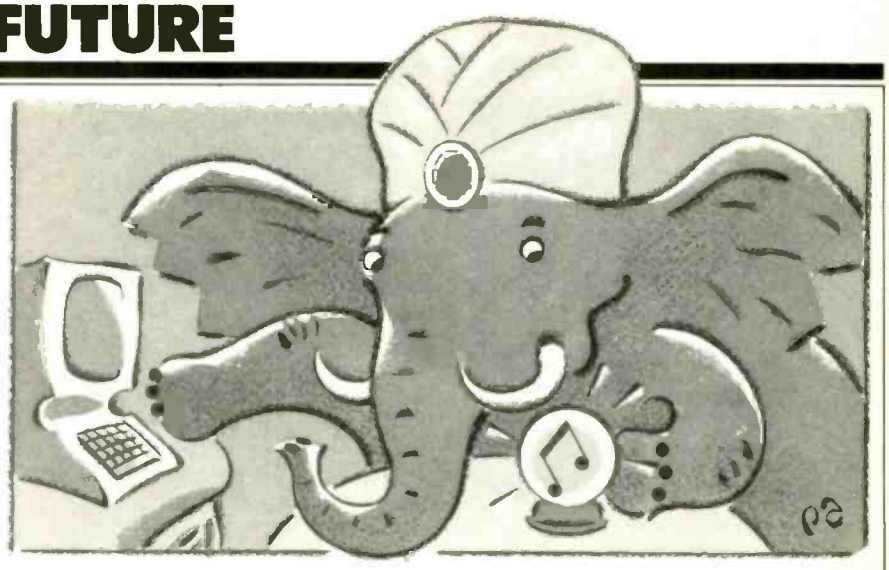

Illustration: Philip Anderson

Unreal Time

Humans can predict the future in ways no electronic circuit can. A recording engineer, for example, can adjust levels not only to match what the musicians are playing at the moment (electronic circuits can do that too), but also to match what those musicians will be playing, before they play it. Those level predictions can be based on familiarity with the music, a reading of the score, or simply a feel for the music's inherent logic—a sense that the music will get louder at a given point because it ought to.

So far, our circuits cannot guess the future—they either *know* what's coming or they're at a loss. One way circuitry gets such sure foreknowledge is by reading the present while acting on the past. For instance, record-cutting setups often have two playback heads reading the master tape. First the tape passes a head whose output feeds the computer that adjusts the spacing between grooves; about 1.8 seconds later it passes a head whose output feeds the cutter. The first head tells the computer what's coming up in terms of signal volume—and, by extension, how wide the land (area between grooves) will have to be 1.8 seconds (one revolution) hence. By the time the signal hits the cutter, it's already history to the first playback head.

That sort of thing is easy to do on music already frozen for posterity, like the master tape in the above example. But how can we time-shift live music so our systems can know what's coming? Digital thinking suggests two ways.

Short time shifts are simple. First, digitize the signal (which we will be doing more and more, anyway). Then, pass it simultaneously into a shift-register memory and into the circuits which compute what's to be done with the signal when it comes out of the memory's other end. Using CD's 16-bit samples and 44.1-kHz sampling rate, the memory in a 640K personal computer would be enough to delay a stereo signal by nearly 4 seconds—a long time, to digital signal-processing circuits.

For longer time shifts, it might be necessary to record our digitized signal on some handy medium. Since the signal is not being permanently stored, computer disks would be ideal, allowing any section that's already been played to be immediately recycled back under the recording head. A 5-megabyte computer disk (about the smallest hard disk now available) would hold nearly half a minute of CD stereo. That would probably be enough advance warning for a level-adjustment circuit to sense where the music's dynamics were heading—to sense, for instance, whether a given loud note was a peak or the start of a long crescendo, and how loud that crescendo might yet get.

This could be done with analog tape loops too, of course. The catch is that each generation of recording on such loops would degrade the signal noticeably. Digitizing would degrade it a lot less—and once digitized, we can record and re-record the signal all we want with no further loss. If that signal is going to be digitized in any case, we're home free.

News & Notes

• A home optical-disc recorder—which will not be compatible with CD—has been announced for limited production by CompuSonics. The DSP-1000 uses 5-inch optical discs which can be recorded once and played indefinitely, but not erased and reused. A two-sided disc can hold about 37 minutes of high-fidelity stereo per side; a data-compression scheme can double that time, though presumably with some loss of quality. With maximum data compression, the disc can hold 4 hours and 16 minutes of monophonic sound per side, but with an upper frequency cutoff of 6 kHz. Only 25 units were planned for initial production, to sell for $6,995 each. Double-sided discs will cost $175 apiece, and single-sided discs will be $99 each.

• A digital recorder with no moving parts has been announced by a London company, Lyric Data, according to *The Sunday Times* of London. The IXI stores music on computer memory chips, in cartridges which the *Times* describes as "slightly smaller than videocassettes." The IXI's capacity is 30 minutes, using three such cartridges, each holding 600 1-megabit memory chips. Presumably, it uses fewer bits per sample or a lower sampling rate than CD, which would require about 850 megabits of storage for 10 minutes of data alone, not counting the memory required for error-correction bits. The price of each cartridge was quoted at about $4,500; no price was given for the IXI recorder.

• Direct digital broadcasting began, on an experimental basis, several months ago in Boston. From August through October, WGBH broadcast digital sound over its UHF TV outlet, WGBX, using a Sony PCM-

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Len explains digital technology...shows you the latest applications...tells you what features to look for when comparing players...and even unveils a few exciting new breakthroughs not yet available in stores.

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And, of course, unlike a live seminar, Len will "repeat" anything you want again and again for you—just use the *rewind button!* Your VCR may also have the capability of freezing specific charts or equipment on your TV screen.

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Can recording studios afford to go digital? Costs are high, tax breaks are ending, and no one is sure which format to buy.

F1 digital adaptor to encode the signal. Listeners with a PCM adaptor and either a VCR, a separate video tuner, or a monitor receiver could receive the broadcasts; WGBH estimates that 200 to 500 listeners in the Boston area are so equipped. The station hopes that this experiment could lead the FCC, now exploring frequency allocations in the upper UHF band, to allocate some of those frequencies to digital sound broadcasting. A digital station would take up about half the bandwidth of a UHF TV channel.

- Digital times may be hard ones for recording studios, reports *Studio Sound* magazine in England. The efforts of record companies are being partially diverted from new recording sessions to CD reissues of LPs. Equipping a studio with digital recording gear is a big gamble, not only because of its high price but also because no one is quite sure which of two competing digital studio recorder systems—ProDigi (PD) or DASH—will win out. And for those U.S. studios that wait until the dust settles before deciding, the 1987 tax laws may make investments in new equipment less attractive. Nonetheless, a Sony executive predicts that within two years digital recording will become more common than analog in studios with 24 tracks or more.
- While American record companies seek an electronic lockout that will prevent DAT (and possibly analog) cassette decks from dubbing CDs, Kenwood has announced the development of a computer-controlled recording system that will make such dubbing easier. The system would sample CD signals to find a peak level, then set a recorder to just accommodate that peak. This would allow uncompressed dubbing without overload distortion.
- Studer and Philips have formed a partnership to develop CD-related studio equipment, including direct CD recorders.
- Several Sony "Pressman" portable recorders now have boundary microphones built in; Sony also has announced, in Japan, a recorder that reverses *before* the tape ends, so as to lose virtually no sound. The TCM-1000 monitors the speed of the cassette reels to determine when the tape is about to run out.
- Sharp has developed a smaller, lighter semiconductor laser for CD players. The company says that players using this laser can be made 1.2 inches thick, 0.4 inch thinner than the current minimum.
- A bilateral agreement between the U.S. and Mexico has opened the door to longer hours for daytime-only AM radio stations in both countries. Stations which formerly went off the air at sundown or 6:00 P.M., whichever came later, may now stay on the air until two hours past sundown. In addition, 321 clear-channel AM stations that were formerly daytime-only may now operate 24 hours a day.
- A patent for a direct digital loudspeaker has been granted to Walter E. Stinger, Jr. of Narberth, Pa. Like other digital speakers which have been patented here and abroad, it is a cellular array. The patent is #4,515,997.
- General Electric, the new owner of RCA Corporation, is selling the RCA/Ariola record division to Bertelsmann AG, of Germany; Bertelsmann already owned 25% of it. The record division had been part of RCA since that company purchased the Victor Talking Machine Company in 1929. Nipper, the fox terrier listening to the gramophone in the famous painting "His Master's Voice," will now have two masters in the U.S.: RCA's consumer electronics division, and the record company.
- A cross between karaoke, jukeboxes, and the old "record-your-voice" booths has opened in Houston. At Music Tracks, customers can record their own voices over instrumental and background vocal tracks custom-recorded for the company. According to Music Tracks, 70 songs were available by mid-1986.
- For once, an audio development —the BTSC stereo TV sound system—has won TV's Emmy award. Honors went to Zenith and dbx for inventing it, to the Electronic Industries Association for work on its adoption, to RCA Labs for research and measurements, and to NBC for being first to use it network-wide.

The White Terror

Bob Carver has suggested an answer to my problem of cats clawing speaker grilles and drivers. Whenever he gets in a new pair of speakers, he cues up some white noise and waits for the cats to check out the new additions. Once the cats get close to the speakers, he gives them a blast of noise. Usually that's all it takes to keep them away from those speakers ever after; only one kitten has needed to get the white-noise treatment twice. To the cats, I suspect, it sounds like the hostility hiss of the largest cat in the world. If you try it, don't do it loud enough to terrorize your tweeters into permanent silence.

Coda: Jack Trux

John H. Trux, Jr., founder and past president of Bang & Olufsen of America, Inc., passed away in September.

Like many prominent audio figures, Jack was also an amateur musician. A jazz drummer, he often followed sales meetings by playing in jam sessions with his staff. After working for Ampex and Bell & Howell (then a maker of tape decks), Jack began importing and selling Bang & Olufsen phono cartridges. In 1970, he founded B & O of America, serving as its president until his retirement in 1983.

Digital Discrimination.

BECAUSE ALL CD'S ARE NOT CREATED EQUAL, THE NEW CARVER DTL-200 COMPACT DISC PLAYER IS INTRIGUINGLY DIFFERENT.

The Carver DTL-200 answers the audiophile's demand for a CD Player which provides not only the greater dynamic range and richer bass expected from compact disc technology, but also the musicality, spectral balance and spatial qualities of well executed analog high fidelity recordings

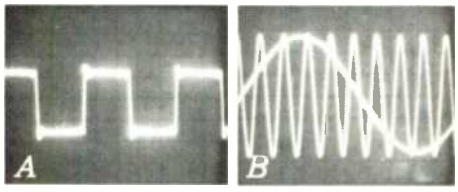
The new remote control Carver DTL-200 represents the next logical evolutionary step towards marrying the awesome technology of digital playback with Bob Carver's commitment to the re-creation of the live performance It embodies the latest digital/analog conversion circuitry with oversampling, sophisticated laser system and a wealth of operating features And it possesses unique Carver circuitry that solves real-world sonic problems associated with commercial CDs

TIME DOMAIN CORRECTION. The Carver DTL-200 incorporates an important new computer logic innovation that monitors the incoming digital signal for imperfections and "glitches" caused in recording and production Such errors are immune to conventional error-correction processes because they are actually data anomalies Yet they can add overall harmonic distortion and cause audible changes in sound quality.

The DTL-200's Time Domain Correction circuit constantly performs a complex, 25-bit digital calculation on passing data This high-speed error correction algorithm, in conjunction with a 121-pole digital filter, terminates distortion-causing high harmonics as they occur in the bit stream The result is frequency response within 1/1000 of a dB of the original, with significant reduction of distortion to less than 0 007%

PLUS THE DIGITAL TIME LENS. On top of this unerring ability to produce natural, real-sounding music from the CDs' digital bits, the Carver DTL-200 has the remarkable Digital Time Lens circuit to insure your listening enjoyment

When Bob Carver obtained his first compact disc player, he was surprised at the sound derived from most of the compact discs he purchased The three-dimensional musical perspective which his analog system provided in lush abundance on phono discs evaporated into a flat, brittle wasteland After extensive testing, Bob uncovered two fundamental flaws in almost all compact discs 1) An unpleasant, harsh spectral energy balance. The overall octave-to-octave energy balance was shifted on the CD towards more midrange above 400 Hz. 2) The amount of L-R signal (which carries the spacial detail of the music) on the CD was inexplicably, but substantially reduced when compared with the amount of L-R signal found on the corresponding analog disc The difference is obvious in these two oscilloscope photos.



A Lissajous pattern showing spatial detail (L-R) (L + R) ratio from an LP record

B The same instant of music but taken from the CD version Note the decreased (L-R) content, as shown by the narrowed trace.

Carvers circuitry corrects the ratio of L-R to L+R by performing one extra, but important mathematical operation on the signal stream that all other CD players fail to perform. This final operation makes all the difference

The result is a natural sound with more of the three-dimensional information that places us in the same space with performers You won't need the Digital Time Lens on all CDs But it is there when you need it

In the beginning, Carver hoped, indeed he expected, that once recording artists and engineers became more experienced with CD technology fewer and fewer CDs would require the Digital Time Lens But both laboratory and listening tests reveal that the majority of even the most recently released CDs benefit significantly from the Digital Time Lens.

PACKED WITH USEFUL FEATURES. The Carver DTL-200 makes enjoying Compact Discs a simple exercise in button pushing from your favorite listening chair You can program any combination of up to twelve tracks from a single CD, repeat a specific track or a whole Compact Disc for uninterruptec enjoyment

Along with the ability to skip forward or backwards song-by-song, a touch of a key allows you to audibly review a disc backwards or forwards at many times normal speed An A-B Specific Phrase Repeat lets you carefully analyze one section of a performance or simply provide a point of reference in a long, un-indexed symphonic movement

All functions are displayed on an easy-to-read but subtle LCD display including programming sequence, current selection number, individual and total playing times plus indexing cues.

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Audition the new DTL-200 today at your Carver dealer, using a variety of discs You will be surprised at how audibly it can improve on what is already the best playback medium ever offered

SPECIFICATIONS. *Frequency Response* 5Hz 20kHz 0dB -0 2dB *Total Harmonic Distortion* 0 007% S N 100db *Channel Separation* 90dB 1kHz *Dynamic Range* 96dB *Wow & Flutter* unmeasurable *Programming* 12 track remote and manual

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ALASKA: **Anchorage** Cartunes **Fairbanks** Hoitt's Music

ARKANSAS: **Arkadelphia** K C Audio Video Center **Camden** K C Audio Video Center **Crossett** Music Mart **El Dorado** Music Mart **Fayetteville** Stereo One Ft. Smith Stereo One **Little Rock** Car Tunes **Magnolia** Music Mart Corp **Mountain Home** Huberts Radio & TV **Pine Bluff** Music Mart **Searcy** Softmart Computer & Electronics

ARIZONA: **Flagstaff** Sound Pro **Glendale** Twenty1rst Century **Lake Havasu City** Sound Bank **Lakeside** Specialty Electronics **Mesa** Twenty1rst Century **Phoenix** Jerry's Audio For Your Car Twenty1rst Century **Prescott** Smith Electronics **Tempe** Twenty 1rst Century **Tucson** Audio Emporium Classic Car Sounds Class c Car Stereo **Yuma** Warehouse Stereo

CALIFORNIA: **Alhambra** Audio Specialist **Anaheim** Anaheim Hills Car Stereo Henry's Auto Stereo **Antioch** Pantell's Antioch Music **Auburn** Auburn Car Tunes **Azusa** Al & Ed Autosound Center' **Bakersfield** Trans Lex Travelin' **Bellflower** Long Beach Auto Radio **Berkeley** Franks of Berkeley **Brea** Cal fornia Mobile System **Canoga Park** Car Fidelity **Cerritos** Your Sound **Chico** How's That Sound **Chula Vista** Mad Jacks **Clovis** The Sound Shop **Compton** Al & Ed Autosound Center **Concord** Autohaus Automotive **Costa Mesa** Car Fidelity Long Beach Auto Radio **Covina** Whistle Stop **Daly City** Matthew's TV & Stereo **Dublin** Mobile Acoustics **El Centro** Kukuk's Warehouse Stereo **El Toro** Henry's **Encinitas** North County Stereo **Encino** Car Fidelity Sound Factor **Escondido** Auto Security Sound Mad Jacks **Eureka** Eureka Car Stereo **Fairfield** C&M Stereo Unlimited **Fremont** Mobile Acoustics **Fresno** Bandha's Hi Fi **Gardena** Allen's Electronics In Motion **Gilroy** Hogue Bros. Auto Stereo **Glendale** Valley Landau **Goleta** Creative Stereo **Hacienda Heights** Audio Alert Concepts **Hanford** Mid Valley Automotive **Hayward** Autohaus Automotive **Hemet** Auto Sound **Hollywood** Car Fidelity **Huntington Beach** Henry's Auto Stereo **Indio** Auto Sound **Inglewood** Al & Ed Autosound Center **La Mesa** Mad Jacks **Lafayette** Creative Car Stereo **Laguna Beach** Laguna Stereo **Lancaster** Cal fornia Sound Works **Larkspur** Marin Auto Stereo **Lawndale** Al & Ed Autosound Center Crazy Stereo **Livermore** Persons Car Stereo **Long Beach** Long Beach Auto Radio **Los Altos** Dealer Car Stereo **Los Angeles** Al & Ed Autosound Center, Auto Stereo Warehouse, B&M Electronics, Beverly Hills Auto Stereo, Columbia Auto Stereo Electronic Entertainment, Florence Car Stereo Fuji den Paris Audio **Lynwood** Century Auto Stereo **Manteca** Pierson's Car Stereo **Merced** Sound Encounter **Mission Viejo** Century Auto Stereo **Modesto** Paradyme **Montclair** Whistle Stop **Monterey Park** Al & Ed Autosound Center **Moreno Valley** Auto Sound **Napa** Autohaus Automot ve **N. Hollywood** Al & Ed Autosound Center, Car Fidelity Sound Factor **Norco** Auto Sound **Oakland** Auto Radio Headquarters **Oceanside** Mad Jacks **Orange** Henry's Mobile Electronics, Speakerworks Mobile **Palm Desert** Auto Sound **Palm Springs** Auto Sound **Pasadena** Al & Ed Autosound Center **Pomona** Auto Sound **Porterville** Perfect Sound **Redding** How's That Sound **Reseda** Auto Sound Engineering **Riverside** Auto Sound **Rolling Hills Estates** Palos Verdes International **S. Lake Tahoe** El Dorado Audio **Sacramento** Paradyme, Stereo Showcase **Salinas** D&R Car Stereo **San Bernardino** Auto Sound **San Carlos** Auto Sound Specialist **San Diego** Mad Jacks, Radio Man **San Francisco** Peter's Auto **San Jose** Century Stereo Dealer's Car Stereo **San Luis Obispo** Car Stereo Stores **San Mateo** Pan Auto Sound **San Rafael** Marin Auto Stereo **Santa Ana** Henry's Auto Stereo **Santa Barbara** Creative Stereo, Santa Barbara Auto Stereo **Santa Cruz** House Of Sound **Santa Maria** Creative Stereo **Santa Monica** Al & Ed Autosound Center, Car Fidelity **Santa Rosa** Santa Rosa Cartunes **Seaside** Kar Tunes **Sherman Oaks** Al & Ed Autosound Center Andy's Auto Radio **Simi Valley** Soundtique Auto Stereo **Stockton** Paradyme Consumer Electronics, Rolling Sounds, **Susanville** Electronic Butterfly **Thousand Oaks** Oaks Auto Radio **Torrance** Installations Unlimited Paris Audio Speaker works Mobile **Ukiah** Music Hut **Upland** Classic Motoring **Vallejo** Stereo Showcase **Ventura** Creative Stereo **Victorville** Incred ble Sounds **Visalia** Lees Stereo **W. Los Angeles** Al & Ed Autosound Center **Walnut** Transonic Inter national **Walnut Creek** Walnut Creek Auto Radio **Whittier** Speaker works, Whittier **Woodland** Jerry's Auto Stereo **Yuba City** Jerry's Auto **Stereo Yucca Valley** Car Stereo Specialties,

COLORADO **Arvada** Soundtrack **Aspen** Main Street Music **Aurora** Soundtrack **Avon** Mountain Music **Boulder** Listen Up, Soundtrack **Colorado Springs** Sight & Sound, Sound Shop **Denver** Listen Up, Soundtrack **Ft. Collins** Audio Junc tion **Glenwood Springs** Stereo Unlimited **Grand Junction** The Sound Company **Greeley** Sound tronix **Littleton** Soundtrack **Pueblo** Soundtronix **Steamboat Springs** Yampa Valley Sound Co **Sterling** Kaned Sound Emporium **Thornton** Soundtrack **Vail** Mountain Music

CONNECTICUT: **Avon** Hi Fi Stereo House of Avon **Canton** Jo-Di's Sound Center **Danbury** Carston Stereo **East Berlin** Cartunes **Enfield** Jo-D's Sound Center **Fairfield** Audiodesign **Glastonbury** Auto fidelity **Greenwich** Auto Sounds **Groton** Leiser Sound **Hartford** Jo-Di's Sound Center **Manchester** Jo-Di's Sound Center **Milford** Installations Unlim ted **New Haven** Audio Etc Champion Auto Safety **New London** Jo-Di's Sound Center **Newington** Hi Fi Stereo House **North Haven** Jo-Di's Sound Center **Norwalk** Audiotronics Jo-Di's Sound Center **Norwich** Leiser Sound **Norwichtown** Leiser Sound **Old Greenwich** Audiocom **Stamford** Fairfield Stereo **Stratford** West chester Stereo **Waterbury** Jo-Di's Sound Center **Waterford** Tweeter, Etc **West Hartford** Jo-Di's Sound Center **Westport** Westchester Stereo

DELAWARE. **Dover** Sound Studio **Newark** Sound Studio **Wilmington** Sound Studio

FLORIDA **Boca Raton** Vern's Elec tronics **Bradentom** Stereorama **Brandon** Stereorama **Clearwater** Stereorama **Coral Gables** Florida Car Sounds, Sound Advice **Ft. Meyers** Stereo Garage **Ft. Lauderdale** Sound Advice **Ft. Pierce** Sound Shack **Ft. Walton** Professional Auto Radio **Gainsville** Couch Elec tronics **Hialeah** Walder Electronic **Hollywood** Sound Advice **Jacksonville** Audio Tech Audio-Tech Regency, Discount Sound, Discount Sound Jackson, Hoyt Hi Fi Center **Lake Wales** Carousel Records **Lake Worth** Audio Advisors **Lakeland** Carousel Records **Longwood** Audi o Garage **Marathon** Sound Source **Miami** Florida Car Sounds Las Fabricas, Metro Electronics Olson Electronics, Preston Electronics Sedoris Electronics Sound Advice Sunday Electronics, Sympathetic Ear, Walder Electronic N. **Miami** Cartronics **N. Miami Beach** Sound Advice **Naples** Stereo Garage **Newport Richey** Stereo Specialties **Orange Park** Audio Tech **Orlando** Audio Garage **Panama City** Watt sound Stereo **Pensacola** All Pro Sound **Pinellas Park** Car Stereos, Unlimited, Stereorama **Rockledge** Car Radios USA **Sarasota** Stereo rama **S. Daytona** The Car Stereo Company **St. Petersburg** All States Radio **Stuart** Fox Audio **Sunrise** Sound Advice **Tallahassee** The Stereo Store **Tampa** Sound Advice, Stereorama Of Tampa **Vero Beach** Audiohouse **Vero Beach** Sound Advice **West Melbourne** Street Sound **Winter Haven** Carousel Records **Winter Park** Audio Garage

GEORGIA: **Atlanta** American Radio, Spectrum Sound, Stereo Designs **Augusta** Stereo City of Georgia **Brunswick** H & H Service Store **Chamblee** American Radio **Cornelia** Vaughn Music **Dalton** Sound Service Inc **Decatur** American Radio **Dublin** World Hi Fi **Gainsville** Electronic Sales **Jesup** Radio Shack **La Grange** R T R Limited **Lawrenceville** Sound Pro **Lilburn** Sound Pro **Macon** Ken's Stereo Junction **Marrietta** American Radio **Milledgeville** World Hi Fi **Rome** World Hi Fi **Roswell** American Radio **Savannah** Radio Tape Center, Southland Sound **Thomasville** Hi Fi Sales & Service **Tifton** Bergers Audio & TV **Valdosta** Stereo Connection **Warner Robbins** World Hi Fi Electronics, Kens Stereo Junction

HAWAII: **Aiea** Electronic Entertain ment **Hilo** Hilo Audio **Honolulu** Auto Audio, Electronic Entertain ment Island Sound Inc **Kahului** Electronic Entertainment **Kailua** Car Tunes **Lihue** Auto Systems Kauai Wiliulku Electronic Entertainment

IDAHO: **Boise** Sound Pro **Coeur D' Alene** American Television **Idaho Falls** Phase Four Stereo **Lewston** Steiner Electronics **Moscow** Aspen Sound Inc **Nampa** Jamison's Music West **Pocatello** Phase Four **Twin Falls** Audio Warehouse

ILLINOIS: **Algonquin** Team Elec tronics **Alsip** Car Tronics **Alton** Reliable Stereo & Video **Aurora** Stereo Systems, **Belleville** Audio Musicale **Buffalo Grove** Columbia Audio Video **Carbondale** Nalder's Stereo **Champaign** Good Vibes Sound **Chicago** Automotive Sound Systems, Un ted Audio Centers **Danville** Bud's Car Stereo **Decatur** Apple Tree Stereo **Deerfield** United Audio Centers **DeKalb** Appletree Stereo **Downers Grove** Safecar **Elmwood Park** Finishing Touch Car Care **Highland Park** Autosonics, Columbia Audio Video **Jacksonville** Music World 1st In Video **Joliet** Stereo Systems **Kankakee** The Shoppe **Lansing** Unitek Electronics **Moline** Ram Automotive **Morton Grove** Un ted Audio Centers **Mount Prospect** Mobile Music **Mt. Vernon** Dons Stereo & Speed Center **Naperville** Stereo Systems **Niles** United Audio Centers **Normal** Appletree Stereo **Palatine** Auto Sound **Peoria** Team of Peoria **Quincy** Music World 1st In Video **Rockford** Appletree Stereo, Columbia Audio Video **Spring Valley** Audio Labs **Springfield** Sundown One **St. Charles** Autobahn Services **Sterling** Sterling Electronics **Vernon Hills** United Audio Centers **Villa Park** Hi Fi Hutch **Westmont** Sounds Deluxe

INDIANA: **Bloomington** Alan Audio **Carmel** Sound Productions **Evansville** R isley Audio **Ft. Wayne** Classic Stereo-Pak, Inc **Highland** Road Concepts **Indianapolis** Sound Product Cons **Jasper** Audio World **Madisonville** Risley's **Marion** Classic Stereo **Mishawaka** Auto Radio Specialist **Muncie** Classic Stereo **S. Lafayette** Good Vibes Sound **South Bend** Classic Stereo-Pak **Terre Haute** Audio Connect on **Vincennes** Record Cellar Audio Video Risley Electronics

IOWA **Ames** Cyclone Motors **Carroll** Sound & Service **Cedar Rapids** Audio Room **Centerville** Wrights Stereo TV & Appliance **Davenport** Audio Odyssey **Des Moines** Audio Lab Stereo Sound Studio **Dubuque** Audio Room **Ft. Dodge** Sound Unlimited **Iowa City** Audio Odyssey Of Iowa **Keokuk** Music World 1st In Video **Mason City** Mason City Sound World **Sioux City** Pfanz Electronics **Spencer** Carey's TV & Stereo **Storm Lake** Sound & Service **Waterloo** Team Electronics

KANSAS: **Arkansas City** Sparks Music **Dodge City** Cartunes **Emporia** Audio-Video Connection **Garden City** Team Electronics, Inc **Great Bend** Audio Electronics **Hutchinson** Hayes Sight & Sound **Lawrence** Kieft's Record & Stereo **Manhattan** Rolling Thunder **Overland Park** Audio Mart Stereo, Santa Fe Auto Sound **Topeka** Nelson's **Wichita** Rolling Thunder

KENTUCKY: **Bardstown** Mr Music **Bowling Green** Poston Electronics **Corbin** Sounds Around Town **Elizabethtown** Replay **Florence** Sight In Sound **London** Sounds Around Town **Louisville** Music City Sound Factory **Murray** Sun set Blvd Music **Owensboro** R isley Electronics **Paducah** Risley Elec tronics **Pikeville** Audio Connec t on **Prestonsberg** B&W TV Appliance

LOUISIANA: **Baton Rouge** David's Car Stereo & Comm , Gonzales Music Center Music Center **Gretna** Campo Appliance Stereo V illage **Harahan** Mobile One **Lafayette** Ricky Smith Audio Sound Electronics **Lake Charles** Classic Audio Systems **Mandeville** Campo Appliance **Monroe** Sound Center **New Iberia** Village Sound Center **Ruston** Music Mart Corp **Shreveport** Stereo & Record Center **Slidell** Gonzales Music Center, Campo Appliance

MASSACHUSETTS: **Ashland** Crea t ve Car Stereo **Billerica** Mobile Automotive **Boston** Nantucket Sound, Tweeter, Etc **Braintree** Nantucket Sound, Tweeter, Etc **Brockton** Soundtrack Audio **Burlington** Tweeter Etc **Cambridge** New England Audio Tweeter, Etc **Chestnut Hill** Tweeter Etc **Danvers** Riches Car Tunes Tweeter Etc **Dedham** Tweeter Etc **Fitchburg** Music Forum **Framingham** Natural Sound, Tweeter, Etc **Framington** Auto Stereo Place **Gardner** Music Forum **Greenfield** Long Radio, Music Store **Hyannis** Nantucket Sound, Tweeter Etc **N. Attleboro** Audio Concepts **N. Dartmouth** Riches Auto Radio **Northampton** Long Radio **Norwood** Northeast Security & Stereo **Pittsfield** Taylor'd Sound **Rockland** Nantucket Sound **Saugus** Nantucket Sound, Northeast Security & Stereo **Shrewsbury** Leiser Sound, Rayco Car Service **Springfield** Long Radio Of Springfield **Stoneham** Sound North **Waltham** Waltham Camera & Stereo **Watertown** Beaconwood Acoustics, Car Tunes

MAINE: **Bangor** Radio City **Camden** Harbor Audio & Video **Lewston** Radio City **S. Portland** Great Northern Sound Co

MARYLAND: **Annapolis** Spaceways Sound **Baltimore** Carsounds, Sight & Sound Stansbury Stereo Center **Bethesda** Audio Sound Systems **Columbia** Car Stereo Systems **Frederick** The Electronic Shop **Hagerstown** Hunt Audio & Associates **Langley Park** Audio Associates **Laurel** Audio Associ ates **Lutherville** Gramaphone **Perry Hill** Stansbury Stereo Center **Rockville** Audio Associ ates, Auto Sound Systems, Greg's Auto Sound **Salisbury** Sound Studio **Timonium** Carsounds **Waldorf** Car Tec

MICHIGAN: **Allen Park** Car Tunes Stereo Center **Ann Arbor** H Fi Buys **Bay City** **Olson** Auto Radic, Superior Sound **Berkley** Car Tunes Stereo Center **Birmingham** Gramaphone **Dearborn** Radio Frank **Drayton Plains** Dixie Sound **E. Lansing** Hi Fi Buys **Flint** Custom Auto Sound **Grand Rapids** Classic Stereo **Jackson** Jackson Auto Sounds **Kalamazoo** Classic Stereo **Lansing** Hi Fi Buys, Skory Auto Sounds **Marquette** American TV **Midland** Hi Fi Buys **Muskegon** Langlois Stereo **Petoskey** Kurtz Music **Saginaw** Olson Auto Radio **St. Joseph** Tri County Audio **Traverse City** Kurtz Music **Warren** Radio Frank **Westland** Car Tunes Stereo Center **Wyoming** Sound In Motion **Ypsilanti** Future Sound & Communication

MINNESOTA: **Alexandria** Audio Concepts **Baxter** Stereo 1 **Bemidji** Team Electronics **Brooklyn Center** Audio King **Burnsville** Audio King **Duluth** Stereo 1 **Edina** Audio King **Fairmont** Midwest Satellite Audic & Video **Fargo** Stereo 1 **Fergus Falls** Team Electronics **Golden Valley** Audio King Car Stereo Center **Grand Rapids** Team Electronics **Hibbing** Team Elec tronics **Hopkins** Transportation Electronics **Maplewood** Audio King Car Stereo Center **Minneapolis** Audio King **Minnetonka** Audio King **Roseville** Audio King St. Louis Park Audio King Electronics **St. Paul** Audio King **St. Cloud** Stereo 1 **Virginia** Team Electronic **Wilmar** Sound Image **Winona** Amalgamated Audio

MISSISSIPPI: **Columbus** Audio Advantage **Greenville** Cartunes **Guitport** Campo Appliance, Empress Of Miss ssippi **Hattiesburg** Hi Fi Crus n' **Jackson** Automotive Audio **Laurel** Hi Fi Cruisin' **McComb** Custom Audio **Natchez** Sound Circuit **Oxford** Sights & Sounds **Pascagoula** Empress Audio & Video **Toledo** Audio Advantage **Vicksburg** Sound Circuit

MISSOURI: **Cape Girardeau** Stereo One **Columbia** D&M Sound **Kansas City** Brands Mart Stereo **Kirksville** Wrights Stereo **Knob Noster** Gambles **Lebanon** Sight & Sound **Poplar Bluff** American Hi Fi **Rolla** End Of The Rainbow **Springfield** Sound Of The South **St. Louis** Hi Fi Fo Fum, Sound Ventures **West Plains** Hubert's Radio & TV

MONTANA: **Billings** Sound Pro **Bozeman** Sound Pro **Butte** Ossello ., Inc **Great Falls** Rocky Mounta n Hi Fi Sound Pro **Havre** Northern Electronics **Helena** Sound Pro **Kalpispell** Logical Choice **Missoula** Electronic Parts

NORTH CAROLINA: **Asheville** Mr Toads **Chapel Hill** Stereo Sound **Charlotte** Carolina Car Stereo Sound Systems **Conover** Audiohaus **Durham** Dashboard Stereo, Vickers Audio **Fayetteville** Sound Systems **Goldsboro** Pro Sound **Greensboro** Audio Video Concepts, Sound Systems Stereo Sound **Greenville** Todd's Stereo Center **High Point** Audio Video Concepts **Jacksonville** Onslow Audio Center **Kinston** Stereo Concepts **Morehead City** Anderson Audio **Morganton** Macs TV **New Bern** Anderson Audio **Raleigh** Audio Express **Rocky Mount** Microwave World **Wilmington** Atlantic Audio **Wilson** Modern Stereo **Winston Salem** Stereo Sound Audio Video Concepts Custom Car Hi Fi

NORTH DAKOTA **Bismark** Pacific Sound **Dickson** Music Hut **Grand Forks** Team Electronics **Jamestown** Music Corner **Langdon** Easy Way **Minot** The Stereo Shop **Williston** Team Electronics

NEBRASKA. **Kearny** Midwest Audio **Lincoln** Stereo West **N. Platte** US Tech **Norfolk** Mid City Stereo **Omaha** Custom Electronics Stereo West **York** Midwest Aud o

NEW HAMPSHIRE: **Concord** Audio Of New England **Exeter** Auto Sounds Of New Hampshire **Keene** Sound Power **Laconia** Audio Of New England **Manchester** Campus Hi Fi Tweeter, Etc **Nashua** Tweeter, Etc **Newington** Tweeter, Etc **Rochester** Campus Hi Fi **Salem** Duomo's **W. Lebanon** Car Sounds

NEVADA: **Las Vegas** Import Audio **Reno** The Audio Authority, Car Audio Systems

NEW JERSEY: **Belleville** Zippos Car Stereo **Cherry Hill** Auto Sound Delaware, Soundworks **Deptford** Hi Fi Connection **E. Brunswick** Atlantic Stereo **Edison** Zippos Car Stereo **Hasbrouck Hts.** Saddle Brook Stereo **Howell** Fidelity Car Stereo **Marlton** Hi Fi Connection **Millburn** Professional Audio **Minehill** Linear Elec tronics **Morristown** Headquarters, Sound Express **N. Plainfield** Audio 22 **Neptune** Audi o **Newton** Partroy Sound **Paramus** Leonard Radio, Stereo Warehouse-Rabson's **Ramsey** Rolling Tone **Raritan** AC Audio & Video **Ridgefield** Galaxy Sound **Ridgewood** Motoring Images **Scotch Plains** Cartunes **Shrewsbury** Monmouth Stereo **Trenton** Hal's Stereo Sound Center, Sound Automotive, Universal Stereo **Union City** A&D Auto Stereo Sound **Waterford Works** Van House Coach **West Caldwell** Samm Sound **Westwood** Crusin Music

NEW MEXICO: **Albuquerque** West Coast Sound Systems, Hudson's Audio Center **Carlsbad** Beason's **Clovis** Towne Crier **Farmington** Sound On Wheels **Gallup** Uncle Hiawatt's Cartunes **Las Cruces** The Sound Room **Raton** Odyssey Music **Roswell** Street Sounds **Santa Fe** West Coast Sound Systems **Taos** Que Pasa Music & Electronics

NEW YORK: **Albany** Jo-Di's Sound Center **Alleghany** Sound Track **Amherst** Amherst Electronics **Auburn** Mayco Radio **Batavia** Uni corn Record & Audio **Bay Shore** Papa Angelos Discount **Boonville** Adirondack Music **Bronx** Fordham Auto Radio, Professional Auto Radio **Brooklyn** Phils Auto Radio, Stereo Warehouse Rabson's **Corning** Chemung Electronics **Eastchester** Auto Concepts **Elmira** Chemung Electron cs **Freeport** Rogers Stereo **Fresh Meadows** Sound Stage **Audio Garden City** Car Tunes Auto Stereo, Stereo Warehouse-Rabson's **Glenn Falls** Audio Genesis **Greece** Stereo Shop **Hartsdale** S&I Electronics **Henrietta** Stereo Shop **Hicksville** Audio Designs, Designatrons **Huntington Station** Audio Breakthroughs **Ithaca** DL&G Audio, Chemung Electronics **Kingston** Auto Sound Systems, **Latham** Auto Radio Repair **Manhasset** Audio Breakthroughs, **Mt. Kisco** Four Wheel Sound **Mt. Vernon** Central Lock Co **Nanuet** Short Stop Car Radio **New York** Leonard Radio Sound Stage Audio, Audio Salon **N. Syracuse** GP Enterprises **Oneonta** Stereo Lab **Patchoque** Square Deal **Plattsburgh** Great Northern Stereo **Wise** Pro **Rabson** Designatron's Stereo Store **Poughkeepsie** Sound On Wheels **Riverhead** Showtime Stereo **Rochester** Sound Concept Stereo Shop **Rosedale** S F Sound Unlimited **Salamanca** Sound Track **Saratoga Springs** Le Sounde **Schenectady** Apollo Sales **St. James** Konstant Audio **Staten Island** Clone Audio Systems **Syracuse** Custom craft **Syracuse** GP Enterprises, Gordon Electronics **Valley Stream** Stereo Warehouse-Rabson's **Vestal** Gordon Electronics **Wappinger Falls** Sound Odyssey **Watertown** Northern Electronics **White Plains** Audio Experts Westchester Stereo **Whitesboro** Adirondack Music **Woodside** Leonard Radio

OHIO: **Akron** Audio Craft, Golden Gramaphone **Canton** Hammond Electronics **Cincinnati** Sight In Sound **Cleveland** Audio Craft B&B Appliance **Columbus** Ham mond Electronics **Dayton** Stereo On Wheels, Inc **Elyria** Wiland Com Audio **Findlay** Audio Craft Soundtrek **Gallipolis** Bob's Electronics **Heath** Hammond Electronics **Lima** Classic Stereo **Mansfield** Hammond Electronics **Mayfield Hts.** Audio Craft **Mentor** West Com Audio **Middleburg Heights** Bud's Stereo **Milford** Sight In Sound **Minster** Gudorf & Sons **N. Canton** Hammond Electronics **Parma** West Com Audio **Toledo** Audio Craft, Car Stereo One **Westlake** Audio Craft

OKLAHOMA: **Bartlesville** The Sound Station **Durant** Rick Mackey Sound Center **Enid** Sounds Incredible **Guymon** Sound Service **Lawton** Audio Tech **Moskogee** Sound World **Oklahoma City** David's Stereo & CB, **Ponca City** Sounds Incred ble **Shawnee** Audio Express, Rave Sound **Stillwater** Custom Car Stereo **Tulsa** Imperial Sound, The Phonograph Ltd **Weatherford** Phil's Stereo Warehouse **Woodward** Gill's Store

OREGON: **Beaverton** Chelsea Audio **Bend** The Stereo Plant **Corvallis** Good Guys Stereo **Eugene** Good Guys Stereo Stereo Loft **Grants Pass** Sheckells Stereo **Klamath Falls** The Sound Chamber **Medford** Sheckells Stereo **Portland** Chelsea Audio **Salem** Focus Electronics **The Dalles** Lutz Enterprises

PENNSYLVANIA **Allentown** Sassafras Audio **Altoona** Sound Concepts **Bloomsberg** Webber's Pro Audio **Bryn Mawr** Sassafras Audio **Camp Hill** The Stereo Post **Chambersburg** Sunrise Electronic **Connellsville** The Electronic Tree **Ephrata** Stereo Barn **Erie** PJ's Auto Sound **Feasterville** Sassafras Audio **Gibsonia** Listening Post **Greensburg** Pat's Stereo **Harrisburg** The Stereo Post **Hazelton** Jannen Systems **Indiana** Sound Concepts **Jenkintown** Sassafras Audio **Johnstown** Gary's Entertainment Store **Kingston** Summit Audio **Lancaster** GNT Stereo, The Stereo Post Trojan Yacht **Lebanon** The Stereo Post **Lewisburg** M&M Stereo Equipment **Monroeville** Audio Communications, Listening Post **Montgomeryville** Sassafras Audio **Norristown** Hts. Sound Shack **Philadelphia** Sassafras Audio, Tepper Auto Sound **Pittsburgh** Listening Post **Pottstown** Audio Video Junction **Reifton** GNT Stereo **Springfield** Soundworks **State College** High Fidelity House **Upper Darby** Perzan Auto Radio **Washington** The Stereo Post **Williamsport** Audio Services **York** Town Sound & Custom Tops, Inc

RHODE ISLAND **Cumberland** Sounds Unl mited **E. Providence** Tweeter Etc **Providence** Tweeter Etc **Warwick** Tweeter Etc **Westerly** Leiser Sound

SOUTH CAROLINA: **Anderson** Music Machine **Charleston** Dashboard Stereo **Columbia** Music Machine, Rogers Stereo **Greenville** Music Machine **Hilton Head** Southland Sound **Rockhill** Tart's **Sumter** OK Tire Stores

SOUTH DAKOTA: **Aberdeen** World Electronics **Rapid City** Team Electronics

TENNESSEE: **Chattanooga** The Radio Clinic **Cookville** Network Entertainment **Jackson** Save A Lot Auto **Johnson City** Mr Toads **Kingsport** Mr Toads **Knoxville** Cartunes, Lindsay Ward **McMinnville** Net work Entertainment **Memphis** New Car Stereo, Save A Lot Auto **Murfreesboro** Audiomasters **Nashville** Karco Auto Audio, Nicholson's Stereo, The Car Stereo Shop, Inc

TEXAS: **Abilene** Bunkley's Sound System **Addison** Earmark **Amarillo** Soundroom of So Western Music **Arlington** Hawk Electronics, Sound Idea **Austin** Audio Video, Road Sounds **Bay City** Car Stereo Center **Baytown** Cooper's Custom Audio **Beaumont** Brock Audio **Brownsville** El Arca Electronics, Panorama Electronics **Bryan** Road Sounds **College Station** Audio Video **Corpus Christi** Tape Town Audio **Dallas** Hawk Electronics **Del Rio** Western Auto **Eagle Pass** Trevino Music **El Paso** Casa Sonido Music Sys tems, Sound Room Electronics **Fort Worth** Hawk Electronics, Sound Idea **Galveston** Car Stereo Center **Graham** Layfield Music **Houston** Custom Car Stereo, Fingers Furni ture, Home Entertainment, Sheffield Audio **Humble** Fingers Furnitures **Hurst** Sound Idea **Lake Jackson** Car Stereo Center **Laredo** Audio Systems, Ramirez Tire Center **Longview** Stereo & Record Center **Lubbock** Hi Fidelity of Lubbock **Marshall** Stereo & Record Center **McAllen** El Centro Sound Center, Showery Stereo, Sound Centers of the Valley **Midland** Electronics Ser vice Center **Nacogdoches** Sornet Music **Odessa** Electronics Service Center **Pampa** Hall's **Pasadena** Coopers Custom Audio Ctr., Fingers Furniture **Richardson** Earmark **San Angelo** Sound Box **San Antonio** Bjorn's Stereo Design, Classic Car Audio Mobile Hi Fi **San Marcos** D scovery Audio Video **Sherman** The Audio House, Texoma Auto Air **Temple** Road Sounds **Texarkana** Texarkana Audio Center **Tyler** Stereo & Record Center **Victoria** Parris Electronics, **Waco** Jacks Stereo **Wichita Falls** Audio Sound Systems

UTAH. **Logan** Lynn's TV & Stereo **Murray** Car Concepts **Ogden** Hi Fi Shop **Provo** Boyers Automotive Center **Salt Lake City** Broadway Music, Standard Audio & Hi Fi

St. George Arrow Audio **Vernal** The Dirk Lambrum Company

VERMONT: **Rutland** Sound Direc tions **S. Burlington** Great Northern Stereo

VIRGINIA: **Arlington** Audio Associates **Blacksburg** Scotty's Radio & TV **Bristol** Mr Toads **Charlottesville** Auto Sound of Virginia, Stereo Types **Collinsville** Holdrens **Colonial Heights** Auto Sound of Virginia **Danville** Sounds Unlimited **Fairfax** Audio Associates **Falls Church** Home Entertainment **Franklin** Audio Showroom **Fredericksburg** Contemporary Sounds **Harrisonburg** Ace Music 'n Electronic **Lynchburg** Don's Car Stereo **Manassas** Automotive Hi Fi **Newport News** Go Ho Audio **Pulaski** Scotty's Radio & TV **Radford** Scotty's Radio & TV **Richmond** Audio Sound of Virginia Lindsay/Ward **Roanoke** Holdren's, Scotty's Radio & TV **Springfield** Greg's Auto Sound, Home Entertainment **Vienna** Greg's Auto Sound **Virginia Beach** Audio Connection, Go Ho Audio Audio, Videorama Audio Audio **Winchester** Sound City

WASHINGTON: **Bellevue** Magnolia Hi Fi., Northwest Audio Video **Bellingham** QC Stereo **Bremerton** Evergreen Audio **Everett** Sound Advice **Federal Way** Sound Advice **Kenmore** Sound Advice, Sound Management **Kent** Northwest Auto Sound **Longview** Sound Authority **Lynnwood** Magnolia Hi Fi North west Audio Video **Moses Lake** Performance Auto Sound **Oak Harbor** QC Stereo **Olympia** Desco Electronics **Seattle** Cartronics, Magnolia Mobile Electronics North west Auto Sound **Spokane** Dis cover Audio **Tacoma** Automotive Sound Magnolia Hi Fi **Tukwila** Magnolia Hi Fi, Northwest Audio Video **Wenatchee** Performance Auto Sound

WEST VIRGINIA: **Barboursville** Pied Piper **Huntington** Pied Piper **Morgantown** Sound Investment **Mt. Gay Stereo** Video Unlimited **Mt. Hope** Pied Piper **Wheeling** Windmill Electronics

WISCONSIN: **Eau Claire** EME Audio Systems **Fond Du Lac** Wisconsin Electronic **Glendale** Cartronics, Of Wisconsin **Green Bay** Sound World, Muntz Audio/Video **La Crosse** Sound World **Madison** American TV **Menomonie** EME Audio Systems **Milwaukee** General Electronics **Neena** American TV **Oshkosh** Electronic Consultant Company **Pewaukee** American TV **Racine** Al's Auto Stereo **Sheyboygan** Gene's Sound & Camera **Thiensville** D & D Sales **Wausau** Sound World **West Bend** Exclusive Company

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Until the 7902, there has never been a CD player and FM/AM tuner engineered *together* in a complete 7"x 2" unit, to fit the dash of virtually any car.

Like the Lamborghini, every cubic inch of the 7902 is serious performance technology. By redesigning and applying advanced Alpine technology to each element in the system, we've created an entertainment package that easily handles rough roads and weak radio signals.

The 3-beam laser pickup created for the 7902 is about 70% lighter than others. It reads data more accurately and rides on a precision drive mechanism that absorbs mechanical backlash, ensuring outstanding tracking accuracy.

The laser transport is protected against road-shock by a silicon-oil suspension system, and is mounted on a rigid zinc die-cast chassis to maintain perfect alignment.

Our T-10 II Tuner™ utilizes multiple FM circuits on a single tiny chip, smaller than ever before, for superior reliability and reception.

How does it sound? You'll just have to audition it at an Alpine dealer. Come on in when you're ready to get serious. ALPINE

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BERT WHYTE

MASTERS & MAESTROS

Illustration: Mary Jo Mazzella

It is axiomatic that the first production models of devices developed using a new technology are quite expensive. This was true with color television and with videocassette recorders, and most assuredly was the case with Compact Disc players. We all remember the kilobuck-plus CD players, many of which left a great deal to be desired in respect to performance.

It is also usually true that the prices of these products generally decline in direct relation to their popularity in the marketplace and the speed with which high-volume production is achieved. Certainly the success of the Compact Disc has been beyond even the most rosy-hued, optimistic projections. In just over three years, the overwhelming popularity of and demand for CD players have brought their price down to levels of little more than $100!

Unfortunately, in spite of the mass appeal of the CD, there has not been a commensurate decline in the price of software (though the proliferation of CD manufacturing plants *has* helped to alleviate some supply problems). In most major markets, CDs cost $10 to $15 each—roughly two to three times the cost of vinyl LPs.

While a great many people are buying CDs at their current prices, and many justify these prices in terms of the quality of the product and its wear-free longevity, no one has any doubts about the market constraints imposed by expensive CD software. Even now, reports are creeping into the trade press about overproduction and subsequent costly warehousing of low-priced CD players. Everyone agrees that if the price of CDs could be reduced by 25 to 30%, the warehouses would be emptied in very short order.

The normal production of CD masters is a complex photo-optical process which must be carried out under clean-room conditions, and the associated equipment in the plant adds up to about $2 million. Other, experimental CD production techniques have been tried, one being a "continuous web" process in which CDs could be stamped out in cookie-cutter fashion. However, there doesn't seem to be any further promise in this approach, and none of the other production schemes have borne fruit.

Well, friends, Teldec is now working on a new CD processing technology which may ultimately be the first step in reducing the cost of Compact Discs.

As far back as the mid-'70s, Teldec was experimenting with cutting video signals onto discs. In fact, at Decca Records in London, the great Arthur Haddy showed me some of these discs and their associated equipment. In later years came an offshoot of this technology, Teldec's Direct Metal Mastering process. Now it seems that some aspects of the DMM technology can be applied to the mastering and production of CDs.

In Teldec's new CD process, just as in DMM, a blank disc is electrolytically plated with copper. The copper is amorphous and must be used within a few days; the blank disc cannot be used if the copper has changed to a crystalline structure. Neumann has built a lathe somewhat similar in appearance to a standard disc-cutting lathe. Mounted on it is a CD cutterhead which works on piezo-electric principles and drives an embossing tool. The incoming signal causes the tool to emboss the soft copper of the CD blank with sufficient force to create a series of wedge-shaped pits whose walls are angled at 45°. An elaborate control system maintains the proper depth of the embossing.

Teldec claims many advantages for this system. The V-shaped information pits are easier for the laser to track and afford better error correction; the V-wall pits also allow better molding of the polycarbonate CD. The cutting need not be under clean-room conditions; it is done directly onto the copper substrate, and this can be easily silvered with standard electroplating equipment. Incidentally, the amount of recording time on a CD made in this process is comparable to that achieved with the standard photo-optical process.

The Teldec CD-cutting process, said to be 80% cheaper than systems currently in use, is undergoing tests by several American record companies. One thing is certain: If the system really works well (and all indications seem to say it does), it will be a great boon to many of the independent cutting labs in this country. Without the necessity of clean-room conditions, it will mean much wider availability of less expensive CD processing. Apparently, this new Teldec technology will eventually bring us less expensive CDs.

Sansui's S-X700 is the intelligent choice for upgrading your system or starting a new one.

Sansui takes performance and value to heart. That's why our new S-X700 AM/FM stereo receiver should be the heart of your system. With solid power,* it flawlessly reproduces the exciting experience of digital music.

Engineered with traditional attention to detail and state-of-the-art performance, there's no comparison for pure quality and real value.

Built with a heavy-duty transformer generally used only in higher output models, plus exclusive Sansui circuitry, the S-X700 produces music with a unique openness and clarity that other receivers just can't match.

Styled for elegance with a functional yet uncluttered appearance, the all-metal cover, chassis and faceplate are only an outward indication of the S-X700's solid performance capabilities. The solid feel of its controls confirms the quality of performance which awaits you.

So why spend more and get less for your system? Put Sansui's S-X700 at the heart of it and get pure performance and value. The idea is just as smart as it sounds.

*40 watts per channel, minimum RMS, both channels driven into 8 ohms at 20-20,000 Hz, with no more than 0.04% THD.

Start smart with this pure performance receiver.

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Matthew Polk's New Generation of Revolutionary TRUE STEREO SDAs

Digital Disc Ready

Matthew Polk's new generation of revolutionary TRUE STEREO SDA Loudspeakers fully realize the astonishingly lifelike three-dimensional imaging capabilities of stereophonic reproduction.

"The Genius of Matthew Polk Brings You A New Generation of Extraordinary Sounding SDAs"

"Literally a new dimension in sound"

Stereo Review Magazine

"The result is always better than would be achieved by conventional speakers."

Stereo Review Magazine

Polk's critically acclaimed, Audio Video Grand Prix Award winning SDA technology is the most important fundamental advance in loudspeaker technology since stereo itself. Listeners are amazed when they hear the huge, lifelike, three-dimensional sonic image produced by Polk's SDA speakers. The nation's top audio experts agree that Polk SDA loudspeakers always sound better than conventional loudspeakers. Stereo Review said, "Spectacular ...the result is always better than would be achieved by conventional speakers." High Fidelity said, "Astounding...We have yet to hear any stereo program that doesn't benefit." Now the dramatic audible benefits of Polk's exclusive TRUE STEREO SDA technology are available in 5 uniquely superb loudspeaker systems, the SDA SRS, SDA SRS 2, SDA-1B, SDA-2A, and the SDA CRS + .

"They truly represent a breakthrough"

Rolling Stone Magazine

Without exaggeration, the design principals embodied in the SDAs make them the world's first true stereo speakers. When the big switch was made from mono to stereo, the basic concept of speaker design was never modified to take into account the fundamental difference between a mono and stereo signal.

What is the difference between a mono and stereo speaker? The basic concept of mono is that you have one signal (and speaker) meant to be heard by both ears at once. However, the basic concept of stereo is that a much more lifelike three-dimensional sound is achieved by having 2 different signals, each played back through a separate speaker and each meant to be heard by only one ear apiece (L or R). So quite simply, a mono loudspeaker is designed to be heard by two ears at once while true stereo loudspeakers should each be heard by only one ear apiece (like headphones). The revolutionary Polk SDAs are the first TRUE STEREO speakers engineered to accomplish this and fully realize the astonishingly lifelike three-dimensional imaging capabilities of stereophonic sound.

How Polk SDAs Achieve True Stereo

Polk SDA technology solves one of the greatest problems in stereo reproduction. When each ear hears both speakers and signals, as occurs when you use conventional (Mono) speakers to listen in stereo, full stereo separation is lost. The undesirable signal reaching each ear from the "wrong" speaker is a form of acoustic distortion called interaural crosstalk, which confuses your hearing.

The Polk SDA systems eliminate interaural crosstalk distortion and maintain full, True Stereo separation, by incorporating two completely separate sets of drivers (stereo and dimensional) into each speaker cabinet. The stereo drivers radiate the normal stereo signal, while the dimensional drivers radiate a difference signal that acoustically and effectively cancels the interaural crosstalk distortion and thereby restores the stereo separation and imaging lost when you listen to normal "mono" speakers. The sonic benefits are remarkable.

SDA Signature Reference System (SRS) – $1395.00 ea.

AudioVideo Grand Prix Winner

The finest speaker that Polk manufactures. This limited production flagship model combines patented SDA TRUE STEREO technology with phase-coherent focused line-source multiple driver topology to achieve new levels of state-of-the-art imaging, detail, coherence, dynamic range and bass reproduction.

New SDA-SRS 2 – $995.00 ea.

This new scaled down version of the SRS incorporates virtually all its innovations without significantly compromising its awesome sonic performance.

SDA 1B - $695.00 EA.

AudioVideo Grand Prix Winner

A beautifully styled, full size floor-standing system combining Polk's state-of-the-art components with exclusive 3rd generation TRUE STEREO technology for extraordinarily lifelike sound. High Fidelity said "the Polk SDA 1 Loudspeaker provides startling evidence of the audio industry's essential creative vitality."

New SDA 2A – $499.00 ea.

AudioVideo Grand Prix Winner

The new SDA 2A is a full size floor standing system which incorporates many of the latest refinements in SDA technology developed for the SRS models. It represents an extraordinary value which combines spectacular SDA performance with a remarkably affordable price. High Fidelity said listening to the SDA 2 is "an amazing experience."

New SDA CRS + – $395.00 ea.

AudioVideo Grand Prix Winner

The new SDA CRS + is the world's best sounding bookshelf loudspeaker and now incorporates many of the latest refinements in SDA technology developed for the SRS models. It combines the extraordinarily lifelike three-dimensional sonic performance of Polk's patented SDA technology with a handsome enclosure (stand or shelf mountable) of attractively modest proportions. Stereo Review said the CRS is "an impressive achievement".

"Breathtaking...a new world of hi-fi listening"

Stereo Buyers Guide

"Mindboggling...astounding...flabbergasting"

High Fidelity Magazine

Words alone cannot fully describe how much more lifelike SDA TRUE STEREO reproduction is. Reviewers, critical listeners and novices alike are overwhelmed by the magnitude of the sonic improvement achieved by Polk's Stereo/Dimensional technology. You will hear a huge sound stage which extends beyond the speakers and beyond the walls of your listening room itself. The lifelike ambience revealed by the SDAs transports you to the acoustic environment of the original sonic event. Every instrument, vocalist and sound becomes tangible, distinct, alive and firmly placed in its own natural spatial position. You will hear instruments, ambience and subtle musical nuances (normally masked by conventional speakers), revealed for your enjoyment by the SDAs. This benefit is accurately described by Julian Hirsch in Stereo Review, "...the sense of discovery experienced when playing an old favorite stereo record and hearing, quite literally, a new dimension in the sound is a most attractive bonus..." Records, CD's, tapes, video and FM all benefit equally as dramatically.

"You owe it to yourself to audition them"

High Fidelity Magazine

SDAs allow you to experience the spine tingling excitement, majesty and pleasure of live music in your own home. You must hear the remarkable sonic benefits of SDA technology for yourself. You too will agree with Stereo Review's dramatic conclusion: "the result is always better than would be achieved by conventional speakers...it does indeed add a new dimension to reproduced sound."

polkaudio

The Speaker Specialists ®

5601 Metro Drive, Baltimore, Md 21210

Where to buy Polk Speakers? For your nearest dealer, see page 144

Engineer Tom Jung thinks mixer electronics are vital, and he's bought a fancy Class-A console. I wish more recordists would do the same!

Now let me tell you about a significant new advance in recording technique introduced by the redoubtable Tom Jung of Digital Musical Products.

Tom has a justly deserved reputation for his superlative CDs. He is an engineer and a consummate mixing artist who most assiduously searches for ways to improve the sonic quality of his digital recordings.

Tom sent me an advance copy of a very special CD project he has been working on for some time. The album features pianist Billy Barber and is entitled *Lighthouse*. Well, Billy does play the piano here, but he is heard along with some of the most complex and exotic and dynamically exciting sounds you can imagine, all the product of Tom Jung's fertile mind and dazzling technology. Here is a glimpse of how Tom recorded this music.

First off, Tom hied himself to the famous Carroll Musical Instrument Co. in New York. This company is known for its comprehensive collection of percussion instruments, including many rare and exotic items. Next, he recorded a large array of these instruments with a pair of omnidirectional Brüel & Kjaer microphones. A Kurzweil synthesizer with an added PCM processor sampled the mike waveforms at 50 kHz per second, and these were stored on floppy disks with a Macintosh computer. Eight other synthesizers were linked, all with preset programs.

Billy Barber, wearing earphones, heard all the outputs of the Kurzweil and the floppy disks with the percussion programmed, and the outputs of the eight linked synthesizers. He played the piano along with all this, and Tom recorded him with a pair of B & K omni mikes. The signals were routed to Tom's new mixing console, which is equipped with all Class-A electronics. The dual output of the mixer was fed into the two channels of a Mitsubishi digital recorder.

You just have to hear this CD to believe the quality of the sound. Bass synthesizer frequencies, the impact and timbre of the assorted percussion instruments, and the piano are heard with an immediacy of presence, and the transient responses are the sharpest and cleanest I have ever heard. The use of Class-A preamps must contribute a great deal to these immaculate sonics. Literally, the clarity of all musical elements is quite breathtaking.

Tom is exploring other areas of recording with a view toward improving quality, but he believes the input console's electronics are vitally important. To this end, he has just taken delivery on a 26-input unit, with all Class-A electronics. He also has acquired some new ribbon microphones which he feels will mate well with the Class-A preamps.

Now if we can only get some of the classical recording people to get behind some of these fancy new consoles!


HEAR WHAT YOU'VE BEEN MISSING!
When you hear the fidelity and accuracy of the AKG K 240DF Studio Monitor Headphones, you'll know why it's become a standard for Digital Compact Disc recording engineers and professional musicians around the world.
The K 240DF establishes a uniform sound quality, free from environmental variables. It has been created to meet a recently proposed international standard. It's so smooth and flat IRT (Institute for Broadcast Technology) that AKG engineers use the K 240DF as a reference headphone in developing digital products for recording studios.
Each K 240DF is tested in a diffused sound field to arrive at a headphone design with a flat frequency response (± 2dB) and matched sensitivity. This professional headphone is close to perfection — without coloration or distortion — allowing you to enjoy all the advantages of the latest in CD technology. The self-adjusting headband supports circumaural ear cups. Each contains hand selected, large dynamic moving-coil transducers and acoustic filters yielding the ultimate in digital CD reproduction. Minimum weight is well distributed for maximum comfort over longtime wear.
The AKG K 240DF Studio Monitor Headphone is a total design concept, just right for you to hear what you've been missing!
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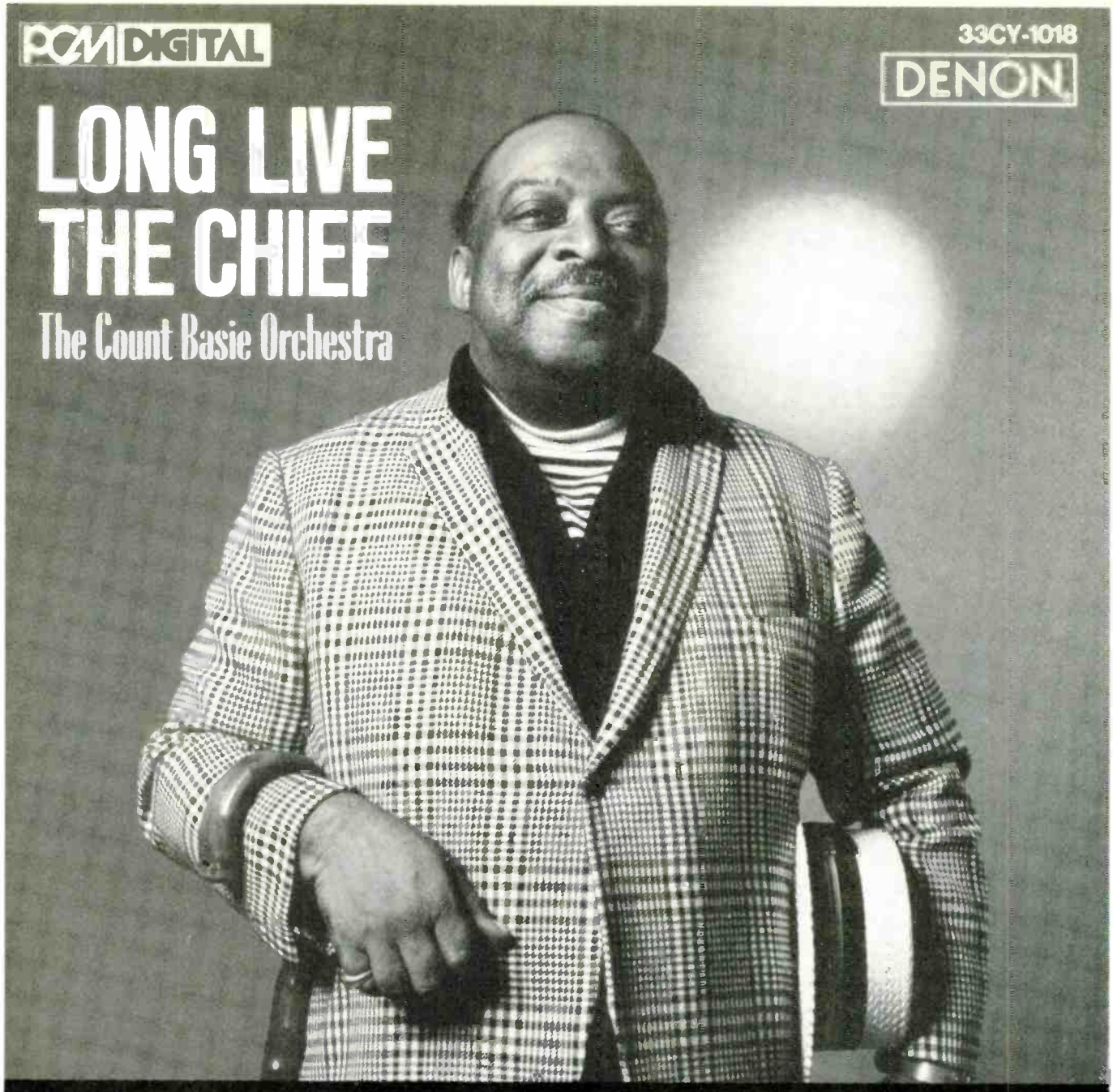
PCM DIGITAL

33CY-1018

DENON

LONG LIVE THE CHIEF

The Count Basie Orchestra



BASIE LIVES!

There is no doubt that the spirit of William "Count" Basie lives on in the countless Basie fans whose number keeps growing in legions. In fact, the Basie Orchestra just won *DownBeat's* 1986 International Critic's Poll. To celebrate the Count Basie Orchestra's 50th Anniversary and to honor the Count's birthdate (August 21st), Denon is releasing an historic compact disc, "Long Live the Chief!". Under the leadership of veteran Basie band member Frank Foster, "Long Live the Chief!" puts new life in many of the Basie Band's standards (April in Paris, Li'l Darlin', Corner Pocket, and Shiny Stockings), and injects the Basie spirit into some brand new material.

New to the Basie Band, but certainly not new to the recording industry, is 75 year old Denon (Nippon-Columbia). Denon brings its unparalleled digital audio recording and compact disc pressing expertise to the party to produce one of the most significant jazz recording events in recent years.

Join Denon and celebrate Basie's birthday and the 50th Anniversary of his band. All say, "Long Live the Chief!".

DENON

The First Name in Digital Recording

Nippon Columbia Ltd., Tokyo, 107 Japan

Denon America, Inc., 27 Law Drive, Fairfield, NJ 07006
Denon Canada, Inc., 17 Denison Street, Markham, Ont. L3R 1B5 Canada

Enter No. 19 on Reader Service Card

KEN POHLMANN

ROM-ANCING THE CLONE

Illustration: Bob Scott

As the name implies, *Audio* is a magazine about audio. Thus, theoretically, the articles should deal mainly with audio topics. But in the case of digital technology, the distinction between audio and data is increasingly blurred. This month, and next, let's consider the growing CD family. While you weren't looking, the music CD has been cloned into two new media, CD-ROM for computer information and CD-I for interactive, multi-media uses. Both carry that silvery surface a long way from Mozart or Manhattan Transfer.

Rather than storing music, the CD format can be treated as a read-only memory system for any kind of program material, and CD-ROM (Compact Disc Read-Only Memory) is the logical extension of digital audio CDs into that much broader application of general information storage. It is intended mainly as a medium for data distribution and mass storage for computer-related applications.

To clarify: The format with which you are familiar, CD-Audio, is a specific application of Compact Disc technology; it is a standard for recording PCM audio. The CD-ROM standard is derived from the CD-Audio standard, but defines a format for general data storage. Unlike CD-Audio, CD-ROM is not tied to any specific application. Both use optical discs, of the same diameter (12 cm, or 4.7 inches) but with different data formats.

Apart from modulation and error-correction overhead, a CD-ROM holds more than 650 megabytes (1 byte = 8 bits) of user information. This is a large storage area, equivalent to 1,500 half-megabyte floppy disks, 275,000 pages of alphanumerics, 18,000 pieces of computer graphics, or 3,600 still video pictures. A CD-ROM can efficiently store information such as computer application software, operating systems, data bases, published reference materials, directories, back issues of journals, encyclopedias, libraries of still pictures, parts catalogs, or other types of information not requiring frequent updating. For example, how about a catalog of every music recording ever made, and every record review ever written? Easy—it would occupy a disc or two.

The amount of data stored on a CD-ROM is, of course, equal to the amount of information stored on a CD-Audio disc. But a ROM makes you more aware of just how information-hungry a music recording is. If you were to download all the information from one fully loaded CD-ROM at a rate of 300 baud (transmitting it to a friend, for example, using a modem and a telephone line) for 24 hours a day, it would take 184 days to transmit the contents. (Hopefully, it wouldn't require a long-distance call!)

Think of CD-ROM as electronic paper (and a lot of it); anything publishable is a candidate for CD-ROM. However, a CD-ROM is much more efficient than paper. For example, the text of the *Grolier Academic Encyclopedia* is available on a CD-ROM, and it occupies only about 60 megabytes, or one-tenth of the disc's storage space. A comprehensive index, occupying another 60 megabytes, greatly facilitates data access. Enter a subject, and a listing of entries comes up on the screen. These entries are far more comprehensive than those in a conventional encyclopedia because the system's catalog can compare your request with the contents of the entire encyclopedia. A phrase like "freedom of speech" might have only a few citations in the index of a conventional encyclopedia, but in a CD-ROM system, every mention of that phrase in the entire encyclopedia would be displayed. Then you could scroll to any entry and read the full text. The words you searched for would be highlighted in the text.

Like an audio CD player, the CD-ROM player contains laser optics, a disc drive, and demodulation and error-correction circuits. However, instead of an audio output section, it has a computer interface. (Combination players, with both audio and computer outputs, could also be made.)

Although a CD-ROM disc looks exactly like a music CD, it identifies itself (through the Q subcode channel) as differing from an audio CD, and it employs a modified data format. Data in a music CD is derived from the 44.1-kHz sampled signal, with 16-bit quantization. The 16 bits are divided into higher and lower 8-bit bytes. These data bytes (before EFM modulation) are grouped into frames of 24 bytes, and parity bits and a synchronization word are added. While satisfactory for music applications, a 24-byte frame is inconveniently short for massive transfers of

You can think of CD-ROM as electronic paper, only it is much more efficient. Anything publishable is a candidate for the format.

computer data or programs. Furthermore, the audio CD makes no provision for locating any specific frame by its address.

The solution to both problems was to design the CD-ROM system around blocks of 98 frames. Addressing information is handled by treating the subcode information for each block as eight 98-bit subcode words instead of the 98 eight-bit words (bytes) used in the audio format. The effective data block becomes 2,352 bytes (24 bytes × 98 frames). This is sufficiently long to handle data in units of 2,048 (2K) bytes—convenient for computer use—without totally discarding the audio CD format.

Each CD-ROM disc is divided into 330,000 blocks, and each block is divided into four fields. The first 12 bytes from each 2,352-byte block are used as a synchronization word. The next four bytes form a header field used for time and address flags. Specifically, the header contains a mode byte (which shows which of two data formats is in use) and three address bytes. These three bytes store location as time: The first address byte holds minutes (0 to 74), the next address byte holds seconds (0 to 59), and the last holds the block number (0 to 75) within the second. For example, an address of 59-20-45 denotes the 45th block in the 20th second of the 59th minute on the disc. This repeats information already found in the Q subcode channel, but it makes searching faster and more accurate.

As I've said, the mode byte distinguishes between two CD-ROM data formats. (Audio and other CD formats are told apart by Q-channel subcode data, while CD-ROM is distinguished from CD-I by data in the disc's table of contents; however, these standards aren't final.) Only one of the mode byte's eight bits is needed for this; the rest may be used for future formats. The CD-ROM Mode 1 format provides for 2,048 bytes of each block—exactly 2 kilobytes—to be devoted to user data. The Mode 2 format allows for 2,336 bytes of user data. Fewer bytes are given to error detection and correction (EDC/ECC) in Mode 2 than in Mode 1, as shown in Fig. 1.

Because of extended error correction, Mode 1 will have the greatest application. The 2,048 bytes of user data is where the actual CD-ROM data resides. (Recapitulating, this is formed from part of the data area gathered

Fig. 1—Data formats for Mode 1 and Mode 2 CD-ROM. The area shown is equivalent to 98 CD audio frames or 1/75 S.

MODE 1

SYNC (12)	HEADER (4)			USER	DATA (2048)	AUXILIARY DATA (288)			
	BLOCK ADDRESS (3)		MODE			EDC (4)	SPACE (8)	ECC (276)	
	MIN (1)	SEC (1)	BLOCK (1)	(1)				P-PARITY (172)	Q-PARITY (104)

EDC = Error Detection Code, ECC = Error Correction Code

MODE 2

SYNC (12)	HEADER (4)			USER DATA (2336)
	BLOCK ADDRESS (3)		MODE	
	MIN (1)	SEC (1)	BLOCK (1)	(1)

SCRAMBLED AREA

2,352 Bytes/1 CD Block

C&C Computers and Communications

Building a breakthrough color TV takes brains: the computer brains of IC chips. Unlike the analog workings of conventional TVs, these new chips from NEC store, process, and control the picture in digital form. So TV performance can be raised to a higher level. The level of NEC Digital Television.

Take a look at our 26" square picture. You'll see richer color, more contrast, more resolution, and more picture than ever before.* With a VCR connected, NEC's digital Picture-in-Picture lets you watch two shows at the same time on the same screen. And our three-way digital freeze lets you stop even the fastest running back in his tracks.

It shouldn't surprise anyone that the company behind this surprising new TV is NEC. We're at the forefront of computers, monitors, and broadcast video. And that takes real brains.

NEC

We bring high technology home.

NEC Home Electronics (U.S.A.), Inc. 1255 Michael Drive, Wood Dale, IL 60191

"Prizzi's Honor" available exclusively from Vestron Video
*Model DT-2680A with 26" screen, measured diagonally. 500 lines horizontal resolution, via video inputs. TV reception simulated.

A whole year of human experience could be put on a single disc—illustrating the storage potential of the CD or the shallowness of human existence.

from 98 frames of data formerly used for music data.) The remaining 288 bytes, called auxiliary system data, provide for a higher degree of error detection and correction; this is a prerequisite for successful numerical data storage, which is more demanding than audio data. This system data forms an extended error-correction code (EDC and Layered ECC) existing independently of, and in addition to, the cross-interleave Reed-Solomon error-correction code already watching over each CD frame; thus, the error rate is improved over that of an audio CD. Typical CD-ROM bit-error rates will be between 10^{-16} and 10^{-17}, or one uncorrectable bit in every 10^{16} to 10^{17} bits. The extended code may be processed either by hardware circuitry contained in the CD-ROM player or by a host computer.

CD-ROM production begins with a master data tape(s), recorded in computer magnetic-tape format. The data is entered into a pre-mastering minicomputer, where the data is placed into the CD-ROM format. (Header, error correction, subcode, etc. are generated.) Following pre-mastering, actual disc production is identical to that of audio CDs, albeit with greater quality control to ensure accuracy of data, because computer data is less forgiving of errors than music.

While CD-ROM uses a data format similar to that of music CDs, the discs are not compatible. A CD-ROM drive dispenses with D/A conversion, output filtering, and audio output stages, but requires a special interface and a computer for output. A CD-ROM drive alone costs less than an audio CD player; the consolidation of both functions into one player is ideally cost-effective. A combination disc holding both music and ROM material could then be implemented.

Player design, even for a combination system, is straightforward. An intelligent interface and system controller is included in the drive, ready for connection to the host computer. Data is transferred to the host computer in blocks of 2 kilobytes. Using the header field, the sector address (in minutes, seconds, and blocks) is verified by the host computer. The disc table of contents can be transferred to the host computer. After receiving an "audio" command from the host, the player can output audio data, accessed by the subcodes in the disc. The disc rotates only when a drive-select "ready" command is given; otherwise the disc is stationary to save power and motor wear. Multiple drives can be controlled by one host computer's interface, thus leaving open possibilities for further expansion.

The average data-transfer rate is 75 sectors per second, and therefore 153.6 kilobytes per second for the constant linear velocity (CLV) of 1.2 meters per second (same as the CD). Proprietary CD-ROM systems can achieve faster rates with special components. Access time for any point on a disc is less than 1 second.

A CD-ROM drive is a rather elegant data storage/retrieval system. Its possible applications are numerous. Extensive amounts of information can be conveniently stored on a few discs; for example, a CD-ROM telephone book for the entire U.S. would be feasible. Assuming 100 million listed telephones, and 40 bytes of information associated with each one, the total of 4 gigabytes could be stored on about five discs—a stack about ¼ inch high.

The CD-ROM will form the basis for a new electronic publishing medium applicable to books, dictionaries, technical manuals, business catalogs, computer storage, expert systems, artificial intelligence, and so on. It represents an entirely new technology of information dissemination.

Finally, an interesting analogy. Just how much information can be stored on a CD? It has been estimated that the capacity of a single disc is some 1 or 2% of that of the human brain. The equivalent of a year of human experience could be stored on a single disc, available for instant recall. This remarkably illustrates the storage potential of the CD—or the shallowness of this view of human existence, depending on your point of view.

Well, what the heck, you're saying. Artificial intelligence? The shallowness of human existence? Does CD-ROM have anything to do with *audio*? It sure does. One forthcoming CD-ROM product, CD-I, will do absolutely everything the audio CD does, and much, much more. I'll begin with that story in my next installment. A

If You Think This Face Is Beautiful, Wait 'Til You Hear It Sing.

Pioneer's KEX-900 car stereo component. The ultimate combination of beauty and grace, this gorgeous model reveals five different faces—one for each and every operating mode.

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The KEX-900.

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A Grace Note

Dear Editor:

Such uncanny timing! First comes Ted Fox's wonderful article on zydeco music (see September 1986), helping convince me that *Audio* tops the list in reading for music *and* hi-fi between the same covers. Then, a mere two weeks later, Paul Simon's *Graceland* sails into the local shops on LP, CD and cassette (*at the same time*—bravo, Warner Bros.!), wearing its Louisiana-to-Africa influences proudly on its record sleeve. (I bought the CD.) I'm sure Mr. Tearson or the Tivens will get to it in due time; for now I'll just say it's all terrific music, first note to last, and that, as you know, ain't too common.

The musical influences Simon is helping introduce to the mainstream (if one can still regard Paul as such) can do nothing but good. I don't know about zydeco taking off like crazy, even in New York, but stranger things *have* happened.

Barrett W. Benton
New York, N.Y.

Some Words About Words

Dear Editor:

Regarding Jon R. Sank's comments on "simplex power" and "phantom power" in his profile of the Shure SM91 microphone (see *Audio,* June 1986), I agree entirely that one term should not have more than one meaning. But in this particular case I have to condemn the electronics industry for accepting second meanings for related terms.

In this case, the terms were in use by the telephone and telegraph industry since the 1800s. "Simplex" is the superpositioning of a d.c. signal over an a.c. signal—that is, a telegraph channel over a voice channel. A one-way channel, that is; a dual channel was called "duplex." The terms are still accepted today; other terms are also in use, such as "half-duplex." These terms are also used in radio communication and have a very similar significance.

The terms "phantom" and "ghost" were also coined by the telephone industry in the late 1800s. The first term defines an artificial voice circuit derived from two physical circuits; a further artificial circuit derived (with great difficulty) from two "phantoms" was called a "ghost." Once more the electronics industry stole a term from others and then was surprised at the ensuing confusion.

The proper term for the SM91 circuit in question is without doubt "simplex." Shure stands vindicated and should be congratulated for their attempt to straighten things out, or at least to bring forth the subject.

For many years I have been shocked at the laxity of the industry in its coining and accepting of terms without proper research and/or application of the correct rules of word creating. For example, quadraphony and its variations should be tetraphony. There is also the odd juxtapositioning of stereophonic vs. monoral, or is it monaural? Maybe it should be monophonic. I wish the editors of the most professional magazine of the trade would stand guard on the proper use and spelling of English.

I will continue to enjoy reading your magazine as I have for many decades.

F. A. Leclaire
Montreal, Que.

Author's Reply: My reference was a book published by RCA Global Communications in 1976, *Communications Terminology Guide*. On page 1-14 "simplex" is defined as: "Method of operation of a communications circuit where signals can be transmitted in one direction at a given time. A radio circuit must always be simplex when only a single carrier frequency is used." This is why I rejected the term as a substitute for "phantom," which has been used for a long time by other manufacturers of condenser mikes.

Some new information has come to light from Shure Brothers. I received a letter from Shure's president, Mr. James Kogen, which enclosed a note from Elaine Shinbrot, who wrote the SM91 data sheet. She relates that the original reason for using simplex, "besides the debate on which was proper, was that Gotham Audio, I believe, claimed to have a copyright on the term 'phantom.'" Since Shure is now using the term phantom with simplex in parentheses, the industry seems to be all together on terms, albeit with a somewhat incorrect usage, according to Mr. Leclaire.

I thank him for setting things straight, and making all of us in today's electronics industry look a little foolish for having mixed up the terms stolen from telephony. I would like to add that Harry Olson did use the term monophonic in some publications circa 1960, but apparently it did not catch on. He defined stereo/monophonic as including field reproduction by speakers, whereas binaural/monaural systems employed headphones.—*Jon R. Sank*

Editor's Note: It's fairly well established among language handlers that usage and meaning do change over the years, even if we don't want them to and even if we're using a well-defined technical term. In the present case, it appears to me that Mr. Leclaire is citing a technology which hasn't been practiced for some time. If language is mimesis, as Aristotle taught, then words describing dead technologies should die too. Clearly false. And what is to be made of the changes in, say, the Greek language over the years? It's thought that ancient Greeks would not be able to understand the current tongue. Too, there's the problem of authorities with opposing definitions, not to mention spellings. While I am not yet ready to turn in my blue pencils and resign my editor's post, I am often amazed that any meaning gets across at all.—*E.P.*

Call from Overseas

Dear Editor:

Do you know where I might be able to get replacement parts for a Triplett sound level meter, M-370? The manufacturer apparently has moved or is no longer in business. To complicate matters, the IC which is defective (the only one, fortunately) does not have a clear number stamped on top. Thus, I would have to contact someone who is an agent or specializes in repair of Triplett instruments in order even to identify the part needing replacement.

Being stationed in Manila, where nothing is obtainable (and what *is* obtainable does not work much of the time), your assistance is especially appreciated.

Douglas K. Ramsey
American Embassy
APO, San Francisco, Cal. 96528

Editor's Note: If anyone can help Mr. Ramsey, we hope you'll let him know.—*E.M.*

ADCOM® GFP-555 PREAMPLIFIER

A remarkable combination of exceptional performance, flexibility and value.

The traditional audiophile has typically had the choice of two opposing designs in preamplifiers. One offered flexibility, with the (assumed) sacrifice in musical accuracy. The other took the purist route, with no features beyond a volume control and on/off switch.

The Adcom GFP-555 preamplifier was designed to face this dilemma head-on, and resolves it in ways that will satisfy the most diehard of purists.

Outstanding performance–affordable price.

The GFP-555's musical performance is outstanding–by any measurement or listening criterion–and at the same time it offers a full array of meaningful controls and features.

What's more, the GFP-555 does it all at a surprisingly affordable price. Surprising, that is, only to those who aren't yet familiar with the Adcom approach to design and performance. Musical performance, in particular.

Getting down to basics: Sound quality is paramount.

Gain path–simple and direct.

The GFP-555's gain path is simple and direct from input to output. The use of a minimum number of components–each of the highest quality–means low waveform distortion and less phase shift.

The gain stages employ the most innovative state-of-the-art linear amplifiers ever used in high fidelity components. These individually selected instrument-grade devices are in a class by themselves.

THE ADCOM

The speed of the gain stages is extraordinarily high—almost fifty times faster than the speed of CD or LP signals. And along with this speed, there's the lowest noise and lowest offset voltage currently available.

The almost nonexistent offset voltage eliminates the need for blocking capacitors used by others, and allows the GFP-555 to be direct coupled for exceedingly wide frequency response—from DC to beyond 400,000 Hz.

Noise is exceptionally low throughout all inputs, with a typical noise floor of four billionths of a volt-per-square-root-hertz—more than 115 dB below a 10mV input at 1kHz!

The power transformer and associated power supply components are of very sophisticated design. Dispersion of radiated noise and hum fields is eliminated by the use of layers of mu-metal shielding on the power transformer. In addition, the use of large filter capacitors permits excellent regulation of power supply, providing consistently high performance regardless of fluctuations in signal or AC line voltage.

Those concerned about preamps with tone-control circuitry should be aware that although the GPF-555 has it, the "normal" position keeps this circuitry out of the signal path as thoroughly as if it weren't there at all. When wanted, it can be switched in.

The high- and low-cut filters are passive. Their gentle slope has very low phase shift, and prevents ringing and significant changes in sound quality.

The output impedance is 470 ohms, low enough to avoid high-frequency loss when long lengths of cable are used between the preamplifier and power amplifier.

CD and phono input jacks, and all output jacks, are gold plated for minimum signal loss.

And speaking of flexibility.

There are times you may want to listen to one input (phono, tuner, CD, tape, etc.) while taping from another. That's precisely what you can do with this preamplifier.

The headphone jack has its own amplifier, both to prevent loading of the preamp output circuit and to provide sufficient gain to drive virtually any headphone.

Two sets of output jacks are provided: one pair for amplifiers, such as Adcom's, which are direct-coupled; the other pair for amplifiers which require coupling capacitors.

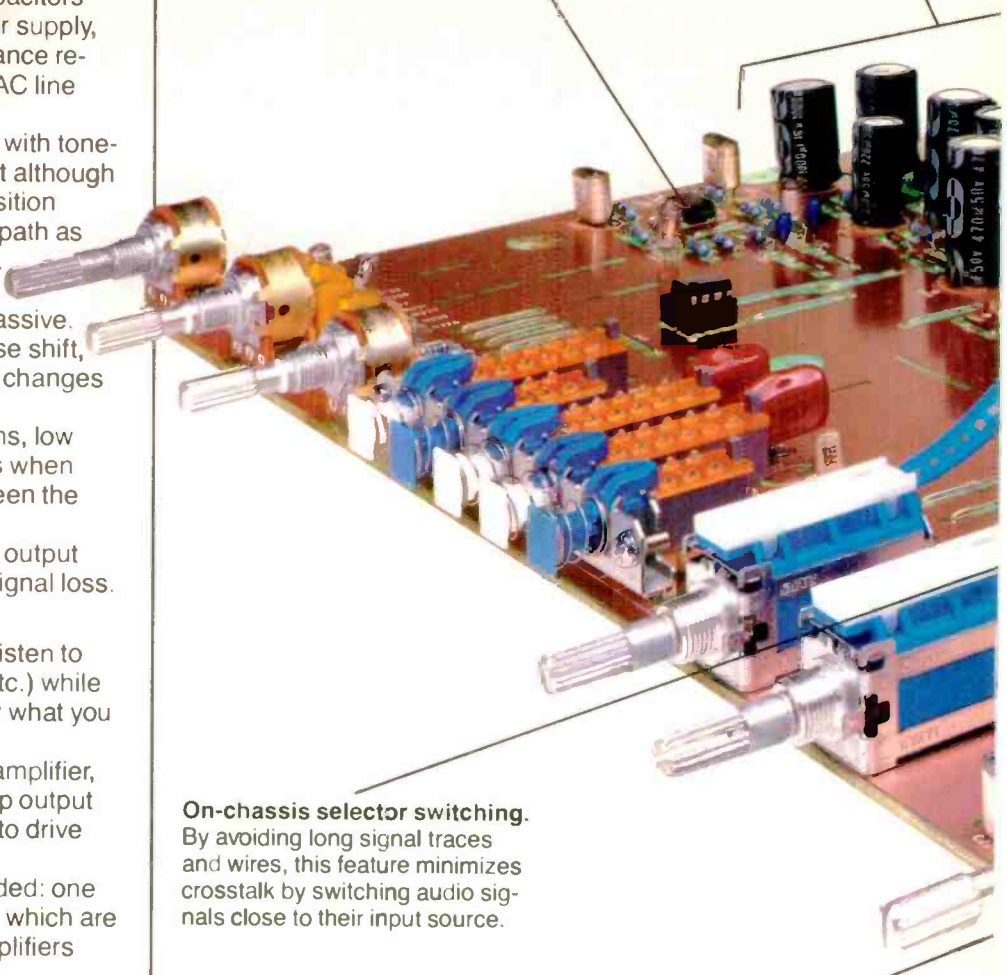
For optimized performance of any magnetic phono cartridge, adjustable capacitance loading is provided.

There's an unusual number of inputs: five for high level inputs (tuner, CD, tape 1, tape 2, video/AUX); and one phono input that can be switched for low- or high-output moving-coil and moving-magnet cartridges.

Contour circuits for enhancing bass response at low listening levels have been around for some time, of course. Ours are considerably

Headphone amplifier.
A separate high quality audio amplifier section is provided for use with headphones.

Tightly-regulated power supply.
Maintains outstanding performance and consistency, regardless of fluctuations in signal level or AC line voltage.



On-chassis selector switching.
By avoiding long signal traces and wires, this feature minimizes crosstalk by switching audio signals close to their input source.

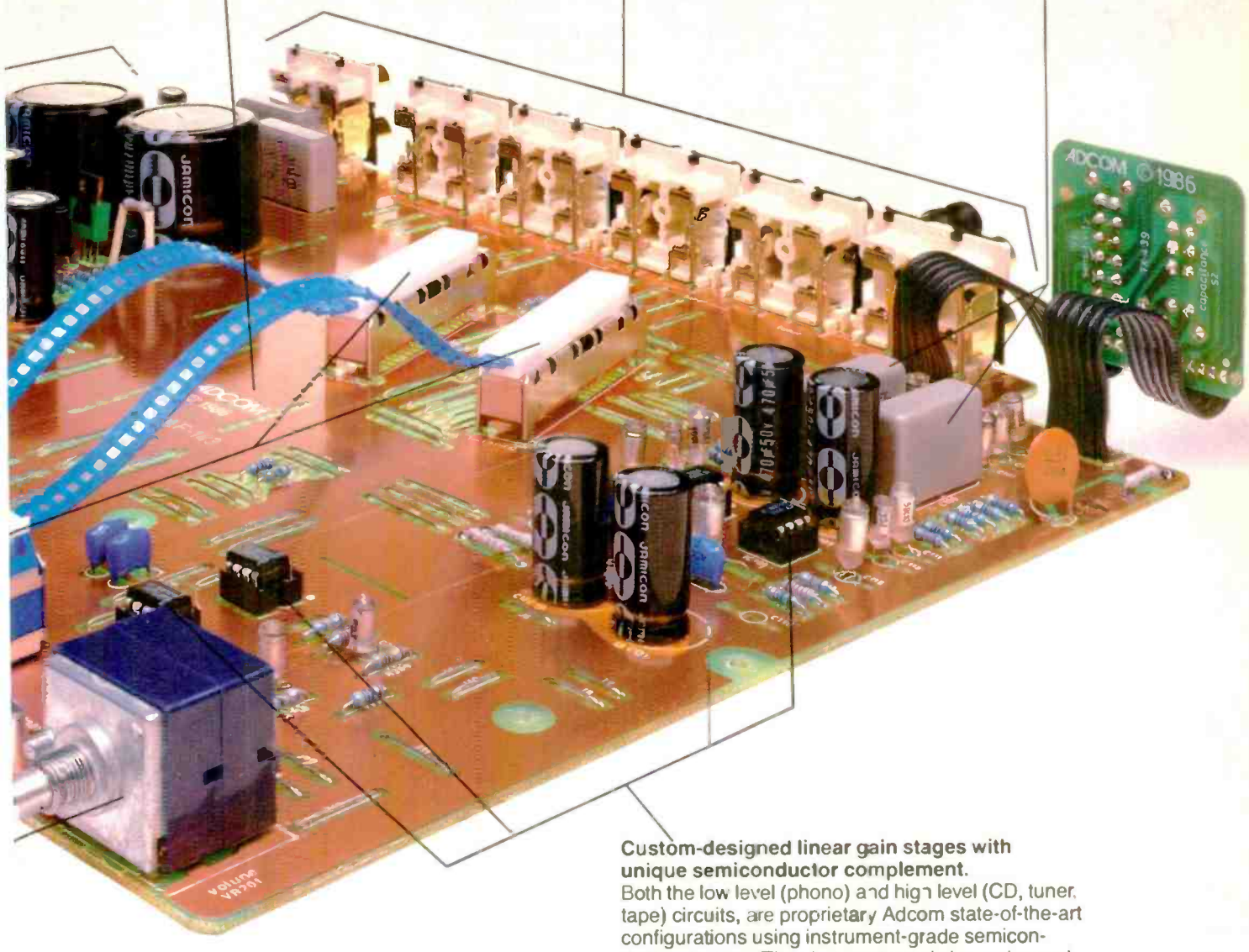
Volume control.
This high quality precision potentiometer maintains ideal balance between channels throughout its rotation.

GFP-555 PREAMPLIFIER

Glass epoxy circuit board, copper plated on both sides.
This allows one side of the circuit board to be used as a shielding/ground plane, thus preventing hum and RF interference from reaching the signal paths.

Direct on-chassis input/output jacks.
This design technique eliminates point-to-point wiring. Induced hum, noise and unreliability in the signal path are no longer of concern.

Bypass capacitors.
Where electrolytic capacitors are necessary in the signal path, all are shunted by high quality polystyrene, silver mica, or polypropylene capacitors. The result is audibly superior decoupling/isolating performance at mid and high frequencies, achieved by the lower inductance and ESR of these devices.



Custom-designed linear gain stages with unique semiconductor complement.
Both the low level (phono) and high level (CD, tuner, tape) circuits, are proprietary Adcom state-of-the-art configurations using instrument-grade semiconductor devices. They have extremely low noise and distortion, and their speed of operation is many times faster than the frequency components found in musical signals.

more sophisticated, more useful and more musically accurate over a wider range of listening conditions than any you are likely to have encountered.

Considering the opportunities offered by the new breed of signal processors, you'll welcome the separate processor loop that leaves both tape loops available for use.

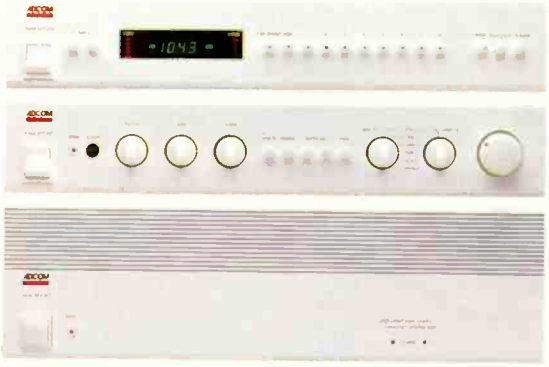
Final word.

What all this adds up to with respect to music is very simple. There is less phase shift between channels, dead quiet background (essential for CDs), total transparency and clarity of detail. The music truly comes alive, with no sense of "electronic presence" in the reproductive chain.

Of course, we hope that this information reaches you at a time when you're interested in a new preamplifier, or should be—whether your first or an upgrade—and that what interests you above all is a demonstrably superior combination of sonic performance, flexibility and value.

SPECIFICATIONS.

Total harmonic distortion: 0.005%
IM distortion: 0.005%
Signal-to-noise ratio:
Phono (re 0.5 V output): >85 dB
Tuner, CD, tape (re 2 V output): >100 dB
Tone controls:
Bass (40 Hz) ±9.5 dB
Treble (15 kHz) ±9.5 dB
Contour (switchable): +6 dB at 50 Hz
Frequency response: 1 Hz – 100 kHz ±0.1 dB
High filter (switchable): –2.5 dB at 20 kHz (6 dB/octave)
Low filter (switchable): –5 dB at 20 Hz (6 dB/octave)
Input sensitivity for 0.5V output:
Phono High MC/MM: 0.4 mV
Phono Low MC: 0.13 mV
High: 40 mV
Maximum output level: 10 volts
Input impedance:
High MC/MM: 47 kohms
Low MC: 100 ohms
Output impedance: 470 ohms
Phono overload at 1 kHz High MC/MM: 140 mV
Phono input capacitance: Adjustable; 100 pF, 175 pF, 275 pF
Line voltage: 120V/60 Hz (Available in 230V/50 Hz on special order)
Dimensions: 17" × 3¼" × 12¾" D (432mm × 83mm × 324mm D)
Weight: 14 lbs. (6.4 kg)
Optional accessory: Model RM-3, rack mount adapters.



Adcom products are available with white or silver front panels on special order. Shown: GFP-555 preamplifier, GFT-555 AM/FM-stereo tuner and GFA-545 power amplifier with white front panels.

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EDWARD TATNALL CANBY

TIME AFTER AIR TIME

Photograph: David Hamsley

Most of us have had certain points in our lives that, as we gaze backwards in our mental rear-view mirror, look more and more like right-angle corners in the broad highway of life. My audio right angle was just like that, in 1946—though at the time all I could see was a blank wall, or maybe a highway dead end. A promising new career in FM radio had dropped out from under me, thanks to the closing of the station where I worked. I would *not* go back to teaching music, thanks! Not to students who didn't like music, anyhow. So I floated, high and dry, and looked at my dead end. It was not a pleasant sight.

But the corner was there. Within months I was writing record reviews for a magazine. And long before the next year was out, 1947, I snagged another opportunity, precisely at the first blossoming of the high-fidelity movement. It was writing for this mag.

When I finally got back on the FM air, much later, it was in the time of a false peace, when the same programs were widely carried by both AM and FM outlets, twins but for the circuitry—negating all that we had done in the way of developing FM's special qualities. Every network, every big AM station, had its FM transmitter on the side, but the FM "program department" was usually no more than a connecting cable in the station's control room. This was cheap and easy and kept the station's fingers in the pot, just in case. It also stifled all trace of initiative among those who valued FM for itself, as a hi-fi medium with great new possibilities for the home listener.

Few AM programs were then technically suitable for FM quality, not only due to those famous telephone lines that tied the networks together but also because of casual standards within the AM stations themselves. I'm sure a lot of engineers, AM as well as FM, would have enjoyed reaching for new quality levels, as they always do. But the way I get it, the general feeling was all too familiar: Why buck the system, why bother? What you gain here you'll lose there. Very understandable, as it always is. It is never easy to reform a system that in its time has been hugely successful—and that was AM radio before FM and before TV.

Meanwhile, to carry on this digression, AM radio itself was rapidly losing ground in favor of television. Soon it was almost as stranded as FM, and just as confused as to where to go next. For a while it seemed to many of us that radio—*all* radio—would simply disappear, in favor of the picture on the tube. There was nowhere to turn—yet. Radio, both types, also faced that blank wall, that seeming dead end. As we know both kinds survived, in spite of television. But it was an incredibly close call. I still wonder at it. Can you imagine—no radio, *no radio at all?*

What saved radio, both the good and the bad, were new things, new concepts, that in 1946 were scarcely imaginable. Hence the blank wall, hence what seemed like the end of the road. But all this is another story, a story in which, happily, what we now call audio at last combines forces with radio for very much of a joint relationship. *We*, in early hi-fi, had good sound. FM also had it. Soon a third medium, the disc record, would join in. TV couldn't care less—for how many years? Decades.

It was a sharp corner, indeed, for the entire area of reproduced sound, that year. Television, being new, didn't have to make any turns. But the rest of us barely made it, including myself, with a safety margin of practically zero. By 1950 we were all there, safely, more or less, and then came the Eisenhower Prosperity. That gave us wings, and we took off . . . .

After my FM station shut down, around the springtime of 1946, as I remember, I managed to put out one final broadcast on the old FM band. It was on a very different station, and to tell the truth I am only deducing that it was "old band," simply because of the date—but I am reasonably certain of it. Mercifully, I can't remember the station's call letters, but I can *see* the place in my mind, all too easily. In any case, it was still on the FM air, independently, for a while after my own outfit quit.

During my station's brilliant (nonprofit) expansion during 1945 and 1946, when I had taken on full-time duties of numerous sorts, I had suggested we establish a "house organ" chorus under my direction—since I had experience in that field—which would be all-radio, like the NBC or CBS Symphonies of the time over at the big networks. It would be on a miniature scale, of course, but would have one feature the networks didn't exploit: FM

For a while it seemed to us that all radio would simply disappear, in favor of the picture on the tube. It was a close call.

hi-fi sound. It asked if we could rehearse the (unpaid) singers right there in our upstairs studio where we would put on a broadcast every so often, myself conducting the music and also commenting on it from a written script directly into our hi-fi mikes. The station had to keep open; we would cost nothing extra, rehearsing in the big studio while records were broadcast or the news, from our smaller studio. The idea was taken up right away—we had an intelligent management, as I have said before. They were open to any practical new thought in that interim period of nonprofit broadcasting, which had at least a fighting chance of keeping things going in the FM future when money would begin to count. We had an audience, and we wanted to build that audience just as far as we could, with so few FM sets out in the field to hear us, so that later on we could expand it on a solid basis as new postwar receiving equipment appeared on the market. Practical? I'd call it shrewd and sensible. My chorus would do the station no harm, cost nothing, and enhance its reputation for enterprising programming. Was that bad for future commercialization?

Remember, this would be live FM broadcast *and* received with a sonic quality that was unheard of at that time. It would be a startling experience (I hoped, in all my youthful enthusiasm) for our listeners.

So we began rehearsals, one evening a week, in that same penthouse studio with the big piano and the fireplace about which I have written before. True, it was a very poor place to sing in, being essentially dead. If Mr. John K. Mitchell (who wrote in this space in July '86) had been around to fix us up with some of those 15-kHz lines, out to a nice, fat church in the vicinity, we could have put on a humdinger of a chorus program, acoustically speaking. But I expect I was a bit vague at that point as to what a 15-kHz line might be, and so we sang in that dead studio, and in due course put on several evening broadcasts, complete with my commentary, just as planned. Musically, I am glad I do not have recordings of those performances—I have done a lot better in the 40 years since. But we did it, and would have gotten better—but suddenly the station wasn't there. And I had an orphan chorus of 25 on my hands with no place to go.

It had to be FM, of course. So I went to this other station. How naive I was. And little did I know. This outfit was somehow into facsimile, the broadcasting by radio signal of whole documents, received and printed out at some other location. It was a modern miracle and surely did have possibilities. Somebody had put a lot of money into a state-of-the-art FM outlet complete with ultra-mod studio as well as facilities for facsimile broadcast. I can only guess that, like the station I'd worked for, they wanted to keep their spot on the broadcast band and had to produce a viable signal on a regular schedule while the facsimile biz got organized. So I waltzed confidently over to this outfit and suggested they take on my FM Radio Chorus. We would give them broadcast concerts as we had at the other station, now departed. After all, they had to fill up time *somehow*; we'd be glad to help.

Well, I have never since run into quite such hard-boiled disbelief as those facsimile guys showed. I don't think they gave a hoot for an audience, as we did. They were on the air (I assume) simply to be on the air and hold their place. As for cultivating a classical chorus, what kind of dandy idea was *that*? Don't you understand we're in *business*? (Well they would be, with luck.) But oddly enough, they took us on, if with no visible enthusiasm. We were clearly a patch of loony notes, but we would fill up some air time for them while they waited things out. This was in late 1946.

There was one error or misunderstanding in their experience: any "talent" that went on the air walked in, did its stuff, and got out. You should have seen those faces when I casually remarked that of course we would want to rehearse in the studio once a week for X months before we could put on a show for them. They simply did not believe me—that isn't what you do in radio, you must be crazy. They didn't say it, they just looked it. But times were bad right then, and they needed some free talent. So they let us in, anyhow. Gingerly.

So we rehearsed, in that anechoic soundproofed studio with the stony

To hear why Genesis records on Sony digital equipment, play them back on a Sony Compact Disc Player.

When it comes to capturing the experience of live music, no audio equipment delivers the lifelike reproduction of digital audio.

That's why the only digital recording equipment chosen by Tony Banks, Phil Collins and Mike Rutherford of Genesis is, not surprisingly, the leader in the industry: Sony.

Not only has Sony led the way in professional digital recording equipment, we invented the digital audio system for playback—the compact disc player. Sony also introduced the first home, car and portable CD players. And Sony sells more types of compact disc players than anyone else in the world.

But whichever Sony Compact Disc Player you choose, each allows you to hear the music the way the artist originally intended.

So why not do what Genesis does? Play back the top-selling compact discs like "Invisible Touch" the way they were mastered. On Sony Digital equipment. You'll find that when it comes to bringing you close to the music, nothing even comes close.

The Sony CDP-55. Sony's best value in a full-featured compact disc player.

From its Unilinear Converter and digital filter to its programming flexibility and supplied Remote Commander® unit, the Sony CDP-55 has everything you need in a home CD player.

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We wanted to build our audience, with so few FM sets out in the field, so that later we could expand it on a solid basis as postwar receivers appeared.

faces always in the background. And eventually we gave our broadcast concert, with the same stony faces in attendance at the controls. We then departed. Forever. That was the end of Old-Band FM for me.

I don't think anybody heard that concert; I doubt if the station *had* any audience, though I might be wrong in my recollection. I remain mystified as to why they had a fancy studio, since they made it so clear that facsimile was their business for the future. All in all, this was a ghoulish way to end five years of sheer FM euphoria on my part! The FM Radio Chorus, of course, dissolved. We were not about to rehearse on a street corner for our broadcasts.

I did not get to another chorus for eight years, until 1954, and that one was strictly for live performance, with an occasional (hi-fi) recording on tape. This group still exists, after 32 years, which sort of makes up for 1946.

Looking back, now, I really question who was the more practical and hard-boiled, the station I worked for or the businesslike facsimile outlet. In death all men are equal, and so are radio stations. But which of these had the more accurate approach to the future of radio?

While the other station worked, apparently, to stay on the air, we had worked our hardest at acquiring a base audience, and for that audience we produced as much in the way of new ideas as we could possibly turn out while we waited for the war to end and business to return. We *got* an audience—an almost fanatical loyalty, and bushels of mail from those few listeners who had come to own FM receivers before the clamp-down of war. I could not believe the wonderful letters I personally received, week after week, from these people, who knew they were in on something new and different that others were missing.

Moreover, even though we died as a station along with our place on the FM band, we had already foreshadowed a great deal of what is now public-radio FM on a much larger scale. And I think we also pointed the way toward the few genuinely commercial "classical" FM outlets that have found the means to stay permanently alive and well. So who was most practical? We were.

A NEW PERSPECTIVE

Stereo is more than just a suggestion of left and right. Ideally, it is the sonic image of an environment, recreating the time and space of a live performance. It's left, right, center and all points in between. It's up, down, near and far.

It's what we call a soundstage. This third dimension (an audible depiction of a recording's spatial cues) is the designer's ultimate goal. At Infinity, it has obsessed us throughout our 18 years of designing and building loudspeakers. Above all, it is a goal which we have approached systematically, through unremitting attention to drivers, cabinets and crossovers.

Traditional driver materials and designs proved inadequate for the accurate rendering of a soundstage. So we developed new materials–like polypropylene compounds and polyimide/aluminum films–and used them in drivers with specially contoured cones, domes and planar diaphragms, whose unique structural properties achieve wider bandwidth, quicker transient response and lower distortion than conventional designs.

Since drivers alone don't recreate an image, we have curved the enclosure's front vertical edges so you hear sound radiated directly from the drivers, not reflections generated by the cabinet. And our elegant, linear-phase crossovers insure seamless transitions from driver to driver.

But we had one more goal in our audible conquest of space: value. Realizing a proper soundstage in our $45,000 Infinity Reference Standard is one thing, but achieving much of that performance in an affordable bookshelf speaker is another. So we invite you to explore our new RS Series–five models, priced from under $150 per pair, that affordably allow you to achieve a new perspective...

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TAPE GUIDE

HERMAN BURSTEIN

Copying Phono Discs

Q. I own a rather extensive collection of 78-rpm and LP records and want to transfer many of them onto cassette tapes. In past years I have read several articles on how to clean up these old jewels, but alas, I did not save them. I own high-quality audio equipment with which to make the transfers, but I am at a loss as to how to proceed. I will appreciate your suggestions.—Clifton T. Chadwick, Wheat Ridge, Colo.

A. One of the articles to which you refer is probably that by Peter Milton, "Get the Most Sound from 78s," in the June 1982 issue of *Audio*.

A great deal of help can be obtained with the aid of an equalizer and/or tone controls between the phono playback system and the cassette deck input; this is particularly the case for 78s. Unfortunately, most preamps and integrated amps and receivers place the tone controls after the tape deck's output, so they are not of help. Hence you probably have to rely on an equalizer, which can be very useful in achieving an optimum balance between extended treble response and minimum noise. A dynamic noise-reduction unit could be beneficial; perhaps it could be advantageously used with the equalizer. In setting such equipment, you must have confidence in your own ears rather than in settings arrived at by some formula.

Rise and Fall of EE Tape

Q. I thought that metal and Type II tapes were to be available for open-reel decks. What happened? Also, I am confused as to the difference between these and conventional open-reel tapes.—Donald Bisbee, Columbus, Ohio

A. Still available from a few manufacturers, Extra-Efficiency or EE open-reel tape is made with particles similar to or the same as those used in Type II cassettes. The tape deck, for its part, must supply a higher bias and different treble equalization to get the most from this hotter tape. These electromagnetic changes are much like those required in a cassette deck in the switch from Type I to Type II tapes.

It turned out, apparently, that at speeds over 1⅞ ips, EE tape didn't present quite so obvious an audible advantage over ferric oxide as it had at the standard cassette speed of 1⅞ ips. And then there was the problem of compatibility between the older non-EE decks and these new tapes, as well as the increasingly excellent performance found in the current cassette decks. For these and possibly for other reasons, the move toward EE tape has apparently come nearly to a halt.

More on Print-Through

Q. Does metal tape offer more protection against print-through than do the other types of tape?—Robert R. Maigatter, Kewaunee, Wisc.

A. I do not know from experience, but on theoretical grounds, I would expect metal tape to be less subject to print-through because of its much higher coercivity, which makes it more difficult to magnetize. (Print-through results from one layer of tape on the reel magnetizing the adjacent layer.)

If you are in the mood to experiment, you could investigate on your own, comparing metal tape with another type. Most of the print-through develops within the first two or three days after recording, so you don't have to wait very long for results.

Record Transfers to Tape

Q. I am in the process of transferring old 78-rpm records to tape. My collection includes old acoustics and post-1925 electricals, including a number of foreign make. My aim is to reproduce these records as they were intended to be heard. I have improved their sound with an inexpensive, no-frills equalizer, but in setting this device I need information about the old equalization curves. I also need accurate information on the current phono standard, the RIAA curve.—George Wheeler, Sea Cliff, N.Y.

A. Old 78-rpm records were recorded with a very substantial variety of equalization characteristics, depending on label and age, and I'm not in a position to provide such a listing in this column. All that can be said here is that some of these old records require more bass boost and some less; the same is true for treble cut (some were even recorded flat in the treble range). The best course is to use what sounds best to you, taking into account not only frequency response but also noise. In other words, at times you may want to accept poorer treble response in exchange for reduced noise. Of course, this will require individual experimentation with each record, using your equalizer.

The RIAA playback curve calls for bass boost commencing (up 3 dB) at 500 Hz and levelling off (3 dB below maximum) at 50 Hz; total boost is 20 dB. It calls for treble cut beginning (3 dB down) at 2,122 Hz and continuing thereafter at a rate approaching 6 dB per octave; thus, for example, response is 13.7 dB down at 10 kHz relative to 1 kHz.

Onkyo has a preamp, the P-3030, with a single "78" equalization setting which may or may not match your 78s precisely, but which should come closer than the standard RIAA. Another device, the Esoteric Sound Re-Equalizer (reviewed in *Audio*, November 1985), can be used to obtain a more precise equalization match to nearly any 78-rpm disc.

What's a "Live Source"?

Q. I have read recommendations about which types of cassette tape to use when recording a "live source." Does this refer to recording a live source directly, or does it mean recording a live source broadcast over an FM station?—Name withheld

A. Recording a live source signifies that one is making a recording at the performance site itself—that there is nothing between the tape deck and the source except a microphone (and perhaps a mixer).

For live recording on cassette, it is desirable to use metal tape to encompass the entire dynamic range, which can be as much as 70 dB or so. This will tend to minimize distortion and loss of high frequencies. But when FM stations broadcast "live," they use compression to reduce the dynamic range to about 60 dB or less. In that case, one can usually get good results by using a high-quality tape other than metal, such as ferric oxide, chrome, ferricobalt, or ferrichrome.

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.

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If your car deck simply stops when ignition is turned off, the rubber roller and drive wheels may develop flat spots, causing wow and flutter.

How Best to Dub

Q. I want to copy a cassette recording of songs I have written. I want the quality to be very good but the cost within reason. My choices are: A real-time dub from my deck to a friend's deck; a high-speed dub on a $5,000 professional machine, which will cost $2; a real-time dub on a studio-quality cassette deck, which will cost $15. Which would you choose?—Steve Holliday, Santa Cruz, Cal.

A. I vote for the first course, namely a real-time dub with the aid of your friend's deck, assuming that your deck and your friend's are both of good quality and in good shape. Try dubbing from your deck to your friend's, and vice versa, to see which gives better results. If the original tape has NR, have both decks' NR circuits switched on (see "Deck-to-Deck Matching and NR: Straightening the Mirror" in the August 1986 issue).

Why not try things in the order you listed? First dub with the help of your friend's deck. If the copy does not compare favorably with the original, try a high-speed dub on the professional deck. If still not satisfied, then try the real-time dub on studio equipment. Keep in mind that you cannot improve on the quality of the original, so the $15 course may sound scarcely, if at all, better than the free one.

Flat Spots

Q. My car's cassette deck does not automatically eject a tape when the engine is turned off, and tapes therefore are forgotten at times and remain in play position. Can this damage any of the deck's parts and cause a deterioration in playback response?—Samuel J. Neiditch, Redlands, Cal.

A. The possibility of damage depends on what your deck does when the power to it is shut off. If the deck just stops, with the tape still squeezed between the rubber pressure roller and the capstan, the roller may develop a "flat spot" at the point where it contacts the tape and capstan. If the mechanism contains rubber drive wheels, they may develop flat spots too. Such flat spots cause wow and flutter, sometimes severe. While they are not necessarily permanent (the rubber tends to have a "memory" and therefore may recover its roundness), flat spots may become permanent if the deck is left in play position long enough. It is difficult for me to define "long enough," however.

On the other hand, some car decks go into "standby" when the power goes off, leaving the cassette in playing position but removing the pressure roller a short distance from the tape and capstan. This prevents flat spots.

It is possible, in hot weather, that a cassette left in either type of deck might warp enough to become unplayable or even enough to get stuck in the transport. Should this happen, the deck would have to be disassembled by a service technician in order to remove the tape.

Dolby and dbx NR systems suppress noise introduced in recording and playback, while DNR suppresses noise which is already present in the program material.

Bright Sound

Q. My cassette tapes have a brighter sound when the equalization switch is in the 120-μS position. Why?—Robert W. Thompson, Glendale Heights, Ill.

A. I do not know whether you are referring to recording or playback or both. And I do not know if the EQ and bias switching are combined into one; I will assume they are. When the switch is in the 120-μS position, this ordinarily applies less bias than in the 70-μS position, resulting in increased treble response but also greater recorded distortion if you use tape formulations other than ferric. In playback, the 120-μS setting applies less bass boost—which comes out to the same thing as less treble cut—and therefore yields brighter treble response.

Combining NR Systems

Q. Can the DNR (Dynamic Noise Reduction) system be used in conjunction with Dolby C NR? Will it enable me to retain the wide frequency response (20 Hz to 17 kHz) I now have with my tape deck? Can the DNR system be used for both playback and recording?—Eric Gagne, South Hadley, Mass.

A. DNR is used solely for playback. Its purpose is to maintain the frequency response of the program source so far as the human ear can detect. It seeks to suppress high-frequency response, and thereby noise, only when the high-frequency content of the program material is minimal; that is, it ought to operate only when the high-frequency content is virtually masked by the noise.

DNR seeks to suppress noise already present in the program material (phono records, recorded tapes, etc.). In contrast, systems such as Dolby and dbx NR cannot suppress noise in the program source; they suppress noise—and remarkably so—in the tape recording and playback system. The Dolby and dbx systems work by encoding (compressing) the signal being recorded and decoding (expanding) the signal that is played back; the downward expansion in playback also takes down the noise present in the tape system.

You could use a DNR system to reduce noise of the program source before the signal is fed to the tape deck. Or you could use DNR after the playback signal has been delivered by the tape deck.

(*Editor's Note*: In my experience, DNR systems whose thresholds are not adjustable, such as those built into many car-stereo systems, do reduce high-frequency response, but only slightly. However, DNR systems with adjustable thresholds, such as those in some stand-alone noise-reducers, can usually be adjusted so as to eliminate *most* high-frequency noise with little or no discernible effect on treble response. Keep in mind, though, that it is rarely, if ever, possible to eliminate *all* audible noise without a slightly diminished treble.—*I.B.*)

AUDIOCLINIC

JOSEPH GIOVANELLI

Hum in Phono Cables

Q. I am puzzled by a minor problem with my turntable. Any power cord within 12 inches of the phono cables causes an audible hum from my speakers. Power cords near other cables, such as those connecting preamp to power amp, tuner to preamp, etc., do not cause this hum. Do my phono cables need replacing? I'd really hate to do that, because these cables are soldered directly to the turntable lug strip.—Jerry Powley, Fort Worth, Tex.

A. Power cords produce a.c. fields which can be picked up by *some* cables and then passed into the audio curcuits, where they are amplified and fed to the loudspeakers as audible hum. Because phono cartridges have very low-voltage outputs, phono input circuits have more gain than the other inputs in your system. As a result, any hum picked up by the phono cables will be amplified more than hum picked up elsewhere, and so will be more audible. Also, the phono system's impedance is likely to be higher than the combined impedance of a cassette recorder and AUX input, etc.

Audio cables are not completely shielded. This is why hum voltages can get into the cables in the first place. Do not replace your cables—just keep the power cords away from them, as stated in most turntables' instructions.

Type I and Type II dbx NR

Q. What is the difference between the dbx Type I and dbx Type II noise-reduction systems?—Tim Schindler, Mechanicsville, Md.

A. Both are full-band 2:1 compression/expansion ("companion") systems. Both boost treble during recording and impose a mirror-image cut in playback. The difference lies in the range in which the companding works. The sensors that control the compander action of dbx Type I read all audio frequencies from 22 Hz to 21 kHz; those that control dbx II's compander action read signals only between 30 Hz and 10 kHz, so they won't mistrack when used with imperfect recording media. This band-limiting applies only to dbx II's *control* circuits, not its *audio* circuits.

Type I is designed for recording systems such as 15-ips studio recorders, which have the ability to record high-level, high-frequency signals. Type II, because of its band-limited control circuits, is more forgiving of media such as cassettes, which have high-frequency headroom limitations, low-frequency head "bumps," and other imperfections.

Faulty Phono Muting

Q. I own a top-grade automatic turntable. At this time, however, the muting circuit is inoperative. In order to avoid possible speaker damage, I have to run to the equipment and turn the volume down during the "change cycle." Any advice?—Bernard A. DuPont, Putnam, Conn.

A. The mute is supposed to silence any output from the cartridge unless the stylus is on the record. This is accomplished by two sets of switch contacts, one set per channel. The contacts are usually flat leaves which touch together during muting. They are wired in such a manner that, when the contacts close, the output from the cartridge is shorted.

In your case, either the contacts never touch or there is dirt, oxide, or even grease on the contacts which prevents the shorting action. If the contacts simply don't close, the cure depends on the design of the leaves and upon the way they are pressed together. You will either have to bend them so they are closer together during "play" or you must adjust the position of a cam which works against the contacts. If there is surface contamination, a suitable contact cleaner should be able to fix the contacts.

Hum in Stacked Components

Q. I often see systems in which the individual components appear to be stacked one on the other. Shouldn't this produce problems? I remember that when I was dubbing eight-track tapes to cassette, the two decks were stacked. I could hear a hum during recording. In fact, that hum was recorded on my cassettes. When I separated the two decks, the hum was no longer there.—Tim Schindler, Mechanicsville, Md.

A. An eight-track machine has a playback head, and this head can act like a transformer. It is, therefore, susceptible to hum fields, which can be produced by power transformers and motors. In your case, either the motor or power transformer in the cassette recorder was sufficiently close to the playback head of the eight-track player for the hum to find its way into the head. Yes, heads are shielded against this hum, but shielding is never perfect, and some heads are shielded better than others.

With good shielding and judicious physical placement of hum-producing elements with respect to elements which tend to be sensitive to hum, it is possible to design components which will operate properly when stacked.

In summary, if a manufacturer designs a set of components to be stacked, he will have taken hum into account during the design process. If, on the other hand, you stack a random set of components, you run some risk of hum.

Interrelating Specs

Q. My stereo receiver has a frequency response of 20 Hz to 20 kHz and about 85 dB S/N for AUX signals; my cassette deck has a maximum frequency response of 20 Hz to 19 kHz and an S/N of 92 dB (with noise reduction). My turntable and cartridge have a signal-to-noise ratio of 78 dB and a frequency response of 10 Hz to 30 kHz. How do these specs interrelate? What is the maximum S/N and the maximum frequency response that could be obtained from the kind of setup I've described?—Tim Schindler, Mechanicsville, Md.

A. The best S/N you can expect from a multi-component system will be that of the noisiest component that is handling the signal at the time (except when playing records, in which case performance is limited not so much by your equipment as by the background on the discs, which can be as low as 60 dB.) Assuming your receiver's S/N at the phono input is about 80 dB, you could expect an S/N of 78 dB, at best, when playing very quiet records, the limit being your turntable's S/N. When playing tapes made from low-noise

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In a multi-component system, the best S/N you can expect will be that of the noisiest component handling the signal at a given time.

sources, your best S/N would be 85 dB, limited by your receiver's S/N at its high-level inputs. In practice you'd achieve slightly worse figures than these, because even the quietest components would be adding some noise to the total; however, the added noise might not be audibly significant.

In frequency response, too, you will be limited by your system's weakest link—and perhaps by the sum of all your components' frequency roll-offs, depending on how their manufacturers specify response. If response is specified flat within a fraction of a dB, then the effects of multiple components would be negligible; your response when listening to records would be 20 Hz to 20 kHz (limited by the receiver) and when listening to wide-range tapes would be 20 Hz to 19 kHz (limited by the tape). If response is specified in terms of the frequencies at which output is 3 dB down, however, the frequency errors would add up rapidly. If your cartridge, receiver, and deck were all 3 dB down at 20 kHz, say, then response when recording from your turntable and monitoring the tape would be 9 dB down at 20 kHz.

The Virtues of Noise

In the March 1986 issue, a question was published in "Audioclinic" from a reader who wondered why a faint hiss is audible even on CDs designated "DDD."

I think it may actually be undesirable to remove every last vestige of wide-band noise from any digital format. Indeed, it can be shown that a small amount of wide-band noise (called "dither") added to raw digital audio will not only mask but actually reduce the small amount of noise and distortion caused by quantization—if the dither meets certain mathematical criteria.

Quantization is a sequence of the smallest voltage changes which can be represented by a digital system, corresponding to changes of one count in the least significant bit. When used, dither is injected at a level which randomly modulates the system by at least one count, plus whatever audio is present, thus "blurring" the sharp, stepwise effect of quantization.

In actual practice, the noise in mixers, preamplifiers, and other nondigital studio equipment may provide this signal. However, as the noise floor of this equipment is further reduced (as a result of design improvements and the continued conversion to digital), it may be desirable to deliberately add dither to the signal. Dither can be added at any point between the studio and the CD player. At least one manufacturer, Carver, adds dither itself, via the Digital Time Lens circuitry in its players. The sound of some CDs may be enhanced by this treatment.

If your reader has a Carver CD player, and if the Time Lens is switched in, this could account for the hiss.—Karl Uppiano, Caldwell, Idaho

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Kevin Eubanks/*Face to Face*

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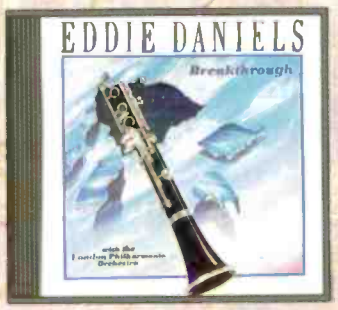
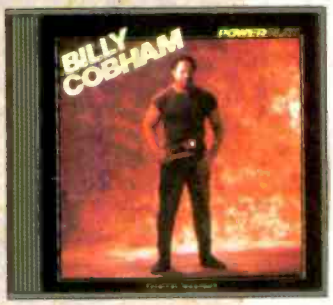


Eddie Daniels/*Breakthrough*

Glenn Miller/*In The Digital Mood*

Dave Valentin/*Light Struck*

Grusin/Ritenour/*Harlequin*



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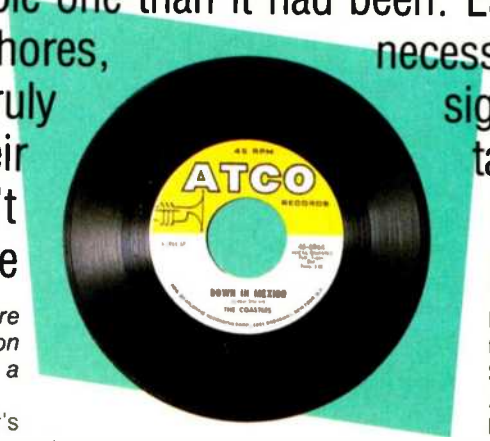
Jerry Leiber & Mike Stoller

The First Independent Producers—Part II

Stoller and Leiber transformed the role of the record producer into a much more responsible one than it had been. Earlier, most producers felt the duties were chores, necessary but without much opportunity for a truly significant contribution. Perhaps because their talents were so strong or because they didn't know where the limits were, they raised the producer's role to art.



Let's talk about The Drifters. "There Goes My Baby" was the first session you produced for them. It was such a beautiful, lush production. . . .

J.L.: That was the time Jerry Wexler's tuna fish sandwich went all over the wall. We played him the record while he was eating his lunch. He started screaming at us: "What are you doing with my money!? This is the dumbest, the craziest! This stupid record is out of tune! Hey, Ahmet, isn't it out of tune!?" [Laughter.] Ahmet says, "Hey, wait a minute! Stoller knows whether it's in tune or not! Is it out of tune?" [Laughter.] Stoller says, "Well, it's a little out of tune, but I think it's kind of interesting." [Laughter.] "Interesting! What kind of interesting? The stupid tympani are out of tune, man! This is a rotten, dumb record! And I'm not going to put it. . . ." And the tuna fish sandwich was all over the wall.

M.S.: Ahmet was trying to mollify us. He said, "You know what, fellows? Look, you guys cut great records, but you can't hit a home run every time at bat. You know that." We said, "But there's something in it. Can we work with Tommy Dowd? Maybe we can fix it up." It wasn't recorded where we usually record because Atlantic's studio was booked that day, and it was done. . . . It was upstairs on 40th Street, off Sixth Avenue.

J.L.: The booth was upstairs, but the recording was down in the pit. There was a terrible time lag in the studio, and a strange echo system. It gave a weird wash to the record. We knew the tymps were out of tune. It sounded like two AM radio stations playing at the same time.

M.S.: It wasn't that they were out of tune, it was that they weren't played by a tympanist. He was an R&B drummer and he just played it straight through, and the one pitch went through all the changes.

Now, this was the first R&B tune to feature strings. . . .

M.S.: We had tympani, four violins, and a cello, with a regular rhythm section which we augmented because I had come up with this Borodin-like line I was playing on the piano during rehearsals. Jerry said, "That should be violins." Stanley Applebaum wrote the line as a unison for the violins and cello. Anyway, the tymp was in the studio, and Jerry and I have always loved a certain Brazilian beat, called the *baion*, which we heard sung by Silvano Mangano in the Italian film *Anna*. It later became the signature of half a dozen years of rock 'n' roll and soul records. It was used extensively not only by us, but after us by Phil Spector and Burt Bacharach.

So Ahmet and Jerry thought you were nuts?

J.L.: Wexler thought it was terrible, god-awful.

M.S.: I think Ahmet thought it was awful too, but he was trying to be kind.

J.L.: I'm trying to remember who came in and said it was a hit. Was it Nesuhi [Ertegun]?

M.S.: No, I think it was Tommy Dowd. We said, "Let us work with Tommy on it." We just mixed it. It was only three or four tracks.

J.L.: I know that at some point Ahmet said he thought it was a hit. Maybe it was just before we released it. I remember Ahmet saying, "It could be a hit." And, of course, it did go on to become a hit.

Then came more with The Drifters, like "This Magic Moment," written by Doc Pomus and Mort Shuman.

J.L.: Yeah. We started building this rhythm section. By the time we were in full swing, we were using like three to

Photograph: Robert Lewis

Mike Stoller and Jerry Leiber

At first, them crazy.

Mike Stoller and Jerry Leiber at the piano in 1959, the year they produced The Drifters' hit "There Goes My Baby" for Atlantic.

Photograph: Courtesy of Leiber & Stoller

five guitars—a 12-string, a lead guitar, two rhythm guitars . . .

M.S.: . . . and one that went "chang." [Laughter.] Electric, using whole notes.

J.L.: Then we used up to three percussionists and a drummer. We had somebody on African drum, a triangle, and vibes and marimbas, then a regular drummer.

Wasn't Phil Spector your apprentice?

J.L.: We brought him in sometime in late 1960. Phil Spector was another discovery of Lester Sill. Lester called me on the phone and said, "There is this very talented young kid out here, and he's bored with the scene." Nothing much was happening there [L.A.]. At the time, everything was happening in New York. He was just out of high school. Lester said, "He wrote one hit song and he made a record, and he wants to hang out with you guys." I said, "Sure, send him along." And he stayed in my house.

M.S.: We sent him a ticket as a favor to Lester.

What did he do as your apprentice?

J.L.: He just hung around us.

M.S.: To help support him we'd put him in the guitar section. Then we started getting him outside gigs.

J.L.: We had too much work. A job came through. Big Top Records—Paul Case—called us and wanted us to cut Ray Peterson. We didn't have time. I said, "You know, there's a very talented young man who's working with us, and I think he can handle it very well. We'll supervise him and check the mixes." He said okay, he'd take a chance. Phil went in and cut "Corinna, Corinna." The rest is history [laughter].

He must have been heavily influenced by the stuff you were doing with The Drifters.

J.L.: I think he was influenced by our techniques and ideas, but he used them in his own way. We used five guitars; he used three pianos. He was influenced by us, but he developed his own thing, which is what anyone who's good finally does.

Jerry Wexler said he remembered that when Atlantic got an early eight-track machine, you were saying, "You can't make R&B records on multi-track, it's going to change the sound of the records, and it won't sound authentic anymore." Is that accurate?

J.L.: Did I say something like that? I could have. Well, they were too clean. I used to talk about "the rub." Then someone explained that it was on the old tube machine.

M.S.: Oh, no, that had to do with the harmonics being different on the tube machines. But Tommy's [Tommy Dowd's] eight-track was running on tubes at that time rather than chips. It was later on that we learned the difference between the transistor and the tube machine, the warmth of the tubes, and the slight harmonic distortion that was different.

J.L.: You couldn't make a Howlin' Wolf record, you couldn't make a Chess record, you couldn't get that sound on a transistor machine. At first, multitrack techniques drove me crazy because of the possibilities and the alternatives. It bothered me because I was always geared for a record session like I was geared for a performance. It all had to do with capturing the spontaneity of the moment. The idea of having so many extra tracks meant that you had the luxury of making mistakes or not being "up" for the moment to really nail it, in that one take or two takes or whatever. You could come in later and overdub it. Not that we hadn't ever used overdubs before, but we didn't normally use them to get the central performance. We would use them to fix a moment, something that was off. But we always felt the band, the rhythm section, and the singer—there was an interaction that was irreplaceable. I don't like to make tracks and overdub a voice. We thought that was dead. So the idea that all these tracks were there would create a kind of laziness in terms of performance. It took a kind of urgency out of the moment for me. Recording, for me, was not as exciting anymore.

Mike, do you agree with that?

M.S.: Well, a little. I recall using the eight-track machine with Tommy as if it were an extension of mono, not like the experiences we've had since in working 16-track and 24-track, where I've definitely felt exactly as Jerry has described. I've gotten hung up on the process, in some cases—lost in the technical possibilities, and the remix possibilities, and sometimes the "we'll do it later" possibilities. But the eight-track, especially with The Coasters, where we had the rhythm divided on the tracks—the main thing that it gave us was three tracks to play with the vocals. If a performance was almost there and we missed one line, instead of having to intercut it with another per-

the possibilities of multi-track tape recorders drove

It seemed like there were too many alternatives.

formance, where the rhythm section might not fit perfectly, we could touch up that particular line. We had the luxury of being able to fix it.

You adapted to this?

M.S.: Very quickly. We were helped, of course, by the fact that we were working with a technician who became a great producer, Tommy Dowd, who understood what we were doing as producers. He was just brilliant. You know, a lot of the engineers we worked with became producers afterward. Tommy Dowd, Brooks Arthur. Phil Ramone was an engineer at A&R Studios. We started working with him in 1959, when we began using orchestras too large for Atlantic's old studio on 56th Street. There were techniques that we used in those early days that you just don't think about now because you can do so many different things electronically. While we were mastering, for example, we were always very aware of the possibility of altering the tempo ever so slightly. But they didn't have all the VFOs, variable frequency oscillators. So we would "speed them a wrap." You took a piece of tape and you wrapped it around the capstan, which made the take-up faster. We wouldn't speed it so many seconds, we'd speed it one wrap or two wraps. It was hard to speed it a half-wrap because then you would get a wobble [laughter].

Didn't you also work briefly for RCA Victor in New York, in 1957?

M.S.: 1958. We moved to New York at the end of '57. We had already started working for Atlantic in California. The RCA thing was arranged by Jean Aberbach through Steve Shoals, who was head of A&R.

J.L.: [At RCA] by the time you filled out a requisition for something, the idea was stale. I got so confused. All the offices looked exactly the same [laughter]. I couldn't find my office. I would come to the building, and every day I would go into an office and sit down and I'd be sitting there for 10 minutes thinking this was my office and a guy would come in and look at me and he'd say hello, and I'd say hi. He'd walk around kind of uneasy, and I'd start to feel uneasy. Then he'd say, "You're in my office." [Laughter.] I'd get up and I'd go into another empty office. They were these cubicles, and they were all furnished the same, the same size. I didn't know where I was. I couldn't make it.

M.S.: We produced seven records in our first four months there, and had six Picks of the Week in *Cashbox*. Varetta Dillard, Georgia Gibbs. . . . But they never sold any of those records. Meanwhile, we made one record for Atlantic during that same period and it was a smash.

J.L.: So we said, "We're wasting our time," because even if we made a hit, it wouldn't be played.

Was it that they weren't greasing the right people?

J.L.: We didn't know what was going on. The records were being sold by the people who sold refrigerators.

M.S.: We didn't know how records were promoted. We only knew that you made them and Atlantic put them out and if they were good they'd be hits.

Let's talk about Elvis Presley, another RCA artist. How did you feel about him before he recorded your material?

M.S.: I heard "Heartbreak Hotel" and I loved it. It was weird and it had more echo than I'd ever heard before, but I loved it. That was in the beginning of '56. Then I went to Europe for three months and I didn't know that Elvis had become the biggest thing going in the States.

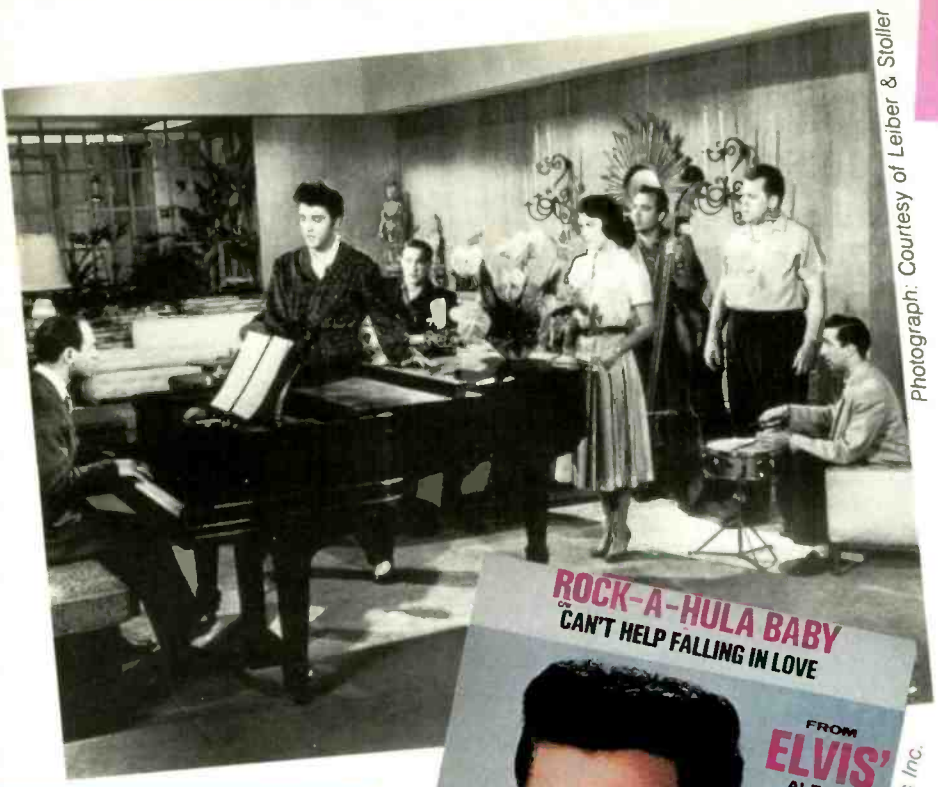
J.L.: He came back on the *Andrea Doria*. I had just come back from California. I had been on this hair-raising fishing trip where we were stranded off the coast of California for like 18 hours. It was terrible. We went out on a little

Photograph: Courtesy of Leiber & Stoller

Jerry testing his pipes in 1959 as Dick Charles (center) and Mike looked on. Youngster is unidentified.

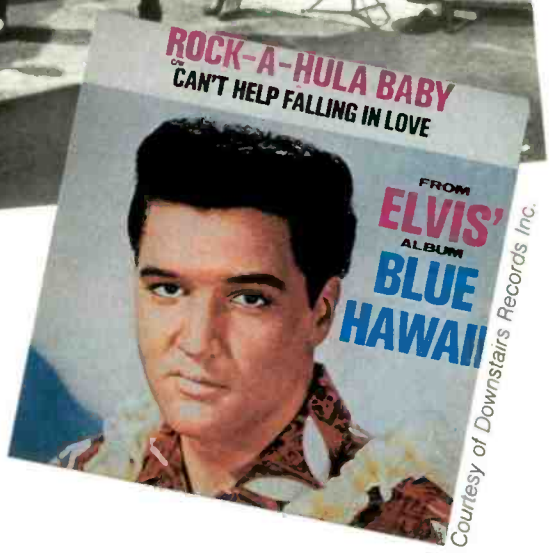
Photograph: Frank Driggs Collection

The Coasters; working with them, says Mike Stoller, "was the most fun we ever had with any artist."



Photograph: Courtesy of Leiber & Stoller

A scene from the Presley movie Jailhouse Rock, *whose music was reportedly written by Leiber and Stoller in one afternoon. That's Mike seated at the piano.*



Courtesy of Downstairs Records Inc.

It was obvious to but his knowledge

fishing boat that shouldn't have gone out more than five or six miles, and it went out about 24 miles. The motors gave out, and we were stranded out there. We were towed in, finally, by the Coast Guard, and the rope broke a few times. I had this great, wild adventure up my sleeve to tell Stoller. I was checked into the Algonquin and I was smoking a cigarette and listening to the news, and I get this news flash that the *Andrea Doria* is sinking off the coast of Nantucket. I thought: He's on that boat, I've been upstaged again! [Laughter.] Actually, I thought of that later. I was absolutely horrified. I had just found out that Elvis' "Hound Dog" was an overnight smash, and I had this great news for Mike that we had this great hit record. Then the news came of the sinking ship. I listened all night and I heard there were survivors. I didn't know who, though. Then, finally, I got a telegram.

M.S.: I had some lire in my pocket. We were on a United Fruit Lines Boat that had picked us up out of a lifeboat. They wouldn't send a telegram unless we paid in cash. I had given money to some other people to send wires back to Italy. I could only afford to send one telegram and I figured Atlantic Records was the place, because I knew Jerry and Lester Sill were planning to meet me there. Jerry was at the dock waiting when we came in . . .

J.L.: . . . with the news about "Hound Dog." I thought he might be wet, so I brought him a suit [laughter].

How did you feel about the way Elvis did "Hound Dog"? He changed the lyrics around and so forth.

J.L.: The first time I heard it, I hated it. I didn't like it at all. My idea of the right rendition was the Big Mama Thornton record. Elvis' record was much too frantic. The original was kind of a cross between a New Orleans buck dance and a blues-rhumba. It was relaxed and nasty. The Presley record that I loved most was "Love Me." I thought Elvis Presley was the greatest ballad singer since Bing Crosby.

What was it like, working with Elvis?

J.L.: He was fast. Any demo you gave him he knew by heart in 10 minutes.

M.S.: He'd sing along with it a few times, and he'd know it.

J.L.: Elvis Presley was like an Olympic champion. He had more vitality than 10 other singers put together.

You didn't feel, as two guys very involved in authentic black music, that he was some kind of usurper of the black sound?

J.L.: I wouldn't say a usurper. I felt he was not quite authentic—after all, he was a white singer, and my standards were black.

M.S.: We had strong feelings about what we thought was authentic. And one of the things we felt was not authentic was a white singer singing the blues. Why we thought that it was all right for *us* to pass, I don't know. Maybe because we were writers, not performers. But even so, I did like Elvis right from the git.

Was he aloof in those days?

M.S.: No. He was *protected*. He was removed. . . .

J.L.: He was protected by the CIA [laughter].

M.S.: The Memphis Mafia CIA. Colonel Parker. They kept him separate. We met him in a studio at Radio Recorders when we were doing the prerecording of the songs for [the film] *Jailhouse Rock*. It was great, very easy. We were surprised at the kind of knowledge that he had about black music. We figured that he had these remarkable pipes and all that, but we didn't realize that he knew so much about the blues. We were quite surprised to find out that he knew as much about it as we did. He certainly knew a lot more than we did about country music and gospel.

What was it like writing the songs for the Elvis films?

J.L.: We thought they were dopey.

M.S.: We would write for them, but after a while they got so dumb and so repetitive that we got bored and decided not to do any more because it was just no fun.

J.L.: We did more Presley movies than we ever intended to do because we were making so much money. But it got to a point where we just couldn't stand it anymore.

M.S.: It got to the point where it got to be too much like work. The score to *Jailhouse Rock* was written in one afternoon in the Gorham Hotel. Because Jean Aberbach, who was the publisher and co-owner of Elvis Presley Music and Gladys Music [and cofounder,

Leiber and Stoller that Elvis had a remarkable voice, of the blues came as a big surprise to them.

with brother Julian, of Hill and Range Music], came in and said, "Where's the score, boys?" He sat down on a big, overstuffed chair and planted himself in front of the door and said, "You're not leaving until I have some songs."

Let's talk about some of the records you produced at United Artists in the early '60s. There were some very nice pop tunes like "Only in America" and "She Cried" for Jay and The Americans, and one of my favorites, The Exciters' "Tell Him."

J.L.: Well, that one's a *baion*, with triangles.

M.S.: Bert Berns wrote the song, and I think they had released a record of it before, on a small label, and it had not been successful. We liked the song . . .

J.L.: . . . and we had this hysterical-sounding group called The Exciters. The girl, Brenda, sang out of tune, but she sang in a wild, exciting way.

M.S.: They used "Tell Him" in *The Big Chill*.

You did Ferrante & Teicher at United Artists, no?

M.S.: One side, "Lawrence of Arabia." [Laughter.] We had them playing inside the piano on the strings.

Your songs and productions, which started out being inside and hip, gradually became more universal.

M.S.: I wonder about that.

"Only in America" seems as universal as can be.

J.L.: Let me tell you something about that. "Only in America" was a song that Mann and Weill wrote with us. Originally it was The Drifters singing "only in America can a guy get a break," again a send-up—a black person talking about what a great place this country is for opportunity, an ironic, bitter statement. Now, Jerry Wexler heard the thing and he said, "Are you kidding? I'm not putting that out. I don't need that kind of trouble." So I said, "Can we have the track?" He said, "Sure." So we made a deal with Atlantic and we took the track and overdubbed it with Jay and The Americans. *They* sang it. A white group singing it sounds like "Tenement Symphony." It sounds as if they meant it. It was no longer ironic; in fact, it was downright patriotic. But you're right about some of our other productions. We did start moving more into the mainstream of the pop music business. We certainly were not cutting the blues anymore. There wasn't a large enough audience for the blues anymore. The business was changing.

M.S.: What was happening at that time in terms of black music was that Motown was starting. And Sam Cooke, and Sam and Dave.

How did you feel about Motown then?

J.L.: At first we thought it was white bread. We thought that Motown was Madison Avenue for black people. We said, "Man, those are white teenage stories. What does that have to do with black culture?" We'd have discussions about that with some black music people from time to time. They'd say, "What? Are you in love with the ghettos? Are you in love with that old regionalism? Things are changing, man. That's not the black image any longer."

Would you say that your Red Bird label was a reaction to this?

M.S.: No. A reaction to United Artists.

J.L.: We had broken with Atlantic in '60, '61. We went to United Artists and made a slew of hits. At one point we looked at each other and asked, "Why are we making these record companies rich? Why don't we go into the record business again, and do what we want to do, and not have to call upstairs for budgets, etc.?" We openec up a record company, Tiger, and each record got hit picks in the trades and we didn't get one of them played. Nothing was selling. We were cutting people like Alvin Robinson, who was a soul/blues singer from New Orleans, and we loved him. Still love him. We cut a number of great singers, and blues-oriented songs that we thought were great, and we couldn't sell two records. We were about to go out of business. Mike and I had been

The Dixie Cups, whose 1964 "Chapel of Love" was a hit for Leiber and Stoller's own Red Bird label.

"Only in America" was first intended for The Drifters, but it was Jay and The Americans who finally recorded it.

The Shangri-Las, another hit-making "girl group" for Red Bird.

Courtesy of Downstairs Records Inc.

Perhaps because Stoller never felt

producing and supervising record production with songwriter-producer teams that we were bringing along, like [Jeff] Barry and [Ellie] Greenwich, and Shadow Morton. Mike had written some arrangements for them with a group called The Dixie Cups. We had some sessions in the can with a couple of little girl groups that had nothing to do with our tastes in music at all. It had to do with the young writer-producers who were now working under our banner. They were doing what they wanted to do. But we were running out of money and time because the records we had made were not selling. Mike, didn't we, with the advent of George Goldner, start a new label because we thought the other label had the stigma of flops?

M.S.: Tiger and Daisy were the first labels, formed when we left United Artists. Our first releases came out the week of the Kennedy assassination. Of course, nothing ever happened with them. The music business, along with everyone else, went into a state of shock. By the following year, in about March or April, when we were coming out of that shock, we needed to start releasing some of these records that had been piling up on our desk. *That* is when Jerry bumped into George Goldner and made what I consider to be the best possible business arrangement that could have been made for us to go into the record business.

How was it the best arrangement?

M.S.: Goldner was the best record salesman, *ever* . . .

J.L.: . . . outside of Jerry Wexler. He had Gee Records, Rama, and Roulette, Tico. . . .

M.S.: He started all these labels. He was a mambo dancer. . . .

J.L.: His problem was gambling; he was a big horse player. He lost every label he ever had, at the track. I met him one night when he was down on his luck and out of money, sitting with Hy Weiss, who owned Old Town Records, in Al and Dick's. Weiss was blowing cigar smoke in his face, calling him a schmuck, and telling him what kind of fool he was and why, and trying to get him [George] to work for him for like $200 a week. George said he needed at least $350. Hy had invited me over to the table, and was using me as kind of an audience to put George down. Hy would turn to me and say, "See this schmuck sitting before you? He was worth $20 million, and he blew it at the track." Then he would blow more cigar smoke at him. I'm sitting there looking at George and thinking, "We don't have much money. I can't really afford to give George $350 a week. . . ."

M.S.: But if he'd made $20 million in the record business, he must've known how to do something right. . . .

J.L.: At some moment I said, "George, you want to go into the record business?" He looked at me and said, "I hope you're not pulling my leg because I wouldn't think it was too funny right now." I said, "I'm not being funny at all. I'm being serious." He said, "What kind of a deal are you talking about?" I said, "A partnership." He said, "A partnership with Leiber and Stoller? What kind?" I said, "Even up. Three ways." Upon hearing this, he went into his inside coat pocket and got an old Tiffany cigarette case, opened it up, took out a Pall Mall, lit it and blew the smoke into Hy Weiss' face. He said, "Hy, we're going to see who the schmuck is." [Laughter.] I had told him I had these acetates. He asked, "Where are the acetates?" I told him, "They're sitting on my desk in the Brill Building." He said, "Give me the keys to your office." I said, "I'll go with you." He said, "No. Don't come with me. Come in tomorrow morning when you normally do and I'll see you." I said, "Are you going to stay there all night?" He said, "I might." I gave him the keys and I came in at 11 o'clock the next morning and he was sitting behind my desk, not a hair out of place, same suit, same tie. He held up this acetate and said, "On my life. On my life." I said, "What are you talking about? Play it." He put it on, and I hated the f---ing record.

What was it?

J.L. (singing): "Going to the chapel, and we're gonna get married. . . ." [Laughter.] He says, "This is a stone smash." I said, "George, you're the boss. You put it out. I hate it." [Laughter.] That was the first record on Red Bird. I think we ran 18 straight hits.

M.S.: Something like that, between The Shangri-Las, The Dixie Cups, The Jelly Beans, The Ad Libs . . . but Alvin Robinson, we released records on him that sold 100,000, and his were the kind of records we loved. After a couple of years we felt distanced from the material that our record company was doing. It was doing great, and selling all kinds of records, but we didn't have any emotional feeling for that. Because we wanted to write.

What happened next?

J.L.: We did some outside productions and writing after that. At some point we gave George Goldner Red Bird Records for one dollar.

Let's talk a little bit about your work with Peggy Lee.

M.S.: It started in '62. We made a demo of "I'm a Woman" and sent it out to Dave Cavanaugh at Capitol Records. Not long after, Peggy was appearing at Basin Street East. We went down to catch her act and she was singing the song. The audience loved it and we went down to the studio about a week later and recorded it.

When did you write "Is That All There

they were so prolific as record producers, Leiber and competitive when lending a hand to other writers.

Is"? It almost sounds like a comment on your careers up to that point.

J.L.: Maybe it was. We were thinking of moving on. We were getting older, and we weren't writing for kids anymore; *we* weren't kids anymore. We were looking for another, more mature audience. We thought perhaps the theater would be the place for us. So I started experimenting with some ideas, and Mike and I got together on that. "Is That All There Is" was one of the first ideas of that genre that we completed.

Was it very successful?

J.L.: Not at first. We did it first with Georgia Brown.

M.S.: I wouldn't say that it wasn't successful. Georgia Brown performed it beautifully on a BBC television show in 1966. But she didn't get to record it, and without record sales it's hard to measure the success of a song. We continued to work on it—we rewrote it a couple of times. Then Jerry presented it to Peggy when she was working at the Copa. She was very taken with it, and Jerry told her that we would produce it with her in L.A.

J.L.: It's funny. I just saw Ahmet the other day, and he said, "Hey man, I want you to write some songs for Peggy. We just signed her."

M.S.: When we went up to Peggy's house she was playing an album of Randy Newman doing his own songs, like "Linda" and "I Think It's Gonna Rain Today." The orchestrations were so beautiful that we decided to use him on "Is That All There Is," and he did a brilliant job of arranging and orchestrating it.

How did it feel for you, as songwriters, to work with other songwriters when you were producers or record-company owners? Did you feel sympathetic?

J.L.: I think so. Strangely, I think because we were prolific enough producers, we never felt very competitive. We would sometimes give the back side of a sure-fire hit to another writer. I guess we thought we could make a hit record any time we felt like it.

M.S.: It wasn't like we were taking pity on anyone. It wasn't charity. There was enough for everybody.

J.L.: There was so much going on. We had so many opportunities to do whatever we wanted. If a songwriter came along with a great song, we'd do it. We loved good songs.

You mean you weren't a couple of pains in the neck who would start rewriting songs?

J.L.: Oh yes, we were. I was very tough on writers. I made Gerry Goffin and Carole King rewrite the lyrics to the bridge on "Up on the Roof." And I had Doc Pomus rewrite part of "Save the Last Dance for Me."

M.S.: We changed the structure on lots of those songs. But we were close friends of these writers and we could say, "Look, Doc, we're going to take this section out, and come out of the instrumental right into here." And he'd say, "Oh man, that sounds great."

J.L.: To make the song better, to make the record better, to make the production better, we felt that we had this obligation as producer/arrangers.

What's happening now?

J.L.: We're starting work on an exciting new musical, with Julian Barry doing the book.

M.S. And 20th Century-Fox just acquired the rights to our life history, and we're looking forward to working on that as well.

The duo from 1953 to today.

Photographs: Courtesy of Leiber & Stoller

Build A LIVE END/ DEAD END Listening Room PART I

William R. Hoffman

Your listening room has a great effect on the sound of your system because of reflections. Here's how to tame them.

Recent developments in sound recording have begun to put more demands on the entire chain of sound reproduction equipment. With the advent of 14- and 16-bit digital coding systems and the Compact Disc as a viable sound-storage medium, the limits formerly set by the natural shortcomings of the vinyl LP record and magnetic recording tape have disappeared. Without the limits on signal levels set by the noise floors of these media, the ability to record low-level information containing the acoustics and character of a particular environment is unprecedented. But with this impressive recording capability must come a reproducing system that can clearly re-create these sounds, including all the important acoustic cues used by the human brain in determining the quality and nature of the original sounds. Electronics and loudspeakers are now available with the required level of performance to meet these needs, yet this is not enough.

The acoustics of the listening room play a major part in the perception ability of the listener. Even the most sophisticated loudspeaker system will be helpless in poor acoustic circumstances. When problems exist, the only remedy is to apply known principles of acoustics—some only recently come to light—to the situation. Then, under correct circumstances, the full capability of digital sound reproduction can be realized.

Room Acoustics and the LEDE Concept

In 1972, Haas [1] showed that the acoustical anomalies of an enclosed space had almost no appreciable effect on the perceived sound from a loudspeaker if one important characteristic of the radiated sound field was carefully preserved: If the direct sound radiated from the loudspeaker was allowed to reach the listener well before the sounds reflected from adjacent room surfaces, then the brain would almost totally ignore the later sound and accept the direct output as the only one present. Specifically, Haas showed that a delay between the direct and reflected sound of more than about 20 mS, equivalent to a distance of about 23 feet, was sufficient to allow complete differentiation under normal circumstances. In addition, he showed that this delay requirement was modified by the strength of the early-arrival sounds. The concept of direct, early, and late sound arrivals is illustrated in Fig. 1.

Another artifact produced by these early reflections is clearly evident when an analysis is made by the use of Time Delay Spectrometry (TDS). Figure 2 shows the output of a studio monitor loudspeaker, both without (Fig. 2A) and with (Fig. 2B) very early reflections. Note the smooth response of the speaker in free space (anechoic conditions) and the very ragged response when the early reflections are added. Complete cancellation of some frequencies will occur when the delay is sufficient to make the direct and reflected output 180° out of phase. Clearly, then, if it were possible to eliminate all early reflection effects, not only would the actual response of a speaker be much smoother, but as far as the perceptions of the listener would be concerned, the room would take on the qualities of an echoless, free-space environment.

As Fig. 1 illustrates, the critical surfaces are those near the loudspeaker system, in the end of the room where the speakers are located. Deadening these surfaces will remove the early reflections, but treating the walls with sufficient damping material could both be expensive and require changes in the room structure—and this is not always practical.

Yet, another approach is possible: Creating a live-end/dead-end (LEDE) environment, by eliminating the sound radiated by the speakers in the unwanted directions. This can be accomplished by the placement of absorptive materials between the speaker and any nearby surfaces. Specifically, by using a number of free-standing absorptive panels, arranged around the loudspeaker in a semicircle or a horseshoe-shaped array, no wall treatments may be necessary.

Construction of the Acoustic Panels

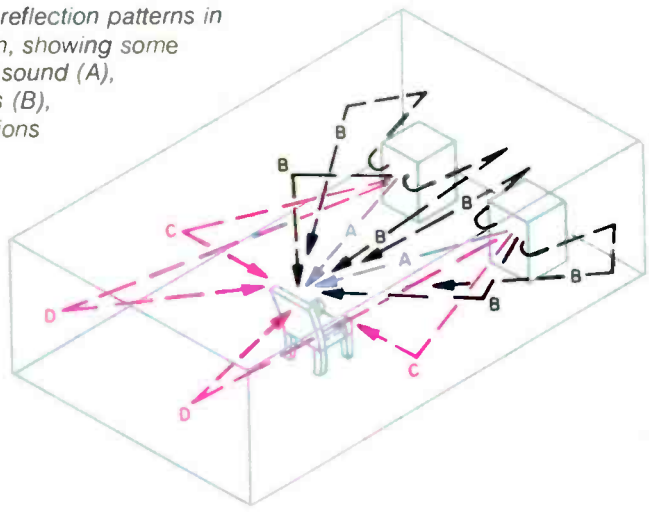
Figure 3 shows cutaway views of the suggested panel construction. Note that the panel is simply a wooden

William R. Hoffman is a senior technician at Precision Audio Labs, Reno, Nevada. This article, a limited application of the live-end/dead-end concept, is based on research and development work by Don Davis of Synergetic Audio Concepts, San Juan Capistrano, California. The term LEDE is a trademark of his company.

Photograph: All Media Photo of Reno, Nev.

An LEDE demonstration room designed by the author for The Audio Authority in Reno, Nevada

Fig. 1—Lateral reflection patterns in a listening room, showing some paths of direct sound (A), early reflections (B), and late reflections (C) and (D).



frame with a solid back, and with architectural fiberglass or rock wool placed inside as an acoustical absorber. Covering the front surface is a thin, open-mesh grid made from screen or chicken wire, stapled to the wooden frame, which retains the absorbing material. A stretched fabric cover is placed over the entire assembly, either fastened by stapling or sewn as one piece and pulled down over the panel, like a sock. Completing the job would be some brackets, or a wood or metal plate, attached to the bottom to support the panel upright.

Note that such a construction is very simple and inexpensive and that it allows the builder to select the style and color of the outside material. In addition, should the cover ever become

Both the vertical and horizontal dimensions of the panels must be great enough to keep sound waves from getting around due to diffraction.

Table I—Minimum panel array widths required to avoid diffraction, for various sound frequencies and wavelengths (where panel width = 717/f).

Freq. (Hz)	Wave-length (Feet)	Minimum Total Panel Width (Feet)
50	22.6	14.3
100	11.3	7.2
200	5.65	3.6
300	3.77	2.4
400	2.83	1.8
500	2.26	1.4
600	1.88	1.2
700	1.61	1.0
800	1.41	0.9
900	1.26	0.8
1,000	1.13	0.7

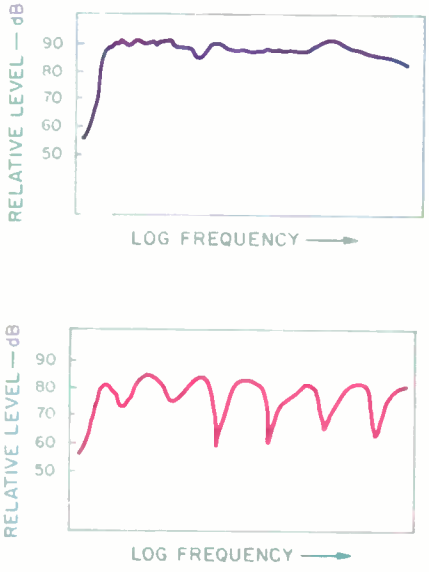


Fig. 2—Frequency response of reference loudspeaker system under anechoic conditions (A) and with effects of early reflections (about 1.1 mS delay) added (B). (After Davis.)

damaged, it could easily be repaired or replaced. The only important requirements for the panels are their dimensions and absorptivity, which are quite easily determined.

Designing the Panels

In designing the panels it must be realized that they will be acoustically effective when two conditions are met. First, their vertical and horizontal dimensions must be great enough so that the sound waves will not go around them due to diffraction. Second, the sound-absorbing material must be effective over the required range of frequencies. For our purposes, this range is from the low-frequency limit determined by room dimensions and panel construction to at least 2 kHz, with at least 80% absorption.

Before proceeding any further, we must have some knowledge of the circumstances under which our treatment will be used. To begin with, we must examine the room in which our sound system is located, and especially the area where the loudspeakers will be placed. This LEDE system works best when the speakers are well away from any wall surfaces—a typical arrangement for many listening rooms today. Keeping in mind that the absorbent panels must eliminate reflections from all surfaces within a radius of approximately 10 to 12 feet, plan enough of them to block all sound radiation toward these surfaces. The panels should be spaced 1 to 2 feet from each speaker in an open, semicircular pattern, as has been mentioned.

Now that we have a general plan for the system, we can use the following four-step procedure to determine both the panel dimensions and the thickness and density of the absorbent material to be used.

The first step is to determine the lowest frequency that needs to be absorbed by the panels, which is a function of the dimensions of the listening room (usually the floor-to-ceiling dimension). To determine this frequency, find the smallest room dimension, in feet, along the bottom of the graph of Fig. 4, and then the corresponding low-frequency cutoff limit for that dimension.

Next, proceed to Table I. From the value of low-frequency cutoff, determine the required total panel width. You may extrapolate for values that are between those given; this will cause no problems, as the exact dimensions are not critical. Note that this dimension is to be the *minimum overall* width of the array of panels that will be built, and is not necessarily the dimension of just one panel only, unless it is convenient to build just one panel.

Next, we must determine the approximate absorption characteristics of the panels according to the material we will place inside them. Table II lists values for standard architectural fiberglass or rock wool. Most of this material is available in 2- or 3-inch thicknesses, and in various densities from about 2 to 6 pounds per cubic foot. Although it comes in various widths, 2 feet is probably the most common. It can be purchased from most lumberyards or material supply houses. What is to be purchased is the common fiberglass or rock wool, with no backing material.

Looking at Table II, it is obvious that even very light material is quite absorptive, and the thicker and denser it is, the more effective it will be. Choose the best material you can obtain that will meet the 80% minimum requirement over the range from the low-frequency cutoff (from step 1) to at least 2 kHz. (But note, also, that at the low-frequency limit the absorption can drop to about 50% or so without causing any difficulties.)

Our final step is to determine the dimensions of the panels we will construct, as taken from the material thickness, low-frequency cutoff point, and array dimensions we have already determined. To begin with, the frame depth must be equal to the fiberglass thickness plus the thickness of the backing material. The panel width will be determined by the size of the speaker system. This dimension is not critical, provided that the width of the array, as it will be arranged around each loudspeaker, meets or exceeds the minimum value from Table I. In most cases, this will be no problem. Now the only remaining dimension to determine is the panel height. Again, this is not critical—as long as the panel is taller than the loudspeaker by the value of the minimum panel width (taken from Table I).

Design Examples

To help understand the procedures, let us do some sample problems. Say a room is 14 feet wide by 19 feet long, with an 8-foot ceiling. The loudspeakers are about 1 foot wide by 2 feet high by 1 foot deep, and are on stands 1 foot high, making the arrangement 3 feet high overall.

To begin with, Fig. 4 tells us the low-frequency limit we need to deal with is about 420 Hz, taken from the room's minimum dimension, its height of 8 feet. Then, Table I tells us that the minimum array width will be about 1.8 feet, based on the 420-Hz limit. Also, with the limit in mind, and from what is available in fiberglass, we select 2-inch material of 4-pound density, giving us much more than the minimum 50% absorption at the low-frequency limit. This means the panel's depth will be 2 inches plus the thickness of the backing we use.

Now we can determine the panel height. The height of speaker and stand is 3 feet. Add to this the value of the minimum array width, 1.8 feet, and we have 4.8 feet (minimum). Finally, from the dimensions of the speaker cabinets (1 foot wide by 1 foot deep), and allowing approximately 1 foot clearance, we see that three panels, each 3 feet wide, will surround the speaker on three sides. So a total of six panels will be needed.

Here is another example. We have a room 12 feet by 10 feet, with an 8-foot ceiling. The loudspeaker is a three-piece system, with two satellites measuring 8 inches square and a single subwoofer. The satellite speakers are on stands that raise them to a height of 3.5 feet overall. For this room and system combination, Fig. 4 tells us the low-frequency limit is again 420 Hz, determined by the ceiling height dimension of 8 feet, and again the minimum array width is set at 1.8 feet, taken from Table I. Also, given the same low-frequency limit, we can again choose to use 2-inch fiberglass with 4-pound density, since its absorbency will meet the minimum needs of the system.

Now, from the small dimensions of the satellite speakers, it is obvious that three panels of 2-foot width will be sufficient for each speaker. Finally, the panel height will be the speaker height, with stand (3.5 feet), plus the minimum array width of 1.8 feet, for a total of about 5.5 feet.

It should be noted here that no treatment has been applied to the bass system used. Because the effective low-frequency limit of the absorption panels is about 420 Hz, and the bass module only operates up to about 150 Hz (typical), it is obvious that no treatment is necessary for it.

Let's take one more example, this time involving a large room, 18 feet by 28 feet, with a raised architectural ceiling having an average height of 16 feet. The loudspeakers used in this room are large, multi-driver, extended-range systems, 3 feet wide by 7.5 feet high by 1.2 feet deep.

Now, this example represents an extreme for the free-standing panel's absorption system. To begin with, Fig. 4 tells us we have about a 200-Hz low-frequency panel cutoff for this room, based on the 16-foot dimension. Table I gives a minimum width, for each array of panels, of about 3.6 feet. In addition, with this rather low cutoff frequency, fiberglass of at least 2-inch thickness and 4 to 6-pound density will be re-

HOW SOUND IS ABSORBED

The process of sound-wave absorption is a complex one, actually involving several simultaneous mechanisms. In general, absorption is accomplished by converting the acoustic energy in the air into other forms of energy, such as simple heat or mechanical motion.

Specifically, in a fibrous tangle (such as fiberglass or rock wool), the acoustic waves that enter the material will also proceed to propagate through it. In the process, a portion of their energy will be converted into heat by the frictional and viscous properties of the tangle. In addition, the fibers of the material are set in limited motion, further reducing the energy in the wave. Altogether, the cumulative effects of these mechanisms will vary with two important factors: Density of initial packing, in pounds per cubic foot, and the mass of each of the fibers in the material used.

One other effect of the fibrous tangle is the reduction of the speed of sound (normally about 344 meters/second, or 1,130 feet/second) for the waves passing through the material. Fig. B1, after the work of Bradbury [2], shows the change, which is a function of the density of the material according to the formula:

$$\alpha = \sqrt{1 + \frac{\text{density of material}}{\text{mass-density of air}}}$$

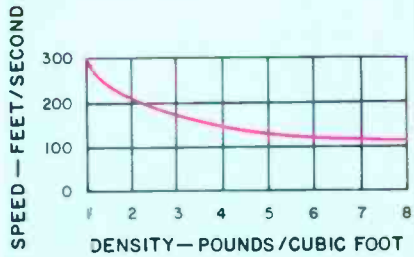


Fig. B1—Speed of sound versus packing density of material. Speed in air is normally 1,130 feet per second. (After Bradbury.)

Table II—Percentage absorption vs. frequency for fiberglass panels of various densities. (After Knudsen, Owens-Corning Fiberglas Corp.)

ABSORPTION OF 2-INCH THICK FIBERGLASS (%)

Lbs./Ft.^{3}	128 Hz	256 Hz	512 Hz	1,024 Hz	2,048 Hz	4,096 Hz
2	32	50	83	86	74	—
3	43	60	92	88	77	87
4	55	69	96	94	87	—
6	57	80	97	97	92	—

ABSORPTION OF 3-INCH THICK FIBERGLASS (%)

Lbs./Ft.^{3}	128 Hz	256 Hz	512 Hz	1,024 Hz	2,048 Hz	4,096 Hz
2	43	76	98	93	87	87
3	68	80	99	97	82	79
4	72	97	99	97	90	81

Photograph: William R. Hoffman

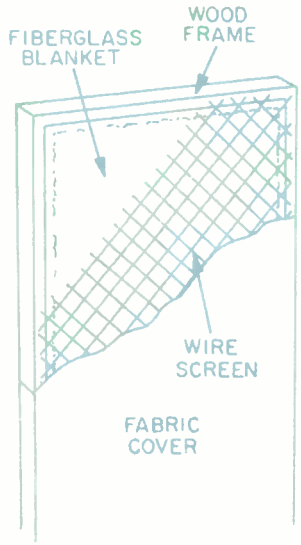


Fig. 3—Photo and cutaway view of absorption panel's construction. The panel should have a solid backing (not shown).

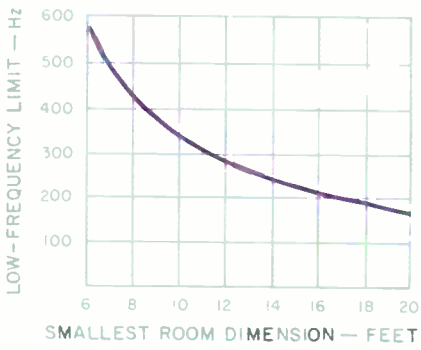


Fig. 4—Lowest effective frequency for acoustic-panel absorbers as a function of room size (where f = 3,390/smallest room dimension in feet). For frequencies below those shown, other forms of absorption (such as wave cavities) would be needed.

You may not like your speaker system after using these LEDE panels, but you will know much better what it really sounds like.

quired. Indeed, such a system will benefit from even more absorption, to help reduce the multiple return echoes that occur in such a large room, so a 3-inch thickness is recommended.

To complete the design work in this example, it is obvious these large speaker systems will require either a large number of panels or a few panels very wide and tall. In this case, we can allow the builder to choose his design to fit his space and needs. As an example, panels 3 feet wide, two behind each speaker and one on each side (for a total of eight), may be chosen, with a minimum height of about 11 feet (the speaker height of 7.5 feet, plus the array minimum-width dimension of 3.6 feet). Their thickness would be 3 inches, plus backing thickness. Please note here that with panels this heavy and tall, vertical stability may be a problem. Therefore, additional upright supports may be necessary or possibly even suspension from the ceiling.

Final Suggestions

Now that the basic LEDE system design has been prepared, a few additional points need to be made for the system to work at its best.

First, the LEDE system we have considered here has been designed to prevent any early reflections on all critical walls within the listening area. But there are other sources of problems. The first is the floor directly in front of the loudspeakers. In most rooms, the floor is only a foot or so beneath the loudspeaker drivers, and therefore is potentially a source of early reflections. In many rooms, carpeting covers much or all of the floor, minimizing these reflections. If it does not, then some kind of substitute must be provided. A rug, or similar, will suffice in most cases, provided that it extends at least 5 to 10 feet in front of the speakers.

Another source of reflections is the ceiling, especially if it is low and the loudspeakers are tall, or set on tall stands. Again, in most cases this is not a problem, as contemporary construction usually includes adequate ceiling treatment. In the event this is not the case, then acoustical tile or similar material, should be used.

A second point: With the advent of Time Delay Spectrometry, an interesting phenomenon was noted when testing some rooms for the effect of early reflections. When a loudspeaker was set firmly on an acoustically live surface, such as a wooden floor, the measured output from the loudspeaker also included some "pre-echo"—sound that originated from the speaker, yet arrived before the speaker's direct sound through the air. This phenomenon was traced to the wooden floor—vibrations from the bass driver were coupled through the speaker cabinet, then through the floor, and were then re-radiated into the air near the microphone used for the measurements. The wood was conducting the sound faster than the air did, and therefore brought the sound to the pickup microphone first. This somewhat surprising phenomenon is also a source of early-reflection effects, and it will cause the same response irregularities as shown in Fig. 2B. Therefore, the treatment of the floor with a carpet has a second advantage: Seeing that the loudspeakers are not firmly coupled by their own weight to a *transmittive* surface that can retransmit sound into the air.

Finally, a word of caution. Attempting to implement the LEDE concept in systems where the loudspeakers are a "Direct Reflecting" type will not be successful. These speakers *require* the many early reflections, because this is what provides the acoustic effects that the systems were designed to have. Under such circumstances, a live, unaltered room is absolutely necessary. For all other system types, even dipole "screen" systems, that do have a degree of backward radiation, the LEDE treatment will still work well. These speaker types do not exclusively depend on their rear radiation for normal operation.

We will conclude this design feature by describing a more complete implementation of the LEDE system, one in which we will actually modify the room surfaces themselves.

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1. Haas, H., "The Influence of a Single Echo on the Audibility of Speech," *Journal of the Audio Engineering Society (JAES)*, Vol. 20, 1972.

2. Bradbury, J. L. S., "The Use of Fibrous Material in Loudspeaker Enclosures," *JAES*, Vol. 24, 1976.

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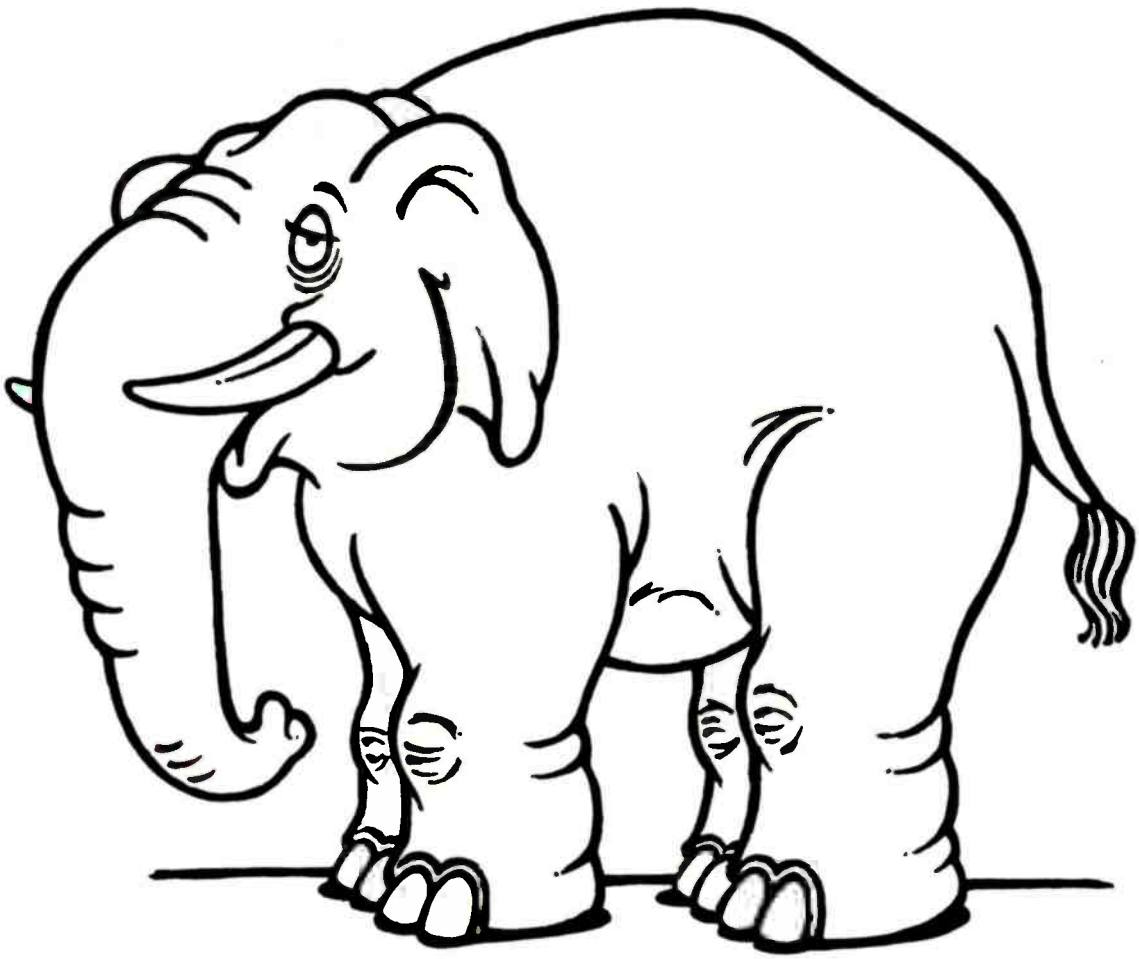

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McLAREN 402 PREAMP AND 702 AMP

Manufacturer's Specifications

Preamplifier

Frequency Response: Phono, RIAA ±0.2 dB, 20 Hz to 20 kHz; high level, 5 Hz to 100 kHz, +0, −1 dB.

THD: Less than 0.015%, 20 Hz to 20 kHz, at rated output level, for any input or output.

S/N Ratio: MM phono, 82 dB A-weighted, 74 dB unweighted, re: 5 mV; MC phono, 76 dB A-weighted, 68 dB unweighted, re: 0.5 mV; high level, 100 dB A-weighted, 94 dB unweighted, re: 500 mV.

Input Sensitivity (For Rated Output at 1 kHz): MM phono, 1.0 mV; MC phono, 100 μV; high level, 100 mV.

Input Overload Level (At 1 kHz): MM phono, 150 mV; MC phono, 15 mV; high level, infinite.

Input Impedance: Phono, 47 kilohms, user-selectable to any lower value; high level, 50 kilohms.

Output Impedance: 100 ohms.

Output Level: Rated, 1.0 V; maximum, 16 V.

Tone-Control Range: Bass, ±8 dB at 100 Hz; treble, ±8 dB at 10 kHz.

Phase: With tone controls bypassed, noninverting from phono to main out, inverting from high level to main out, both reversed by switching tone-control circuits in; inverting from phono to tape out.

Dimensions: 16.5 in. W × 4.1 in. H × 11.2 in. D (42 cm × 10.5 cm × 28.5 cm).

Weight: 14.3 lbs. (6.5 kg).

Price: $1,495.

Power Amplifier

Power Output: 100 watts rms per channel continuous (120 watts IHF dynamic power), both channels driven into 8 ohms; 160 watts rms per channel continuous (200 watts IHF dynamic power), both channels driven into 4 ohms.

Power Bandwidth: 10 Hz to 50 kHz.

Rated THD: Less than 0.05%, 20 Hz to 20 kHz, at or below rated output.

Frequency Response: 5 Hz to 60 kHz, +0, −1 dB; −3 dB at 120 kHz.

S/N Ratio: 110 dB, A-weighted, below rated output.

Rise-Time: 2.5 μS at rated power.

Channel Separation: 70 dB, 20 Hz to 20 kHz.

Input Sensitivity: 1.0 V rms for rated output.

Input Impedance: 50 kilohms.

Output Impedance: 0.05 ohm.

Phase: Noninverting.

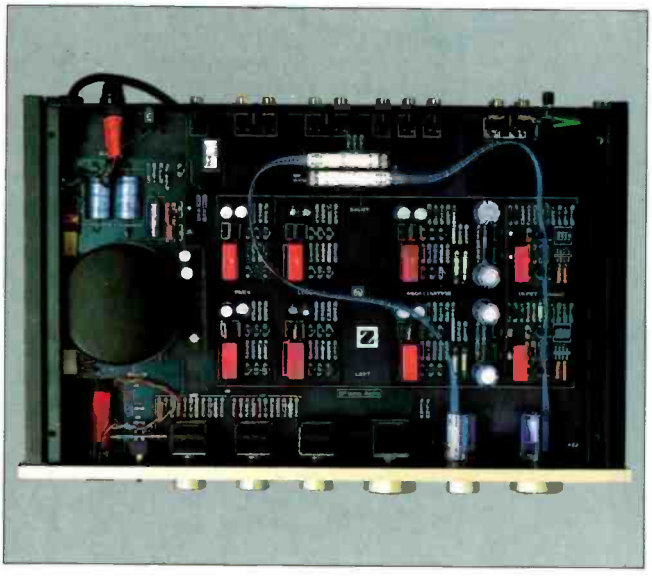
Dimensions: 16.5 in. W × 4.1 in. H × 11.6 in. D (42 cm × 10.5 cm × 29.5 cm).

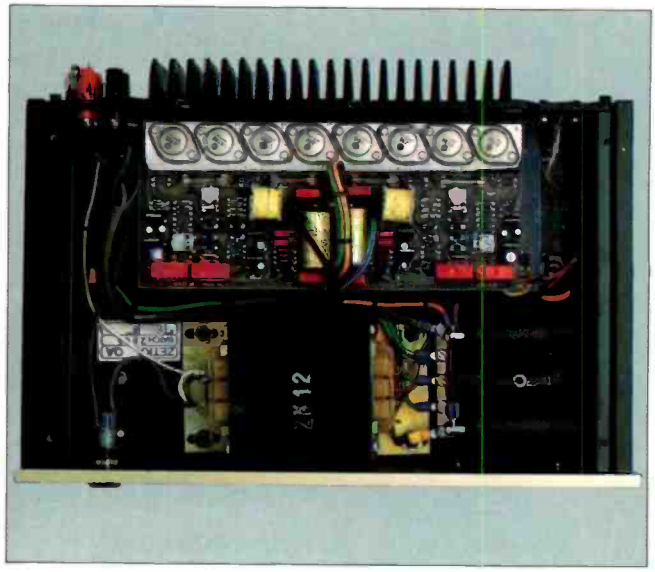
Weight: 28.6 lbs. (13 kg).

Price: $1,195.

Company Address: c/o AudioQuest, 629 Camino de Los Mares, #306, San Clemente, Cal. 92672.

For literature, circle No. 90





Photograph: ©1986, Bill Kouirinis

The McLaren 402 stereo preamp and 702 power amplifier are very attractive, nicely made pieces of audio gear from New Zealand. I heard the 402 preamp and a pair of the 902 mono power amps driving a pair of Vandersteen speakers at the '86 Winter CES and was favorably impressed with the sound. As it turned out, *Audio* had the 402 and 702 slated for review, and they turned up on my doorstep a month or so after the show.

Construction

Both units are built up from two thick aluminum-extrusion sides bolted to the front panels. The rear panels and bottom plates bolt to the extrusions. The top covers slide from the rear into slots in the extrusions and are held in place by four Allen-head bolts. In both units, the top covers are mounted so as to allow an air space about a quarter of an inch high by 14 inches wide; this allows internal heat to escape out the rear.

The power amp's rear panel is a thick aluminum casting with vertical fins over most of its outside surface. Two pairs of five-way speaker binding posts, a pair of female RCA input jacks, a line fuse, and a power cord are on this panel. A horizontal ledge on the inside of the rear-panel casting has four pairs of Hitachi power MOS-FETs in TO-3 metal cases mounted on it. A p.c. board extending under the ledge picks up the power-transistor pin connections and carries the rest of the amplifier circuitry. A pair of 15,000-μF, 63-V main filter capacitors are mounted on their sides near the right front of the amplifier. A bus bar connects the ground sides together and serves as a means to connect the various circuit grounds to this point. A good sized EI-lamination power transformer is mounted to the amp's bottom plate at front center. On the front panel are a pushbutton power switch anc a yellow LED to indicate when power is turned on.

The preamp has a large p.c. board that takes up the whole interior of the unit. A potted toroidal power transformer and the other power-supply components are located along the left side of this board. Tone, balance, and volume control potentiometers are sealed Alps dual units which mount to the front of the p.c. board. The tape source and main selector knobs operate rotary-to-linear converter mechanisms that control, via a flat metal cable, remotely located slide switches at the rear of the board near the signal input jacks. The preamp's active signal circuitry takes up the remainder of the board space. Of note here is the use

Of note in the preamp's construction is the use of a "star grounding" scheme where all grounds come from various points to one common point.

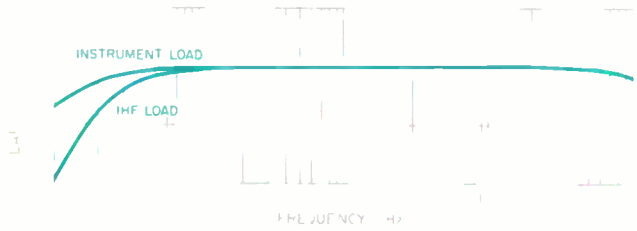


Fig. 1—Line-level frequency response, 402 preamplifier, for reviewer's instrument load (see text) and for standard IHF load.

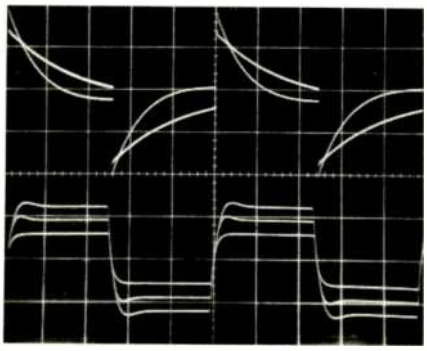


Fig. 2—Square-wave response, 402 preamp line-amplifier section. Upper traces are for 20-Hz signal, with instrument load and (showing greater tilt) with IHF load. Lower traces are for 20 kHz, right channel, with balance control set full right (largest trace), centered, and set full left (smallest trace). Scales: Vertical, 2 V/div.; horizontal, 10 mS/div. (upper traces), 10 μS/div. (lower traces).

of a "star grounding" scheme whereby all signal grounds come from various points in the circuitry to one common point. Signal in/out jacks are gold-plated p.c.-mount types.

The preamp's front-panel controls, from left to right, are a pushbutton power switch; a tone-control bypass toggle switch; and rotary knobs for bass, treble, balance, volume, record-out selection, and main input selection. A yellow power-on LED is located above the power switch. On the rear panel are the signal input and output jacks, power cord, line fuse, and a ground terminal post.

Preamplifier Circuitry

The 402 preamp consists of four active circuit blocks per channel: A phono input stage, phono equalizer, output or line amplifier, and tone-control amplifier. All of these blocks have essentially the same circuit topology—complementary dual-differential input amplifiers driving complementary common-emitter output stages whose collectors are tied at the output point. All have direct-coupled inputs and capacitor-coupled outputs. Emitter degeneration (negative feedback) is not used in the input stages but is used in the output stages.

The input-stage emitter pairs are fed via a simple resistor tied to the appropriate supply rail. All devices are bipolar. Each block has its own three-terminal plus-and-minus regulator. The phono input stage operates the differential amps at 5 mA per device and has a switchable feedback loop for two closed-loop gains: 21.5 dB for moving-magnet cartridges and 43.3 dB for moving-coil. Frequency response is flat in this stage. The shunt feedback resistor in the moving-coil feedback divider is 4.7 ohms for lowest noise in this mode. There are two 4PST DIP switches on the p.c. board, one for each channel, to control the mode of the phono input stage. Two poles select the feedback divider, a third puts 1,000 pF across the phono input in moving-coil mode, and the fourth pole selects 100 ohms or 47 kilohms for phono-input resistive loading. The phase of the phono input stage is noninverting. Output coupling to the phono equalizer is via a 1-μF polypropylene capacitor. The equalizer stage is configured as an inverting amplifier. The input resistor is split into two parts with a capacitor to ground at the junction of the two resistors. This forms a passive roll-off at 2,120 Hz for the high-frequency equalization. The feedback network contains an RC network to accomplish the bass boost between 50 and 500 Hz. A consequence of this phono topology is that absolute phase is inverted at the tape output for a correctly connected phono cartridge.

The main and tape-out selector switches in the 402 are functionally very effective. All high-level inputs, including both tape inputs and the output of the phono equalizer, go to the contacts of both switches. The wipers of the tape selector go to tape out, and the wipers of the input selector go off to the volume controls feeding the output amplifiers. This arrangement allows one to record and listen to each input source independently.

The line amplifier is different from most such circuits in that it is connected in the inverting mode instead of the more usual noninverting connection. The output of the volume control, which is 50 kilohms, drives the input summing resistor, which has a value of 12 kilohms. This causes the

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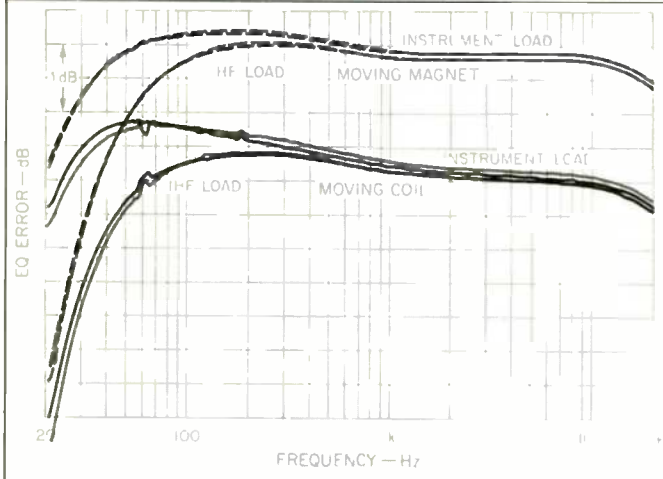

Fig. 3—RIAA equalization error for 402 preamp's MM and MC inputs, with instrument and IHF loads. Note the low-end roll-off and the expanded scale.

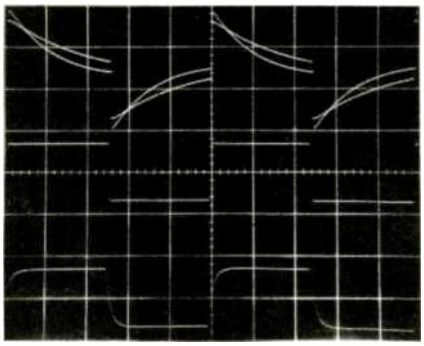

Fig. 4—MM phono response, 402 preamp, to pre-equalized square waves at 40 Hz (top traces), 1 kHz (middle trace), and 10 kHz (bottom trace). Note effects of IHF (greater tilt) and instrument loads at 40 Hz. Scales: Vertical, 2 V/div.; horizontal, 5 mS/div. (top), 200 μS/div. (middle), 20 μS/div. (bottom).

high-level input impedance or the load on the phono equalizer to drop down to only about 10 kilohms when the volume control is fully up. This is not a likely occurrence in normal use, but it can arise. For example, I ran into this condition when using a 0.5-mV moving-coil cartridge in the moving-magnet phono mode. I had to set the volume control close to maximum to get the listening levels desired.

The balance function is accomplished by altering the feedback resistors in the line amplifier in a complementary manner with the balance-control dual potentiometer. When the balance control is centered, gain is set at about 21 dB by the ratio of the feedback resistors to the input resistors. The balance control alters the gain of each channel by ±3 dB for a total channel difference of 6 dB.

The tone-control amplifier, the last active block in the chain, is always driven by the output of the line amp. The circuit is inverting, using the usual Baxandall tone-control topology with a gain of −1. The main output jacks are connected to the wipers of a DPDT toggle switch that selects either the main output of the line amp or the output of the tone-control amp.

Since the phono output is inverting and the line amp is inverting, the overall phase from phono input to main out is noninverting. However, high-level inputs to main output *are* inverting but can be rendered noninverting (at the expense of adding the tone amp) by engaging the tone-control switch. The only thing one can't correct is the inverting phase of the phono input to tape out. High-level inputs to tape out are, of course, noninverting, as there are no active electronics in this path.

The power-supply circuitry of the 402 preamp starts out with full-wave-rectified ±34 V d.c. filtered by two 1,000-μF/50-V capacitors. This rectified and filtered d.c. is regulated down to ±27 V d.c. by 24-V, three-terminal regulators with their reference terminals going to ground through 3-V zener diodes. The regulator outputs are bypassed by 100-μF electrolytics and 0.1-μF film capacitors. The first stage of the phono preamp is regulated down to ±11 V by a zener-follower arrangement.

Power Amplifier Circuitry

The 702 power amplifier's circuitry is fairly simple and straightforward; it consists of a two-stage differential amplifier with a turn-around circuit in the second stage, driving two pairs of complementary MOS-FET power devices in parallel. All front-end transistors are bipolar. The signal input to the input differential amp is capacitor-coupled by a 1-μF polypropylene capacitor loaded with 47 kilohms to ground, followed by a 2 2-kilohm series resistor and a 330-pF capacitor to ground at the noninverting base. The input devices are PNP, with an overall d.c. output offset-adjustment pot in their emitter circuit. Collector outputs of the first stage are direct-coupled to the bases of the second differential stage, which utilizes NPN devices. One collector output is part of the composite drive to the output stage; it is connected to the bottom of the bias-spreading resistor and drives the gates of the P-channel output devices. The other output collector goes up to the base of a PNP device which has a diode in series with 100 ohms up to a positive power supply. The emitter of this transistor also goes, through 100 ohms, to


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Measured noise and crosstalk in the phono circuitry is quite good, though there is a low-end roll-off in moving-magnet.

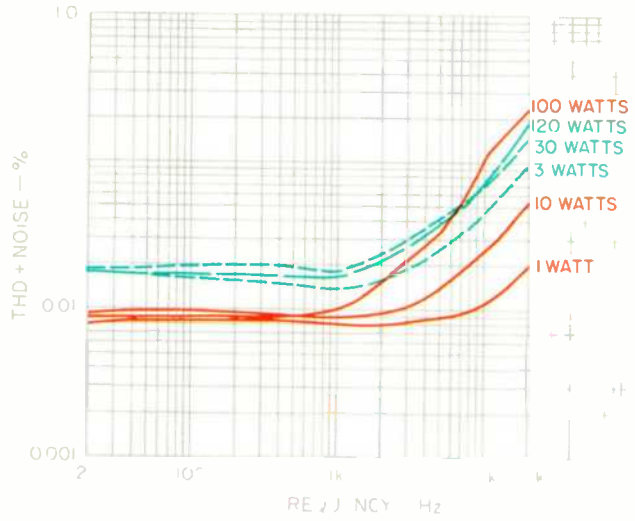

Fig. 5—THD + N vs. frequency, 702 amplifier, for power levels of 1, 10, and 100 watts into 8 ohms (solid curves) and 3, 30, and 120 watts into 4 ohms (dashed curves).

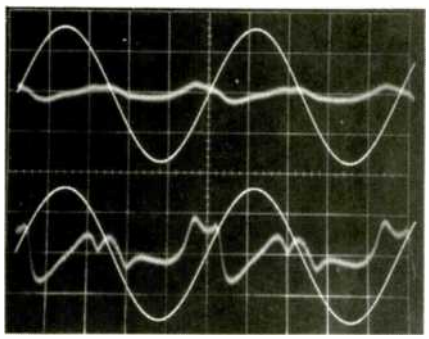

Fig. 6—Harmonic-distortion residue, 702 amp, for two frequencies, at 10 watts output into 8-ohm loads. Upper traces show 0.008% THD at 1 kHz; lower traces show 0.025% THD at 10 kHz. Note similarity between distortion waveforms (see text).

the same positive supply. The collector goes down to the positive end of the bias-spreading resistor and drives the gates of the N-channel output MOS-FETs. The function of the aforementioned turn-around transistor is to take one of the differential output phases of the NPN differential pair, invert that phase, and add the resultant output to the other phase to develop a complementary signal based to ground; this drives the output stage. The output resistance of this drive stage is fairly high. Most designs that use MOS-FET output devices use an additional complementary emitter-follower stage to more effectively drive the considerable capacitance that MOS-FETs have at high frequencies. On the other hand, the 702 has one less stage and may be sonically the better for it.

Overall negative feedback is taken from the output to the inverting input of the input differential amp via a series resistor bypassed by a small capacitor. The shunt feedback resistor is returned to ground through a 220-μF capacitor bypassed by a 1-μF polypropylene film capacitor. Thus, the d.c. gain of the circuit is 1, with an input roll-off of about 3 to 4 Hz and a second roll-off, in the feedback network, of about 0.9 Hz.

A full-wave bridge-rectified supply provides ±53 V d.c. for both output stages. A separate half-wave-rectified supply provides power for two positive regulators and one negative regulator for each channel to feed the front-end circuitry with one negative and two positive voltages. These voltages are higher than the output-stage potentials to ensure full drive to the MOS-FETs.

Preamplifier Measurements

Line-amp gain of the McLaren 402 was found to be about 10.75× or 20.6 dB. This yields an IHF sensitivity for AUX inputs of some 46.5 mV. Output impedance of the line amp was a low 36 ohms in series with 1 μF. With the tone stage switched in, output impedance was found to be lower yet (due to more feedback from its −1 gain), about 5 ohms in series with 1 μF.

THD + N at 10 V rms output was less than 0.01% from 20 Hz to 20 kHz for my instrument load (91 kilohms in parallel with 250 pF) or the IHF load of 10 kilohms in parallel with 1,000 pF. This was true whether the tone stage was switched in or not. Clipping level was some 16 V rms. The line amp would drive 600 ohms to 10 V rms at about 0.3% distortion, although the 3-dB low-frequency cutoff point was around 260 Hz due to the 1-μF output coupling capacitor.

Frequency response for the line section is shown in Fig. 1. The low-frequency roll-offs are due to the 1-μF output coupling capacitors.

Channel-to-channel crosstalk was measured using the "CD" high-level input, with the volume control fully on and the undriven input terminated by 1 kilohm. Results differed slightly, depending on which channel was driven. For the worse direction, R to L (drive right, measure left), crosstalk was better than −80 dB up to 10 kHz, increasing to −78.8 dB at 20 kHz and −66.7 dB at 50 kHz. With the tone stage engaged, crosstalk increased to −70.8 dB at 20 kHz and −61.4 dB at 50 kHz—very good figures. The crosstalk signals were in phase for pulse or square-wave excitation.

Volume-control tracking was found to be within ±0.2 dB

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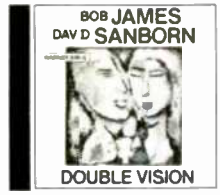

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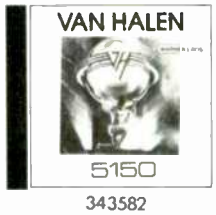

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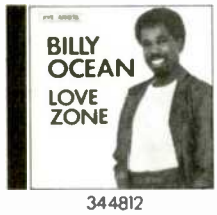

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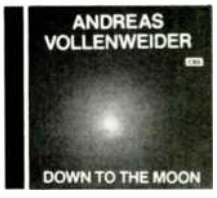

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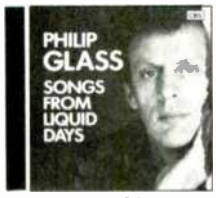

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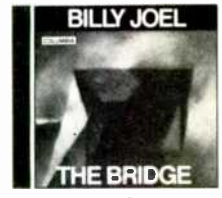

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286914. Fleetwood Mac—Rumours, #1 Hit Album. Includes *Don't Stop*; more. (Warner Bros.)

346767. Johnny Mathis—Most Requested Songs. (Columbia)

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337519. Heart. Top 10 Album. *What About Love*; etc. (Capitol)

339242. Puccini Heroines. Eva Martan, Renata Scotta, etc. (CBS Masterworks)

321570. Beethoven: Symphony No. 5; Schubert: Symphony No. 8—Larin Maazel, Vienna Phil *(Digital—*CBS Masterworks)

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346809. Dvorak: Symphony No. 9 "New World"/Carnival Overture. Landon Phil Orch. (Verese Sarabande)

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Table IA—Phono noise referred to input, MM mode.

Source Impedance, Ohms	Bandwidth	Phono Noise L	Phono Noise R
0	400 Hz to 30 kHz	355 nV	382 nV
0	A-Weighted	252 nV	289 nV
100	A-Weighted	260 nV	293 nV
1k	A-Weighted	347 nV	367 nV
IHF MM	A-Weighted	1.82 μV	1.72 μV

Table IB—IHF phono S/N (re: 5-mV, 1-kHz input), MM mode.

Source Impedance, Ohms	Bandwidth	S/N, dB L	S/N, dB R
0	A-Weighted	86.0	84.8
100	A-Weighted	85.7	84.6
1k	A-Weighted	83.2	82.7
IHF MM	A-Weighted	68.8	69.3

Table IIA—Phono overload vs. frequency and loading, MM mode, right channel.

	IHF Load		Instrument Load	
Frequency	E Out, V	E In, mV	E Out, V	E In, mV
20 Hz	10.4	20.2	14.6	20.2
100 Hz	14.9	33.0	15.5	33.0
400 Hz	15.4	96.5	15.5	96.5
1 kHz	15.3	152.0	15.3	152.0
3 kHz	15.1	260.0	15.3	260.0
6 kHz	15.4	465.0	15.5	465.0
10 kHz	14.8	780.0	14.9	780.0
20 kHz	7.25	620.0	7.3	620.0

Table IIB—Phono overload vs. frequency and loading, MC mode, right channel.

	IHF Load		Instrument Load	
Frequency	E Out, V	E In, mV	E Out, V	E In, mV
20 Hz	10.5	2.0	14.8	2.0
100 Hz	15.0	3.4	15.6	3.4
400 Hz	15.2	9.6	15.3	9.6
1 kHz	15.4	15.2	15.5	15.2
3 kHz	15.2	26.5	15.3	26.5
6 kHz	15.4	46.5	15.4	46.5
10 kHz	13.9	70.0	14.0	70.0
20 kHz	7.0	70.0	7.1	70.0

down to −45 dB, ±0.5 dB to −60 dB, and almost 3 dB out at −70 dB.

Rise- and fall-time for the line amp, with or without the tone amp engaged and with instrument or IHF loading, was 1.8 μS up to ±20 V output. Further, it was about the same with the volume control down 6 dB from maximum. This is good performance. The right channel had about 6% overshoot, probably due to the tolerance of the small capacitors across the feedback resistors in the line-amp circuit. 'Scope photos of the line section's square-wave performance are shown in Fig. 2. The top traces are for a 20-Hz signal for instrument and for IHF loading; the greater tilt is for the IHF loading. The bottom traces are for a 20-kHz signal through the right channel, with the balance control fully clockwise, centered, and fully counterclockwise. The highest amplitude trace is for the clockwise (maximum right) position.

Phono preamp gain in the moving-magnet mode turned out to be 101× or 40.1 dB at 1 kHz. I ran into erratic results when attempting to measure MC gain by feeding both input channels in parallel from a common source, my usual method. Further investigation revealed a tendency for the preamp to oscillate at about 10 MHz when the inputs were paralleled physically close to the jacks in MC mode. With one input driven at a time, gain was stable enough to be measurable. This instability under measurement conditions also prevented reliable assessment of input noise in the MC mode with low-value terminating resistors plugged directly into the input jacks. All of this seems to be a peculiarity that the 402 displays only under measurement conditions—I had no problem using the unit in several audio systems. The majority of cartridges, with no external tie points between their signal grounds, would act as separate signal sources of each channel; therefore, the problem would not occur. When finally measured, moving-coil gain turned out to be 60 dB at 1 kHz. Phono sensitivity (IHF) measured 5 mV for MM and 500 μV for MC from phono to tape out, and 465 μV for MM and 46.5 μV for MC from phono to main out.

Phono noise in MM mode is summarized in Tables IA and IB. MM input noise in the band from 400 Hz to 20 kHz appeared to be about 100 nV. In use, the subjective noise in MC mode was about 10 to 12 dB quieter than in MM mode.

Phono overload versus frequency and loading is summarized in Tables IIA and IIB. One thing is of note here: Up to about 10 kHz, the output waveform indicated overload by distorting one or both peaks in some way. Above 10 kHz, the input acceptance should about double, theoretically, but does not in this design. Looking at the THD residue while doing this test, peak aberration turns into a symmetrical compression above 10 kHz, indicating that the first-stage block of the phono preamp circuit is probably clipping. Still, 152 mV at 1 kHz for MM is a good, respectable figure. Large-signal response to a pre-equalized, non-band-limited square wave into the phono section was good up to about ±2 V. Above this output level, the waveform started to symmetrically compress the high frequencies.

Phono equalization error for MC and MM modes, measured at tape out, is shown in Fig. 3. Of interest is the very noticeable roll-off in the low end, especially with the IHF load. For some reason that I don't understand, the low-end roll-off is worse for MM than for MC. One thing to remember in this design is that the more clockwise the volume control is, the lower the load impedance that the volume control/line amplifier will present to the phono output, the limit being about the 10 kilohms of the IHF load. I don't care for this measured characteristic in the 402, as I believe that the lower the low-frequency response—all other factors remaining the same—the better the overall sound.

The phono section's square-wave response in MM mode is shown in Fig. 4. The top traces are a 40-Hz signal, shown

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The primary function of an amplifier is to take a very small audio signal from a source such as record, tape or CD, and amplify it to a level that is strong enough to drive a loudspeaker. However, amplifiers are usually designed not with loudspeakers as a load, but instead with rather simple loads using resistors of fixed impedance. It is well known that the electrical characteristics of loudspeakers provide a complex load to the amplifier, resulting in less than ideal performance.

Typically, conventional amplifiers use a main (or primary) power transformer to convert the household AC current to lower levels suitable for the amplifier's output stage. Unfortunately, due to the reactive nature of loudspeakers, a phase shift between the power supply's charging voltage and current is inevitable. The more complex the speaker load and the music signals being amplified, the greater the phase shift. This phase degradation is audible, resulting in poor stereo imaging and a lack of bass definition.

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ONKYO

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The 702 amp can provide an extremely smooth and spacious sound, with a harmonic "rightness" which will amaze.

with instrument and with IHF loading, the latter having the greater tilt. The middle (1-kHz) and bottom (10-kHz) traces look the same with IHF or instrument loading.

Finally, MM phono channel-to-channel crosstalk was measured with the undriven channel terminated by 100 ohms. Results were extraordinary—greater than 80 dB down, from 20 Hz to 50 kHz, in both directions. With the undriven channel terminated by the IHF MM load, crosstalk was absolutely symmetrical (a first) in both directions, rising to −60.6 dB at 5 kHz and peaking at −50 dB at 9 to 10 kHz.

Power Amplifier Measurements

The 702 power amp was run at one-third power (33.3 watts) into 8-ohm loads for one hour. The heat-sinks got very hot during this interval. Since I could not find any indication of a thermal cutout in the schematic, I decided not to run the test into 4-ohm loads.

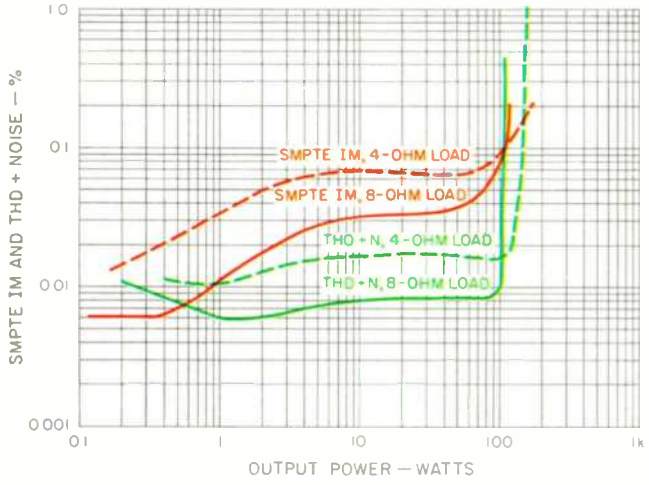

Fig. 7—Distortion vs. frequency, 702 amp, showing THD + N at 1 kHz, and SMPTE IM, for 8- and 4-ohm loads.

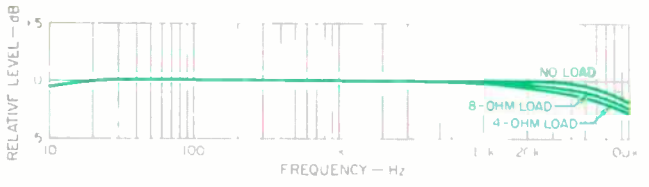

Fig. 8—Frequency response, 702 amp, with no load (open circuit) and with 8- and 4-ohm loads.

Voltage gain was found to be 33.5× or 30.5 dB, which yields an IHF sensitivity of 84.4 mV to produce 1 watt into 8 ohms. The manufacturer's spec for input sensitivity is 1 V to produce rated output; in view of the measured gain, input sensitivity for rated output is more like 0.84 V.

THD + N as a function of power, frequency, and load is shown in Fig. 5. Typical harmonic-distortion residue is shown in Fig. 6 for 10-watt outputs at 1 and 10 kHz. Sensitivity for distortion is the same in both 'scope traces. I measured 1-kHz distortion as 0.008% and 10-kHz distortion as 0.025%. What is interesting is that the wave shape is very similar for the two frequencies. The magnitude increase at 10 kHz is probably due to lower loop gain (less feedback) at higher frequencies. There are no stability-compensation capacitors per se in the circuit except the small one across the feedback resistor. Therefore, I deduce that the reduction in loop gain at higher frequencies is most likely due to the high drive impedance to the MOS-FET output transistors against their input capacity. Figure 7 shows 1-kHz distortion versus power and load, along with SMPTE-IM distortion.

Dynamic power was found to be 121 watts into 8 ohms and 210 watts into 4 ohms. Steady-state clipping power was 105 watts into 8 ohms and 160 watts into 4 ohms. All tests were done, as usual, with 120-V a.c. line power.

Frequency response, at a 1-watt level into 8 ohms (2.83 V rms), is shown in Fig. 8 for no load (open circuit), 8-ohm loading, and 4-ohm loading. 'Scope photos of square-wave behavior appear in Fig. 9. The top traces are for a 10-kHz signal with no load and with loads of 8 and 4 ohms. The middle trace is for 10 kHz loaded with 8 ohms in parallel with 2 μF. The bottom trace is for 40 Hz with an 8-ohm load. The output buffering inductor in this design seems to have more inductance than usual, as evidenced by the top traces in Fig. 9, where the effect of output loading at the higher frequencies extends more into the half-cycle time of the 10-kHz signal. However, the low ringing on the 8-ohm, 2-μF load is exemplary. Rise- and fall-time into 8 ohms was 2.8 μS at ±5 V output. Large-signal rise- and fall-time increased to 3 μS, with some overshoot on the positive-going transition only. Clipping behavior at high frequencies showed considerable evidence of "sticking."

Crosstalk versus frequency was measured with the undriven channel terminated in 1 kilohm. The crosstalk was some 6 to 8 dB worse in the right-to-left direction and still measured better than −80 dB at 1 kHz, rising to −69 dB at 5 kHz, −56.7 dB at 20 kHz, and −49.5 dB at 50 kHz.

Signal-to-noise ratio (IHF) for the 702 amp was 95.3 dB for the right channel and 93.8 dB for the left. Damping factor versus frequency is shown in Fig. 10.

Regarding peak current delivery: I have been using, at different times, 0.1- and 1-ohm loading for this test. It is obvious that 1 ohm is a more realistic load to use, as some speakers have been known to dip down to nearly 1 ohm but certainly not to 0.1 ohm. Accordingly, I have decided to use 1 ohm for this test from now on. The 702 was able to deliver a respectable ±24 amps into 1 ohm with one channel driven using the IHF 1-kHz tone-burst signal.

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Now, there's a new standard for receiver convenience and separates performance. The ONKYO Integra TX-108.

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I have listened to these units for hours on end without irritation, and am fairly satisfied with their presentation.

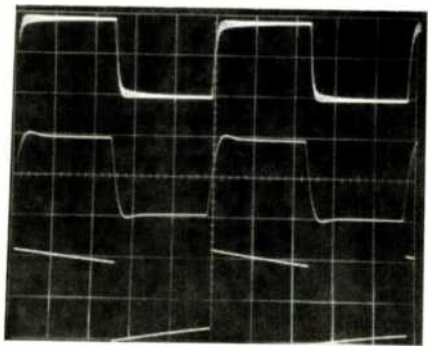

Fig. 9—Square-wave response, 702 amp. Top traces: 10 kHz into 8- and 4-ohm resistive loads and into open circuit (no load). Middle trace: 10 kHz into 8 ohm, 2-μF load. Bottom trace: 40 Hz into 8-ohm load. Scales: Vertical, 5 V/div.; horizontal, 20 μS/div. for 10-kHz traces, 5 mS/div. for 40-Hz trace.

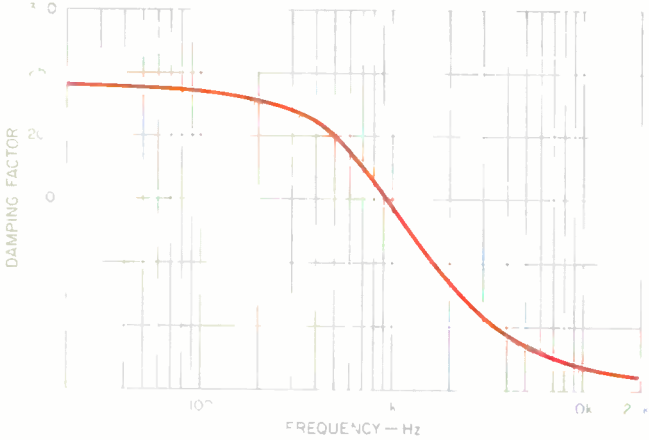

Fig. 10—Damping factor vs. frequency, right channel, 702 amp.

Use and Listening Tests

Equipment used in my system to evaluate the 402 and 702 included an Infinity air-bearing turntable and arm with a Koetsu EMC-1B cartridge and Infinity RS IIB speakers. Other electronics on hand were Robertson Twenty Twenty and Cook/King reference preamplifiers and Marantz Nine power amplifiers.

My first reaction to the McLaren components was that the preamp was pretty good and the amp wasn't so good. However, after both pieces had warmed up by being left on for a couple of days, I found myself commenting, "This equipment makes pretty good music after all." I would definitely recommend leaving these pieces on continuously; otherwise, one will never hear them at their best. I found that the sound of the preamp was noticeably better in the MM mode using my 0.5-mV Koetsu than in the MC mode, considerations of noise, and of bass roll-off with volume control at max, aside. No operational glitches were observed in use with either piece, separately or in combination with other components. Subjectively, I didn't like the tone-control characteristics because the turnover frequencies seemed to be too low for the bass and too high for the treble.

The importer of the McLaren equipment informed me of a modification to the power amp that has improved its sound and is representative of current production. This consists of bypassing the four internal power-supply fuses with 0.01-μF Wonder Caps. After receiving and installing these capacitors, I warmed up the amp again and found that, indeed, the sound was better. I have listened to these units for hours on end without irritation and have been fairly satisfied with their presentation.

I tried the preamp in a friend's system which includes Snell Type A-III speakers, a conrad-johnson PV5 preamp, a Robertson Forty Ten amp for bass, and Gordon Mercer feedback-less tube amps for mid/highs. The sound was very good and musical with the McLaren preamp in this system. It was interesting to find that when an Infinity hybrid Class-A power amp was substituted for the Gordon Mercer tube amps for mid/highs, the system also sounded very good, and similar to the sound with the tube amps. However, when the conrad-johnson PV5 preamp was reinstalled in place of the McLaren, the sound wasn't so hot with the Infinity amp, but was good again with the tube amps—one of the many combinational puzzles I've encountered.

The 702 power amp was tried in the system of my associate Geoff Cook, where we used it as a bass amp up to 300 Hz along with a Crown Microtech 1000 and a Robertson Sixty Ten. The McLaren 702 was judged to be the best in this application by a considerable margin.

In my system, I have used the 402 preamp with Marantz Nine power amplifiers and have obtained very good results. Even better results come from using the 702 power amp with the Cook/King reference tube preamp; this is what makes me suspect that the power amp has better sound than the preamp. Sound with the combination of 702 and Cook/King is extremely smooth and spacious, with a harmonic "rightness" that continues to amaze me.

In conclusion, I would have to say that I like these pieces of McLaren gear quite a lot and would recommend a serious listen.

Bascom H. King

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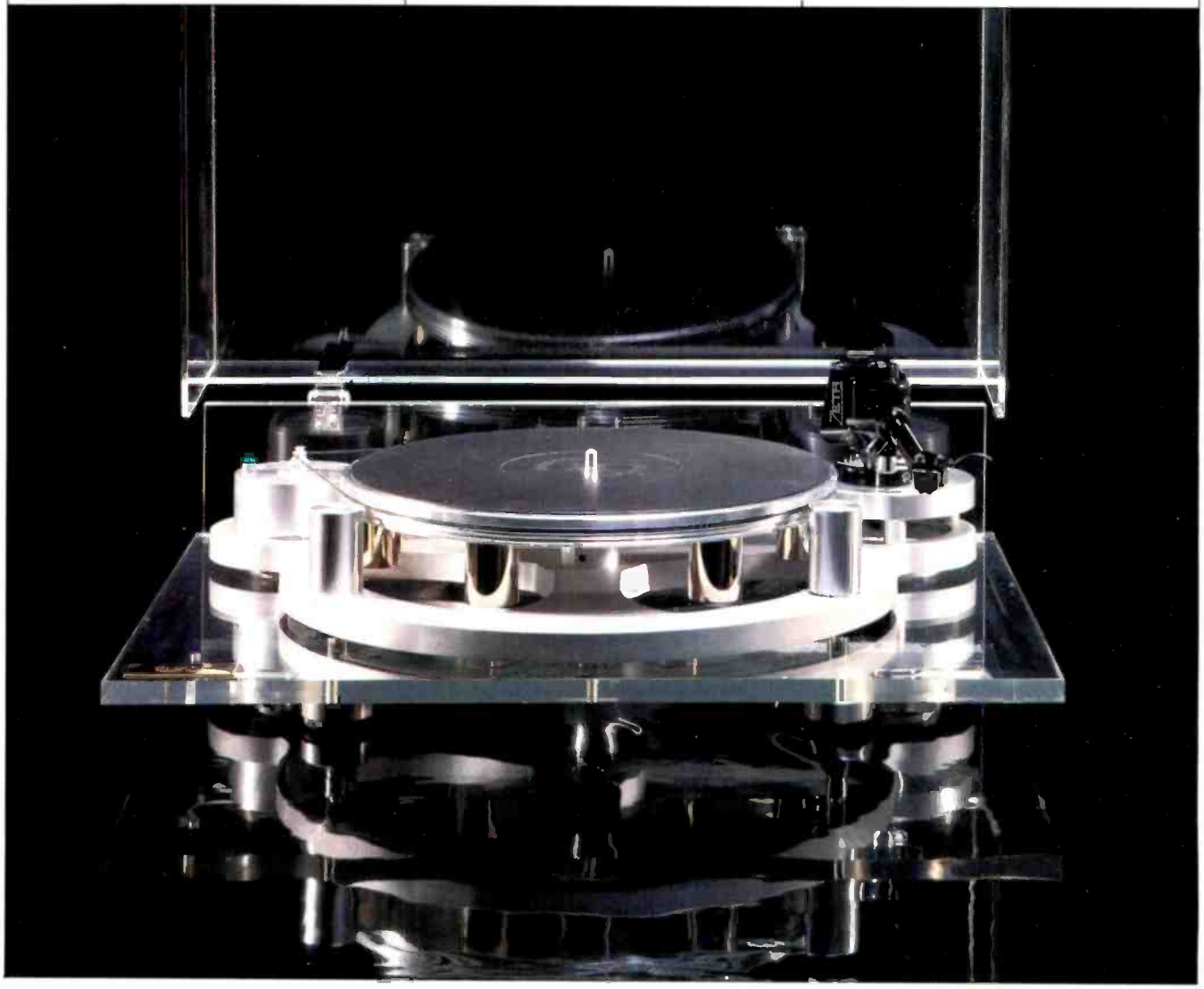
Ford JBL

AUDIO SYSTEMS

2

MICHELL GYRODEC TURNTABLE

Manufacturer's Specifications
Drive System: Belt.
Speeds: 33⅓ and 45 rpm.
Wow & Flutter: 0.04%.
Rumble: −78 dB.
Speed Accuracy: ±0.1%.
Dimensions: 21¼ in. W × 7½ in. H × 16¾ in. D (54 cm × 19 cm × 42.6 cm), including dustcover.
Weight: 37 lbs. (16.8 kg).
Price: $1,190.
Company Address: c/o Reference Monitor International, 2615 Jacaranda, Carlsbad, Cal. 92008.
For literature, circle No. 91



Michell Engineering was one of the first companies I know of to make what might rightfully be termed an audiophile turntable. Back in the early 1970s, John Michell designed what he called the Hydraulic Reference turntable. With its striking appearance, that unit turned more than phonograph records—it turned a lot of heads too. The present GyroDec turntable bears a strong resemblance to the Hydraulic Reference, even though many of the early features, including the hydraulic system, have long since been discarded in favor of more conservative engineering. The original hydraulic turntable featured a rotating bath of high-viscosity oil and an adjustable paddle. Although a synchronous motor was used, the turntable was designed to run slightly fast. By adjusting the drag of the paddle in the rotating oil bath, the speed of the platter could be slowed down. The exact speed was determined by using the stroboscopic disc which was supplied with the turntable.

Another feature of the original turntable was the use of cylindrical pods arrayed around the periphery of the platter. The pods faced up, and the phonograph record was supported only at its edges. In those days a great deal of effort was made to reduce the buildup of static electricity in a record, because noises caused by electrical discharges between the record and the phono cartridge could be heard during playback. The pods were used not only to reduce this static-electricity effect but also—since they were made of solid brass—to place extra mass at the periphery of the turntable platter to increase its inertia. This increased the flywheel effect of the platter, thus reducing wow and flutter. The GyroDec (which is made in England) still uses these pods, but only for their inertial effect; the disc rests on a conventional platter and mat, and the pods are attached to the underside of the platter.

First Impressions

The GyroDec makes a very strong visual impression. It will never be mistaken for any of the usual run of mass-market turntables: Its styling is very, very "modern," making use of handcrafted, crystal-clear acrylic plastics and highly polished, plated metal parts. In fact, the cylindrical metal pods are gold-plated. Other metal surfaces, such as the subchassis, have a satin-smooth aluminum finish. But while the quality of the styling is open and airy, the whole assembly, including the clear acrylic cover, is very heavy; the mass necessary to achieve a stable record-playing system is engineered into the GyroDec while remaining beautifully disguised. There is no turntable base in the usual sense; instead of the closed, rectangular box we are all used to seeing, the GyroDec has a main support base made from a single sheet of thick, clear acrylic.

MEASURED DATA

Parameter	Measurement	Comment
Speed Stability	±0.12%	Excellent
Wow, Unwtd.	0.18%	Very Good
Wow, DIN Wtd.	0.08%	Excellent
Flutter, Unwtd.	0.13%	Very Good
Flutter, DIN Wtd.	0.03%	Excellent
Wow & Flutter, Unwtd.	0.22%	Very Good
Wow & Flutter, DIN Wtd.	0.08%	Excellent
Long-Term Drift	0.10%	Excellent
Rumble, Unwtd.	−80.9 dB	Excellent
Rumble, Wtd.	−93.6 dB	Excellent
Suspension Resonance	4.67 Hz	See Text

Features

While it appears upon first look that styling is paramount in the GyroDec, a closer examination reveals that good engineering principles are not compromised to achieve the excellent appearance.

The GyroDec has a low-voltage synchronous motor with a stepped pulley on the spindle for 33⅓ and 45 rpm. The motor is located at the left rear corner of the turntable and is mounted directly to the main support base. The flexible belt which drives the outside rim of the turntable is completely accessible, so changing the turntable speed, by moving the belt from one step on the motor pulley to another, is very easily accomplished. The power supply is a separate unit with a 3-foot cord that plugs into an a.c. outlet and a 6-foot cord that plugs into the motor. No a.c. line voltage is present at the turntable, so hum from this source is not a problem. There are three grooves around the edge of the platter. The unit that I tested had a single drive belt; however, I have been informed that later versions have two belts to improve speed stability. A ring, which is part of the suspended subchassis, surrounds the motor housing. This ring was intended originally to allow the use of two tonearms simultaneously, with the motor mounted elsewhere on the main support base. (Most audiophiles eschew the practice of using two tonearms to play the same record because of the interaction between the two arms that can result. This interaction arises when mechanical energy travels through the vinyl record material from one pickup stylus to the other.) The clearance between this ring and the motor housing was less in the unit I tested than in later models, but, by carefully balancing the turntable, I experienced no problems caused by the narrow clearance.

The suspended subchassis is of aluminum, cast in the form of a large central ring and two smaller ones. The large ring has spokes to a central hub which carries the main turntable bearing. The smaller rings, at the left and right rear, hold the motor housing and the tonearm mounting platform, respectively. The spokes of the large subchassis ring are weighted with lead to increase the suspended mass and to damp any resonance.

The springs on which the subchassis is suspended form an equilateral triangle, one corner of which is located in line with the center of the platter and the tonearm's mass. The other two springs are equidistant from this line.

The six gold-plated brass weights on the underside of the platter are distributed evenly around its periphery. This accomplishes at least three things: First, as mentioned earlier, it causes the effective mass of the platter to be increased, thereby increasing the flywheel effect without pro-

Wow and flutter is very low, and the quality of sustained piano tones, which are very difficult to reproduce without waver, was deemed excellent.

Fig. 1—Computer plot of wow and flutter spectrum, from 0 to 100 Hz. The peak at 5.9 Hz is due to the tonearm/cartridge resonance; actual turntable wow is very low.

Fig. 2—Speed drift over 42-S period. The variations at 0.56 Hz are related to the 33⅓-rpm speed. Note the high stability, with very low short-term and long-term drift.

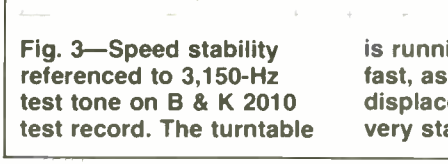


Fig. 3—Speed stability referenced to 3,150-Hz test tone on B & K 2010 test record. The turntable is running about 0.94% fast, as shown by displaced curve, but is very stable at that speed.

portionately increasing the mass load on the main bearings. It also puts the effective mass closer to the horizontal plane of the main bearing, which lessens the tendency of the platter to wobble. Last, it helps to damp the natural ringing modes of the platter. These cylindrical weights, which are 1.25 inches in diameter and 1.5 inches long, increase the platter weight to 9.5 pounds.

The main bearing is made of phosphor bronze and has a tolerance of 0.0001 inch. A hardened-steel ball is fitted to the main shaft, which extends down from the center of the platter.

The main platform is first levelled by adjusting the three rubber-tipped feet, and then the subchassis can be levelled by adjusting the three compression-type springs, which are under easily removable covers. These springs have foam pads inside and rubber pads on each end to damp any ringing.

Tonearms can be mounted to a circular acrylic disc which is supplied with the turntable. This disc fits into the circular ring on the right rear of the subassembly and is locked in place with three screws. A number of tonearms can be mounted, adjusted, and then easily interchanged by using a different disc for each arm. For measurements and listening tests, I used the Zeta tonearm and the Goldbug Clement II cartridge, which are also imported by Reference Monitor International. (This tonearm and cartridge combination is the subject of a separate report in this issue.)

Measurements and Listening Tests

As has been the case in my past reports for *Audio*, I will try to show correlation between the technical measurements I made on the Michell turntable and the comments of members of a listening panel. The panel members are asked not to make any verbal comments while they are listening to particular selections; they are asked to write down such comments and, after the selection has ended, to discuss these and any other reactions they might have with other panel members. A test form has been developed which allows rating the sonic quality of the reference system and the equipment being tested on a scale from 0 to −5. High-quality recordings which feature piano, percussion, vocals, orchestral crescendoes, etc. are selected to allow the panel members to make their evaluations. The ratings of 0 to −5 were chosen because it is easier to hear faults in reproduced sound than to hear things which can be considered positive. I look at the results of the ratings, the written comments, and notes which I have made during the discussions, and try to relate these to my technical measurements. I always adjust the equipment being evaluated and make the technical measurements before the listening sessions to make certain that the equipment is performing properly.

Figure 1 shows the spectral distribution of energy caused by wow and flutter. The main peak, at 5.9 Hz, is due to the resonance of the tonearm mass and the cartridge compliance. This peak shows that the percentage of wow, read from a wow and flutter meter, would be even lower if the contribution of the tonearm/cartridge could be removed. The actual wow, caused by the turntable alone, is thus very low. The ratings given by the listening panel to the reference system and the GyroDec were essentially identical for the

This turntable has the lowest rumble I have ever measured, and its isolation is excellent as well.

reproduction of piano recordings, except for staccato passages. The quality of sustained piano tones, which are very difficult to reproduce without waver, was deemed excellent.

Figure 2 shows that, over a 42-S period, the GyroDec turntable is very stable. The speed drifts less than ±0.10% from the 33⅓-rpm speed during this period of time, and the short-term cyclical variation is less than ±0.20%. The short-term variations occur once per revolution of the turntable or at a rate of 0.56 Hz. Both the long- and short-term drift are very low and must be considered excellent. Figure 3, a graph of the change in frequency of the 3,150-Hz wow-and-flutter test tone on the B & K 2010 test record, shows that the GyroDec is running about 0.94% fast and that it holds this speed very closely over a long period. Because the Nicolet 660A-2D FFT spectrum analyzer which I used for this measurement was in the "zoom" mode, with a total window width of only 80 Hz, the 16 samples were necessarily taken over a long period of time.

The spectrum of the GyroDec's rumble components is shown in Fig. 4. Once again, the contribution of the tonearm/cartridge resonance can be seen. The actual rumble caused by the turntable would measure much lower if the output due to this resonance could be removed from the total. Even with this effect, which of course contributes to the perceived sound quality, the graph shows that the GyroDec has very low rumble—the lowest I have ever measured for a turntable. No comments were made by the listening panel about rumble, and I consider the performance of the GyroDec to be superb in this regard.

Figure 5 shows the output caused by a mechanical impulse applied to the edge of a stationary record with the phono stylus resting in a groove. This test is made to determine the turntable's effectiveness in damping the mechanical energy in the record. The GyroDec is only moderately effective in this regard; certain comments made by panel members, who rated the reference system as being clearer and more precise when reproducing a staccato piano passage, may be related to this delayed energy. Figure 6 is a graph of the spectral distribution of the energy caused by a series of mechanical impulses similar to the impulse applied for Fig. 5. As is the case for all the turntables I have tested, there is a great deal of energy near the tonearm/cartridge resonance—in this case at 5.9 Hz. (The exact frequency varies with different tonearm/cartridge combinations, of course.) The cursor is set to 100 Hz, where the next greatest output occurs. The fact that this output is due to delayed energy added to the desired signal is probably more important than the exact distribution of that energy. This energy probably contributed to the coloration of human voice which was noted by one panel member. The coloration was slight, but it was noticed because it was less apparent in the sound of the reference system.

Figure 7 shows the output which resulted from a mechanical shock applied to the heavy platform on which the turntable rested during all of the technical testing. This platform is extremely massive and very well isolated from mechanical vibrations which might otherwise reach the turntable. The force of this impulse was set to the highest level I have used on any previous turntable. The isolation of the GyroDec is excellent. The tendency for the vibration to die down and

Fig. 4—Rumble spectrum, measured with B & K 2010 test record. Main output is from tonearm/cartridge resonance at 5.9 Hz. Rumble is the lowest I have measured for a turntable.

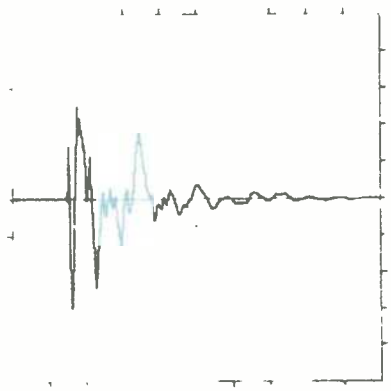


Fig. 5—Output vs. time for mechanical shock applied to edge of a stationary record, with stylus resting in groove.

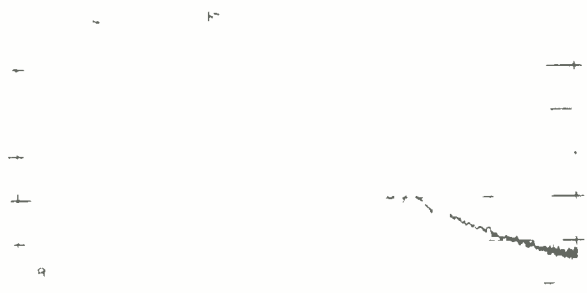


Fig. 6—Spectrum of output caused by a series of mechanical impulses to edge of a stationary record, with stylus resting in groove near the middle of the disc. Output is highest at arm/cartridge resonance; cursor is at 100 Hz, where the next greatest output occurs.

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I recommend that you audition the GyroDec with the very best equipment. I am certain that you will be impressed.

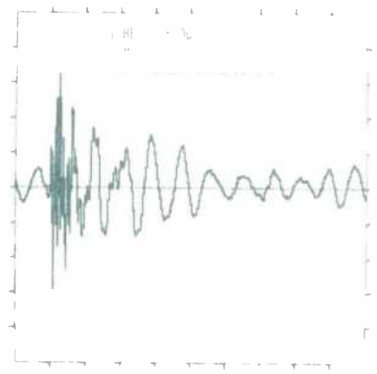

Fig. 7—Output vs. time response for mechanical shock applied to heavy platform on which the turntable rested. The GyroDec's isolation from the shock is excellent.

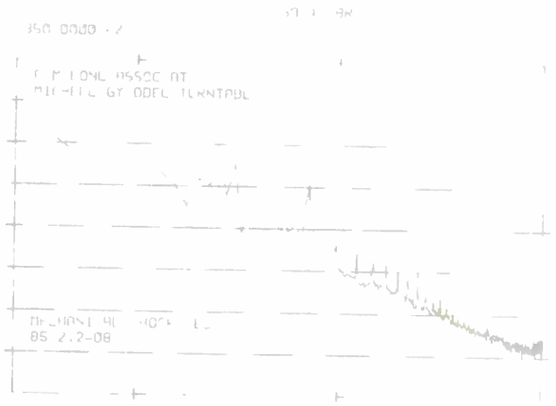

Fig. 8—Spectrum (to 5 kHz) of the vibrations caused by mechanical shock applied to platform supporting the turntable.

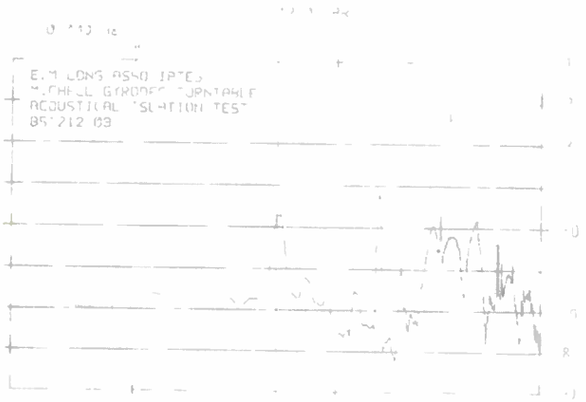

Fig. 9—Spectrum (to 100 Hz) of the vibrations from a 100 dB SPL acoustic field at the surface of a record. Cartridge stylus is resting in a groove near the middle of the record.

then come up again is due in part to the fact that the suspension has some closely spaced resonances which add and cancel at a very low frequency. There is also a tendency for the turntable subchassis to rotate slightly at this low frequency.

Figure 8 shows the spectral distribution of the energy caused by a series of mechanical impulses applied, as in Fig. 7, to the turntable platform. The cursor is set at 350 Hz, which is the highest frequency of a number of spikes which appear between about 100 and 350 Hz. These energy clusters could be a source of coloration, but they are hard to correlate directly with any comments made by the listening panel. The other closely spaced group of spikes, which appear between about 500 Hz and 2 kHz, are at a very low level and probably do not contribute any significant coloration to the sound.

Figure 9 shows the spectrum of the output generated by a very slow sweep of frequencies from 20 to 100 Hz, which produces an acoustical level of 100 dB SPL at the surface of a record on the turntable. The stylus was resting in the groove of the record, which was stationary. This is a very severe test. The GyroDec did quite well—breakthrough output is at least 30 dB below the 10 cm/S reference—and should be considered very good as far as acoustical isolation is concerned. However, I have seen better performance from other turntables that I have tested. The output at 5.9 Hz is again due to the tonearm/cartridge resonance, while the output at higher frequencies is probably due to internal eigenmodes (natural modes of resonance) of the suspension springs. The results are still good enough to allow the GyroDec to be classified as an audiophile turntable.

Conclusions

As I have said, the GyroDec has the lowest rumble of any turntable that I have measured. It compared well with the reference standard, except for slightly greater coloration on voice and a bit more blurring on staccato piano passages. On most program material, the difference was extremely subtle and the listening-panel ratings were identical for the GyroDec and the reference system. I should mention that the reference system did not employ vacuum clamping of the record. I have found vacuum clamping to be so effective that to use it on a reference system when evaluating the sonic attributes of a turntable without it, like the GyroDec, would be almost like comparing apples to oranges. I did use a very good turntable platter-to-record interface on the reference system. I recommend that you audition the Michell GyroDec with the best associated equipment; I am certain that you will be impressed. *Edward M. Long*

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3

ZETA STANDARD TONEARM AND GOLDBUG CLEMENT II CARTRIDGE

Manufacturer's Specifications

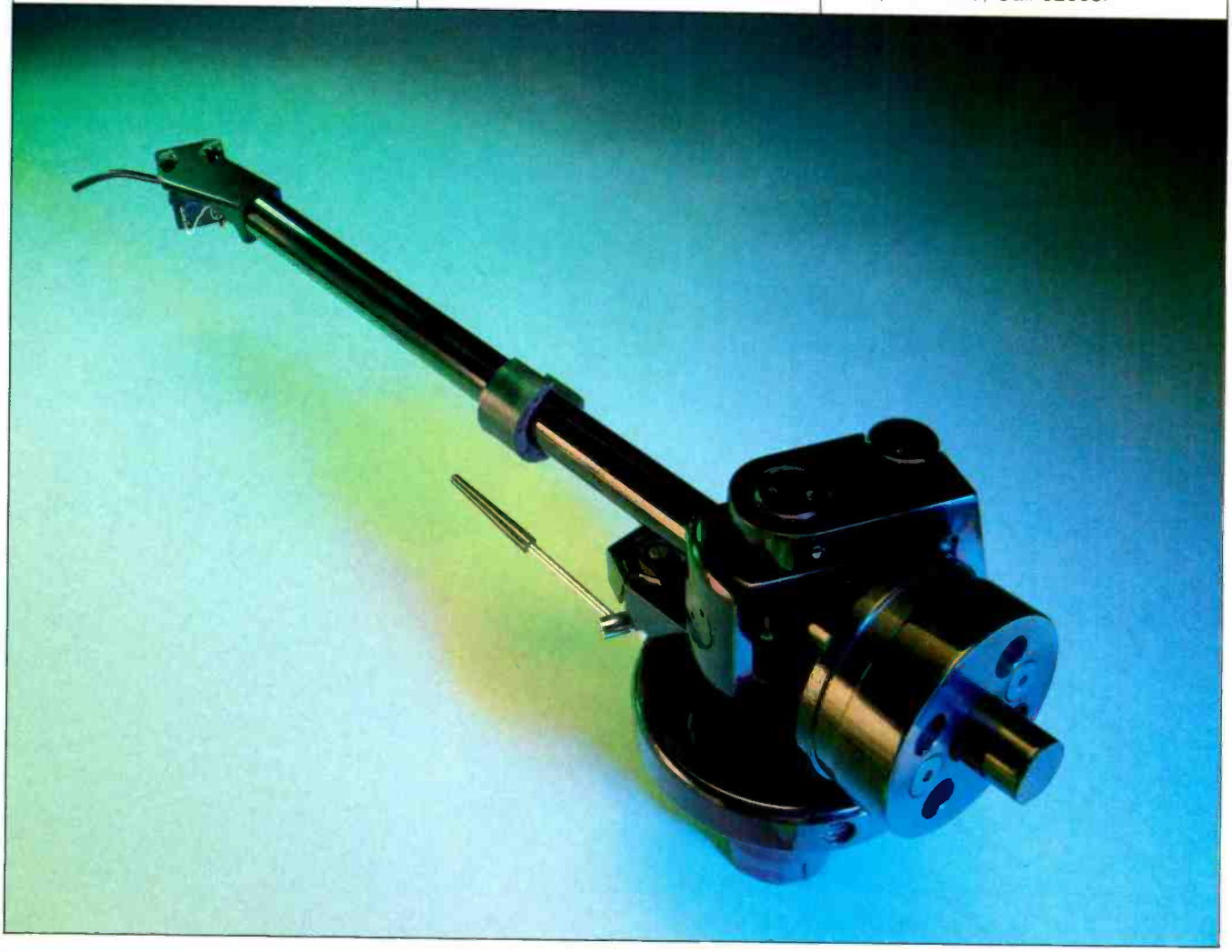
Tonearm

Type: Large-diameter, thin-wall, pivoted tube with fixed headshell and adjustable counterweight mass.
Pivot-to-Stylus Distance: 9 in. (22.9 cm).
Overall Length: 11½ in. (29.2 cm).
Offset Angle: 23.75°.
Effective Mass: 16.0 grams, without cartridge.
Cartridge Weight Range: 4 to 12 grams.
Total Cable Capacitance: 90 pF.
Price: $875.
For literature, circle No. 92

Cartridge

Type: Moving coil.
Stylus: Oval diamond on beryllium-pipe cantilever.
Output: 0.25 mV for 3.54 cm/S at 1 kHz.
Frequency Response: 20 Hz to 35 kHz.
Channel Separation: 28 dB at 1 kHz.
Channel Balance: 1 dB.
Impedance: 14 ohms.
Compliance: Static, 38 × 10^{-6} cm/dyne; dynamic, 17 × 10^{-6} cm/dyne at 100 Hz.
Recommended Tracking Force: 1.3 grams, ±0.1 gram.
Weight: 5.6 grams.
Price: $490; replacement stylus, $245.
For literature, circle No. 93

Company Address: c/o Reference Monitor International, 2615 Jacaranda, Carlsbad, Cal. 92008.



One of the reasons that analog disc is still the medium of choice among audiophiles is that, a few years ago, tonearms took a turn for the better, as designers began to apply what some might term "space-age" technology. One of the tonearms that has resulted from this new technology is the Zeta, manufactured in Willesden, England by C & B Tools & Developments and distributed in the U.S. by Reference Monitor International of Carlsbad, Cal. Other tonearms which use similar engineering principles and materials include the Sumiko MDC-800 and the Linn Ittok LV II. Some of the ideas incorporated in the SME Series V can also be traced to this new approach to tonearm design. The Sumiko, Linn, and SME tonearms have been tested previously; reports can be found in the September 1983, March 1984, and June 1986 issues of *Audio*.

Like the other tonearms mentioned above, the Zeta features a relatively large-diameter, thin-walled, straight tube. Armtubes used in older designs were usually smaller in diameter, with thicker walls, and often were angled near the headshell or had S-shaped bends along their length. The use of thinner walls of larger diameter allows the mass of the tonearm to be reduced while equalling or even surpassing the strength and integrity of the older designs.

MEASURED DATA

Zeta Standard Tonearm
Pivot-to-Stylus Distance: $9\frac{3}{16}$ in. (233 mm).
Pivot-to-Rear-of-Arm Distance: $2\frac{5}{16}$ in. (59 mm).
Overall Height Adjustment: $\frac{5}{8}$ in. (16 mm).
Tracking-Force Adjustment: 0 to 1.8 grams; no calibrations.
Tracking-Force Calibration: None; auxiliary gauge required.
Cartridge Weight Range: 5 to 12 grams.
Counterweights: One, with steel inserts.
Counterweight Mounting: Steel discs screwed to aluminum carrier.
Sidethrust Correction: Coil-spring type, uncalibrated knob.
Pivot Damping: None.
Lifting Device: Damped lever and finger lift.
Headshell Offset: 23.8°.
Overhang Adjustment: Slots in headshell.
Bearing Alignment: Excellent.
Bearing Friction: Less than 40 mg, no play.
Bearing Type: Ball-and-race, vertical and lateral.
Lead Torque: Very low.
Arm-Lead Capacity: 88 pF.
Arm-Lead Resistance: 1.2 ohms.
External Lead Length: 42 in., with gold phono plugs.
Structural Resonances: 350, 900, and 1,650 Hz.
Base Mounting: Round hole, six screws.

Goldbug Clement II Cartridge
Coil Inductance: 15 μH (left and right channels).
Coil Resistance: Left, 14.0 ohms; right, 13.6 ohms.
Output Voltage: Left, 0.096 mV/cm/S; right, 0.093 mV/cm/S.
Recommended Tracking Force: 1.6 grams.
Cartridge Mass: 5.7 grams.
Microphony: Very low.
Hum Rejection: Excellent.
High-Frequency Resonance: 27.8 kHz.
Rise-Time: 20 μS.
Low-Frequency Resonance: 6 Hz (in Zeta Standard tonearm).
Low-Frequency Q: 1.
Recommended Load Resistance: 40 ohms.

Fig. 1—Frequency response and interchannel crosstalk of Zeta Standard arm and Goldbug Clement II cartridge, using B & K 2010 test record.

Fig. 2—Low-frequency tonearm/cartridge resonance is at 5.9 Hz with a Q of 3.1, B & K 2010.

Fig. 3—Slow-sweep check (20 Hz to 2 kHz) for tonearm resonances. Note small discontinuities at 28, 42, and 320 Hz.

Using thinner tube walls of larger diameter allows the arm's mass to be reduced while equalling or even surpassing the strength of older, thick-wall designs.

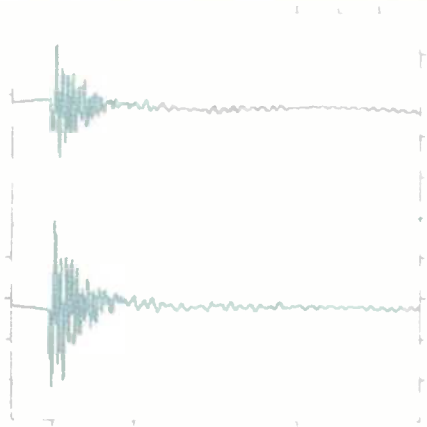


Fig. 4—Output of arm/cartridge when mechanical impulse was applied to armtube, with arm on rest. Decay rate is a bit slower than desirable.

Fig. 5—Output (averaged) of arm/cartridge due to 16 mechanical impulses applied to armtube. Note peaks between 1 and 10 kHz.

Fig. 6—Interchannel phase difference of arm/cartridge, using pink noise from B & K 2011, band 7.

Another, less obvious design idea used in the Zeta was to make the armtube continuous from the headshell to the rear of the tonearm. This is a result of rethinking the design parameters in terms of energy transfer and dissipation. By using the same material for the headshell and the armtube, the velocity of energy is unchanged from one end of the tonearm to the other. The rationale behind this stems from the fact that whenever kinetic energy meets a barrier, standing-wave energy is generated. This causes interference effects in the mechanical energy that is traveling along the tonearm and makes damping and dissipating this energy more difficult. Any energy which is not properly dissipated can cause delayed-energy interactions with the desired mechanical energy being transduced by the pickup cartridge stylus, because it can be reflected back to the stylus tip. A change in material, and therefore a change in propagation velocity, acts as an unwanted barrier, to a greater or lesser extent, depending upon how different the materials are. The fact that the Zeta headshell is bonded to the armtube not by adhesives but by a tight, thermal bonding technique is good because it ensures a minimal barrier effect between the two. In other words, the unwanted mechanical energy in the tonearm can be transferred along the armtube to the pivot bearings and then through the arm pillar to the mounting board, where it can be dissipated. While (for practical reasons) the bearings cannot be of the same material as the armtube and headshell, the arm pillar is. Therefore, any energy which is reflected will encounter a similar energy velocity characteristic on either side of the bearings, and thus ensure at least a symmetrical relationship.

First Impressions

I tested the bearing friction in my usual manner by holding the tonearm pillar in one hand and pulling and pushing the armtube with the other hand. The Zeta tonearm bearings, which are ball-and-race for both vertical and horizontal pivots, had no noticeable play and yet were very free of friction in either plane of motion.

The Zeta comes in a sturdy wooden case with a hinged cover. The satin-black finish of the headshell, armtube, gimbal support, pillar, and mounting base is excellent. The arm pillar and the gimbal bearing support give an outward impression of really solid construction, and indeed they have been machined from solid blocks of aluminum and finished to a satin smoothness. All of this tells me that the manufacturer is committed to producing a very high-quality product, albeit in necessarily small quantities.

Features

The Zeta's solid headshell has two slots which allow for minor final adjustments in the overhang and offset to bring forth that last bit of performance. The finger lift is well designed and easy to grip.

The counterweight consists of an aluminum shell which holds different steel inserts that can be chosen to balance the cartridge so that the counterweight is as close to the arm pillar as possible. This minimizes the dynamic mass of the tonearm by reducing the moment of inertia. The aluminum outside shell of the counterweight is not decoupled from the armtube by any rubber or plastic rings, as is usually the

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One of the outstanding attributes of this arm and cartridge combination is its ability to present a stereo image that is both stable and wide.

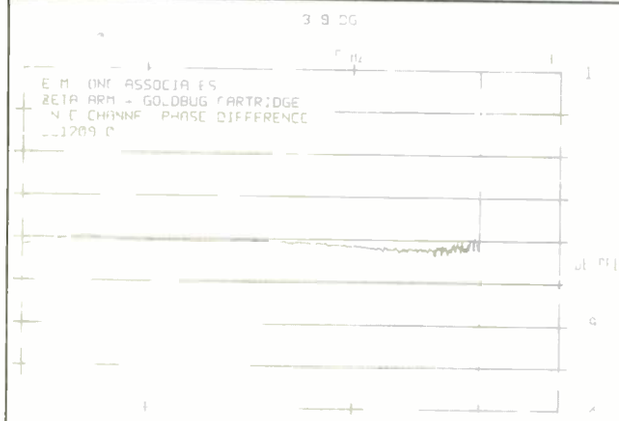

Fig. 7—Interchannel phase difference of arm/cartridge as a function of frequency (B & K 2011, band 7, pink noise). Phase difference at 20 kHz (cursor position) is 3.9°, equivalent to only 0.5 μS of interchannel delay.

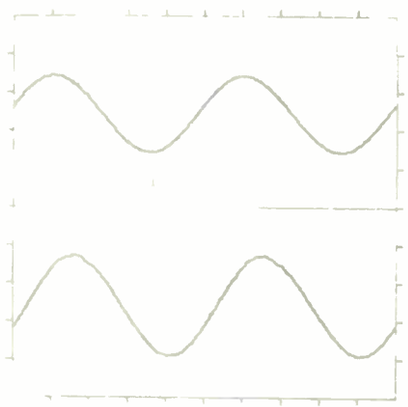

Fig. 8—Tracking of arm/cartridge with a 1-kHz test tone from the B & K 2010 at 20 cm/S (top) and 25 cm/S (bottom).

case with other tonearms, so the energy which reaches the counterweight can enter it and be dissipated. The Zeta uses the counterweight to set the tracking force and therefore is not a dynamically balanced design, as the previously mentioned tonearms are. After the cartridge is installed, the tracking force is adjusted by sliding the counterweight toward the arm pillar. Since there are no markings on the Zeta to indicate the tracking force, a separate gauge must be used. A locking screw is provided to ensure that the counterweight cannot move after the tracking force is set.

The sidethrust correction can be adjusted by turning a small knob located on the side of the gimbal support. This knob controls the tension of a coiled spring, which applies a horizontal force to the tonearm. This force counteracts the sidethrust force caused by the offset headshell and the velocity of the record groove. There are no calibrated markings for this adjustment; some experts contend that it is best made while listening to some typical recordings, because different levels of groove modulation can be a factor.

Measurements and Listening Tests

Since the Goldbug Clement II moving-coil cartridge is also distributed by Reference Monitor International and was recommended for use with the Zeta tonearm, this is the cartridge which I used for the technical and listening tests. The Clement II features an elliptical stylus mounted on a beryllium cantilever.

The output and interchannel crosstalk versus frequency are shown in Fig. 1. A listening panel evaluated the sound quality of the Zeta/Clement combination with respect to my reference system. After listening to various recordings, they made numerous comments which could be easily correlated with the upper frequency range of the Zeta/Clement combination. The downward slope of the upper frequency response, as heard by panel members, was not stated as directly negative comments about the Zeta/Clement combination, but as positive comments about the reference system. The quality of closely miked piano as reproduced by the reference system was termed "brighter," while the Zeta/Clement combination was heard as being "clearer" and "more sonorous." A recording of brass was heard as "sharper" when reproduced by the reference system. I think these comments indicate that, while the high-frequency output of the reference system is a bit stronger, the output of the Zeta/Clement combination is at least pleasant, and with certain recordings even more so than the reference system. The very low interchannel crosstalk shows that the Zeta/Clement combination is capable of producing excellent stereo images, which I will discuss later.

Figure 2 shows the low-frequency resonance caused by the mass of the tonearm interacting with the compliance of the cartridge. This resonance occurs at about 5.9 Hz. The Q is about average for this type of tonearm/cartridge combination. From the measured data, the Clement II would seem to require a tonearm with slightly less mass than the Zeta. However, comments about the reproduction of deep bass being "more boomy" with the Zeta/Clement combination were expressed only after playing a recording made with the microphone inside a drum which was highly damped with padding. After listening to orchestral recordings which featured big drum sounds, and which were made in large halls, no comments were made about the lack of tightness in the bass. I take this to mean that although the Q is a factor, it is not a major one.

Figure 3 is a graph of the output for a slow sweep made to reveal any tonearm resonance effects. Small discontinuities can be seen at 28, 42, and 320 Hz. These effects are very small, and the only correlation to actual sound that I could even suggest is based upon comments that voices seemed to be a "a little bit more colored" when reproduced by the Zeta/Clement combination. I really feel that these comments by the listening panel are more closely related to the effects seen in Figs. 4 and 5, which show the output versus time and the amplitude versus frequency, respectively, when the Zeta tonearm is excited by a mechanical shock applied to

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The very low distortion measurements correlate well with listeners' comments about clarity and sonority.

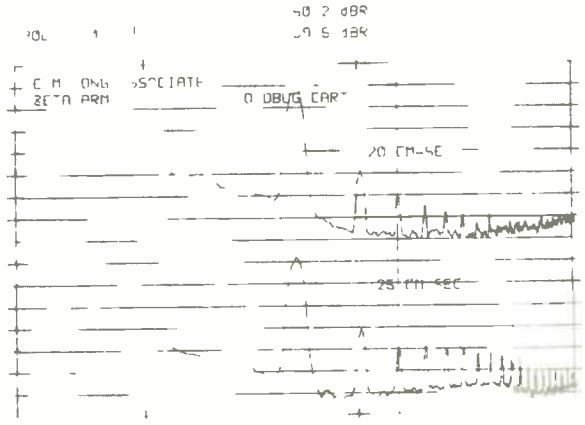

Fig. 9—Spectral analysis of the cartridge output when reproducing the test signal of Fig. 8. The third harmonic (at the cursor position) is 0.35% in the left channel and 1.05% in the right.

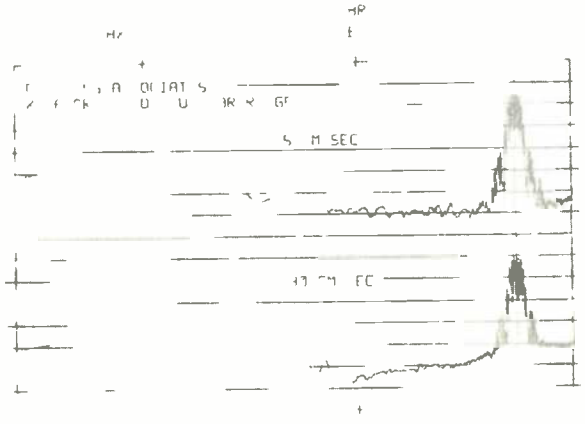

Fig. 11—Spectral analysis of distortion products from signals shown in Fig. 10. Distortion is very low.

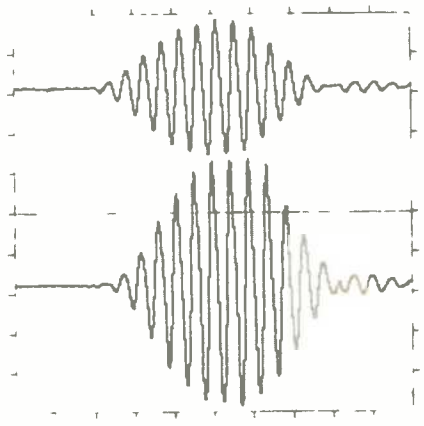

Fig. 10—Output from 15- and 30-cm/S, 10.8-kHz pulse test, Shure TTR-103 test record. Note the small amount of asymmetry and compression.

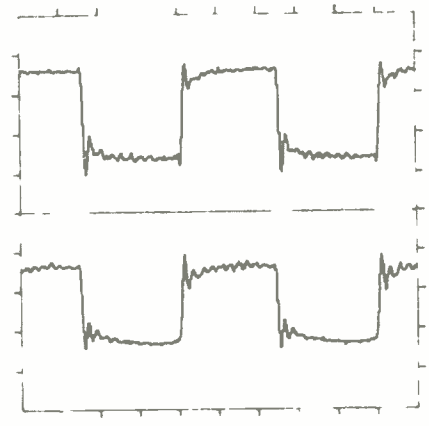

Fig. 12—Output from 1-kHz square wave, CBS STR-112 test record. Ringing is at 27.8 kHz.

the armtube. This test is designed to reveal any standing-wave energy in the tonearm. As shown in Fig. 5, there are numerous resonances between 1 and 10 kHz. The decay rate, as shown in Fig. 4, is a little slower than desirable. This could add a bit of coloration, and the human voice is a very sensitive test for this.

One of the most outstanding attributes of the Zeta/Clement combination is its ability to present a stable and wide stereo image. Comments made by the listening panel with respect to the stereo image were very favorable as compared to the reference system. The excellent interchannel amplitude separation, shown earlier, when combined with the data of Fig. 6, confirms the panel members' observations. Figure 6 shows the output of the left channel versus the right. A perfect 45° line would indicate no deviation between channels; the deviation here is very slight. Also, the interchannel phase difference versus frequency, shown in Fig. 7, is as good as I have ever measured.

The clarity of the sound of single instruments and small ensembles, especially at high levels, was commented upon by some panel members. This correlates well with the low amount of distortion and the excellent tracking of the Zeta/Clement combination, shown in Figs. 8 and 9. Both figures show that, even for the highest level band of the B & K 2010 test record, the tracking is very good. Many tonearm/cartridge combinations are not capable of tracking this band.

It is easy for me to recommend the Zeta arm. The Goldbug cartridge is also an excellent performer, especially its tracking of high levels.

The spectrum of the distortion products is shown in Fig. 9. The very low distortion, especially for the odd harmonics, correlates well with the panel's comments about the Zeta/Clement combination having good clarity and a "sonorous" quality. High amounts of odd-order distortion are usually heard as a "harsh" or "bright" quality.

Some comments made by listening-panel members seem to correlate well with the data shown in Figs. 10 and 11. For example, one comment was made that the piano in the RCA recording of the Saint-Saëns Symphony No. 3 (with Charles Munch conducting the Boston Symphony Orchestra) was "clearer" and "more sharply defined" when reproduced by the Zeta/Clement combination, while sounding more "sonorous" with the reference system. The ability of this panel member to hear the sharply defined piano was most likely possible because of the high degree of separation and lack of the fuzziness usually caused by poor interchannel phase relationships; the "sonorous" quality produced by the reference system was probably due to its slightly better performance when reproducing complex waveforms. The sound of full orchestra at high levels, especially the sound of cymbals, was "slightly clearer" when reproduced by the reference system, but the comments made by panel members for the Zeta/Clement combination with this kind of music were very complimentary. Even at the highest level of the Shure TTR-103 test record, which is 30 cm/S, Fig. 10 shows only a small amount of asymmetry and compression. Figure 11 shows that the low-frequency modulation components due to nonlinearity are very low, even at the 30 cm/S level.

Figure 12 shows the output of the Zeta/Clement combination for the 1-kHz square wave of the CBS STR-112 test record. This is a very good waveform and is typical for a cartridge which has a roll-off of high frequencies such as that indicated in Fig. 1. The ringing, at 27.8 kHz, is the high-frequency resonance due to the interaction of the stylus effective tip mass with the compliance of the vinyl of the test record. This resonance, obviously, is well above the audio band, which shows that the Clement II cartridge has a very low effective tip mass, and that it can therefore handle high-level high frequencies very well.

Conclusions

The fact that the Sumiko MDC-800 tonearm is no longer available makes it very easy for me to recommend the Zeta, which I consider to be its closest rival. The Goldbug Clement II cartridge is also an excellent performer, especially with regard to tracking high levels, particularly in the mid-range of frequencies. The stereo image which this combination can produce is its strong point. In my opinion, the Zeta Standard tonearm and the Goldbug Clement II cartridge offer good value.

Edward M. Long

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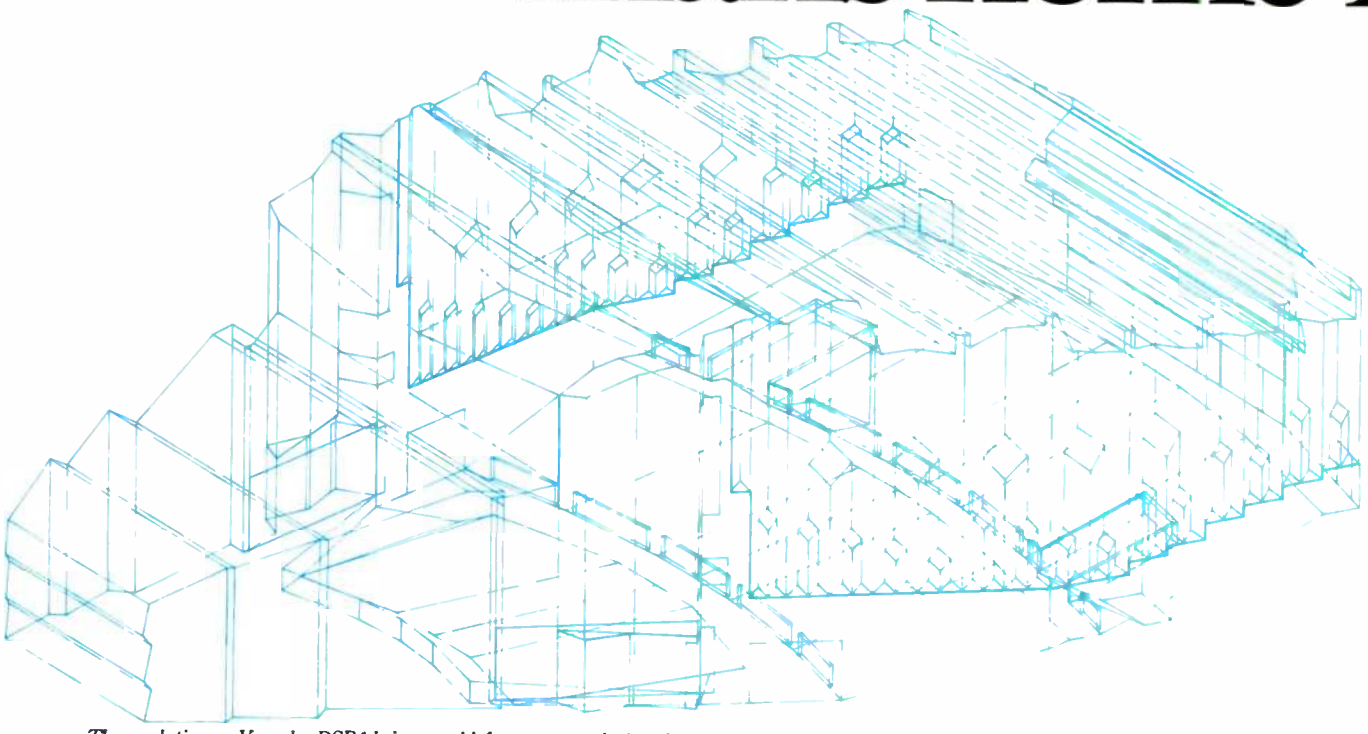

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characteristics from your stereo source material trigger the continuous release of this information, to precisely reproduce the acoustic personalities of selected performance environments.

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Each reflection is calculated using the very same sampling rate and quantization as compact discs (44.1 kHz, 16 bit linear), producing an output with dynamic range of 94 dB and 0.006% THD, making audiophile quality digital sound field synthesis possible for the very first time.

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In addition, there are 16 sound effector programs built in, such as time-delay, stereo flange, tremolo, chorus, pitch change and auto panning. So the DSP-1 can also be used effectively as a musical instruments effects device.

All sound field modes and parameters are controlled from the palm of your hand, since the DSP-1 is operated by a 30-key wireless remote control. This allows you to select the performance environment and adjust parameters—even program them into memory—without sacrificing the perspective of your listening position.

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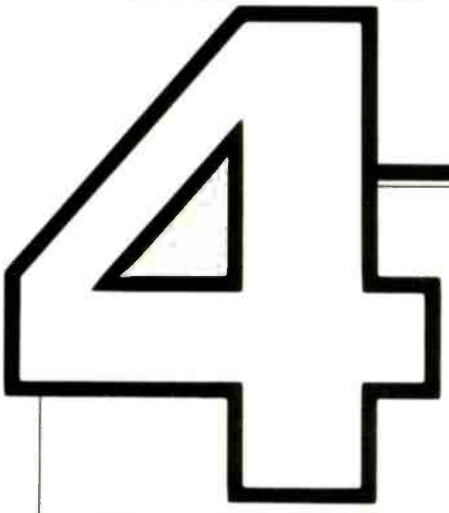

REVOX B286 TUNER/PREAMP

Manufacturer's Specifications

FM Tuner Section

Usable Sensitivity: Mono, 12.8 dBf.
Quieting Sensitivity: Mono, 15.2 dBf; stereo, 36.8 dBf (per DIN Standard).
S/N Ratio: Mono, 84 dB; stereo, 80 dB.
THD at 1 kHz: Mono, 0.15%; stereo, 0.3%.
Frequency Response: 20 Hz to 15 kHz, +0.3, −0.8 dB.
Capture Ratio: 2.0 dB.
Adjacent-Channel Selectivity: 16 dB.
Alternate-Channel Selectivity: 96 dB.
Image Rejection: 110 dB.
I.f. Rejection: 110 dB.
Spurious-Response Rejection: 110 dB.
Subcarrier-Product Rejection: 78 dB.
Stereo Separation at 1 kHz: 43 dB.
Muting Threshold: 18 dBf.
Stereo Threshold: 26 dBf.
Output Level at Tape Out: 1.8 V.

AM Tuner Section

Usable Sensitivity: 36 μV.
Frequency Response: 120 Hz to 3 kHz, −6 dB.
THD at 1 kHz: 1.5% for 80% modulation.
S/N Ratio at 80% Modulation: 60 dB.
Muting Threshold: 50 μV.
Output Level for 80% Modulation: 1.5 V at tape output.

Preamplifier Section

Frequency Response: 20 Hz to 20 kHz, +0, −0.3 dB.
Phono Equalization: RIAA ±0.3 dB.
THD at 1 kHz: 0.005% for rated output.
S/N Ratio: MM phono, 80 dB re: 5 mV input; MC phono (optional), 76 dB re: 0.5 mV input; high level, 96 dB re: 500 mV input and rated output.
Channel Separation at 1 kHz: Phono, 60 dB; high level, 75 dB.
Crosstalk Between Inputs at 1 kHz: 90 dB.
Rated Output Level: Output "A," 6 V; output "B," 2 V; headphones, 6 V; tape, 500 mV.
Input Sensitivity for Rated Output: MM phono, 2.7 mV; MC phono (optional), 0.5 mV; high level, 250 mV.
Maximum Input Level: MM phono, 150 mV; MC phono (optional), 6 mV; high level, 8 V.
Tone-Control Range: Bass, ±12 dB at 40 Hz; treble, ±10 dB at 15 kHz.
Subsonic Filter (Phono Only): 12 dB per octave, −3 dB at 15 Hz.

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Power Requirements: 115 V a.c., 60 Hz; 50 watts maximum.
Environmental Operating Temperature: 40° to 104° F (5° to 40° C).
Dimensions: 17¾ in. W × 6 in. H × 13 1/16 in. D (45 cm × 15.3 cm × 33.2 cm).
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Prices: $1,690; MC input, $95; B205 remote, $125; B206 Transceiver, $125; B203 timer controller, $500.
Company Address: 1425 Elm Hill Pike, Nashville, Tenn. 37210.
For literature, circle No. 94

I have long wondered why the combination tuner/preamplifier component is so uncommon. Years ago, in the early days of high-fidelity equipment, many manufacturers offered such units. One reason for the relative rarity of this very practical combination today may be the relative unimportance of FM broadcasting in Japan, where so much of our present-day audio hardware comes from. In fact, receivers, too, are practically never sold in Japan, but there seems to be enough of a demand for them in the U.S. to justify their manufacture by Asian firms for export.

By contrast, in Europe—and specifically in Switzerland and West Germany, where the Studer and Revox divisions of Willi Studer AG are based—FM is as popular as it is in this country. In light of that popularity, the advantages of a high-quality tuner/preamp such as the B286 become obvious. It can be combined with a power amplifier that delivers exactly the output power you require or it can be used with powered speakers (such as Revox's own Agora Bs.)

The Revox B286 tuner/preamp is one of the most versatile and feature-laden units of its kind that I have ever tested. Its dual-microprocessor tuning section lets you program a total of 29 AM and FM stations into its nonvolatile memory. Optimum reception modes for each station can also be programmed. Furthermore, since not all FM (and certainly not all AM) stations are received at equal volume, it is possible to individually set loudness levels for each of the stations you preset, as well as for all other program sources connected to this remarkable component. Therefore, when you switch between memorized stations or between sources, you won't have to scramble for the volume control.

When used with the B286, the optional B205 remote control handles such functions as power on/off, source selection, preset-station scanning and recall, A/B output selection, volume adjustment, balance, tone defeat, and 20-dB muting. With the addition of the optional B203 timer controller, the B205 remote can also operate and program other Revox components connected to the tuner/preamp. The timer controller also has an RS-232 port for programmed control by a computer. With the further addition of the B206 remote-control "Transceiver," which relays control commands between rooms, the B205 can control an entire multi-room system.

Control Layout

At the upper left of the front panel are numbered keys for addressing the 29 possible station memories, a "Tuner/Enter" key, and a key which is used to sequentially read out the assigned station memories. "Volume" buttons (up and down) are at the center of the panel; farther to the right are the audio-mute, tone-defeat, and program-source selector buttons ("Phono," "Disc," and "Tape 1" and "Tape 2" loops). In the upper right corner is the main "Power" switch which, when used to turn on the tuner/preamp, powers up the unit with the last selected source. However, you can also turn the unit on by pressing the "Phono," "Disc," or "Tuner/Enter" buttons, which simultaneously selects the indicated input. This is a rare and worthwhile convenience, giving you direct access to any source you like, even when the B286 is turned off.

The "Tuner/Enter" button has yet another function in addition to source selection and turning on the power. It is also used when recalling preset stations to register the memory number you select.

The lower left section of the panel, aside from the phone jack, is devoted entirely to tuner-related controls. Two "Alphanumeric" buttons permit you to key in the call letters of memorized stations. To do this, you first press the "Display" key, then the preselect button for the station whose call letters you wish to store; next you scan up and down through the alphabet with the "Alphanumeric" buttons. When you find the first letter you desire, press the "Cursor" button to get into the second letter position, and so on for each position. When you're finished, press "Store" to enter this information into memory. You can store other information, too, such as the type of programming each station favors or you might even enter the name of a disc jockey on each station.

Other buttons at the lower left are used for up/down "Autotuning" (automatic station search), "Frequency Step" tuning, FM muting, mono/stereo and stereo blend selection, and AM/FM selection.

Controls at the lower right of the panel handle all preamplifier-section functions. The "Sensitivity" control allows programming of input sensitivities for the preset stations and other program sources. A control marked "Volume Top"

Revox managed both to keep FM response flat all the way to 15 kHz and to attenuate the 19-kHz tone by 75 dB—a neat trick.

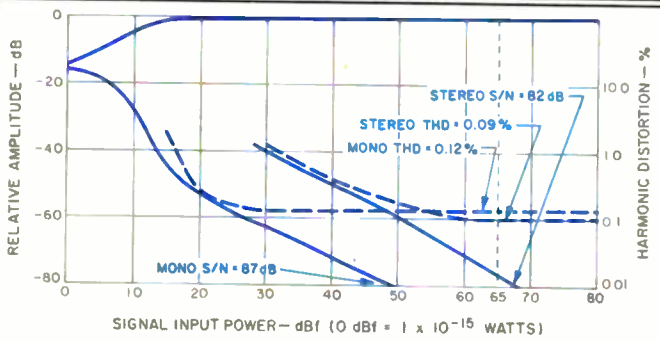

Fig. 1—Mono and stereo quieting and distortion characteristics, FM section.

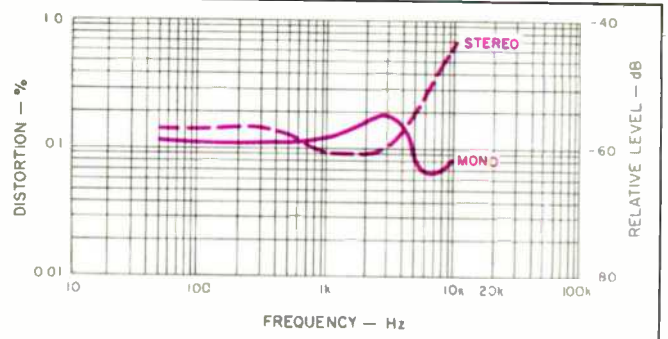

Fig. 2—THD vs. modulating frequency, FM section.

enables you to limit maximum listening volume. Buttons for both tape monitors, subsonic filter (in the phono mode), bass, treble, loudness compensation, channel balance, and selection of outputs are also located in this area. You may select either a high-level output ("A"), low-level ("B"), or neither, for headphone-only listening.

A display area at the center of the panel offers a variety of status indications. Tuner functions shown on the display include station frequency or call letters, the number of the station memory in use, center-tune indication, FM muting status (auto or off), mono/stereo and blend switching, tuner band (AM or FM), and stereo FM reception. Preamp displays include volume level (in dB), −20 dB mute, balance, bass and treble tone-control settings, and the status of the input, output, and tape-monitor selectors, subsonic filter, and loudness compensation.

On the rear panel of the B286 are jacks for high- and low-level output, CD and phono inputs, and two sets of tape record/play jacks. There are also a ground terminal, a serial link terminal for connection to the B203 timer controller or B206 Transceiver, the antenna connections, and two switches. One of these switches selects any of three phono load capacitances to match whatever moving-magnet cartridge and arm cabling you use. The other, a pushbutton near the phono input jacks, selects moving-magnet or moving-coil operation—but only if you purchase the MC input option.

The FM antenna terminal is a 75-ohm coaxial type, but it uses a European connector rather than the Type F or BNC connectors used in the U.S. Revox therefore supplies a matching male plug for this terminal, as well as a 300/75-ohm step-down transformer. For AM reception, a separately mountable loop antenna is supplied; the antenna terminals also allow an outdoor antenna to be connected for both FM and AM.

FM Tuner Measurements

Mono usable sensitivity for the FM tuner section of the B286 was 12 dBf, slightly better than claimed. In stereo, a signal level of 22 dBf was required to reach "usable-sensitivity" performance. Fifty-dB quieting was reached with a signal level of 14 dBf in mono and 38 dBf in stereo. These levels are not comparable to the manufacturer's "Quieting Sensitivity" spec, since, as a European company, Revox uses the DIN Standard. In any case, the sensitivity of this tuner was very good, regardless of how you define the measurement.

Best signal-to-noise ratio obtained with strong input signals was 87 dB in mono, significantly better than the 84 dB claimed. The S/N in stereo also exceeded the manufacturer's spec, with a measured value of 82 dB. Quieting characteristics, as well as harmonic distortion at 1 kHz, are plotted in Fig. 1 as a function of input signal level. With strong signals applied, THD at this frequency reached a low of 0.12% in mono and was actually a bit lower in stereo, reaching only 0.09%. Both figures are lower than those claimed in Revox's conservative specification sheet.

Test standards require measuring THD at 100 Hz and 6 kHz, as well as 1 kHz. At 100 Hz, THD measured 0.11% in mono and 0.14% in stereo; at 6 kHz, THD was 0.065% in mono and 0.27% in stereo. Figure 2 shows how harmonic distortion varies with frequency for the FM tuner section operated in mono and in stereo.

Rather than have stereo "blend" turn on automatically in the presence of a noisy or weak stereo FM signal, Revox leaves the decision about blending up to the user. Figure 3 shows FM frequency response, full separation, and separation with the blend control turned on. Response was extremely flat from 30 Hz to 15 kHz, with the output down only 0.3 dB at the high-frequency extreme. This is very unusual for an FM tuner. Most tuners, in an attempt to provide a high degree of attenuation at 19 kHz, begin to roll off somewhat short of the 15-kHz cutoff point. Revox was able to maintain virtually flat response all the way out to 15 kHz while at the same time providing more than 75 dB of attenuation (or rejection) of 19- and 38-kHz subcarrier products! On the other hand, SCA rejection was not as good as I might have hoped, measuring only 55 dB. It is quite possible that SCA is not used extensively in Europe, and the designers of this tuner section may not have had much experience with SCA interference problems. Since a majority of FM stations in this country no longer employ an SCA carrier (for secondary

As soon as the dealer said, "To/without/and," I said "Okay, Akai."

There were other things about Akai's CD-A70. Naturally, I loved the 3-beam laser pick-up, digital filter, subcode terminal, and insulated floating mechanism.

Loved 'em.

But then the dealer showed me the Natural Logic Operation.

Three buttons take me to the music I want to hear **without** the music I don't. **And** play all that's in between just like a CD should.

It blew me away.

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4 FUNCTION DISPLAY
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- INDEX NO.
- INDIVIDUAL TIME
- TOTAL TIME

MUSIC NO. 2 INDEX NO. 1
TIME 0 MIN 07 SEC
PROGRAM

POWER PHONES DISPLAY

DIGITAL
COMPACT DISC PLAYER CD-A70

Enter No. 4 on Reader Service Card

The B286's stereo blend works at all frequencies, not just the highs. When I thought a bit and listened, I realized this approach makes a lot of sense.

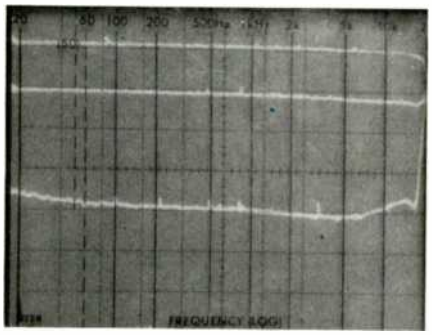

Fig. 3—Frequency response (top trace) and separation vs. frequency with blend activated (middle trace) and deactivated (bottom trace). Note flatness of middle trace (see text).

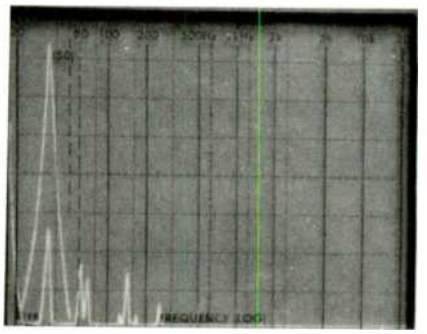

Fig. 4—Analysis of distortion and crosstalk for 5-kHz FM modulating frequency. Note lack of spurious crosstalk components and of subcarrier leakage.

programming), the rather poor SCA rejection may not pose a problem in your area or with the stations which you normally listen to. It's a point that should be checked out, though, if you know that your favorite stations transmit SCA programming.

With the blend feature deactivated, separation at mid-frequencies measured 45 dB. At 100 Hz, separation was equally high, and at 10 kHz, it decreased to 36 dB—still more than adequate. With the blend switch turned on, separation was reduced to around 12 dB across the audio band. Unlike most blend circuits, Revox's reduces separation over the entire audio spectrum almost equally, rather than just at the high-frequency extreme. When I thought about this (and listened to some weak stereo signals), I realized that it makes a lot of sense. After all, background noise in FM is essentially white noise that's already somewhat rolled off at the high end by de-emphasis. Therefore, the noise spectrum contains low and middle frequencies. In some cases, these frequencies may be as great in amplitude as the high-frequency hiss which first comes to mind when you think about FM background noise.

Figure 4 shows what can be done, as far as crosstalk is concerned, in a properly designed tuner. The tall spike at the left represents a 5-kHz signal modulating the left channel at 100%. The shorter spike contained within it shows separation at 5 kHz, and the shorter spikes to the right represent second-, third-, and fourth-harmonic distortion components appearing at the output of the unmodulated channel. The greatest of these (second harmonic) is down some 55 dB relative to 100% modulation. More important, there is not the slightest evidence of any other spurious crosstalk components at the unmodulated channel's output. There is no subcarrier leakage visible within the dynamic range of this spectrum analyzer display.

Muting threshold measured 17 dBf, very close to the 18 dBf claimed by Revox and an ideal setting. Stereo threshold was actually a bit lower than stated, with the switchover from mono to stereo occurring as signal levels reached 22 dBf. At this switchover point, signal-to-noise ratio was already close to 40 dB.

Capture ratio measured 1.8 dB, and alternate-channel selectivity measured 95 dB. Spurious-response rejection, i.f. rejection, and image rejection were all in excess of 100 dB. AM suppression, not specified, was a very high 62 dB.

AM Tuner Measurements

Revox is one of only a few companies to spell out the full performance—for better or worse—of their AM tuner sections. Since they have been so honest about this often-overlooked section, I decided to make a few more AM measurements than I usually do. As shown in Fig. 5, frequency response extended to 3.5 kHz for the −6 dB cutoff point. That may not sound like much—until you compare it with the −6 dB point of most other AM tuners, which usually occurs at around 2.0 or 2.5 kHz. In any event, Revox claims response only to 3.0 kHz for this AM section, so they more than meet that claim. Signal-to-noise ratio for the AM tuner, referred to 60% modulation, measured 53 dB, and THD for a 1-kHz signal at 30% modulation was 1.4%. Usable sensitivity was 30 μV, quite a bit better than the 36 μV claimed. The AM muting threshold was set at 25 μV.

Preamplifier Measurements

The sample B286 that I measured was not equipped with the optional moving-coil inputs. Phono input sensitivity via the built-in moving-magnet cartridge inputs measured 1.7 mV for the standard 0.5 V to be delivered at the low-level preamp output terminals. Since the high-level outputs provide more gain, you will only need 0.55 mV at the phono inputs to produce the same 0.5 V at these outputs. Phono overload, for a 1-kHz input signal, was 200 mV, well above the 150 mV claimed. Phono signal-to-noise ratio measured at the high output terminals was 77 dB; at the low outputs it was almost the same, 78 dB. For these measurements, a standard 5-mV input signal was used and the volume control was adjusted for a standard 0.5-V output.

It was clear from my measurements that Revox has chosen to use a modified RIAA playback curve rather than the original equalization curve specified by the RIAA more than 30 years ago. The IEC (International Electrotechnical Commission) supports an equalization characteristic which produces an extra roll-off at the low end, beginning at about 35 Hz and continuing all the way down to 2 Hz; they take the position that this added roll-off reduces the audible effects


So then the dealer said, "Get the Akai, okay?"
So I said, "Okay." And then I said, "But like why the Akai, okay?"
And he said, "The Interactive Monitor System."
And I said, "Omygod, no *way*."
He said, "Yes indeed, on-screen VCR programming on every one of their models."
So I said, "Okay, okay. Akai."
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FINE TUNE
/TRACKING

This unit is bulky but has near-perfect ergonomics and astounding sound quality. If you can afford it and have the room, it's well worth owning.

of turntable rumble. So, when I measured the RIAA equalization accuracy, I found less than 0.2 dB of deviation from 15 kHz down to 50 Hz. At 30 Hz, however, the extra time constant recommended by the IEC (and incorporated in this preamp section) produced a −1.0 dB deviation compared with the original RIAA curve. At 20 Hz, there was an additional roll-off to −2.5 dB. If the subsonic filter is turned on, additional attenuation is introduced which results in a further reduction of subsonic frequency response. At 20 Hz, response is then down 3.0 dB (compared to the unmodified RIAA curve), and at 10 Hz, an additional attenuation of 13 dB occurs.

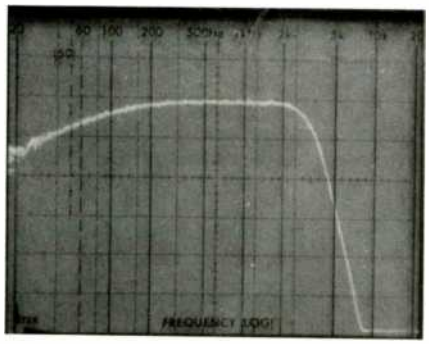

Fig. 5—Frequency response, AM section.

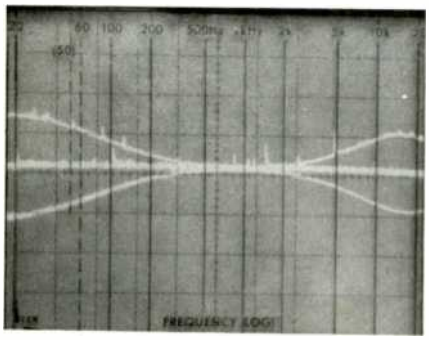

Fig. 6—Tone-control range, preamplifier section. Note absence of effect on midrange.

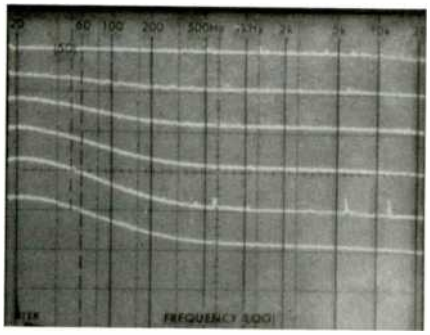

Fig. 7—Characteristics of loudness compensation. Note that only bass is affected.

High-level input sensitivity measured 26 mV for 0.5 V output at the high-level ("A") output jacks and 80 mV for the same output level at the low-level ("B") jacks. Signal-to-noise ratio for the high-level inputs measured 89 dB at the "A" outputs and 92 dB at the "B" outputs, for 0.5 V out and a 0.5-V input signal at 1 kHz. Overall frequency response via the high-level inputs extended from 6 Hz to 50 kHz for a −1 dB roll-off and from 3 Hz to 95 kHz for the −3 dB cutoff points. Within the audible range from 20 Hz to 20 kHz, response was flat to within 0.2 dB. Maximum output at the high-level outputs was 10.0 V before significant amounts of harmonic distortion were observed. From the low-level outputs, as much as 3.0 V could be obtained before noticeable distortion occurred. The volume control's two stereo sections tracked each other perfectly (I couldn't even detect 0.1 dB of difference between channels) all the way from maximum setting down to the −80 dB setting.

Figure 6 shows the cut and boost range of the bass and treble controls. Notice that levels of the midrange frequencies, from around 400 Hz up to around 2.5 kHz, are not affected, even when the bass and treble controls are set to their maximum or minimum points. This is how a good set of bass and treble controls should be designed, though all too few are.

I am also in full agreement with Revox's treatment of the loudness compensation. Revox has wisely elected to boost only bass response when the volume control is adjusted for lower and lower listening levels. A careful examination of the well-known Fletcher-Munson "equal loudness" curves will show that, although human hearing does tend to fall off at the high end (i.e., it takes higher levels of high frequencies to be perceived as equal in loudness to middle frequencies), the fall-off does not increase as listening levels are lowered. Therefore, the treble boost added by most loudness-compensation circuits is really not necessary; only the amount of bass compensation needs to be increased as lower and lower listening levels are used. The curves of Fig. 7 show that the Revox engineers understand this psychoacoustic phenomenon and have designed their loudness-compensation circuitry accordingly.

Use and Listening Tests

If you have the room—and can afford it—the B286 is a precision component worth owning. Revox has never been known for miniaturized products, and this tuner/preamp is no exception. Once you accept its rather bulky size and begin to use its intelligently designed features, you quickly realize, as I did, that its ergonomics are as close to perfection as anyone has yet achieved. Beyond all this, however, it's the excellent sound quality of the B286 which astounded me. Although the distortion figures for the FM tuner section were not the lowest I've ever measured, signals from properly operated FM stereo stations were received with an openness and clarity that has to be heard to be believed. With a good antenna connected, background noise was so low that I was able to enjoy listening to broadcasts of CDs


The dealer said, "Surround Sound" is the difference between okay and Akai.
And *every* Akai receiver has "Surround Sound."
So I surrendered. Wouldn't you?
Wouldn't you buy a receiver that wrapped you in a saxophone sound so big it made you shiver and so real it woke up your cat?
Especially if it came with a seven-band graphic equalizer and wireless remote?
Wouldn't you?
Surrender.
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Just because the preamp is only part of the B286, don't think that it can't stack up against some of the best separate preamps I've tested.

without having to make excuses for the background noise levels which normally limit the dynamic range of such transmissions.

The controls had a nice, positive tactile feedback, despite the light touch needed to activate them. While the alphanumeric station-designation storage may seem a bit unnecessary to some, it probably didn't account for much of the cost of this product, and it *is* fun to use and observe.

Years ago, preamplifiers (and, for that matter, tuner/preamplifiers) had input level controls which served to equalize the levels of all program sources connected to them. Revox's "input sensitivity alignment" feature goes well beyond that, in that it adjusts listening levels for individual stations (some of which modulate more heavily than others) as well as for different external program inputs. If you have ever had to reach for a volume control whenever you switched stations or program sources, you will really appreciate this feature. I suspect that this would be even more important if I were sitting across the room from the set and switching stations or program sources using the optional remote. That remote (which I didn't have when testing the B286) does have a volume control, but it probably responds slower than built-in volume controls, since those on remotes usually do.

Certainly not everyone is prepared to spend well over $1,000 for a tuner/preamp, but the price is not really that out of line when you consider that a separate tuner would have to be augmented by either a separate preamplifier/control component or an integrated amplifier. With the B286, all you need is a power amp or, as mentioned earlier, an active speaker system which includes its own power amplifier. And make no mistake about it. Just because the preamplifier is an integral part of the B286, don't think that it could not stack up against any separate, high-quality preamp. In many ways, the preamplifier performance of this two-for-one unit surpasses that of some of the best high-priced, high-performance preamplifiers I have measured and listened to. For example, if you've generally been against the use of tone controls because they tend to color critical mid-frequency response, you'll quickly change your mind when you begin to use the bass and treble circuits of the B286. I found myself able to compensate for source material which I felt lacked upper treble or which was recorded with an exaggerated amount of lower bass. I was able to do this without using an expensive graphic equalizer and without having to tolerate obvious imbalances in the tonal structure of the music itself.

Anyone who has ever dealt with a Revox tape deck knows the true meaning of the phrase "Swiss craftsmanship." Now that same phrase applies to the Revox B286. It has the unmistakable touch of excellence that I've come to expect from Dr. Willi Studer and his crew of perfectionists.

Leonard Feldman

NOW PLAYING AT A RECORD STORE NEAR YOU.

COMPACT DISC (CD-80137) 2CD
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5

NEC CD-650E COMPACT DISC PLAYER

Manufacturer's Specifications
Frequency Response: 5 Hz to 20 kHz, +0.5, −1.0 dB.
S/N Ratio: 96 dB.
Dynamic Range: 92 dB.
THD: 0.006%.
Channel Separation: 86 dB at 1 kHz.
Number of Programmable Selections: 15, random access.
Output Level: Fixed, 2.0 V rms for 0-dB level; variable, 0 to 2.0 V rms; headphone, 0 to 2.0 V rms into 30 ohms.
Average Access Time: 3 S.
Power Requirements: 120 V a.c., 60 Hz, 25 watts.
Dimensions: $16^{15}/_{16}$ in. W × $2^{15}/_{16}$ in. H × $12^{5}/_{8}$ in. D (43 cm × 7.5 cm × 32 cm).
Weight: 11.1 lbs. (5 kg).
Price: $449.
Company Address: 1255 Michael Ave., Wood Dale, Ill. 60191.
For literature, circle No. 95

I had begun to believe that all CD players priced below $500 were compromised designs, intended for the more casual listener who couldn't differentiate between "good" and "superb" sound. The NEC CD-650E changed my mind about that! In terms of reproduced sound quality, this player has to rank with the best at its price level or, for that matter, at any price level. And no wonder! It incorporates what are obviously very linear *dual* digital-to-analog converters, two-times oversampling with true 16-bit digital filters which introduced no measurable phase delay, and a three-beam laser pickup, which, by industry consensus, seems to be the way to go for superior tracking.

I found the chassis of the NEC CD-650E to be extremely well built and resistant to external vibration, thanks to the "floating" mount of its critical components, such as the laser pickup assembly.

The unit is supplied with a wireless remote control, so many convenience and basic operating features can be activated from your listening position. The remote module has a numerical keypad which not only enables you to access specific tracks on a CD but also permits memory storage of up to 15 selections that can be played in any order you choose. The remote control even has a pair of buttons which let you adjust volume level, providing you connect your amplification system to the player's "Variable" outputs. Prior to seeing the 650E, this is a feature I've found only on models costing over $800. There's one control on the remote, however, that I did feel was a bit of overkill: The "Open/Close" button. I really see no point in being able to open and close the disc tray from across the room!

Control Layout

Thanks to the many functions that can be controlled via the remote module, the front panel of the CD-650E is relatively uncluttered and aesthetically pleasing. The usual "Power" switch and the disc drawer are at the left of the panel. To the right of the drawer is the remote's sensor window, and to the window's right are four indicator lights. These illuminate to show "Repeat" play, "A-B" repeat play, "Memory" (when selections have been stored in memory), and "Remain T." The latter lights up when the corresponding button on the remote unit is pressed to switch the display from elapsed time of the current track to total remaining disc time. The display area for track number and time is adjacent to the four indicators, and major operating controls ("Play/Pause," forward and reverse skip, and "Stop/Clear") are conveniently clustered at the upper right.

A few additional controls are along the middle and right of the panel's lower section. These include an "Open/Close" button, "Repeat" and "Memory" buttons, a stereo phone jack, and a tiny volume control knob. When the remote control is used to adjust output level, this motorized control knob actually turns.

The rear panel is equipped with a subcode output jack, in anticipation of the CD-graphics decoder boxes which may be available soon. (For how long have I been saying that?) The "Fixed" and "Variable" left- and right-channel output jacks are also on the rear.

In addition to duplicating the front-panel functions, the supplied remote control has several buttons not found on

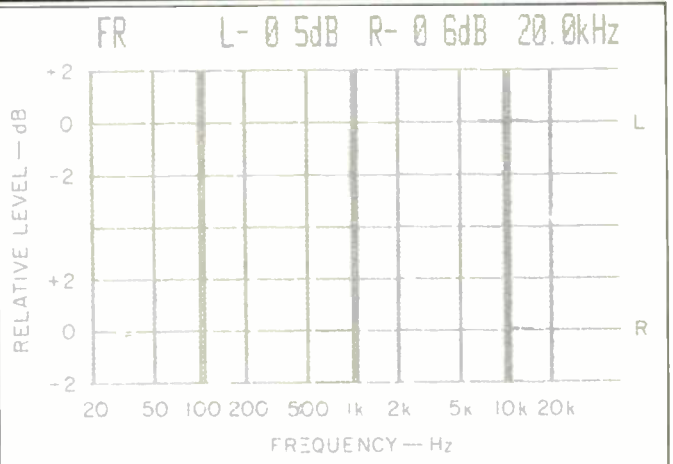

Fig. 1—Frequency response, left (top) and right channels.

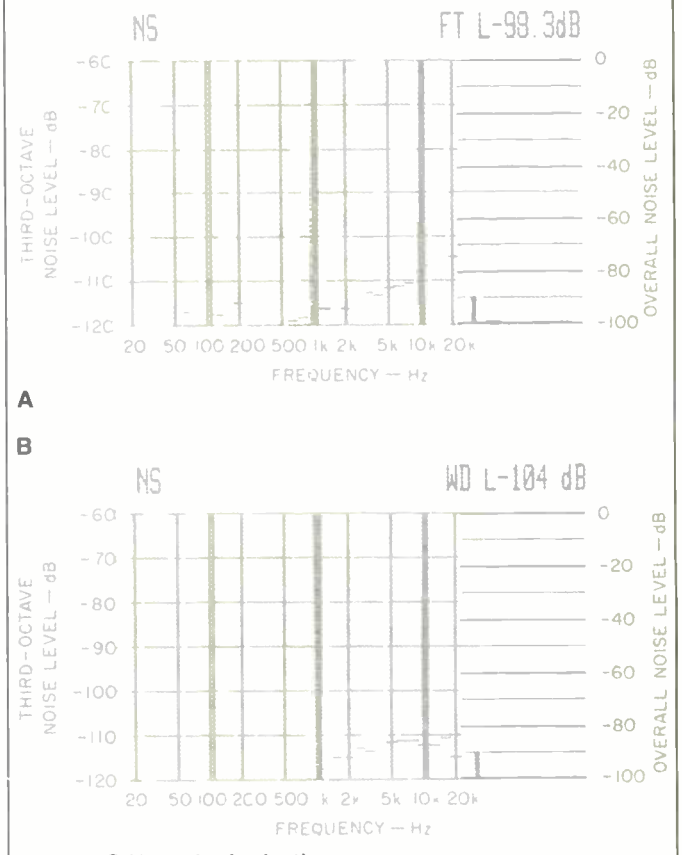

Fig. 2—S/N analysis, both unweighted (A) and A-weighted (B).

Not Evolutionary,

Pioneer's Revolutionary C-90/M-90 Elite High-Fidelity Components.

Audiophiles, take note: The preamp and amplifier you've been waiting for are finally here.

Introducing the Pioneer Elite Hi-Fi C-90 Preamp and M-90 Power Amplifier. Together, they combine the finest in both audio and video to retrieve every detail and nuance found in your cherished records, tapes, compact discs, LaserVision™ discs and other software. Imagine a soundstage spread throughout your entire listening room! Stunning, transparent, three-dimensional music, the likes of which you've never heard, apart from a live performance.

We paid fantastic attention to detail to gain this level of musical truth. One example: the C-90 volume control is a motorized, high precision rotary potentiometer. This permitted us to create the world's first high-end preamp with a no-compromise hand-held "SR"™ remote-control unit.

The C-90 features three separate power transformers—two to power left and right audio channels for vanishingly low crosstalk, and a third transformer to drive the preamp's unique video capabilities, relays, display and microprocessor. All switching functions are accomplished by electronic relays. Thus the signal paths are as short as possible, improving signal-to-noise ratio and channel separation. Anti-vibration measures taken to further the C-90's sonic excellence include a solid aluminum volume control knob, polycarbonate chassis feet, and rubber-cradled PC boards. Soft copper-plated screws insure a snug fit of chassis, transformers, transistors, and help to dampen vibration.

The C-90 Preamp readies you for the video revolution, with six video inputs, a built-in video enhancer, and two-buss switching (separate "Record" and "View" selectors). The C-90's unique system remote-control unit features volume adjustment, input source selection, and control of audio and video input devices such as Pioneer's "SR" compatible VCRs, CDs, LaserVision players and cassette decks.

The M-90 is a superb high-power stereo amplifier, utilizing dual-mono construction. It is conservatively rated at 200 W/CH into 8 ohms[1] and delivers 300 W/CH of dynamic power at 2 ohms.[2] The wide dynamic range of digital sources can now be reproduced effortlessly, with any loudspeakers. The M-90's high current capacity of 47 amps can handle the challenge of the most complex speaker loads. To further enhance S/N ratio and channel separation, relay-operated electronic switches and a long shaft volume control keep the length of signal paths down to a minimum. Why include a high quality volume control on a power amp? Simple. To pursue the straight-wire-with-gain philosophy when using a CD player connected directly. Pure sound, redefined.

The exquisite finish of the M-90 and C-90 reflects their quality. Elegant rosewood side panels and front panels with a deep hand-brushed lacquer finish emphasize the care of craftsmanship we've lavished on these two components. The Pioneer C-90 Preamp and M-90 Power Amp. Evolutionary? Hardly. Revolutionary? Most definitely.

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 [1]Based on FTC rules regarding measurement of amplifier power ratings. [2]Measured by EIA method.


Revolutionary.
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PIONEER
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An unusual feature allows using the remote to call up a *programmed* number in a series of selections, not just the *track* number.

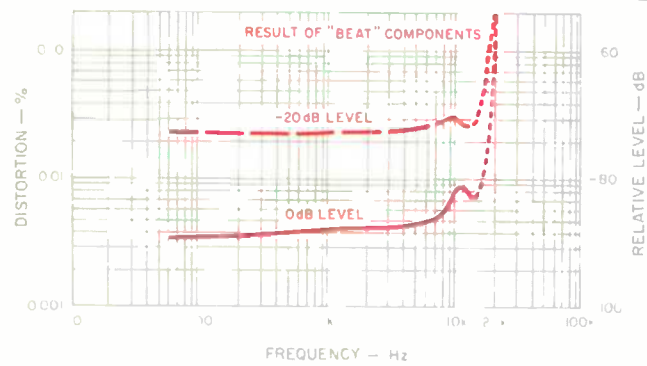


Fig. 3—THD vs. frequency, at two output levels (see text).

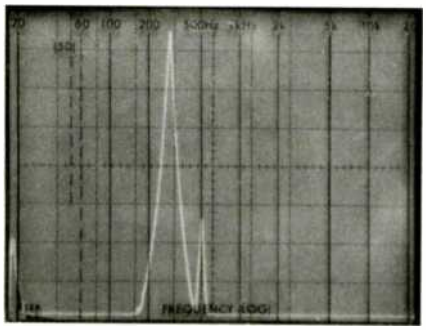


Fig. 4—Spectrum analysis of reproduced 20-kHz test signal. Note the lack of in-band beat components.

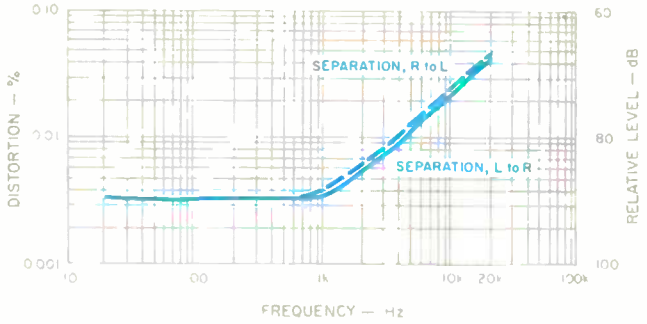


Fig. 5—Separation vs. frequency.

the main unit. Besides the numeric keypad already mentioned, there are buttons for changing the time display back and forth between current track time and total remaining time; for initiating, clearing, and specifying A-to-B repeat-play; and for audible fast search. The forward and reverse fast-search modes move the laser pickup slowly for about 3 S and then speed up the process if you continue to depress either button.

In the course of experimenting with this unit's features, I discovered an unusual one that I hadn't run across before. If you press a number button on the remote control during playback of a series of programmed tracks, play will continue from the selection stored in the corresponding memory address. In other words, if I pressed "5" while listening to playback of a memorized series of tracks, the CD-650E would start playing whatever track I had entered into memory as the fifth selection—*not* track number 5. I discovered this little trick quite by accident, but then found it fully explained near the back of the owner's manual. Incidentally, because of the very logical layout of the CD-650E's front panel and remote control, everything that needed to be said in the owner's manual took only about 10 pages, not counting the cover, trouble-shooting guide, and listing of specifications.

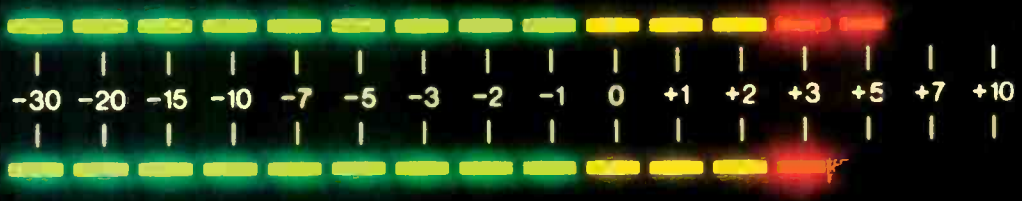
Measurements

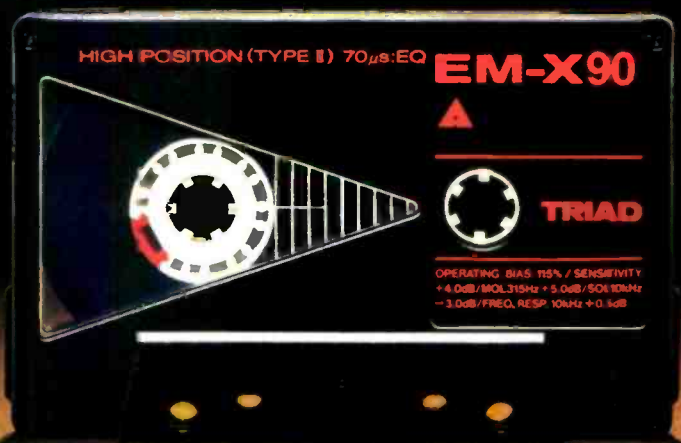
Before I get into the test results themselves, a few words are in order about several changes in my test procedure, prompted by a new test disc being prepared by the CBS Technology Center under the guidance of my good friend and colleague Robert Finger. Bob has been participating in an EIA Standards Subcommittee charged with creating a standard for measurement of CD players. If you're a regular reader of *Audio*, you may remember that some months ago I described a proposed standard, for the same purpose, drafted by the EIAJ (the Electronics Industry Association of Japan). While that standard was an excellent piece of work, members of the EIA subcommittee (including myself) felt that it was deficient in certain areas and that certain characteristics of CD players weren't being addressed or included in the test procedure.

The new disc that the CBS Technology Center has been working on addresses those missing points and has tracks which provide appropriate signals for making the additional tests. For example, in checking linearity, additional levels at −30, −40, −50, and −70 dB have been included. Sweep frequency response now extends to 22.05 kHz, instead of 20 kHz; this enables testers to get a very accurate response reading at the 20-kHz top limit of a Compact Disc player. Square-wave tests and other impulse signals have been added to the disc, so that I no longer have to jump back and forth among a number of test discs in order to complete my measurements.

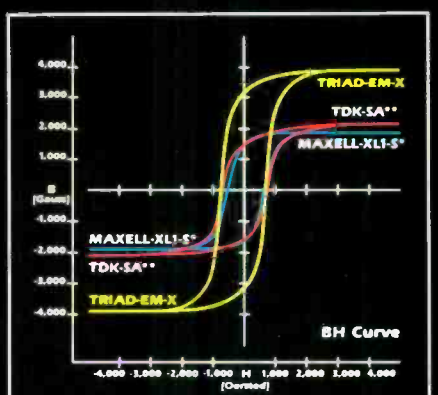
Because I am a member of the standards committee, Bob Finger was kind enough to send me a test pressing of the new test disc. It's not yet available generally, so please don't write to ask where you can buy it. When the actual production pressing of the disc takes place, I'll give you details about how to get it. Meanwhile, I'm beginning to use the new disc, starting with this report, with thanks extended

TAPE IT TO THE LIMIT.





The dawn of a new tape decade.
The digital age has pushed recorded sound to the limit. Now Triad Digital Transcription Tape takes you there, too. It's the first totally new tape for your deck in a decade.



Comparison of the magnetic flux of Triad EM-X vs. two leading tapes under identical recording conditions. EM-X records approximately twice the signal, for increased dynamic range and lower distortion at higher signal levels.

Leading tapes share limited, pre-digital formulas. They just don't measure up to today's advanced recording techniques and audio equipment.

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Triad and true performance for every deck.
Unlike pre-digital tapes designed for sources with dynamics averaging only 45-50dB, Triad's advanced metal technology delivers over 80dB of exciting, true-to-life dynamic range. With Triad, tape decks can actually perform beyond the limits of their own manufacturers' expectations.

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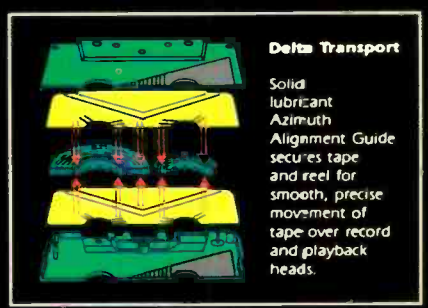

high frequency response and spatially accurate, three-dimensional sound. The unique Delta Transport housing also features a full-length, solid lubricant slip shield for less friction, reduced wow-and-flutter and prolonged tape life.

Triad Digital Transcription Tape. Three advanced formulations that tape you to the limit of today's recording technology.

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At 98.3 dB, S/N was far better than claimed, and dynamic range was an incredibly high 106 dB.

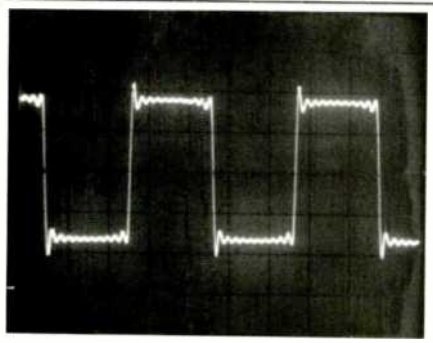

Fig. 6—Reproduction of a 1-kHz square wave.

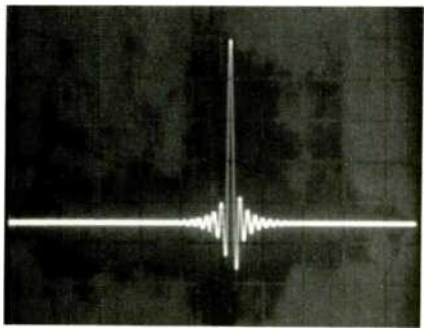

Fig. 7—Single-pulse test.

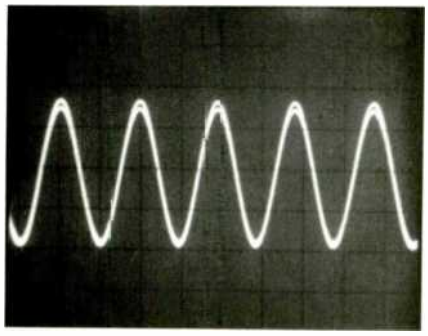

Fig. 8—Interchannel phase difference when reproducing a 20-kHz tone. One trace was vertically displaced for clarity.

to Robert Finger and to the CBS Technology Center for making it available to me.

Frequency response, shown in Fig. 1, was perfectly flat to below 20 Hz. At 20 kHz, it was down only 0.5 dB on the left channel and 0.6 dB on the right. Signal-to-noise ratio was far better than claimed. In an unweighted measurement, shown in Fig. 2A, the S/N was 98.3 dB; with an A-weighting network in the signal path (Fig. 2B), the S/N increased to a remarkably high 104 dB.

Figure 3 shows how harmonic distortion varied with frequency at maximum recorded level (0 dB) and at a level 20 dB lower. Notice that I have not included results at −30 dB as I have done in the past. Experience has shown that the THD difference between −20 and −30 dB will be linear, an increase of roughly 3:1, so there's really no point in making measurements at the lower level. The dotted curves in Fig. 3 represent the appearance of out-of-band "beats" which are not actually harmonic distortion and which are, of course, inaudible. Figure 4 shows the single beat obtained at around 24 kHz when a 20-kHz signal is reproduced. Even this out-of-band beat was down some 50 dB or more, compared to the reference level, and was of no concern to me. It's when I start seeing in-band beats (as I have on several CD players of lesser quality) that I begin to worry. If I had measured THD in accordance with the EIAJ proposal, using a 20-kHz low-pass filter in the signal path, I wouldn't have seen this beat and couldn't compare it with nonharmonically related out-of-band and in-band components seen on other units.

Dynamic range, measured by adding 60 dB to the THD (expressed in dB) observed for a 1-kHz signal at the −60 dB level, turned out to be an incredibly high 106 dB. Either NEC is being very conservative in their specification of dynamic range, or they're measuring this important spec in some other way than the method endorsed both by EIAJ and EIA.

Channel separation measured nearly 90 dB at mid- and low frequencies, as plotted in Fig. 5, but decreased almost linearly at higher frequencies, to about 70 dB at 20 kHz. Overall linearity was within 0.5 dB from maximum recorded level down to −80 dB. SMPTE-IM distortion measured 0.01% at maximum recorded level. CCIF IM was a very low 0.002% at 0-dB level and did not change at −10 dB recorded level.

The reproduced 1-kHz square wave shown in Fig. 6 confirms the fact that digital filtration is being used here, and it is about as close as a CD player can come to "flat-top" square-wave reproduction. Figure 7 shows a reproduced unit-pulse signal, while Fig. 8 confirms the fact that NEC used two D/A converters and compensated perfectly for any time delay between channels. Had I not slightly displaced one trace from the other, you wouldn't be able to tell that both the left and right 20-kHz signal outputs were being displayed in separate traces on the monitoring 'scope.

Output level (from the CD-650E's fixed output jacks) was a relatively high 2.48 V at the left channel and 2.52 V at the right, for a level difference between channels of 0.2 dB or so. Wow and flutter, if present at all, was below the measurable limits of my test equipment.

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The piano-concerto sound reproduced by the NEC was absolutely superb, as good as I've heard from just about any CD player.

Short access time—the time needed for the laser pickup to move from one track to an adjacent track—was 1.0 S. Long access time was about the only disappointing feature of this player. It took a full 7.5 S for the pickup to find its way from the innermost track of a test disc to its outermost track. Certainly this is not a serious problem. It was simply an unexpected result from a player that is, in every other respect, so superior to the average unit.

The CD-650E zipped right through my special defects test disc, as I would have expected. As CD players have improved, it is obvious that the original Philips disc designed to assess error correction and tracking ability is no longer adequate. One of the future projects of the EIA CD Standards Subcommittee—after we complete the basic measurement standard and issue the first test disc about which I spoke earlier—is to develop a second test disc that truly does check error correction and tracking in a way that is meaningful for today's CD players. In any event, my own finger-tapping tests on the sides and top of this player revealed that NEC's claims about isolation from external vibration are fully justified. I really had to tap the unit pretty hard to make it mistrack at all.

Use and Listening Tests

I have found that the sound of a piano is one of the most difficult to reproduce faithfully. Furthermore, even if mike placement and recording technique are good, some CD players will impart to piano sounds an unnatural and somewhat strident character which is immediately apparent (even to less-experienced listeners). It was for this reason, in addition to the fact that I like the music, that one of the CDs I used to check out this player was a new Telarc release offering Prokofiev's Piano Concerto No. 3 and Tchaikovsky's Piano Concerto No. 1, played by Jon Kimura Parker with André Previn conducting the Royal Philharmonic Orchestra. I'm told that Schoeps MK-2 and MK-4 mikes were used and that the digital recorder was a modified version of Sony's PCM-1610. Monitor speakers were B & W 801Fs (no wonder the recording engineers got the balance right). To put it succinctly, the sound reproduced by the NEC CD-650E hooked up to my reference system was absolutely superb—as good as I've heard from just about any CD player.

The supplied remote control worked flawlessly, and when listening to nonclassical fare, I found the ability to do random-access programming from my easy chair rather a nice convenience. I'll even confess to having pushed the open/close button a couple of times from across the room, even though that feature serves no practical purpose. Oh, well, NEC can be forgiven for this slight overembellishment, in light of the excellent player they have created at a very reasonable price. *Leonard Feldman*

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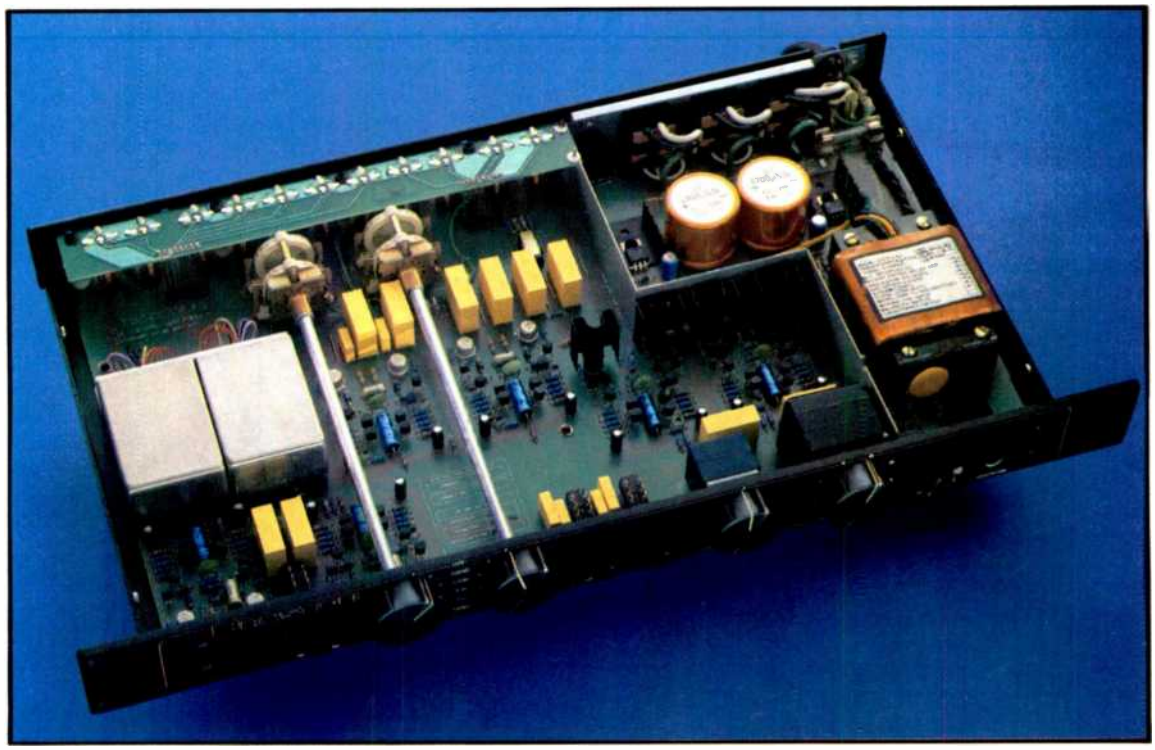

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AUDIO RESEARCH D-250MKIIS AMPLIFIER

Company Address: 6801 Shingle Creek Pkwy., Minneapolis, Minn. 55430.
For literature, circle No. 96

The Audio Research D-250 Mark II Servo is the third generation of one of the most widely praised vacuum-tube power amplifiers ever built. It is also one of the most expensive—it costs $6,900—and one of the most powerful. The D-250MKIIS will deliver about 240 watts per channel into 4-, 8-, and 16-ohm loads. While this kind of power is not exceptional when compared to transistor designs, it is amazing in a tube amplifier.

As you might expect from its power rating, the D-250MKIIS is not small; it measures 19 in. × 10½ in. × 20¾ in. and weighs 138 pounds. It is not the power amplifier for an audiophile without strong friends. It also is not simply a tube amplifier, it is a *32-tube* amplifier. The D-250MKIIS uses 16 6550s for amplification, four 6550s for electronic regulation, and 12 smaller tubes for the input amp (6DJ8), cross coupler (7044), driver amp (6DJ8), driver cathode follower (7044), and regulator drivers (12AT7).

A glance at the inside is also very impressive. The circuit layout is very clean for so complex a design, and the passive components are all top quality. The tubes are placed along both sides and the rear of the chassis, with two exceptionally large output transformers and a massive power transformer in front. With the filaments glowing, one feels a little like asking for certification by the Nuclear Regulatory Commission, but the D-250MKIIS has proved to be an exceptionally stable and trouble-free unit.

Such reliability is important in any amplifier, but particularly in one so heavy and complex. Fortunately, Audio Research has been able to draw on both experience and technology to correct the problems that affected the original D-250. The company is now using 6550 output and regulator tubes that are made by Philips (USA) rather than by G.E., and has found that the Philips tubes have a life of up to 2,000 hours in the D-250. The circuit's fusing and key resistors were changed in the Mark II version, and soft-start circuitry is used to largely eliminate any risk of the kind of "meltdown" that would require a service call.

As for design features, the Mark II is more the result of Audio Research's steady refinement of tube design than a radical breakthrough. The main change from the previous versions of the D-250 is the introduction of "servo" circuitry first seen in the Audio Research M-100 mono power amplifier. This adjusts the bias to keep tube pairs balanced in spite of tube aging, and is particularly valuable because the D-250MKIIS does not have the front-panel bias adjustment of the M-100. Once the bias is properly set up—and mine came right on the money from the factory—the D-250MKIIS can be left alone and simply enjoyed. This amp also has a new direct-coupling circuit, taken from the M-100, and a number of other circuit refinements. It is probably enough to say this is the new state of the art from the firm which has as much experience in top-quality tube designs as anyone in the business.

As with most tube amplifiers, the technical specifications of the D-250MKIIS are good, without reaching the hyperbolic performance levels of the most expensive transistor designs. It is conservatively rated as having typical harmonic-distortion levels of 1% from 20 Hz to 20 kHz. The power bandwidth (−3 dB) is 12 Hz to 60 kHz. IM distortion is less than 0.1% at 1 dB below rated output. Input sensitivity is 1.2 V rms, and input impedance is 75 kilohms. The slew rate is 25 V/μS, rise-time is 3 μS, negative feedback is 19 dB, and output regulation is 0.4 dB with a 16-ohm load to open-circuit. The D-250MKIIS also has the relatively low damping factor common with all tube amplifiers (about 20).

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The midrange makes a seamless transition into the bass and treble, with no apparent coloration other than a slightly forward sound.

These specifications, however, tell relatively little about the sound of this amplifier, and it is unquestionably one of the best-sounding amplifiers ever built—whether tube or transistor. One of the most sonically revealing and musically realistic, it does not have anything like the classic "tube sound"; there is no tube warmth or forgiveness. The D-250MKIIS will reveal everything a top-ranked transistor amplifier will reveal. At the same time, it still has the air, the natural harmonics and upper frequency performance, and the freedom from listening fatigue that have characterized the best tube units.

The D-250MKIIS has an almost faultless midrange, and appears exceptionally linear in terms of frequency response and timbre. This gives it outstanding performance in two areas which seem particularly important, the upper bass/lower midrange, and the upper midrange. The D-250MKIIS is one of those few amplifiers whose midrange seems to make a seamless transition into the bass and treble. Most amplifiers call attention to themselves with characteristic colorations in these areas. Tube amplifiers tend to be slightly warm in the lower midrange; transistor amplifiers tend to be too lean and recessed. Tube amplifiers tend to be forgiving and lose detail in the upper midrange and treble; transistor amplifiers tend to overemphasize the upper midrange and be too hard. In contrast, the D-250MKIIS has no apparent coloration other than a slightly forward sound character. Even this sound character may stem from the amplifier's exceptional transparency and ability to reveal normal miking and recording techniques, rather than being a true coloration.

The D-250MKIIS is not as "sweet" as some top-quality tube amplifiers (such as the Counterpoint SA-4 or the New York Audio Laboratory OTL designs), but it provides equal upper octave detail, without a trace of hardness. The treble, upper midrange, and midrange also "float" together in a musically natural way. Most power amplifiers good enough to float an image—that is, providing a natural illusion of imaging, sound-stage size, and depth—tend to emphasize some aspect of the sound stage or frequency spectrum over others. The D-250MKIIS minimizes these effects to an exceptional degree.

The sound stage is extremely three-dimensional, although there is less depth than in some competing designs, like those of conrad-johnson. The width, height, and placement of instruments are all excellent. The sound stage is, however, a large one and has a somewhat forward character. You feel you are sitting close to the performance rather than in mid-hall. This impression may be reinforced by the amplifier's apparent tendency to make the upper midrange a bit more live or detailed than may be fully natural. However, because so many re-

Audiophiles seeking a *ne plus ultra* system must audition this amp before making a choice. It gives a real-world education in what the High End can do.

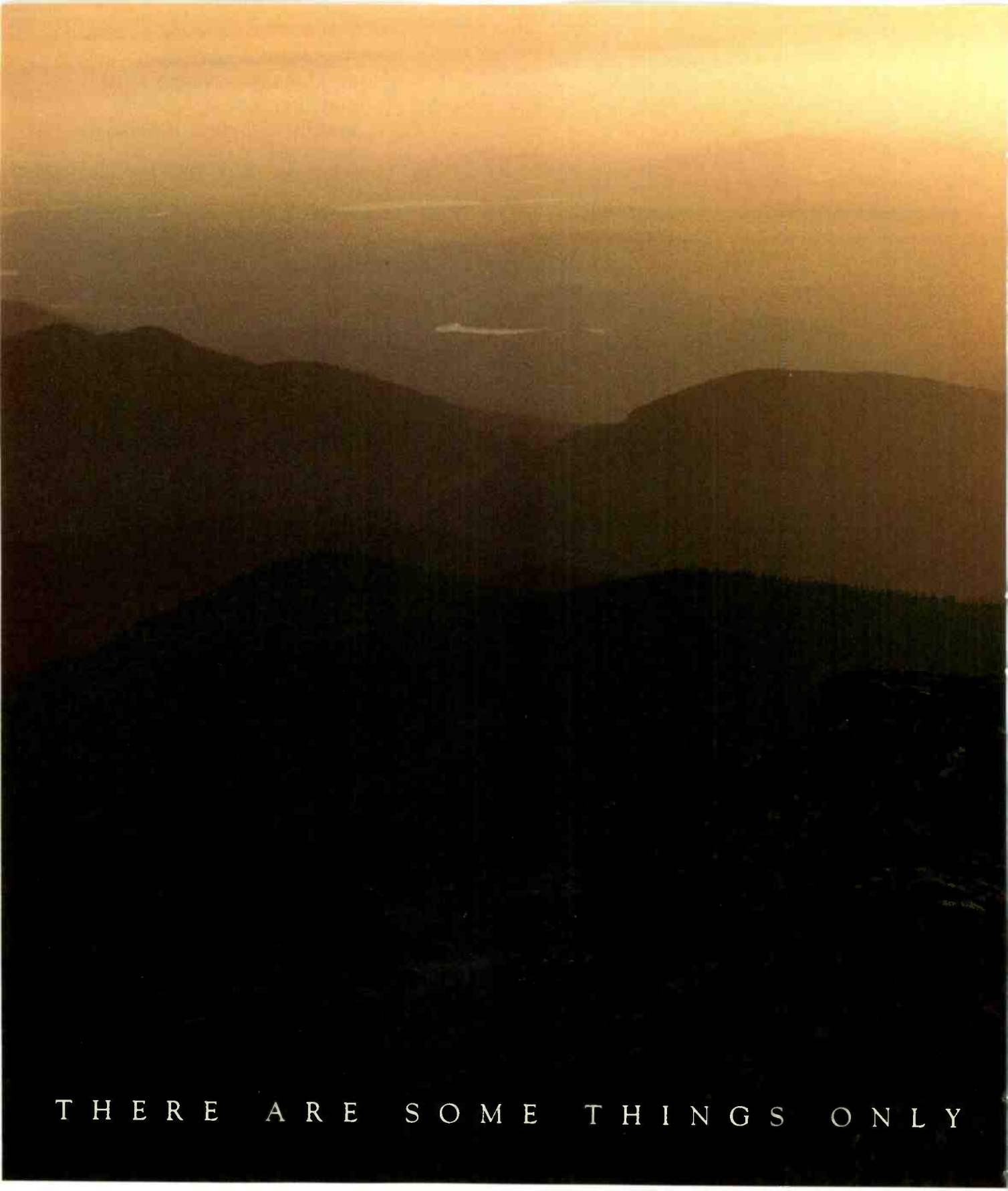
cordings are made under conditions in which this is the natural sound, it is again unclear to me whether the characteristic is in the amplifier or the source material.

The bass is surprisingly well controlled and natural. The D-250MKIIS does not have the power, control, and bass extension of the best transistor amplifiers, but it comes very close. In fact, with many speakers it produces a more natural feeling of bass power than its transistor counterparts. Many speakers benefit from a slight increase in low bass, provided that the amplifier involved does not run out of power and begin to lose control. Organ fanatics may still prefer transistors, but anyone who pays close attention to the pitch and character of bass strings will find the D-250MKIIS is one of the few amplifiers which can reproduce bass strings in a fully convincing manner.

As for the value of 240 watts per channel, this unit demonstrates how sheer power pays off in terms of superb dynamics and power-handling capability. Many amplifiers handle either loud passages or soft passages well, but few handle both well. Few provide a full range of convincing musical detail when there is a great deal of low-level information mixed in with major musical climaxes. The D-250MKIIS deals effortlessly with such shifts in the music, and it's exceptionally good in handling grand opera and symphonic and choral music like Mahler's Eighth Symphony. This ability to combine power with superb sound staging also helps to free the listener from the consciousness that he is listening to a recorded performance.

The D-250MKIIS also performs well into a range of loads that is unusually wide for a tube amplifier. However, since it uses an output transformer, it is not the amplifier for speakers with ultra-low impedances, in the 2-ohm range, say, and a little care will be needed to ensure a proper match of speaker and amp. Nevertheless, the D-250MKIIS is far less sensitive to speaker load, and far more predictable in sound character, than are lower power tube amplifiers.

Minor caveats aside, the Audio Research D-250MKIIS is one of the few amplifiers that audiophiles seeking a *ne plus ultra* system virtually must audition before making their choice. It is also a product that audiophiles should listen to even if they can't afford its steep price tag. It helps provide a benchmark for evaluating the sound of other components and for judging the strengths and weaknesses of other amps. Most important, it provides a real-world education in what the High End can do. Used with other equipment of comparable quality, the D-250MKIIS shows both that components really do sound different and that selecting the very best can pay off in a tremendously more enjoyable and musical system. *Anthony H. Cordesman*



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ALTEC LANSING

AUDIOSOURCE RTA-ONE REAL-TIME ANALYZER

Company Address: 1185 Chess Dr., Foster City, Cal. 94404.
For literature, circle No. 97

In recent years, combination equalizer/RTAs have become quite popular, and these units do work very well in most cases. However, there are a number of excellent equalizers, both octave-band and parametric, which do not include any form of spectral display. Audiophiles should always have faith in their own listening tests, but it *is* difficult to make equalizer adjustments without an RTA for basic reference and guidance.

Not many octave-band RTAs are on the market, and the AudioSource system which I checked out is one of the few made to fit within a typical audiophile's budget. The retail prices are $249.95 for the RTA-One analyzer, $54.95 for the accessory PNG-One pink-noise generator, and $29.95 for the RTA-One remote microphone. The RTA, noise generator, and an a.c. adaptor for the RTA ($15.95) were contained in a handy carrying case ($34.95). My first impression was that the RTA-One is slightly large and heavy for easy hand-holding. On the other hand (no pun intended), I appreciated the ruggedness of its steel case, a major contributor to the weight.

Three rotary switches on the front control "Power/Decay" ("Off/On Fast/On Slow"), "Input Display" ("Line Level/Line RTA/Mic RTA/Mic Level"), and "Level (dB)." The level settings for "Mic S.P.L." range from "60" to "110" in 10-dB steps and for "Line" go from "−40" to "+10," also in 10-dB steps. The knobs are of good diameter and have very legible indices. However, they were a bit hard to turn, despite the grooving on their edges, because their detents were quite stiff and they do not normally project very far from the panel. Although the manual does not mention it, the knobs can be pulled out one-half inch, but I found that they were hard to pull.

All front-panel designations are white on a black background, making them easy to read.

The LED-type display above the knobs has the 10 standard octave-spaced bands at 31.5, 63, 125, 250 and 500 Hz, and 1, 2, 4, 8 and 16 kHz. The nine vertical LEDs for each band range from "−10" to "+10" in 2.5-dB steps. All of these LEDs are red, with the exception of the 10 in the "0" row, which are green. The 2.5-dB steps are somewhat coarse, but a worthwhile improvement in resolution can be gained by adjusting level and EQ for equal momentary flashing in each channel when using pink noise. I really liked the green reference-level LEDs—I felt that they helped to speed the equalization process.

At the top of the level display are three red indicators: "Power," "Low Bat." and "Overload." All are aids to proper operation of the RTA-One.

The microphone, which projects out from the end of the case, has a fairly large conical surround. The shape should help to prevent unwanted reflections, but the microphone cannot be checked with a standard calibrator—a common characteristic of most inexpensive RTAs. When the unit is in "Line RTA" and "Mic RTA" modes, the individual levels in each of the 10 bands are displayed. In the "Level" modes, the total energy in all 10 bands is summed and shown as a horizontal row of LEDs. A fast check showed that the RTA-One did quite an accurate job of summing, which most RTAs do not.

The AudioSource unit has good-quality jacks for external d.c. (standard coaxial), external microphone (phone), and line input (dual phono). The left/right summing at the phono jacks was both unexpected and very nice to see included. On the back are four rubber feet for horizontal placement, and two rubber-strip feet are on the end for

Critic's Choice

I found the AudioSource unit easy to use in a home listening system, and it can be helpful in sound reinforcement as well.

setting the unit vertically—handy for monitoring levels at a distance. The tripod socket on the back is useful when notes need to be taken and some form of holding is required. The battery compartment, which holds four AA cells, is easily opened with a quarter-turn of the slotted thumbscrew.

Before trying to do any equalizing, I checked over the ranges of levels available. Usually it is necessary to have at least 60 dB SPL in a room when making adjustments; the RTA-One will indicate as low as 50 dB SPL ("−10" on the "60" scale). It will show levels as high as 120 dB SPL ("+10" on the "110" scale). A fast comparison showed that the SPL indications were accurate within about 2 dB. The reference level for line inputs is 1.0 V, so the range of voltage indications is from 3 mV ("−10" on the "−40" scale) to 10 V ("+10" on the "+10" scale). With the signal levels in typical equipment ranging from perhaps 20 mV to 2 V, it appeared that line levels would not be a problem.

The owner's manual is not detailed, but the instructions are generally quite good, with important cautions on avoiding excessive boosts at the frequency extremes. I noticed a couple of oddities, inlcuding a reference to the "audible audio range."

I monitored music for a while and concluded, as I had expected, that "Fast" mode was essential to get an accurate sense of the changing music spectra. To me, the attack time was good, but the decay time was a little fast. The 20-dB range was rather limiting for this use with many types of music. There seemed to be good separation between bands, and a vocal tone at the center of the 250-Hz band was indicated as 7.5 dB lower in the two adjacent bands—typical for many octave-band RTAs.

In preparation for doing some equalizing, I took a look at the PNG-One pink-noise generator. There were a number of similarities with the RTA-One: Steel case, readily accessible battery compartment (dual 9-V), dual phono jacks, rubber feet, and a power-on indicator—a good collection of features. The PNG-One also has an output-level control, important for setting test levels correctly. The sound from the device was quite smooth, with just a slight burbling, but no recycling clunk was observed.

With the PNG-One connected directly to the RTA-One, the display was quite flat, in general, but the level in the 31.5-Hz band was about 2.5 dB low. The 63-Hz band was slightly low and the 500-Hz band slightly high. The response was almost exactly the same for both slow and fast response times. You can use the PNG-One and RTA-One to check for flat response in any piece of gear inserted between them; the display after insertion should be the same as before.

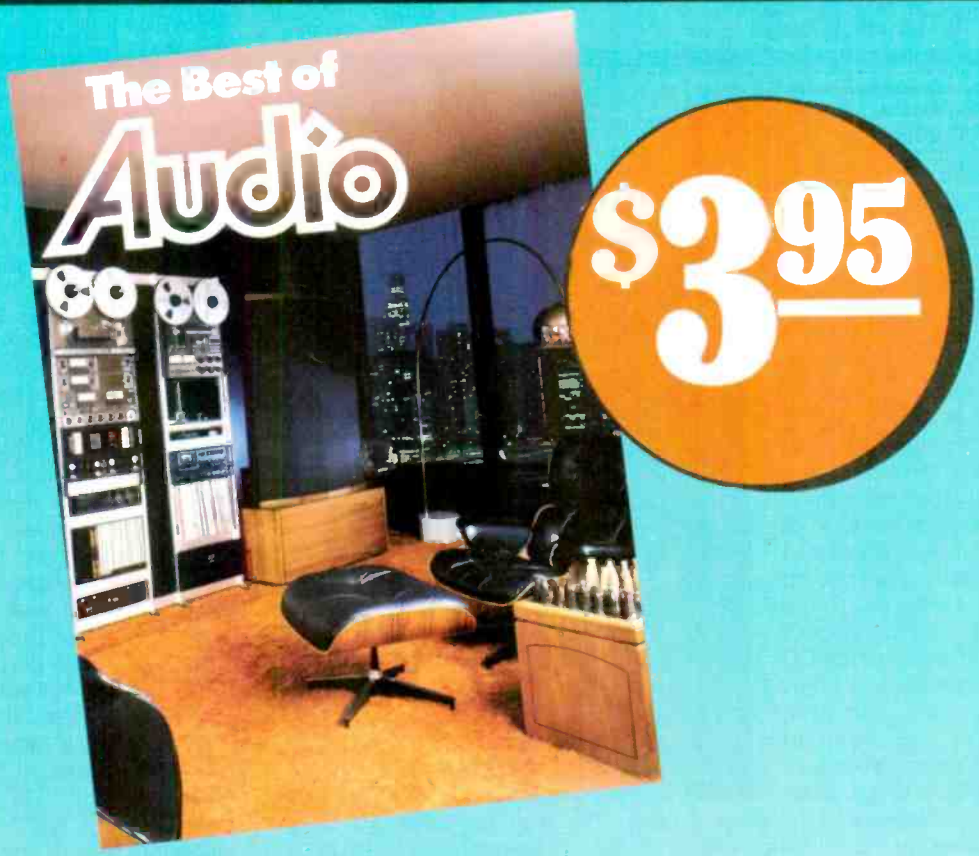
With pink noise fed through the entire system, I checked the RTA-One microphone for directionality by pointing the unit directly at the loudspeaker and rotating it back and forth. Very little change occurred in the level of the 16-kHz band, showing that the microphone was insensitive to exact pointing—a desirable trait which is lacking in most RTA microphones. The overall mike response was acceptably flat.

I found the AudioSource unit easy to use in a home listening system, and the green reference row helped to speed the process of equalizing and adjusting levels as needed. "Slow" had just a little bit of level spreading, and "Fast" was too jittery for most equalizing, as would be expected. I did find, however, that "Fast" was good for pinpointing the relative band levels—increasing the resolution of the level readout, as it were.

I also used the unit in a high-school auditorium, in a sound system used for a production with many musical numbers and a few skits. My ⅓-octave RTA wasn't fit to travel at the time, so the RTA-One and PNG-One were used to guide equalizing, to get basic smoothing for the system output and to compensate for some room conditions. AudioSource does not claim that this equipment can do sophisticated analysis, but they're right that it can be helpful in sound reinforcement.

I just lifted the RTA-One off my desk, and it still seems on the heavy side, but it also appears to be rugged and reliable, and I'll opt for those two characteristics any day in the week. Overall, there are quite a few more positive points than negative ones for this unit and its accessories. If you need an RTA, take a look. *Howard A. Roberson*

SOUND INSURANCE



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JUST FOLKS

New Acoustic Music: Various Artists
Rykodisc RCD 20002.

New Acoustic Music is a collection of choice cuts drawn from the Rounder Records catalog. Despite the title and the "new wave" cover art, the music is traditional in style, played on folk instruments such as banjos, mandolins, dobros, and guitars. Rykodisc calls it "new acoustic music" because all but one of the tracks are original compositions rather than old standards.

The folks at Rykodisc selected a group of pieces that work well together, and presented them in an order that stands up to repeated playbacks. There are no jarring juxtapositions or weak fillers. When an entire CD glides by effortlessly, you know that someone with good taste and judgment has been at work. The company also took advantage of CD's longer playing time. The 15 tracks add up to over 64 minutes of music. Here is a label that understands the nature of the medium and makes a point of fully utilizing it.

The sound quality is exemplary. Clearly, the original analog recordings were outstanding, and the CD reveals their virtues, not their imperfections. Although each track was recorded in a different place, at a different time, the contrasts in room ambience are never distracting. During "Marv Pontkallec," for Celtic harp, the background sound of waves gently rolling onto the shore adds to the atmosphere without drawing undue attention to itself. This track has been tastefully put in the middle of the disc, creating a neat pivot point.

Darol Anger's octave violin work on the second track, Todd Phillips' "Fat Kid," sounds a bit like that of Jean-Luc Ponty. Anger appears again with a loose, swinging fiddle solo in Tony Trischka's "Pour Brel," with similar effect. But Anger is definitely his own man, and the references only serve to add spice to his playing. Fred Carpenter displays still another violin style. His dark, rich tone sounds more like a viola than a violin in Tony Rice's mellow, reflective "A Child Is Born."

In "Thirteen," from his *Solo* album, Rob Wasserman shines in a wonderful acoustic bass solo. You'll hear pitch bends, fingers sliding, strings hitting the fingerboard, and other close-up sounds, all done with flair and good taste. The way he plays his bass—including fragments of accompaniment figures—makes it sound as flexible as a guitar.

Mandolins, dobros, and banjos are everywhere. David Grisman and Andy Statman play a mandolin duet in "Two White Boys Watching James Brown at the Apollo." Jerry Douglas and his group use them all in "Intro," a delightfully percolating piece.

New Acoustic Music is as fresh and clean as the produce at a farmer's roadside stand. It's just the kind of music to put on your stereo after a long, hard day. *Steve Birchall*

The Bridge: Billy Joel
Columbia CK 40402.

He's street-tough and worldly-wise; he's tender, vulnerable, and sensitive. He's a rocker. He's a crooner. He's a knockout lyricist, a damn fine musician, and he has great taste in women. Billy Joel has matured into a pop artist with real staying power. His latest album, *The Bridge*, reveals the piano man in top form.

This Compact Disc is an original digital recording which, like Joel himself, is light on flash and heavy on substance. Don't let the lack of studio razzle-dazzle fool you, though; there is no finer example of professional recording than this.

The reproduction of Joel's piano, for instance, is simply perfect. Although he is equally expert on synthesized keyboards, the artist's passion for the acoustic instrument comes through in every note of "Baby Grand," his latest piano love song. This bluesy, minor-key ballad was written specifically to lure the great Ray Charles into the studio with Mr. J., and damned if it didn't succeed. Joel eases himself into Charles' vocal territory smoothly and naturally. The two trade verses and fluid piano runs so well that you'll find yourself programming your Compact Disc player to run it by a few more times.

But if this kind of mellowness isn't your frame of reference for Billy Joel, if the sweet, sexy gentility of "Temptation" doesn't really get to you, or if the thoughtful beauty and rich, slow guitar of "This Is the Time" fail to catch your heart, then you probably like Joel in his harder mode. *The Bridge* actually starts out rocking with a passion as Joel plunges into the first cut, "Running on Ice." His sophisticated lyrics about the tensions of modern urban life are carried by a wonderfully anxious piano figure and sharp, nervous punctuation from drums, cymbals, and synthesizer. Need a cut you can really sink your feet into? How about the rock-steady beat and familiar-yet-new melody of "A Matter of Trust"? The radio-famous "Modern Woman" chugs along, shaking up your blood; "Code of Silence" and the final cut, "Getting Close," have a certain melodic monotony, but lyrically they'll bring you to attention if you just give a listen.

Joel has enlisted some of the heaviest hitters in musicdom to assist in this winning production. Cyndi Lauper's unique voice soars behind his on "Code of Silence," which she cowrote. For the jazzy "Big Man on Mulberry Street," jazz greats Ron Carter and Michael Brecker apply their considerable chops to acoustic bass and tenor sax, respectively. On "Getting Closer," Steve Winwood runs his hit-creating

fingers across the keys of a Hammond B-3 electric organ.

The heaviest hitter in the production department is producer Phil Ramone, who has helped put together another exquisitely recorded disc. The gentle percussion that travels oh-so-smoothly from left to center to right on "Modern Woman," and the subtle echo on Joel's vocal that just picks up sibilants and the very ends of lines on "A Matter of Trust," are impressive. What really counts here, though, are the expert reproduction of true tonal values for all instruments, and the clarity and sense of depth that capture every nuance of Joel's complex lyrics and dramatic instrumental delivery.

If you have a taste for terrifically recorded, moving, rocking, thought-provoking albums, *The Bridge* is for you.

Paulette Weiss

Pinchas Zukerman

Mozart: The Four Horn Concertos. The St. Paul Chamber Orchestra, Pinchas Zukerman; Hermann Baumann, horn.
Philips 412 737-2.

Horn virtuoso Hermann Baumann gave us a superb reading of the Telemann horn concertos on an earlier Philips CD (412 226-2), and his performance of the famous Mozart horn concertos is equally convincing.

Inevitably, Baumann's recording of these works will be compared to Barry Tuckwell's great performance on London (CD 410 284-2). Both players are consummate artists. Tuckwell has a lighter tone and achieves a wonderful cantable quality in his playing. Baumann is darker hued and more sonorous, and his tone often emphasizes the gutteral qualities of his instrument. Both approaches work well. Baumann's horn is more forwardly recorded than Tuckwell's, and indeed, his orchestral accompaniment is more close-up as well. Tuckwell's orchestra is in a more recessed acoustic perspective and has more hall ambience.

In spite of the ripe fullness of horn and orchestra in this recording the Philips engineers have provided it with fairly spacious acoustics. Pinchas Zukerman and his St. Paul Chamber Orchestra obviously have a fine rapport with Baumann; their playing is very polished and displays a lovely string tone.

Bert Whyte

André Previn

Walton: Belshazzar's Feast; Suite from Henry V. The Royal Philharmonic Orchestra, André Previn.
RPO Records CDRPO 8001.

This release deserves special attention for several reasons. First, it represents the inauguration of the new RPO

On the Vivaldi concertos, guitar transients are utterly clean and the orchestra's strings sound incredibly sweet.

label, owned by the Royal Philharmonic itself. Second, it presents an absolutely definitive recording of the ever-popular "Belshazzar's Feast."

As early as 1967, Previn proved that he was a Walton specialist when RCA released his recording of Walton's first symphony with the London Symphony Orchestra. That recording still remains the benchmark. Now, nearly 20 years later, Previn has the field all to himself. There is no question that he understands both the architectural and emotional dimensions of Walton's music better than any other living conductor, and he is consequently able to draw meaning and substance out of Walton's music, where most others produce tentative results.

From a purely orchestral point of view, there is more limning of detail and structure than ever before. Once you've heard the work straight through, it is very instructive to rehear it, with score in hand, to *see* some of the things Previn does. And of course the sonics are up to date, complete with organ and antiphonal brass bands.

The only runner-up to this disc is the old Roger Wagner EMI recording with the same orchestra. In that version, soloist-narrator John Cameron turned in an absolutely stunning performance and captured the Old Testament fire and drama perfectly. In the new RPO version, baritone Benjamin Luxon handles the lyrical tasks beautifully, but he lacks the dramatic zeal of Cameron. The choral duties are well handled by the Brighton Festival Chorus and the Collegium Musicum of London.

The moving music which Walton wrote for Olivier's 1944 film *Henry V* remains one of the high points in cinematic writing. Here it is given the best performance on record since Walton's own, back in the '60s.

In short, if you are a Waltonian, you must get this CD! *John M. Eargle*

Vivaldi: Guitar Concertos. The Academy of St. Martin-in-the-Fields with Los Romeros, Iona Brown.
Philips 412 624-2.

If you love Vivaldi, you'll be enamored of this CD. The superbly accomplished instrumentalists of Los Romeros perform these guitar transcriptions of five Vivaldi concertos with their usual technical brilliance and sensitive musicality. The always reliable, always virtuosic Academy of St. Martin-in-the-Fields orchestra provides a well-integrated, finely wrought accompaniment.

The Philips engineers have achieved a very natural balance between guitarists and orchestra, and their acoustic perspective is warm and spacious. The transients of the guitars are utterly clean, while the string sound of the orchestra is incredibly sweet and smooth, yet well defined. Even the most rabid anti-digital folks would be pleased with this lovely sound. Highly recommended. *Bert Whyte*

Los Romeros

Tchaikovsky: The Nutcracker. The London Symphony Orchestra, Sir Charles Mackerras.
Telarc CD-80137-2, two-disc set.

In the relatively short time since Telarc Records was founded, the label has achieved an enviable and justly deserved reputation for the sonic excellence of its recordings. Producer Bob Woods and engineer Jack Renner must be particularly proud of this recording of the complete "Nutcracker" ballet because it marks their entry into the "big-time" show-biz world: This "Nutcracker" is the soundtrack of Hyperion Pictures' new movie of the same title, which features a celebrated and somewhat controversial version of the ballet danced by the Pacific Northwest Ballet of Seattle.

Sir Charles Mackerras was the ideal choice to conduct the complete "Nutcracker." A ballet conductor of wide experience, he gained an early reputation in the field with his delightful ballet, "Pineapple Poll," based on Gilbert & Sullivan themes. Above all other considerations in this performance, Sir Charles does not treat the score as a concert performance of a ballet, but as a totally balletic entity. His tempi, his pacing, and his phrasing guide us smoothly through the various scenes and tableaux, yet there is never any lack of dynamic experession, nor does he oversentimentalize the more lyrical sections.

Working in Watford Town Hall near London, Jack Renner has given us a superlative recording of this beloved score. He has caught just the right perspective for this music. There is a nice, spacious ambience, yet orches-

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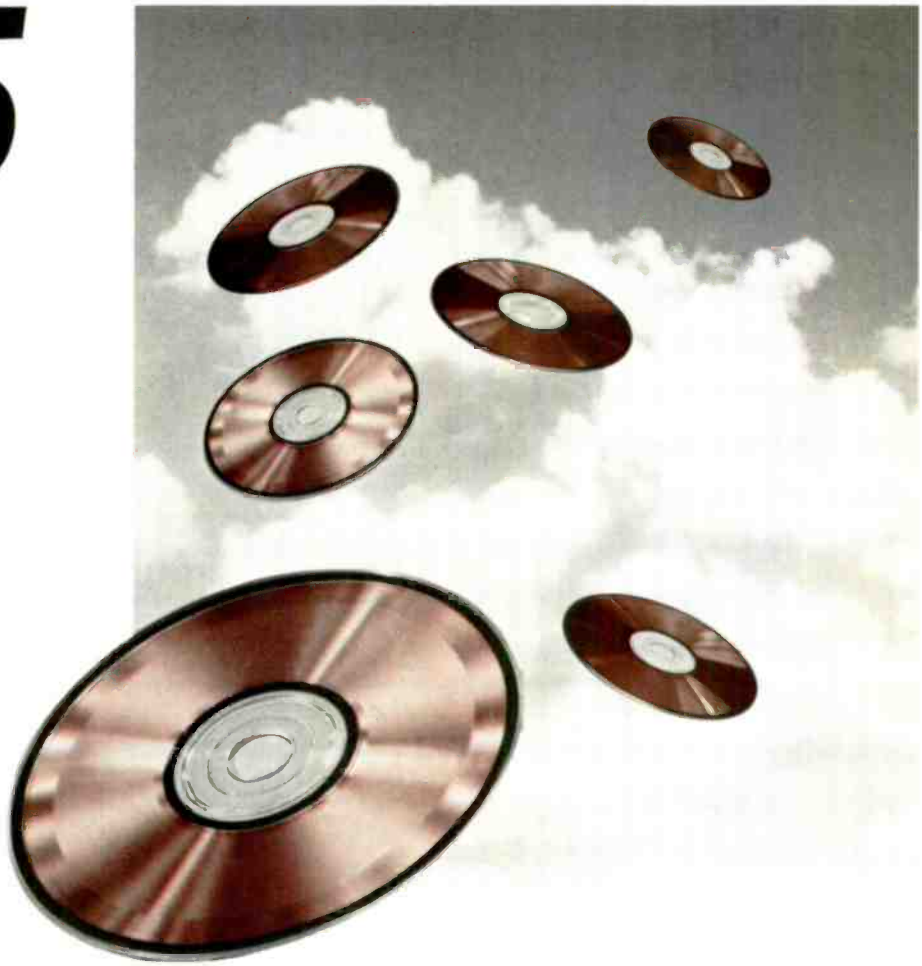

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ELVIS COSTELLO AND THE ATTRACTIONS **"Blood & Chocolate"**
BOSTON **"Don't Look Back"**
'TIL TUESDAY **"Welcome Home"**
JOAN JETT AND THE BLACKHEARTS **"Good Music"**
SURVIVOR **"When Seconds Count"**
"West Side Story" ORIGINAL BROADWAY CAST
"The Sound Of Music" ORIGINAL BROADWAY CAST
RODGERS & HAMMERSTEIN: **"South Pacific"** Te Kanawa, Carreras, Vaughan, Patinkin; Ambrosian Singers; London Symphony Orch./Tunick
MOZART: **Don Giovanni** Raimondi, Te Kanawa, Berganza; Paris Opera Orchestra & Chorus/Maazel
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COMPACT disc DIGITAL AUDIO

The impeccably English *Carols for Christmas* is nicely varied, with lots of solid vocal sound. For an Anglophile, it's heaven.

tral detail is always well maintained. The tumultuous "Battle of the Mouse King" sequence has tremendous dynamic energy, and just to give it more visceral impact, Jack dubs in a few of the cannon shots he had handy from his famous recording of the "1812 Overture"! This is a real gem, with superb balances, even in difficult sections like the boys' wordless chorus during the "Waltz of the Snowflakes" scene.

A triumph for all concerned, this production ought to be made into a videodisc with digital soundtrack. It would be a stunning audio/visual experience.

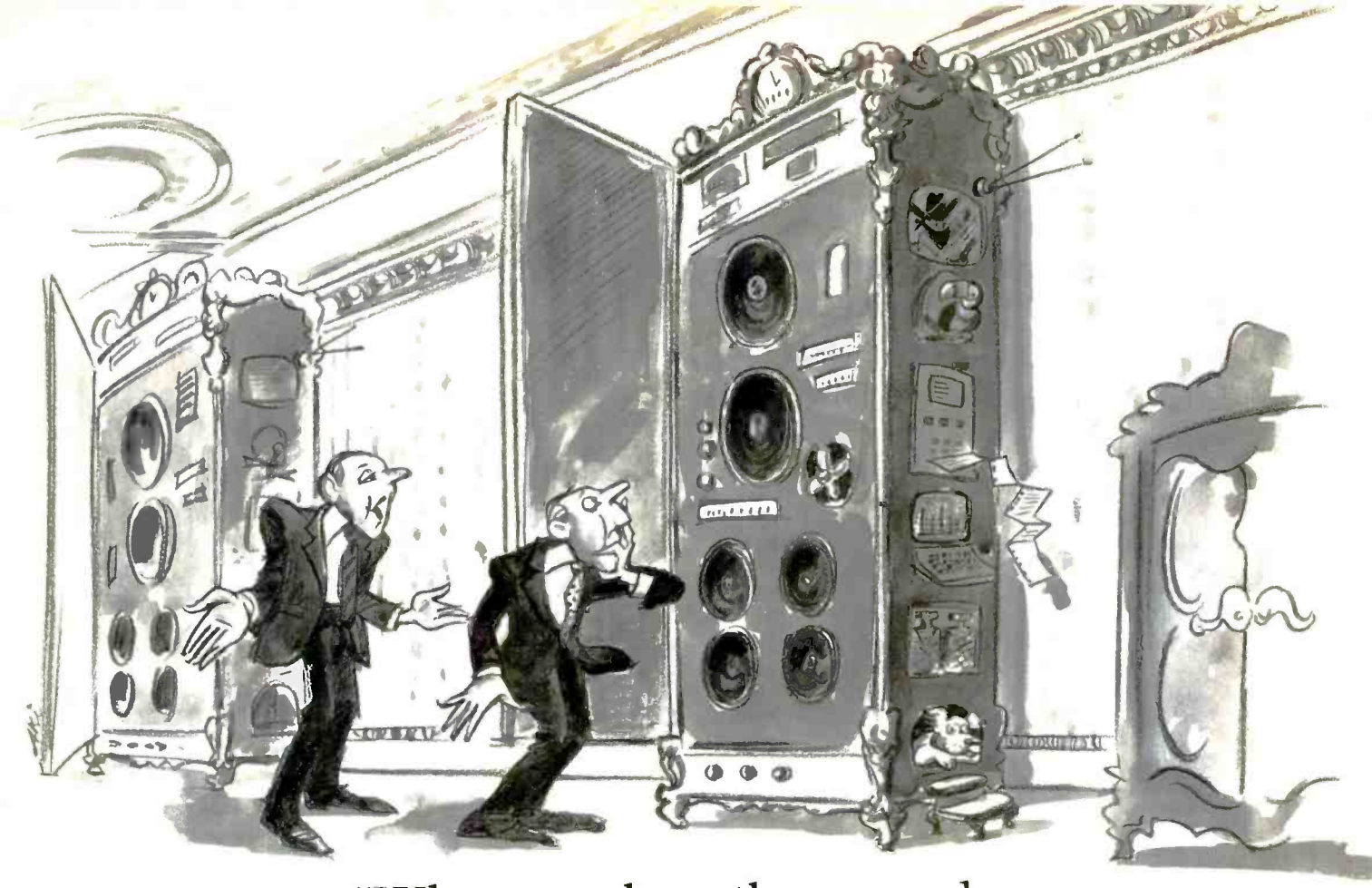
Bert Whyte

Carols for Christmas, Vol. I and Vol. II. The Royal College of Music Chamber Choir and Brass Ensemble, Sir David Willcocks.
Rykodisc RCD 1004/5, two-disc set.

Phew—if I puff and I hurry, this will be the first Christmas recording in years I've been able to get into the December issue. We receive scads of holiday releases every year—just in time for January.

There are two CDs and no less than 41 carols here, enough for anybody's Christmas, and more. Excellent background stuff for department stores too, and banks. Impeccably English, the music was arranged and conducted by Sir David Willcocks, the very Dean of British choral conductors. It's nicely varied, some with voices alone, some with the inevitable boy soprano (or are they little-girl sopranos, by this late date?), others with piano, full cathedral organ, brass choir, Christmas bells, what have you. Sir David isn't of the conservative school; his chosen voices have always (on records) had a somewhat professional fullness and vibrato, in contrast to other cathedral-type English choirs and soloists. So that's what you will find here—lots of solid vocal sound and, of course, the most utterly, impeccably British pronunciation. For Anglophiles it's heaven on earth.

As for me, coming from *New* England, out of these 41 carols I found I instantly knew the tunes and some of the lyrics of at least 35 of them. Yep, same old music, and nicely, if conventionally, arranged by Sir David. "We Three Kings from Orient Are," "We



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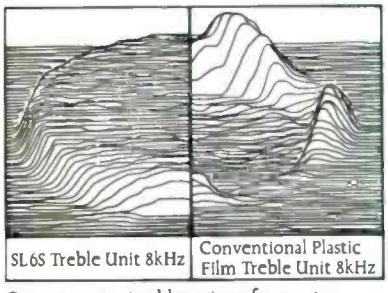
When you realize how hard it is to make a simple design perform correctly, it's easy to see why some speaker designers use compensating gadgetry to disguise the shortcomings of their basic components. It's also easy to proclaim the virtues of these "engineering breakthroughs." But it can be difficult to hear the music through all that hardware.

Celestion speakers contain some of the most sophisticated engineering you're ever likely to hear. Or not hear, to put it more accurately. We design speakers to vanish in the presence of good recordings. To that end, our engineers concentrate on making them as simple as possible.

There's a catch to this approach, of course. With nothing to hide mistakes, we have to do everything right. So we do everything ourselves (surprisingly few companies can build a speaker from scratch) optimizing every component. Then we combine them in elegantly simple systems that function directly, truthfully and musically.

Choosing speakers is no great mystery. Neither is good speaker design, although there seems to be plenty of mystification going around.

If you've grown tired of speakers that give you everything *but* open, transparent sound and accurate imaging, arrange an audition at your Celestion dealer. And discover the music that's been hidden behind all that hardware.



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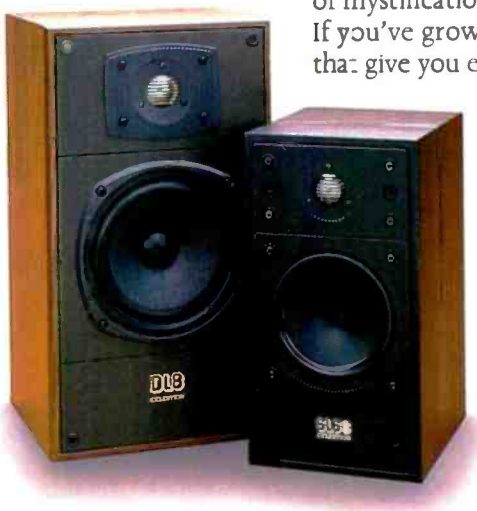

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Lionel Richie's new disc may not be very touching, but no praise is too great for the technical side. Every cut is vibrantly, thrillingly alive.

Wish You a Merry Christmas," "Joy to the World"—it took me back.

You can't go wrong here, even if the very British performance comes to us straight from its pressing in Japan, the home (away from home) of Western recording. If you don't get this in time for Christmas 1986, try it for '87.

Edward Tatnall Canby

Dancing on the Ceiling: Lionel Richie **Motown 6158MD.**

A writer from the South was fond of the phrase "slicker than mule spit," and though I took a powerful liking to the image it conjured up, being a city kid I never really knew just how slick mule spit was. I believe Lionel Richie's *Dancing on the Ceiling* has given me a better grasp of the metaphor.

Now, now, you Lionel Richie fans—don't get all hot under the collar. I really *like* him. His classic ballads have become permanently installed in the pop repertoire, and his up-tempo material is tuneful, cheery, and full of high spirits.

While this album may be too surface-slick to touch the emotions, no praise is too great for its technical side. Every cut here is vibrantly, thrillingly alive. Instruments are vivid and defined with precision, as Richie's vocals brush up against your ear with the intimacy of someone singing to you alone. The gorgeous tone of the electric keyboard on "Ballerina Girl" is a real aesthetic treat, and the piercing sweetness of the strings is breathtaking; the arrangement (by Richie and John Barnes) on "Don't Stop" is a masterful interweaving of synthesizers and percussion, with some absolutely eerie electronic effects. The digital process keeps those big, silent spaces yawningly empty. The recording is equally spectacular throughout, with gorgeous balances and a sense of space so keenly delineated that instrumental movement from left to right will have you involuntarily whipping your head about to follow the sound, while foreground-to-background movement will pull you deeply into the recording.

Unfortunately, this sense of depth will satisfy the ear alone; it rarely touches the heart or mind. The material is about as deep as the thoughts of a backward gnat. There is also a real sense of aural *déjà vu*; recycled riffs appear throughout.

It's a real shame that this very attractive surface is so slippery that there's nothing to hold onto. I'm going to just let it slip right off my CD player.

Paulette Weiss

William Tell and Other Favorite Overtures. The Cincinnati Pops Orchestra, Erich Kunzel. **Telarc CD-80116.**

If you want to exercise your woofers and overindulge in digital dynamics, simply "turn up the wick," as our British cousins say, and stand back!

This is a typical Telarc blockbuster


Charles Dutoit

CD, with Erich Kunzel at the helm of the Cincinnati Pops Orchestra. Tried-and-true overtures are here in all their massively orchestrated glory—"Light Cavalry," "Fra Diavolo," "Poet and Peasant," and by all odds the best performance of the much-maligned "William Tell Overture" in years. The prologue to the "Tell" is simply lovely, with gorgeous cello sounds, and the "Hi-Ho Silver!" section is played at full gallop with stunning effect.

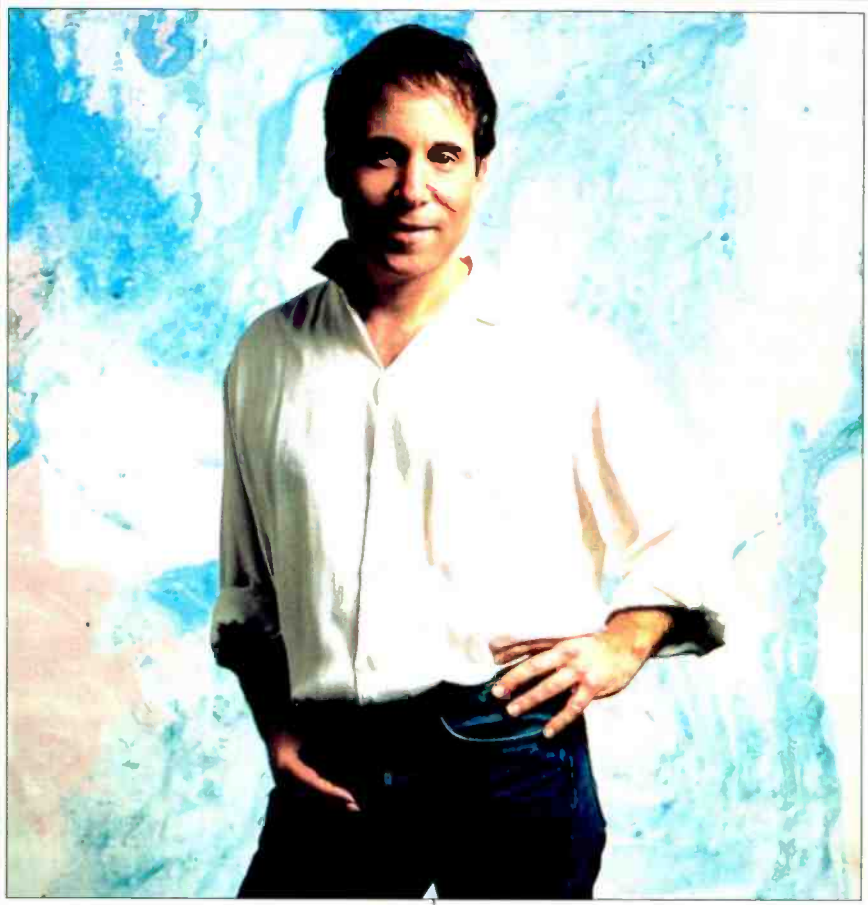
Throughout this CD, the brass, so essential in these overtures, rings out with bright and brazen voice, and the famous Telarc bass drum lends its authority with visceral impact. *Bert Whyte*

Mendelssohn: Piano Concertos Nos. 1 and 2. The Bavarian Radio Symphony Orchestra. Charles Dutoit; András Schiff, piano.
London 414 572-2.

András Schiff's brilliant pianism shines in his spirited and highly expressive traversal of these ingratiating Mendelssohn concertos. Conductor Dutoit elicits a most sympathetic accompaniment from the orchestra, and the engineers have provided a very high-energy, dynamic recording with a rather close-up perspective. There is a lot of presence, with the piano a bit prominent, but just the same it is a lovely sound, leavened by the resplendent acoustics of the Herkulessaal in Munich. *Bert Whyte*

MICHAEL TEARSON
JON & SALLY TIVEN

CONTINENTAL RHYTHMS



Graceland: Paul Simon
Warner Bros. 25447, $9.98.

Sound: B Performance: A

What a delicious smorgasbord of sounds this album is! Much of *Graceland* was recorded in Johannesburg, South Africa, with native black musicians. It is not so much that the sounds are bizarre or particularly exotic, but that they are exotically deployed.

The sound of an accordion, of all things, frames the album. "The Boy in the Bubble" opens *Graceland* with an insistent, chugging figure on the squeeze box (played by Baghiti Khumalo); the band soon joins in, playing a hard shuffle. Bass guitar is virtually the lead instrumental voice, dipping all over and around the melody. A taut tension binds "The Boy in the Bubble." I remember, at first listening, how impatient this opener made me to hear the rest.

Next is the jaunty "Graceland," a song of fragments in which Elvis Presley's mansion becomes a metaphor for a safe haven, an Eden. The sounds of percussion and steel guitar (played by Demola Adepoju of King Sunny Ade's band) are the song's tattoo. The Everly Brothers join Simon on vocals.

"I Know What I Know" is about an attempted seduction, for which Simon is joined by General M. D. Shirinda and The Gaza Sisters, who add some wild counter-vocals. "Gumboots" features The Boyoyo Boys. Set at a quick, finger-popping pace, it is written as a stream-of-consciousness series of urban events. "Diamonds on the Soles of Her Shoes" opens with a collaboration with the a cappella group Ladysmith Black Mambazo. Then, a rhythm section featuring bassist Khumalo and guitarist Chikapa "Ray" Phiri joins in to make extremely happy music, over which Simon weaves a dreamy tale of night life and dancing and escaping the blues.

Side two opens with "You Can Call Me Al," *Graceland*'s first single and the only selection that I feel doesn't quite work. This is not due to the music, however, which is aces. The same crew as the one used for "Diamonds" sets up a hot, popping groove, and expatriate South African Morris Goldberg contributes a blazing pennywhistle solo. The problem is that Simon's singing here is inescapably wimpy.

"Under African Skies" is a portrait of an African walking in his native land. Paul sings it beautifully as a duet with Linda Ronstadt. This leads directly to "Homeless," performed with Ladysmith Black Mambazo, whose voices swoop, blend and soar. Sung in English and in Zulu, it is a breathtaking showstopper.

Graceland closes with two songs which employ American bands, each with its own exotic feel. Good Rockin' Dopsie and The Twisters propel "That Was Your Mother" to a white-hot Cajun shuffle. The accordion reappears here as a lead instrument. It figures, too, in the finale "All Around the World or The Myth of Fingerprints," on which the Los Angeles group Los Lobos appears. The beat here is the hardest and strongest of the set. Los Lobos cooks!

On first listening to the LP, I was struck with the warmth of the sound and the subtlety of a mix which allows many elements to be heard very well. Sounds of percussive effects, accordion, bass, horns, guitars, and especially voices are wonderful. The cassette, by comparison, doesn't have the same warmth or smoothness, but the detail of the percussion is sharper and more brittle. Of the two, I prefer the LP. The CD blows them both out of the water, with superb presence and phenomenal detailing. Some elements come alive that were almost masked in the other formats: Bongos beneath voices, the feel of the room, stereo placement. All of a sudden you are in the room with the musicians. This is a CD to play for doubters of the medium.

Graceland is a remarkable album, a genuine work of art as fine as any Paul Simon has ever done. The diversity of its sounds, the excellence of Simon's compositions, and the quality of the performances are undeniable. This album demands a spot near the very top of my best-of-the-year list. I know I'll be listening to it for years to come.

Michael Tearson

Itchy Twitchy Feelings: Various Artists
EMI Treasury ST-17203, $8.98.

Sound: B+ Performance: A

Rock Me All Night Long: Various Artists
EMI Treasury ST-17201, $8.98.

Sound: B+ Performance: A

EMI's Alan Warner and John Guarnieri have dug into the files of two labels they acquired, Sue and Aladdin, and come out with two superb packages of early rock 'n' roll tracks, digitally remastered and well annotated. The artists featured in some of their earliest recorded performances, include Ike & Tina Turner, Don Covay, Inez Foxx, Louis Jordan, Shirley and Lee, Helen Humes, and plenty more. These are some of the recordings that gave birth to rock 'n' roll and R&B, and they've long been out of print. The performances are often hysterical and full of surprises—a treat for music fans of all ages. *Jon & Sally Tiven*

True Colors: Cyndi Lauper
Portrait R 40313.

Sound: B– Performance: C+

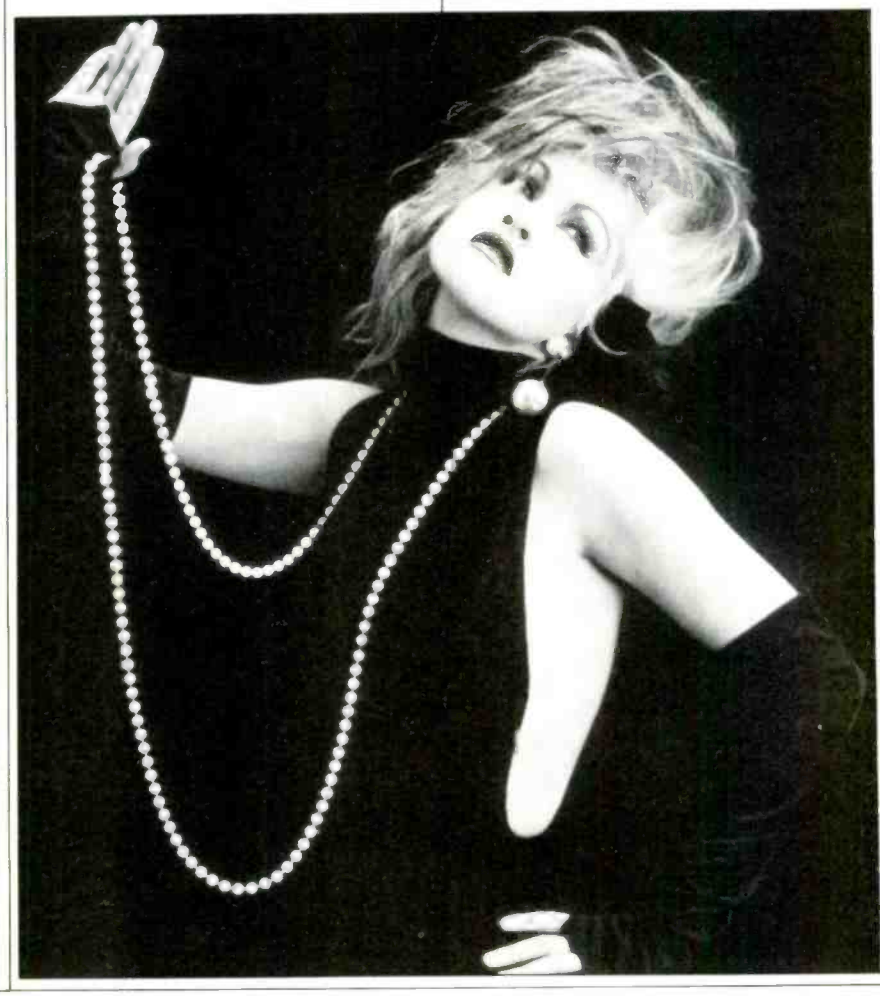
Money changes everything, boy. Not too long ago, Cyndi didn't have two sides of vinyl to rub together, and yet she still managed to whip out perhaps the finest debut album of the decade. Even after the first *four* singles from *She's So Unusual*, Lauper had hitting power to spare—talk about a deep bench! Now, with her second album, *True Colors*, she's got clout enough to get Pee-wee Herman to guest star. But somehow, even that momentous musical event isn't enough. *True Colors* is mostly devoid of *any* colors.

Aside from the obviously heartfelt torch/pop song "Boy Blue," the album is engulfed by self-consciousness. Lauper needed something "catchy" to start with—hence an overproduced bit of bubble gum ("Change of Heart") the likes of which she made fun of in "Girls Just Want to Have Fun." She needed something "soulful"—hence a syrupy cover of Marvin Gaye's "What's Goin' On" that not only misses Marvin's point (did *he* need to open with gunfire to get it across?), but hasn't anywhere near the pain and longing of her own "Time After Time." And, of course, Lauper needed something "wacky"—hence an old calypso tune ("Iko Iko"). The opening lyrics say it all: "Here I am/Just like I said I would be." Just giving the people what they want.

Yes, Lauper's voice is still exceptional—technically—and on this album it does technically wonderful things. But like guest Nile Rodgers' overcooked guitar work on "Change of Heart," Lauper's bent notes, pops, and echoes are gimmicky. So are the undistinguished guest appearances by The Bangles and Billy Joel, among others, which only serve to point out this album's bloated nature. Such massive artillery—and no victory.

All this calculation might have held a certain smug charm if it weren't being passed off as sincere. As it is, if this album shows Cyndi's true colors, she should get a new paint job.

Frank Lovece



Mars Needs Guitars!: The Hoodoo Gurus
Bigtime/Elektra 60485-1, $8.98.

Sound: B Performance: B+

Man-oh-man, what crazy atomic retro! *Mars Needs Guitars!* is an aural museum of 1960s artifacts, into which we can peer with the benefit of perspective. It all gets a little too obvious when the album credits salute Barbara Eden, Hank Kimble, Tina Louise, and Jonathon Harris, who played the evil Dr. Smith on *Lost in Space*, but musically, there's nothing so unsubtle as, say, painter Roy Lichtenstein's oversize comic-book panels.

In fact, this irony-fisted album is surprisingly full of nuance. Sure, the title track's lyrics boom out "I'm a stone-age Romeo/Got a space-age Juliet," but then check out something as subtle as the futuristic Mersey sound of

What a crazy retro sound! The Hoodoo Gurus have created an aural museum of 1960s artifacts, but they're not reverential in the least.

"Show Some Emotion"—why, it's The Dave Clark 2005! Then there's the cautionary ballad "Hayride to Hell," about Charlie, who drove a thousand miles and had a teenage daughter who fell in with a city mayor's son and . . . . Oh, it's too horrible.

The Hoodoo Gurus are not, however, reverential in the least. With strumming major chords, delightful "ooh-wee" fill-ins and cymbal-crashing big finishes, the band re-creates key '60s motifs and then twists them out of shape. Sort of like cubist artists, except they swing.

The band's virtues, unfortunately, are also its vices. There's little rhythmic variation from song to song, and you can't really tell if these guys have got their chops ready for the long run or not. While David Faulkner's adorably homely vocals never grate, they're never great. Still, if you like big red Coca-Cola signs, hot rods and drive-in beach movies, then you'll probably dig The Hoodoo Gurus' brand of preliterate rock 'n' roll. Or is that postmodern? I always get those two confused.

Frank Lovece

Class of '55: Carl Perkins, Jerry Lee Lewis, Roy Orbison and Johnny Cash **America/Smash 422 830 002-1,** digital, $8.98.

Sound: B Performance: B

I'm always amazed that Roy Orbison and Jerry Lee Lewis are still alive; they have been through nearly every rock-legend tragedy and misfortune one could name, both self-inflicted and otherwise. Thus, their collaboration with Johnny Cash and Carl Perkins takes on a mythic quality, as if Jimi Hendrix and Janis Joplin had come back to jam with Mick Jagger and Tina Turner. (I'm kidding! But you get the idea.)

This Memphis reunion of four great rock 'n' roll pioneers singing mostly new material is a joy, but not joyous. It starts out promisingly with a Carl Perkins rocker, "Birth of Rock and Roll," that jumps up and down every inch of the guitar neck. It's finger-pickin' rockabilly leaping like a Tijuana toad—and damn the missed notes, this is rock 'n' roll, boy! Jerry Lee follows with a delightfully lascivious "Sixteen Candles." But after that, sentimentality takes hold. This tendency reaches its nadir with a tribute to Elvis Presley called "We Remember the King." The idea is altogether appropriate, of course, but the horns of Gabriel in the background do get to be a bit much; I mean, no king was ever really a god.

The record winds up with a big number called "Big Train (from Memphis)," written by John Fogerty and featuring Fogerty, the late Rick Nelson, Dave Edmunds, June Carter Cash, The Judds and others. While "Train" is energetic, it never reaches the anthem-

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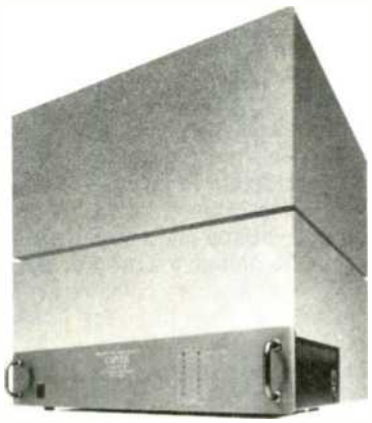

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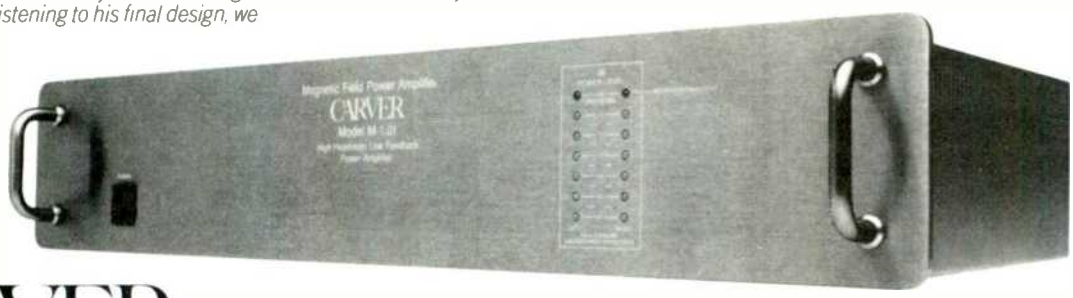

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Despite its shortcomings, this Memphis reunion is a flat-out great reminder of what down 'n' dirty rock is all about.

Perkins, Lewis, Orbison, Cash

ic—a shortcoming, in fact, of the entire record.

But the hell with it. *Class of '55*, with whatever shortcomings, is a flat-out great reminder of what down 'n' dirty wonderfulness rock 'n' roll is all about. Aficionados of old-time hollow-body mono may not like the fact that the album was digitally recorded and mixed, but the high tech doesn't detract. How can it, when the four stars here are greater than the sum of their parts? *Frank Lovece*

True Stories: Talking Heads
Sire 25512-1, $9.98.

Sound: C– Performance: D+

Is there something clever about throwing everything you know out the window? Perhaps it's a function of Talking Heads' resolve to leave behind the Afro-polyrhythms of their middle period and return to basics. Or maybe David Byrne poured so much of his creative juice into the movie, *True Stories*, that he had only a drop or two left for this record, which consists of Talking Heads versions of songs from the film.

Whatever the reason, this is a very unsatisfactory album by one of the best bands of the '80s. Many of the songs are disappointing in the worst way: They inspire no comments whatsoever. Of "Puzzlin' Evidence," however, one can at least say it has a very nice, slow-build introduction and a choir which is used in a manner very reminiscent of Philip Glass.

The first two cuts are paeans to convention, unredeemed by a good melody or an exceptional lyric. The third, "Hey Now," is a slightly Caribbean tune with hints of zydeco, but otherwise it's just like the first two. Things take a brief turn for the better with "Papa Legba," in which careful, imaginative positioning makes the most of the subtle, idiosyncratic percussion by Paulinho da Costa.

After two more write-offs come "Dream Operator," "People Like Us," and "City of Dreams," which, if not brilliant, are at least a respite from the rest of the album's pointless strutting and fretting. Among these three, two have gentle, decent lyrics, and all have pretty melodies.

There's no point in paying close attention to the production of this album, because the group obviously didn't. This is a strictly functional self-production—one that makes little or no use of the creative opportunities of the recording studio. No delightful details await discovery at remote levels of the mix; virtually everything that happens technically happens in a very small range of sonic possibility, just as everything that happens musically happens on just one or two levels of organization. However it happened, the majority of this album's nine tunes sound like first drafts. *Susan Borey*

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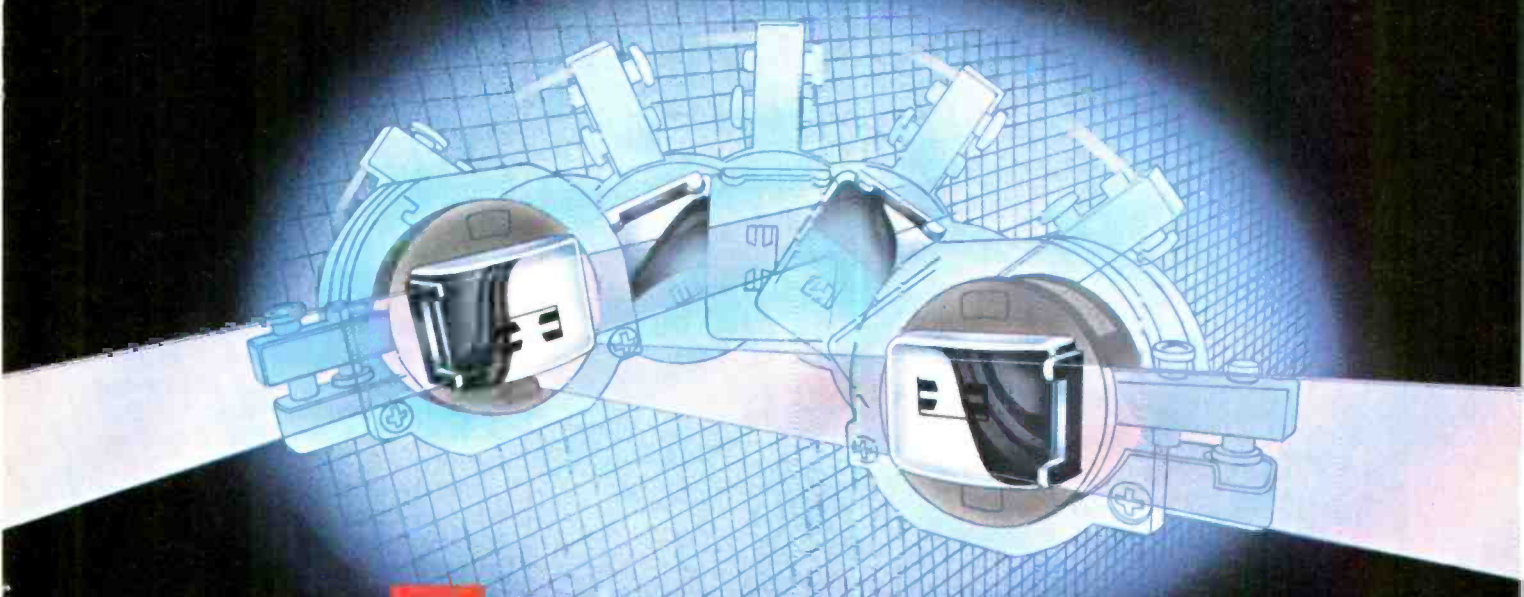

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Aided by luminous sidemen, Marti Jones is aiming for the mainstream now, with vocals that stretch from pure pop to hardish rock.

Match Game: Marti Jones
A&M SP-5138, $8.98.

Sound: B+ Performance: A–

Marti's first album was a cult classic, an eclectic debut produced (and mostly written) by Don Dixon, a fine guiding hand if ever there was one (ask R.E.M. or Dumptruck). Her second album is more of a stab at the major marketplace. Losing none of her charm, she tackles songs that seem more likely to land her in the Top Ten, including Elvis Costello's "Just a Memory," Dwight Twilley's "Chance of a Lifetime," and John David's "It's Too Late." Her vocals stretch from pure pop to hardish rock, aided and abetted by luminous sidemen like Mickey Curry, Ricky Byrd, Marshall Crenshaw, and T-Bone Burnett.

Whether Marti Jones crosses over from local heroine to nationwide starlet with *Match Game* is anybody's guess, but she's got a lot of style and appeal, and she makes very likable records.

Jon & Sally Tiven

Emerson, Lake & Powell
Polydor 829 297-1, $8.98.

Sound: B Performance: B+

Confession time: I hated Emerson, Lake & Palmer with a passion. Their overbearing and humorless pomposity left me cold and flat. Quite to my own surprise, the debut of Emerson, Lake & Powell I find sprightly and buoyant by comparison.

One line in the credits leaps out at me as a partial explanation of how EL&P went right. Thanks are given to Lee Abrams, the radio consultant who's lately been helping bands to better tailor their music for radio (and isn't *that* a scary concept?). Among his clientele have been Yes, Asia and GTR. His advice: Make sure you give listeners melodies they will remember and hum later—a simple principle that is not nearly as simple to execute.

Yet EL&P have done it admirably. The first side of their album contains three selections, two of which are fairly lengthy and involved, yet melodic. Together the three flow into a seamless album side that plays so nicely that it's over way too soon. Side two has four shorter songs plus an eight-minute reworking of the "Mars" section of Holst's

....remarkable!

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Emerson, Lake & Powell have delivered a buoyant album, with a big sound whose dynamics are vivid and wide-ranging.

"The Planets." The hit single "Touch and Go," a catchy piece of powerful pop music, opens the side with dynamics to spare. "Love Blind," the set's romantic piece, is followed by the cool, jazzy "Step Aside." "Lay Down Your Guns" is an intricate construction that begins softly and builds to a crashing martial conclusion. It leads directly to "Mars," the closest to the old ELP's grandeur/pomposity of anything here.

Bringing in Cozy Powell to replace Carl Palmer (still occupied with Asia) hasn't made a bit of difference in the EL&P format, especially with Lake and Emerson writing the material. But make no mistake—Cozy Powell has long been a top drummer in England. And most important, he has the right initial.

To say that the sound is big is a mighty understatement. This album requires volume to be heard properly; its dynamics are vivid and wide ranging. Add the fine performance, and EL&P emerges as one of 1986's nicest surprises. *Michael Tearson*

Three Hearts in the Happy Ending Machine: Daryl Hall
RCA AJL1-7196, $9.98.

Sound: B Performance: B+

The stuff of Daryl Hall's second solo album is infectious, unpretentious, and well crafted. Although it almost never challenges the listener by stretching or exploding the conventions of soul- and rock-derived pop, neither does it insult the listener by pretending it's something it isn't. And with its modest but heartfelt inventiveness, its consistent tunefulness, and Hall's mellifluous, passionate singing, it never fails to entertain.

The production, by Hall, Tom "T-Bone" Wolk, and Eurythmics' Dave Stewart, is characterized by tasteful abundance and savvy emulation. The consistently spacious, asymmetrical positioning of elements fully utilizes all three dimensions—up/down, left/right, and near/far. Echoes bounce back and forth between left and right channels, and hot, prolonged decays give the impression that drumbeats and piano chords are dissolving in the air. Sounds are clear and distinct, with the exception, perhaps, of "Dreamtime," in which a bid to render an overactive imagination degenerates—like an overworked watercolor—into mud.

Sometimes, it sounds as if the producers consciously appropriated the production styles of their hippest peers. "What's Gonna Happen to Us" has much in common with Prince's "Purple Rain": A compressed, echoed, and distanced lead vocal, a relatively spare instrumental setting, an all but identical chord progression, and a very similar melody line. The space,

Hearing Dr. John anew is like a blast of fresh air, and the 12 tracks from Delbert McClinton are some of his best.

isolated accents, inventive licks, light touch, and understatement of "Only a Vision" bring to mind the perfectionist production of Steely Dan. Sometimes the emulation might better have been avoided: Only the warmth and unpretentiousness of Hall's vocal and the superiority of his melody save the moving "Someone Like You" from sounding like a clone of Foreigner's ponderous, anthemic "I Want to Know What Love Is." Here, as elsewhere on this surprisingly likable album, what emerges is a portrait of a nice guy, trying to grow. *Susan Borey*

Gumbo: Dr. John
Alligator AL 3901, $8.98.

Sound: B Performance: A

Honky Tonkin' (I Done Me Some): Delbert McClinton
Alligator AL 3902, $8.98.

Sound: C Performance: B

Alligator Records, that fountainhead of blues and reggae, begins its new Rockback series of classic rock 'n' roll reissues with two excellent albums.

Dr. John's *Gumbo*, originally a 1972 Atlantic release, is a primer in the New Orleans rock 'n' roll of the '50s and '60s, arguably rock 'n' roll's richest vein. The playing and performances are infectious, filled with sly joy. The song choices are impeccable. Hearing anew Dr. John's versions of "Iko Iko," "Big Chief," "Junko Partner," and the rest is like a blast of fresh air. It helps a lot that Dr. John's original annotation is included, unedited. The sound is faithful to the original release, and *Gumbo* remains a landmark album.

Delbert McClinton's *Honky Tonkin'* is his own choice of top tracks from the first two albums he cut for ABC Records, his first solo efforts. The 12 selections here are no less than a celebration of steamy honky-tonk music, an indigenous American form that includes ballads, rockers, and blues. These remain some of his best recorded performances despite a sound that now seems a bit pinched.

Alligator's new series is off to a super start. I can't wait to see what they come up with next. *Michael Tearson*

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FOR ADDITIONAL INFORMATION: CLASSIFIED LINE ADS: Mary Jane Adams—(212) 719-6345. **CLASSIFIED DISPLAY ADS:** Laura J. Lo Vecchio—(212) 719-6338

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2). Audioquest Profile Auto Armlift $35
3). Audioquest Sorbothene Mat $35
4). Audioquest Isofoot $10
5). Audioquest CD Damper $15
6). Sumiko HS-12 Headshell $30
For AR turntables:
7). Predrilled Aluminum Armboards MMT, Linn, or AR arms $30
8). Hum-shielding for AR Platters $39
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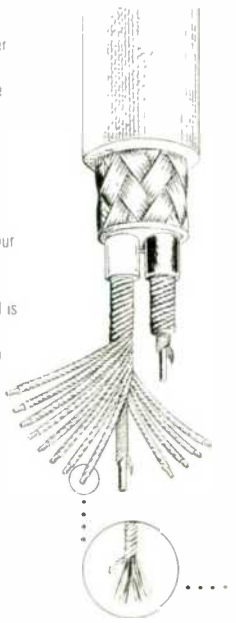

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—Dissipation factor @ 20°C: less than .01%
—Dielectric absorption factor @ 20°C: less than .01%
—Insulation resistance @ 20°C: More than 100kMΩ/μFD
—Dielectric: Polypropylene Film
—Working Voltage: 250V DC or higher
—Test Voltage: 2.15 times related voltage
—Encapsulation: Plastic, Epoxy Closing
—Leads: Tinned pure copper multistrand insulated sleeves, radial 4 inches
—Capacitance tolerance: ±10% (grading to 1% available)

Dimensions in inches:

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
15μFD	1.4D	2.6L	80μFD	1.75D	3.4L

AUDIOPHILE NET PRICES:

1.0μFD	$1.85 each	12.0μFD	$ 4.30 each
2.0	2.05	15.0	5.30
3.0	2.15	20.0	6.80
3.3	2.50	25.0	7.55
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
7.0	3.25	60.0	15.45
8.0	3.50	70.0	17.60
10.0	4.20	80.0	19.75

Matched pairs or grading to 1% tolerance: add 10%. Ten pieces or more of the same value: deduct 10%. Order Information: All capacitor orders will be shipped promptly, if possible by UPS. COD requires a 25% prepayment, and personal checks must clear before shipment. Adding 10% for shipping facilitates shipping procedure: residents of Hawaii, and those who require Blue Label air service, please add 20%. There is no fee for packaging or handling. We will accept MasterCard or VISA on mail or phone orders.

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A TEFLON® circuit board??? Yes!!! The new MC-2 is an improved version of our highly acclaimed MC-1, rated "best solid state preamp" by Audiogram. The MC-2 Teflon® offers astounding inner detailing and delicacy. "Seeing into" the soundstage has never been like this! Mil quality glass/epoxy version of MC-2 also available. MC-2 will retrofit into Hafler DH-101, Dyna PAT-4/5 and scratch built units. Recent retrofits by our customers have included the PS-IVH and Audible Illusions Modulus. MC-2T (Teflon®) $400/kit, MC-2 $269/kit. Musical Concepts, #1 Patterson Plaza, Florissant, MO 63031, 314-831-1822, 1-5PM CST.

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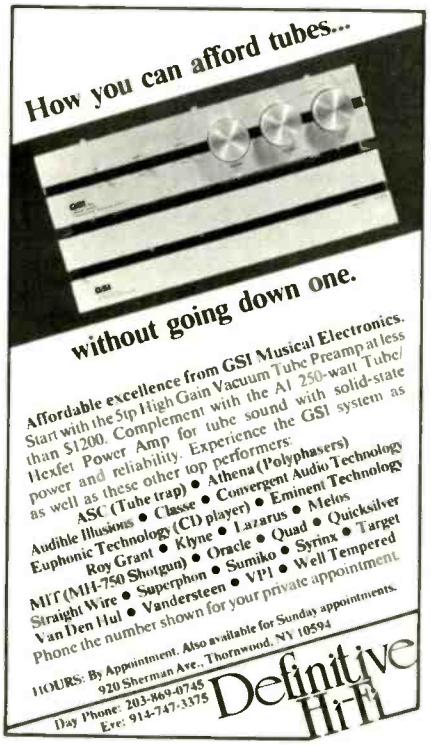

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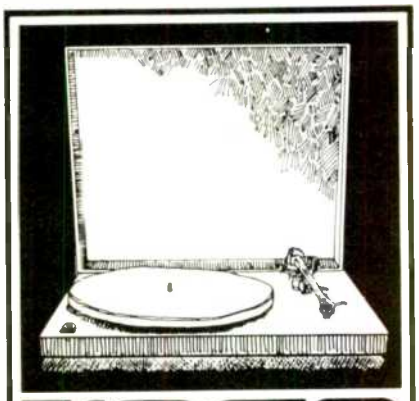

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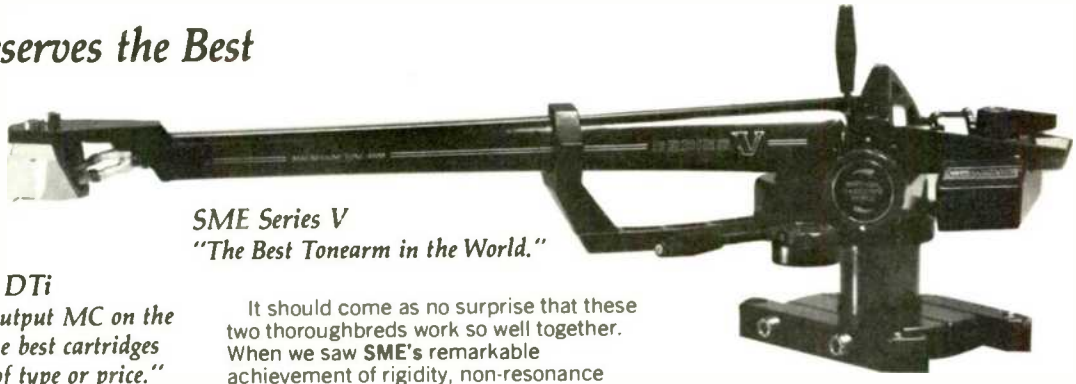

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—Stereophile Magazine Vol. 9, #4

It should come as no surprise that these two thoroughbreds work so well together. When we saw **SME's** remarkable achievement of rigidity, non-resonance and neutrality, we set about creating a phono cartridge designed to the same parameters.

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sumiko

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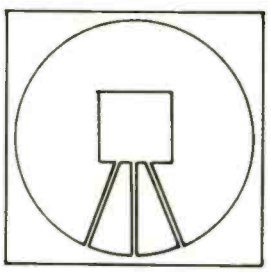

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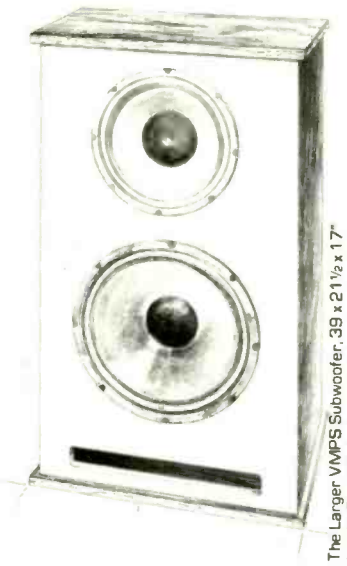

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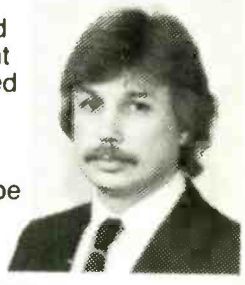

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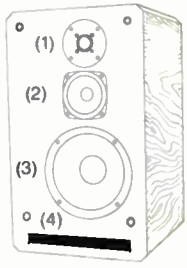

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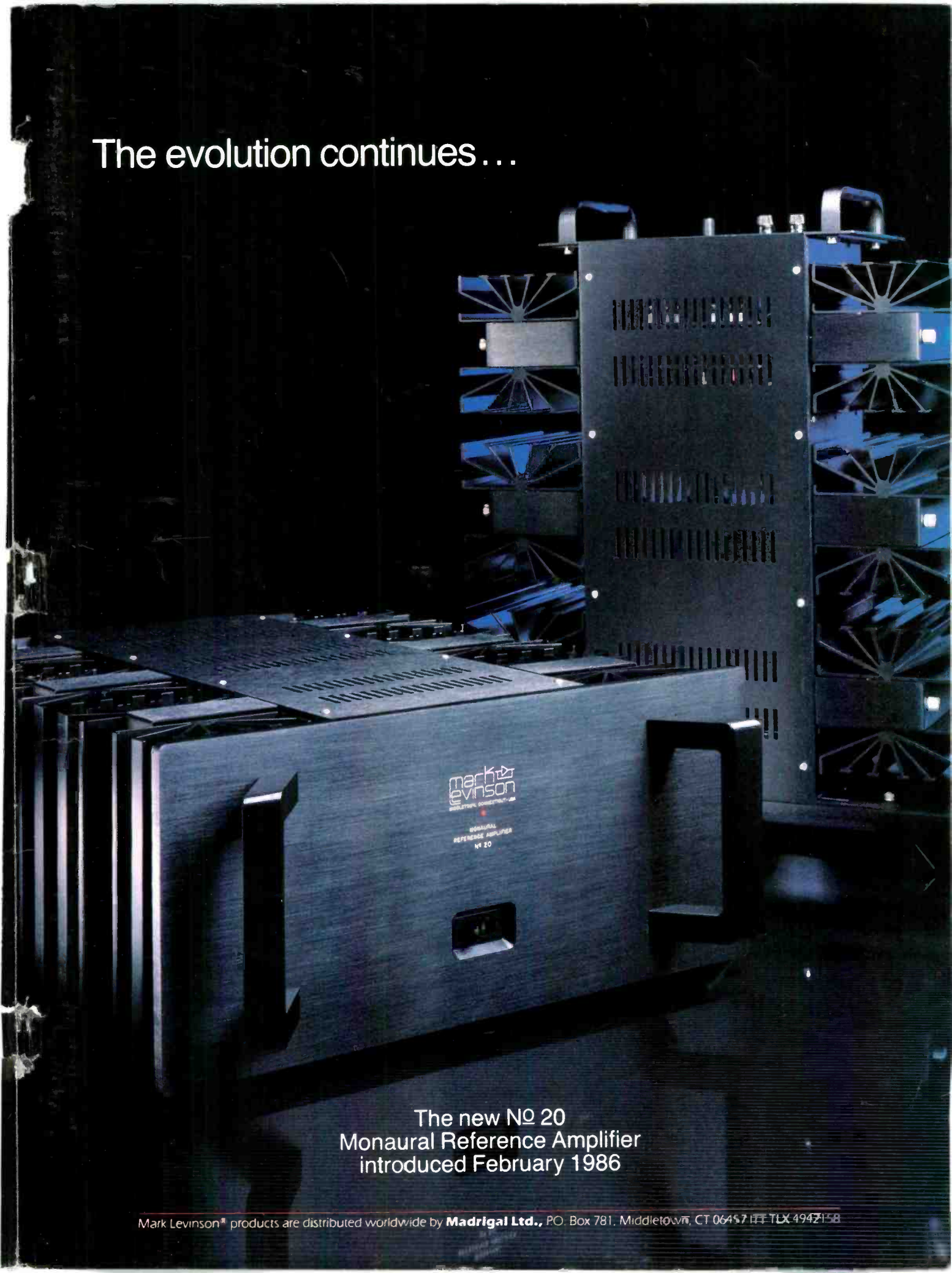
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