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VOL. 71, NO. 4



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The Cover Equipment: Tandberg TCA 3018A preamp and TPA 3026A amp.
The Cover Photographer: Carl Zapp



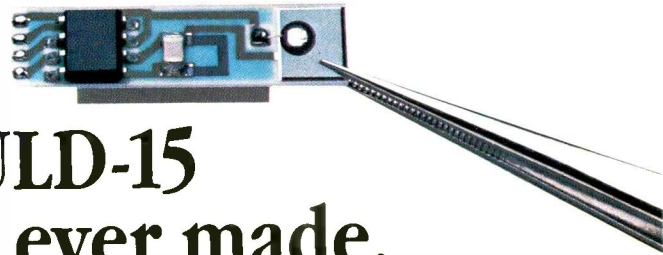
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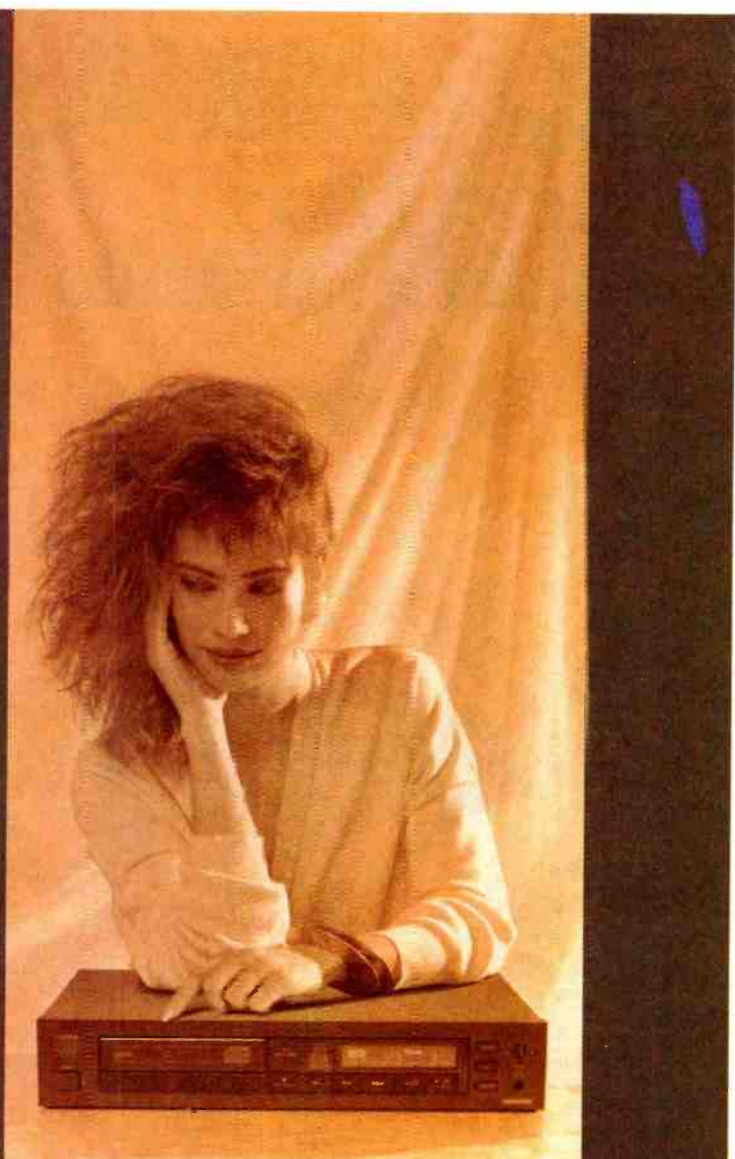
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AUDIO (ISSN 0004-752X, Dewey Decimal Number 621.381 or 778.5) is published monthly by CBS Magazines, A Division of CBS Inc., at 1515 Broadway, New York, N.Y. 10036. Printed in U.S.A. at Dyersburg, Tenn. Distributed by CBS Magazine Marketing. Second class postage paid at New York, N.Y. 10001 and additional mailing offices. Subscriptions in the U.S.: \$19.94 for one year, \$35.94 for two years, \$49.94 for three years; other countries, add \$6.00 per year. **AUDIO** is a registered trademark of CBS Inc. ©1987, CBS Magazines, A Division of CBS Inc. All rights reserved. **Editorial contributions** are welcomed but should be accompanied by return postage. Submissions will be handled with reasonable care, but the Editor assumes no responsibility for safety or return of manuscripts, photographs, or artwork. The Publisher, in his sole discretion, reserves the right to reject any ad copy he deems inappropriate. **Subscription Service:** Forms 3579 and all subscription correspondence must be addressed to **AUDIO**, P.O. Box 5316, Boulder, Colo. 80302. Please allow at least eight weeks for the change of address to become effective. Include both your old and your new address and enclose, if possible, an address label from a recent issue. If you have a subscription problem, please write to the above address or call (800) 525-0643, in Colorado, (303) 447-9330.

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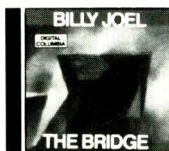
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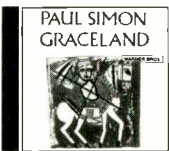
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Phonograph Cartridges and D.c.

Q. Transistorized preamplifiers use capacitors to block d.c. from the phonograph cartridge. I notice that vacuum tube preamps do not use such blocking capacitors. Why?—Tom Unger, Gardena, Cal.

A. Blocking capacitors pass audio frequencies from the cartridge to the preamplifier, but they isolate the cartridge from the solid-state circuit's d.c. bias. Without them, some of the solid-state preamp's bias could reach the cartridge. It is important to keep the bias from the cartridge because direct current can wreck a cartridge. Also, the cartridge's load on the circuit would change the bias voltage, which would certainly cause distortion and might even damage the preamplifier.

Vacuum tube circuits are another matter. There is virtually no d.c. voltage between the grid and ground. True, the grid is biased negative with respect to its cathode, but the cathode is usually raised above ground by the desired amount of bias voltage.

Power and Heat

Q. My solid-state receiver puts out 150 watts per channel, and its power consumption is said to be 550 watts. Does this mean that the receiver uses this much power during the whole time it is turned on, or only as a maximum when the music calls for maximum power? If the receiver draws 550 watts continuously, does that mean the excess power must be dissipated as heat? And does the amount of heat have anything to do with the load on the amp?—Jerry Wilce, Banks, Ore.

A. If your receiver operates in Class A, the amount of power it consumes will be more or less constant regardless of its power output at any given instant. Also, such an amplifier will run warmer than a non-Class-A unit having the same power output rating because the idling current is higher for a Class-A design. It is essentially true that any power supplied to an output stage which is not sent to the load (loudspeakers) must be wasted as heat.

In other amplifier designs, the amount of power taken from the a.c. power line varies in accordance with the demands of the music. In your case, the 550 watts would be required only when the amplifier is delivering

maximum power, probably only during transient peaks.

While power consumption is greatest at high power, power dissipation (heat) is greatest at moderate power levels. This created some consternation among amplifier makers when the FTC mandated that amplifier power tests be preceded by a warmup for one hour at one-third rated power, a condition producing very near-maximum heat. As a result, the test is more stringent than even the FTC intended.

Lowering the load impedance will also produce more output heat for a given input signal. The reduced load impedance draws more current from the output circuit, raising the power to the load, even though the output voltage remains fairly constant.

Monophonic Listening and Stereophonic Recording

Q. I have a stereo recorder, a stereo mixing console, and one monophonic amplifier. If I combine the mixer's main outputs to feed the mono amp when I monitor recordings, then the recordings made at the time are monophonic as well.

The only solution I have found is to unplug one channel's output from the feed to the amplifier. It is annoying to hear only one channel's signal, and it is also a nuisance having to unplug one channel each time I record a stereo program. Is there a way to wire the left and right channels to my amplifier and not have them affect the recording?—David Robbins, Tacoma, Wash.

A. I know of no easy solution to your problem. The most logical solution would be to use a stereo amplifier. Presumably you intend to get one at some point, or why would it matter to you if your recordings are monophonic rather than stereophonic?

If you have another mixer, you might use that to provide a monophonic mix to feed the amp. Connect two of the second mixer's inputs to the outputs of the first mixer that now feed your amp. Set the second mixer so that both input signals go to the same channel, and feed that channel's output to your amp.

You could also build a passive mixing circuit. Assuming that your recording mixer has a low-impedance output, such as 100 ohms, connect a 10-kilohm resistor to that mixer's left- and

right-channel "hot" outputs. Then tie together the free ends of these resistors and connect them to your amplifier's "hot" input terminal. It will probably suffice to connect the amplifier's input ground terminal to the ground terminal of one mixer output. If it does not, it should probably be safe to connect both output grounds to the amplifier's input grounds, since your mixer's output is apparently not a power-amplifier stage.


The resistors will probably not cause too much signal loss, though that depends on your mixer's output impedance and your amplifier's input impedance and gain.

Using this resistor network will somewhat reduce stereo separation in the mix fed to the recorder. If the loss of separation is too great, increase the value of the resistors.

Adding Antennas for AM

Q. Is there any way to use an external AM antenna with a tuner that provides no connections for one?—Ben Shepherd, Margate, Fla.

A. If you have an AM tuner which is pretty good but lacks the provision for attaching it to an external antenna, you can often add one. Wrap a couple of turns of wire around the "cold" end of the ferrite rod which serves as the built-in antenna. You will have two free ends of this "link." Attach one end of the coil to chassis ground. Attach the other end to the "hot" conductor of a piece of coaxial cable, with the shield connected to chassis ground. You will perhaps wish to mount a terminal strip to make attachment of the coaxial cable a bit more rugged and neat.

Connect the far end of this cable to the end of a piece of wire perhaps 30 feet long. Keep this wire well clear of surrounding objects and as far from power lines and TV antennas as practical. This will keep noise from being picked up. You can also (but it is not usually necessary) attach a similar length of wire to the shield of the cable, and run it in the opposite direction to the main wire we just discussed. 

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

Silent Running.

CARVER'S FAMOUS TUNING TECHNOLOGY TAKES TO THE ROAD WITH THE ONLY AM/FM TUNER CASSETTE DECKS CAPABLE OF CUTTING MULTIPATH INTERFERENCE UP TO 92.9%!

The new TX-Seven and TX-Nine audiophile autosound decks employ the same Asymmetrical Charge-Coupled FM Stereo Detector circuitry as Carver's revolutionary TX-11a home tuner. They also incorporate an ingenious automatic computer logic-controlled antenna switching system that further vanquishes multipath distortion.

In point of fact, no other autosound decks in the world — regardless of price — even begin to approach the TX-Seven and TX-Nine's ability to maintain a hiss-free, glitch-free FM listening environment in your car.

COMPUTER LOGIC-CONTROLLED DIVERSITY ANTENNA SWITCHING DRIVES AROUND MULTIPATH. One way to get temporary relief from interference at home is to move the antenna around slightly. Instead of physically moving your car antenna, the TX-Seven and TX-Nine use computerized circuitry to switch between *two separate antennas*, one out-of-phase, and one in-phase with incoming FM signals.

When multipath occurs, a special "smart" circuit automatically switches (at the speed of light) to the other antenna, automatically correcting phase and eliminating the multipath before you ever hear it. What little multipath distortion gets through this smart antenna system runs headlong into the remarkable tuner innovation *High Fidelity Magazine* described as "... distinguished (by) its ability to pull clean, noise-free sound out of weak or multipath-ridden signals."

Alone, without antenna diversity switching, the TX-Seven and TX-Nine's Asymmetrical Charge-Coupled FM Detector Circuitry delivers a *net noise and distortion reduction of 93.5%*! Together, they set a new standard for clear, clean FM autosound reproduction.

REAL WORLD CONFIRMATION. Both decks were tested on a torturous 6-mile course near the Carver factory which could regularly trigger at least *287 separate multipath occurrences* in conventional autosound FM tuners.

The TX-Seven and TX-Nine with Asymmetrical Charge Coupled FM Detection and diversity antenna system, reduced multipath occurrences to an average of *two* during the same course while listening to the same stations!

FACTORY—LOADED WITH EXTRAS. The fifteen random presets on the TX-Seven and TX-Nine are incredibly easy to set. Just press the button marked BEST and the logic circuitry *automatically* selects the fifteen strongest signals and locks them in on the presets. Plus you can select another fifteen on your own!



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There's even a security code system that renders the TX-Seven or TX-Nine inoperable to anyone but you, and a quick removal system so you can slip out your TX-Seven or TX-Nine in seconds for storage in trunk or house.

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DX4200 DESCRIPTION

The new DX4200 Preamp/Equalizer is the most versatile preamplifier available. It was designed for the most demanding audiophile who takes a "hands-on" approach to his or her music system. The preamp section includes specially-designed "overload-proof" inputs for the latest CD players, with their potential for unsurpassed wide dynamic range. The phono preamp utilizes fully-discrete circuitry instead of the more common IC "chips," eliminating coloration and making it exceptionally quiet. It accommodates most moving-coil cartridges and the exclusive Cartri-Match® circuitry even permits adjustment in capacitance loading from 50 picofarads to 800 picofarads, in 50 picofarad steps, for exact matching of virtually any phono cartridge. Soundcraftsmen's exclusive AutoBridge® circuitry permits the user to start with one stereo amplifier, and then to add a matching amplifier at a later date, operating both amplifiers in "bridged mono mode," thereby TRIPILING per-channel power output with no loss in performance. Ideal for meeting the power demands of digital audio. Only the finest available parts, such as the legendary Noble 31-position resistance-loaded volume control, are used in Soundcraftsmen preamps. Three-way tape dubbing and two external signal-processor loops add to the DX4200's versatility.

The Equalizer Section is the finest high-fidelity graphic equalizer available today. Nineteen years of designing and manufacturing equalizers have given us significant performance advantages over other manufacturers, with revolutionary technology like the Differential/Comparator®-0.1dB True Unity Gain circuitry, essential for reproduction of the new digital audio discs and wide-dynamic-range recordings without severe limitation of needed "headroom," and for ultra-low noise and distortion. Our Wire-Wound Coil Filter circuitry makes possible 15dB boost or cut on each individual octave and an incredible Signal-to-Noise Ratio of 114dB!

DX4200 SPECIFICATIONS

PREAMP SECTION: FREQUENCY RESPONSE: Hi-level: $\pm 1/4$ dB, 5 Hz to 100 kHz • Phono $\pm 1/2$ dB, 20 Hz to 20 kHz • TOTAL HARMONIC DISTORTION: 0% at 1 Volt • IM DISTORTION: Less than 0% at 1 Volt • PHONO IMPEDANCE: 47K or 100 Ohms • PHONO SIGNAL-TO-NOISE: 97 dB • PHONO CAPACITANCE SENSITIVITY: Any High Fidelity cartridge 0.28 millivolts or greater output • PHONO PREAMP DESIGN: Two separate mono preamp circuits • PHONO LEVEL ADJUSTMENT: Individual ± 20 dB gain controls • HEADPHONE LEVEL: Capable of driving 8 Ohms to 2000 Ohms

EQUALIZER SECTION: IN-CUT MONITORING: Differential/Comparator® circuit with LEDs, for 0.1dB accuracy • HARMONIC DISTORTION: Less than 0% at 2 V • IM DISTORTION: Less than 0% at 2 V • SIGNAL-TO-NOISE: 114 dB at 10 V output • OCTAVE CONTROLS: ± 22 dB boost or cut each octave (all other octaves set at maximum) • ± 15 dB boost or cut each octave (all other octaves set at zero) • GAIN CUT CAPABILITY: ± 32 dB ± 38 dB at all controls maximum • UNITY GAIN CONTROLS: 18 dB range • FILTER TYPE: Precision tuned passive wire-wound coil inductors

FEATURES

DX3000
DX4000
DX4100
DX4200

- Dual 10-Band ± 15 dB equalization
- Dual 10-Band ± 12 dB equalization

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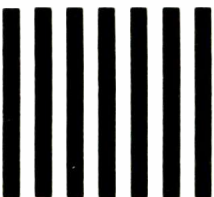
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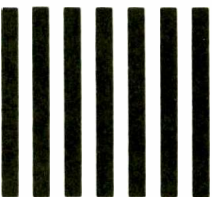
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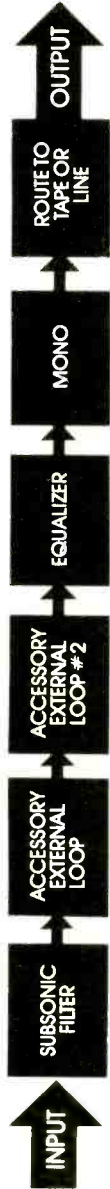
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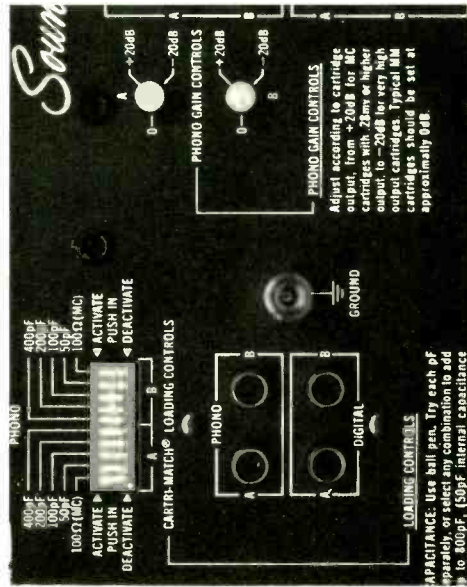


SIGNAL PROCESSING



Four useful and individually costly components are combined in each Soundcraftsmen Preamp/Equalizer: a Ten-Band Stereo Equalizer, a superb Phono Preamplifier, a versatile Patch-Bay Switching Box and a stereo amplifier Bridging Adapter. With the growing number of excellent signal-processing devices available, it has become extremely difficult to connect these components to a stereo system and then be

able to route any desired combination to loudspeakers and/or tape recorders. With Soundcraftsmen preamps it is as simple as pushing a button! No more cable-switching; add-on devices are permanently connected to the patch-bay section of the preamp. For the serious tape recordist, this one feature can eliminate hours of frustration associated with the interconnecting of add-on specialty components.



CARTRI-MATCH®

Every magnetic phono cartridge is designed to operate optimally only when it "sees" the correct capacitance and impedance loads at the phono preamp. Improper loading results in degraded frequency response and inaccurate reproduction of recorded material. The Soundcraftsmen DX4200 Cartri-Match® permits proper loading of virtually any magnetic phono cartridge, in 50 picofarad increments up to 800 picofarads. We know of no other preamplifier which makes this crucial matching possible. Cartri-Match® also accommodates any moving-coil-type phono cartridge whose output level is at least .28 millivolts, and independent input level controls are included for precise balancing of left and right phono cartridge channels, and to match the phono level to the other program sources.

AutoBridge®

The new Digital Audio Discs have, for the first time, the capability of recreating the dynamic range of a live musical performance. A stereo system's ability to reproduce this tremendous dynamic range ultimately depends upon one thing: the availability of adequate amplifier power. Even if one listens to music at an average listening level requiring only *one watt* of power, *over 300 watts* may be needed to reproduce dynamic "peaks" in the music! Soundcraftsmen has developed an active circuit called AutoBridge® to deal with this

- Tone Controls, Bass and Treble
- Differential/Comparator® Unity Gain/LED adjustments
- Sub-Sonic Filter: -3dB @ 15Hz, 12dB/octave rolloff
- Auto/Bridge circuitry for Triple-Power operation
- Variable cartridge loading in 50 picofarad steps
- Individual phono input level adjustments ±20dB
- Moving-coil cartridge inputs
- Two mono phono preamplifiers
- CD Digital Audio Inputs
- Noble 31-position volume control
- Inputs for audio portion of video source
- Three-way tape dubbing
- Two-way tape dubbing
- Low-impedance headphone output jack w/amplifier
- Front-Panel tape inputs & outputs
- Three signal-processor loops
- Two signal-processor loops
- One signal-processor loop
- 19" rack-mount front panel
- Frequency Spectrum Analyzer Test Record
- Computone Charts
- Genuine Hardwood side panels available

Soundcraftsmen Preamplifier prices start at only \$299.00.

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16-PAGE FULL-COLOR BROCHURE, AND \$19.95 SYSTEM-EVALUATION KIT: 1-12" LP Spectrum Analysis Test Record, 2-sets of Computone Charts, 1-Connector Cable for use with your present stereo comparison test, 1-instruction folder for use with your present stereo system. JUST WRITE TO US OR CIRCLE READER SERVICE CARD for FREE SPECIAL OFFER DETAILS.



problem. AutoBridge® allows the normal connection of a stereo amplifier to a Soundcraftsmen DX-series preamp, with the option of adding a second, identical amplifier at a later date, and operating both stereo amplifiers in "bridged mono mode," one for each channel. Bridged operation *triples* the 8-ohm power per channel of Soundcraftsmen stereo amplifiers with absolutely *no* degradation of any aspect of performance. AutoBridge® assures non-obsolence no matter how elaborate your music system becomes in the future.

MADE IN U.S.A.

STEP UP TO Soundcraftsmen

TAPE GUIDE

HERMAN BURSTEIN

The Source of Pre-Echo

Q. I recently added some high-quality prerecorded cassettes to my collection. Although I am pleased with their overall performance, I detect some pre-echo before some of the selections. If these tapes are dubbed directly from the master tape, as claimed, how does one explain this?—Mark Metzger, Woodstock, N.Y.

A. The pre-echo you hear—a form of print-through—may have been on the master tapes, or it may have been picked up by your tapes after they were dubbed from the masters.

Print-through is more likely to occur when a tape is recorded at a high level and is more severe when a recorded tape is stored under conditions of high temperature or subjected to a slight magnetic field. Most of it occurs during the first few days of storage. To some extent, print-through can be reduced by putting the tape through fast wind and rewind just prior to playback.

Pre-echo occurs when the tape is stored head out—that is, with the beginning of the tape at the outside of the reel. Post-echo occurs when the tape is stored tail out, with the end of the tape at the outside. Because post-echo is generally less offensive than pre-echo, professional master tapes (which are recorded only in one direction) are usually stored tail out. This technique won't help much with home tapes, which are recorded in both directions; no matter how they're stored, print-through will show up as pre-echo in one direction of play and post-echo in the other. If the print-through on your tapes occurred after they were dubbed, they will exhibit this phenomenon; if the print-through takes the form of pre-echo for both tape directions, then the master tape was probably at fault.

Home Taping for the Car

Q. I have a compact system (including AM/FM receiver, cassette deck, eight-track deck, and turntable). I use it to record cassettes for playback in my automobile. What is the best brand and type of tape to use?—Arthur Goldklang, Wantagh, N.Y.

A. My guess is that the cassette deck in your compact system is intended for ferric-oxide (Type I, normal-bias) tape, inasmuch as you do not mention

its having a switch that adjusts equalization and bias for different types of tape. However, if it does have such a switch, you may get good results with either Type I or II (chromium dioxide or ferricobalt, high-bias). Try both types and judge with your own ears which gives better results. If you hear no significant difference, you might as well use whichever type costs less.

In playback on your car's deck, the equalization switch should ordinarily be set to 120 μ S for ferric-oxide tape and to 70 μ S for any other types. However, there is no harm in experimenting with "wrong" settings, which sometimes provide more pleasure to the ear.

Of course, you should limit your choice of tape to brands of good reputation. The policy of *Audio* prohibits me from recommending specific brands.

Clarifying Noise Reduction

Q. Why would one want to use Dolby or dbx NR when recording Compact Discs onto tape? I realize that these NR systems help eliminate noise that occurs while taping a phono record, but are they still necessary when recording a nearly noiseless CD?—Paul C. Lessard, Davis, Cal.

A. An NR system such as Dolby or dbx reduces noise produced by the tape recording and playback system. It cannot reduce noise already present in the signal source that is fed to the tape deck. Basically, the Dolby and dbx NR systems compress all or part of the signal in recording and expand it in playback. The downward expansion in playback not only reduces the signal level but also the noise produced by the tape system.

Tape system noise is produced by the record and playback amplifiers, by distortion in the oscillator waveform used for recording bias and erasure, by irregularities in the motion of the tape across the heads, and by irregularities in the tape's magnetic coating. A good cassette deck can typically achieve a signal-to-noise ratio of about 50 to 60 dB without NR. With Dolby B it typically achieves 60 to 70 dB; with Dolby C, from 70 to 80 dB, and with dbx, 80 dB or more. Hence NR is important in preserving CDs' dynamic range and S/N when taping from them. However, inasmuch as the dynamic range of music seldom exceeds 70 dB

and is often substantially less, any NR system which ensures an S/N of 70 dB may be considered quite effective.

Dubbing and Decoding

Q. My present two-head cassette deck has Dolby B and C and dbx noise reduction. I am planning to buy a three-head deck with the same three NR systems plus HX Pro. Can I dub satisfactorily from one deck to the other, or should I get another three-head deck? When dubbing tapes made on the three-head deck, is it better to dub from that deck to the two-head machine, or should I play those tapes on the two-head deck and use the three-head deck for recording? Also, can I dub from a three-head deck using dbx NR to a two-head deck using Dolby B or C NR?—Tyrone Thompson, Baltimore, Md.

A. Theoretically, one will be best off playing a tape on a three-head deck because its separate playback head can have a narrower gap and therefore yield better high-frequency response. On the other hand, usually it is best to play tapes on the same deck that was used for recording them. This tends to minimize problems of azimuth misalignment and (if you are using Dolby NR instead of dbx) Dolby tracking. However, the ultimate answer is obtained only by trying the dubbing process in the various possible ways.

You shouldn't have any problems if you want to play a dbx-encoded tape with a deck that provides dbx decoding and then record with a deck that provides Dolby encoding.

Solution Confusion

Q. Recently I bought a major manufacturer's cleaning kit for my cassette deck. The kit has two different solutions, one for the tape heads and the other for the pinch roller. During the cleaning process, I accidentally used the pinch-roller solution on the heads. I am worried that this may have damaged the heads and might cause distortion or other problems in playback. Also, how do I know whether the

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.



Revox B226: Digital at the Vanishing Point

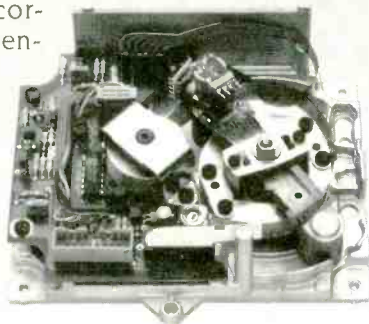
Connect a new Revox B226 CD player to a very high quality home audio system. Load it with a superbly recorded disc. Sit back, press "play" on the IR remote control . . . and something peculiar happens.

The B226 virtually disappears.

What you hear is pure music. Nothing added, nothing taken away. No harshness, no grittiness, no coloration, no shrinking, no softening, no etching. Nothing except all the depth, dynamics, and subtle nuances of a live musical performance.

This "vanishing act" does not come easily. For example, the B226 transport chassis is made from solid die-cast aluminum alloy to provide long-term stability. The entire mechanism is suspended on damped isolation mounts to minimize potential problems from vibration or resonance.

Also, the B226 incorporates the newest generation of European-developed LSI chips for D-A conversion, interpolation, error correction, and digital filtering. Resolution is full 16-bit, with quadruple oversampling and dual D-A converters for precise phase linearity. New adaptive error correction selects



the best error correction strategy (from 60 possibilities) to greatly improve performance on dirty or damaged discs.

In the crucial analog output stages, Revox uses strictly professional grade components. B226 circuit boards meet the same performance and reliability standards as boards made for our Studer professional mastering recorders. Little wonder, since both come from the same plant in the Black Forest of West Germany.

Essentially, then, the B226 delivers a purity and transparency of sound that challenges "custom conversion" units. But without sacrificing convenience and flexibility.

With Revox you still get full programmability of virtually every imaginable function, plus digital outputs for audio or auxiliary data, fixed and adjustable audio outputs with ample voltage for directly driving power amps, and the convenience of infrared remote control with multi-room capability.

For a convincing demonstration, visit your nearest authorized Revox dealer. Slip your favorite CD into a B226, sit back, and listen to digital audio at the vanishing point.

STUDER REVOX

1425 Elm Hill Pike, Nashville, TN 37210
615-254-5651

In principle I am opposed to purchasing a deck some eight years old, but it may be worth the risk if the price is low.

heads are in good condition?—Jim Tang, San Francisco, Cal.

A. I am inclined to doubt that the roller-cleaning solution would harm the heads. It is to be expected that some users might get into this mixup, and I believe that a reputable maker of such kits would take appropriate precau-

tions. Cleaning the heads again with the proper solution is probably all that is necessary. Of course, I can't be sure. The best answer has to come from the manufacturer of the kit; you might write to them. If your deck sounds the same as before the mixup, it is unlikely that harm has been done.

As for judging the condition of the playback or record-playback head, one can tell when a head is unduly worn by its failure to reproduce the highest frequencies—that is, when the sound is dulled in playback. A good test is to record and play interstation FM noise and compare the tape playback with the source. However, dulling of the sound could also be due to improper (excessive) bias. In the case of a deck with separate record and playback heads, azimuth misalignment could also be responsible.

Mystery Deck

Q. I went into a pawn shop the other day to see what they had in stereo equipment. I saw a cassette deck, the Project/One FLD 7000, which I had never seen or heard of before, and I have been an audiophile since 1960. It was the most impressive and good-looking deck that I have seen, with quality written all over it. It seemed at least eight years old, weighed at least 20 pounds, and appeared in excellent condition. I would appreciate any information you can give me about who made it, in what year, and its approximate price.—Guido Stabile, Boynton Beach, Fla.

A. I'm sorry, but no one at *Audio* has heard of this deck. Perhaps some reader can enlighten us.

If you are thinking of buying it, in principle I am opposed to purchasing a deck some eight years old. It won't represent the current state of the art, and it is generally inadvisable to buy second-hand equipment of a mechanical nature. Much may have gone wrong or may be on the verge of going wrong.

Still, the Project/One may be an exception. If you plan to buy it, ascertain how well it performs in playback and in record/playback. Do your ears tell you that it does well in such respects as extended and flat frequency response, low distortion, low noise, and steady and accurate motion? Does it offer the proper equalization and bias facilities for at least Type I and Type II tape? Does it have the features you consider desirable? If the answer is yes to all of these questions, and the price is low, the risk may be worth taking. I wouldn't advise your spending more than \$100, however.



Photo: Massotti

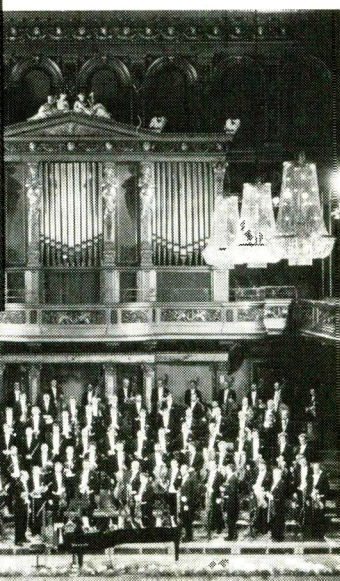


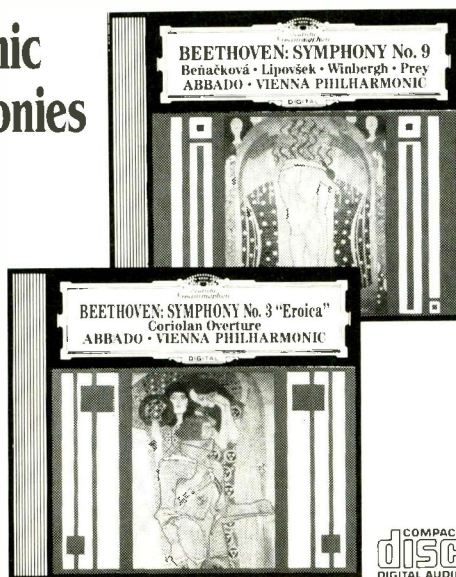
Photo: Fayer



Claudio Abbado Vienna Philharmonic Beethoven Symphonies

Claudio Abbado is recording his first Beethoven Symphonies cycle for Deutsche Grammophon with the Vienna Philharmonic. The debut of the series features Symphonies Nos. 3 and 9, simultaneously released on imported Compact Disc, LP and chrome-cassette.

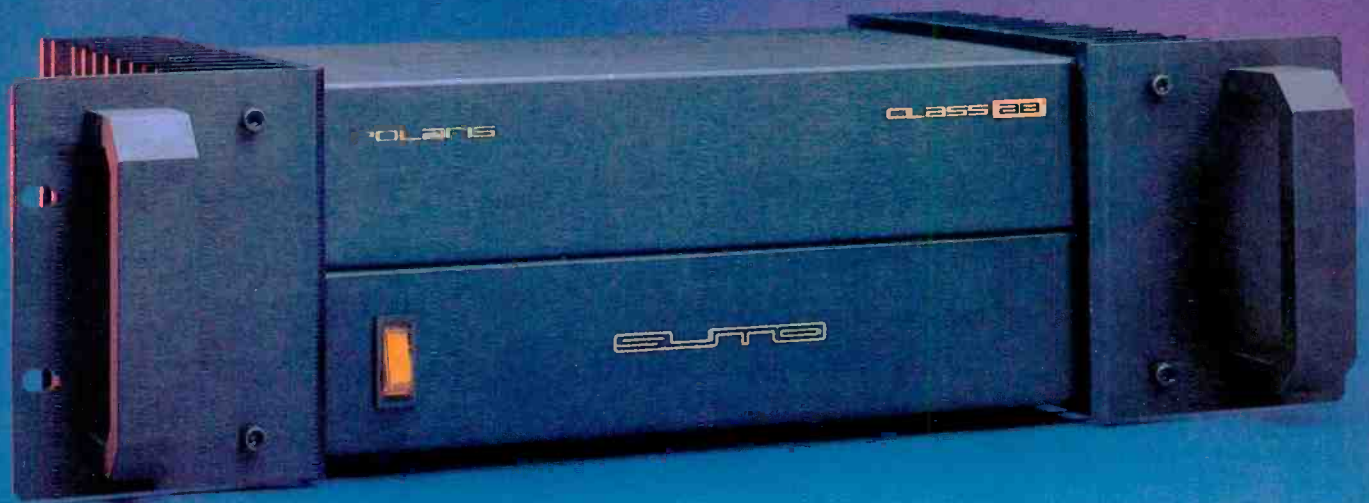
Abbado and the Vienna Philharmonic perform the complete cycles of the Beethoven Symphonies and Piano Concertos (with Maurizio Pollini) in the United States this spring.



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THE DELICATE BALANCE



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.

Sumo products are manufactured in the USA. Among the select group of dealers stocking them are:

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148 E. Route 59
Nanuet, NY 10954
Tel: 914/623-3983

K & W AUDIO
1039-17th Ave. SW
Calgary, Alberta T2T0B1
Tel: 403/244-8111

POLARIS by

SUMO

SUMO PRODUCTS GROUP, 21300 Superior St., Chatsworth, CA 91311 Tel: 818/407-2427
SUMO CORP CANADA, 1305 Odium Dr., Vancouver, B.C. V5L 3M1 Tel: 604/254-5148



Alpine Car Equalizer

For cars with little room for conventional equalizers, the 3330 remote unit provides seven-band control without the need for a dashboard slot or under-dash housing. The control head, less than 1 inch thick, can be hand-held, hung from a supplied hook mount, or fastened to any convenient surface with supplied Velcro. When not in use, the head can be unplugged and stowed out of sight. Four of the seven center frequencies are in the bass, concentrating the equalizer's action where most common car acoustic problems lie. The unit also has a front/rear fader. Price: \$160. For literature, circle No. 100

Perreux Power Amplifier

Operating in Class A-A/B, the PMF 3150 has a transient power supply that yields 1- μ S rise-times. The amplifier operates in Class A from 0 to 30 watts output, and in Class A/B from there up to its full rated power of 300 watts per channel (with 8-ohm loads, 20 Hz to 20 kHz, at 0.03% THD or less). Into an 8-ohm load, it is rated to deliver 900 watts per channel on transients before distortion becomes audible. Maximum

current output is 10 amperes per channel, continuous, and maximum voltage swing is 180 V peak to peak. Damping factor is rated at more than 400 from 10 Hz to 1 kHz. Price: \$2,395. For literature, circle No. 101



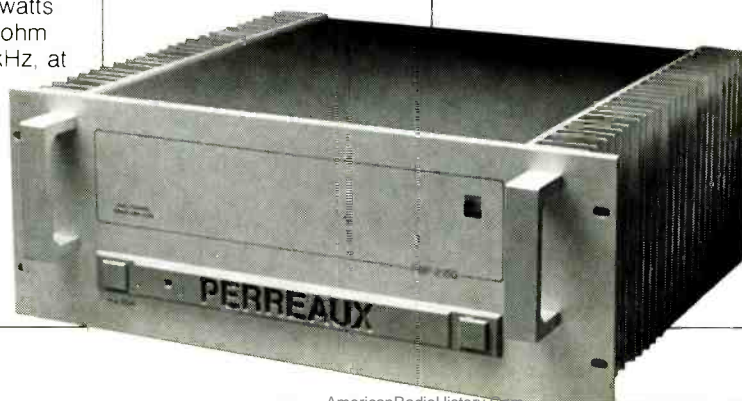
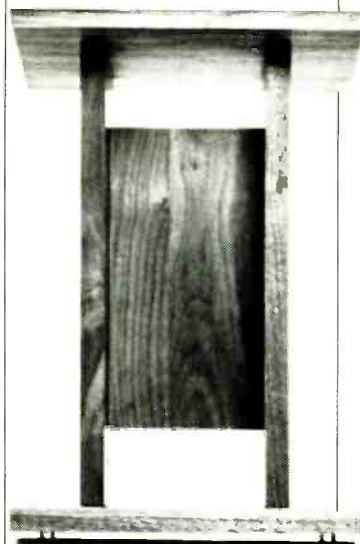
Polk Car-Stereo Speakers

The Mobile Monitor 6502 system combines a 6½-inch woofer with a two-way midrange/tweeter module that contains a crossover. Mounting depth for the woofer is 2½ inches, while the mid/tweeter module can be mounted on, flush with, or within the car's interior panels. Rated frequency response is 38 Hz to 20.5 kHz. Versions featuring 6 x 9-inch and 5¼-inch woofers are also available. Price: \$115 each. For literature, circle No. 102

Custom Woodwork Speaker Stand

Woodmore speaker stands from Custom Woodwork & Design have solid hardwood side and center panels and veneered particleboard tops and bottoms. They are available in three heights: 30-inch for mini speakers, 15-inch (shown) for bookshelf or small floor-standing speakers, and 9-inch for larger floor-standing models. Included with the stands are adjustable spiked feet in two different lengths and stick-on wire ties to route cables out of sight. The stands are available in natural, dark, or black oak; natural American walnut, and high-gloss black. Price: \$100 to \$200 per pair, depending on size and finish.

For literature, circle No. 103



THE INS AND OUTS OF A SONIC TRIUMPH.



This was a combination of many things. Long and intense product review sessions. Critical testing of alloys for durability and conductivity. Throwing good prototypes away because they weren't good enough. And in the end, emerging with three removable FM-AM tuner/cassette players worthy of the name Alpine.

The problem wasn't making these units removable. It was making them *sound* absolutely magnificent regardless how many times they had been removed (progressive sound degradation being the most common failing of removable radios).

To this end, Alpine technicians employed in these new units their most reliable tape mechanisms, engineered to maintain precise tape-head alignment despite the typically rough handling

removable radios must endure.

They included the legendary T-10 II Tuner for the most satisfying, noise-free reception of any tuner on the road.

And at what might be considered the weakest link in the chain, the connection between dash and radio, Alpine placed a new multi-pin connector with a life expectancy of 25,000 cycles (in and out of the dash = 1 cycle) with no degradation of signal.

What was an idea has become a triumphant reality: three sonically superior removable radio/cassette players that are Alpine-quality down to the last circuit. And built for the long, long haul.

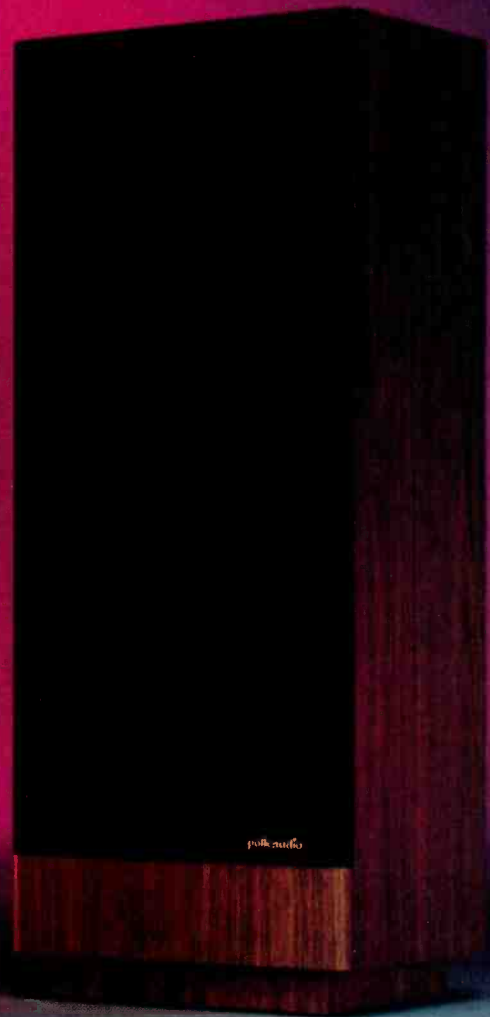
You can now hear the new Alpine Removables, the 7385, 7284 and 7283, at your nearest Alpine specialist.

ALPINE



Alpine is standard equipment in the Lamborghini Countach.

Matthew Polk's Magnificent Sounding New SDA 2A



SDA 2A
\$499.00 ea

Digital Disc Ready

Matthew Polk stands proudly alongside the latest version of his Audio Video Grand Prix Award Winning SDA 2A

The Magnificent Sound of Matthew Polk's Extraordinary New SDA 2A Puts the Competition to Shame!

*"It has the ability to make your
previous favorite speaker sound almost second rate"*

Stereo Review Magazine

Matthew Polk's magnificent sounding new 3rd generation SDA 2A incorporates many new advances pioneered in his top-of-the-line Signature Edition SRSs. It achieves stunningly life-like musical reproduction which would be remarkable at any price but is simply extraordinary at \$499. each. Stereo Review said, "listen at your own risk." Once you hear them you'll never be satisfied with anything else!

Polk's Revolutionary True Stereo SDA Breakthrough

The magnificent sounding new SDA 2A incorporates Polk's revolutionary True Stereo SDA technology. This patented, critically acclaimed, Audio Video Grand Prix Award winning breakthrough is the most important fundamental advance in loudspeaker technology since stereo itself. In fact, the design principles embodied in the SDAs make them the world's first and only True Stereo speakers.

Why do Polk SDAs always sound better than conventional speakers? When conventional loudspeakers are used to reproduce stereo both speakers are heard by both ears causing a form of acoustic distortion called interaural crosstalk which cuts down stereo separation, obscures detail and interferes with the proper reproduction and perception of imaging, and spaciousness. Polk SDAs are designed to eliminate interaural crosstalk so that each speaker is only heard by the one correct ear (i.e. left channel/left ear, right channel/right ear), like headphones. The result is dramatically improved stereo separation, detail and three-dimensional imaging. In order to accomplish this each SDA incorporates a separate set of drivers which radiates a special dimensional (difference) signal which cancels the undesirable interaural crosstalk coming from the wrong speaker to the wrong ear. High Fidelity called the results "Mind Boggling".

The Most Extraordinary Value in High End Audio Today

The new SDA 2As, like all the current SDAs, incorporate the latest 3rd generation SDA technology developed for Matthew Polk's Signature Edition SRS and SRS-2 including **1:** full complement sub-bass drive for deeper, fuller, tighter and more dynamic bass response; **2:** phase coherent time-compensated driver alignment for better focus, lower-coloration smoother, clearer, more coherent midrange and improved front-to-back depth and; **3:** bandwidth-optimized dimensional signal for smoother high-end and even better soundstage and image. The new SDA 2A is the finest sounding and most technologically advanced speaker ever produced at its extraordinarily modest price. It sounds dramatically better than speakers from other manufacturers that cost 4 times as much and more and is, at \$499 ea., truly the speaker of your dreams at a price you can afford.

"Breathtaking...a new world of hi fi listening." *Stereo Buyers Guide*

The spectacular sonic benefits of SDA technology are dramatic and easily heard by virtually anyone. Reviewers, critical listeners and novices alike are overwhelmed by the magnitude of the sonic improvement achieved by Polk's SDA technology. Stereo Review said, "These speakers *always* sounded different from conventional speakers — and, in our view, better — as a result of their SDA design."

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always better than would be achieved by conventional speakers". High Fidelity said, "Mind Boggling...Astounding...Flabbergasting...we have yet to hear any stereo program that doesn't benefit". With SDAs every instrument, vocalist

"Mindboggling, Astounding, Flabbergasting"

High Fidelity Magazine

and sound becomes distinct, tangible and alive: allowing you to experience the spine tingling excitement, majesty and pleasure of live music in your own home.

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Where to buy Polk Speakers? For your nearest dealer, see page 108.

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AmericanRadioHistory.Com

CAR-ROUSING AT CES

The hottest car-stereo trend at the Winter Consumer Electronics Show was DAT, and that was being soft-pedalled, because its makers don't know just when the system will actually hit the market. There were prototype in-dash R-DAT players from Clarion, Kenwood, Mitsubishi, and Sony, and Alpine was promising one to come. Kenwood's included a tuner, and Clarion says its production models will too.

In-dash CD players with tuners overwhelmingly outsell players without. So this year Alpine, Audiovox, Denon, Kenwood, Panasonic, Philips, Pioneer, Sanyo, Sony, and Technics showed them. Of these, only Alpine, apparently, has managed to cram all its circuitry into one chassis, with no subchassis holding leftovers. Sony's CDX-R88 (\$750) has a built-in amplifier section and accepts an optional cassette player, the XK-8 (\$270). The XK-8 is a half-DIN-slot high, so it and the CDX-R88 can fit into many U.S. cars' radio slots. Alpine also introduced a trunk-mounted changer and half-DIN control module, with a half-DIN tuner module optional. The Model 5950 player holds 12 discs and will cost \$1,500; the Model 1341 tuner will be \$220.

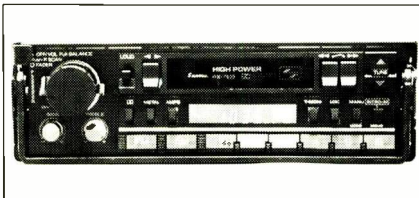
Diversity FM reception, a system that continually compares the signals from two antennas and selects the stronger one, is now available in Clarion's new Audia 2000E, Blaupunkt's Berlin TQR 07, and Carver's Model Nine and Model Seven. (Sony used to offer diversity in their car tuners, but now uses it only in a mobile video system.) Blaupunkt's diversity system not only has a separate r.f. front end for each antenna, but a separate i.f. section too. To assure enough difference between the signals, the antennas must be at least 3½ feet (and preferably 6 feet) apart. Unless your car is very wide, antennas on both rear fenders will only give your car a rakish '50s look—you'll need antennas fore and aft. Two antennas need not mean two masts, however; a windshield antenna can be used for the front, and Carver has an accessory that uses the rear-window defroster wires for signal pickup at the rear. I've heard that the directionality which makes window antennas so poor when used alone makes them work better in a diversity setup.



Sony, the first to have offered a radio/CD combo, is also first with a combo that includes built-in power amp, the CDX-R88. A matching, half-height cassette player is optional.



Blaupunkt's Berlin TQR 07 offers diversity tuning, variable AM bandwidth, and secret-code security.



Sansui's RX-7100 slide-out has automatic memorization of strongest stations and a locking handle that holds the unit firmly in the dash yet allows easy removal.

The new trend in AM reception is variable bandwidth. Top-of-the-line models from Blaupunkt, Clarion Audia, Kenwood, and Sansui now have it, though Pioneer (which had it in a Centrate model a year or two ago) apparently no longer does. Even some Delco AM-stereo units switch from 3-kHz to 6-kHz bandwidth when receiving stereo stations.

If AM and FM aren't enough for you, Proton's 203T (\$379) picks up the sound from VHF TV channels 2 to 13 (but not in stereo), and Carver's Model Nine and Model Seven pick up both long-wave and shortwave broadcasts.

Shortwave is fun to listen to, but I've heard hardly anything except airport beacons on the long-wave band.

A system that automatically programs the strongest local channels into memory, introduced by Carver and Philips last year, is now also available on some Blaupunkt and Pioneer models and on Sansui's RX-7100 and RX-5100. Sansui's version seems to be the only one whose designers were sensible enough to let you accept or reject each station before it's programmed; without that, classical or jazz fans can wind up with presets full of rock and easy-listening stations.

On the security front, almost everyone seems to have slide-out cassette/radio units, though Denon's DCC-8900 appears to be the only slide-out CD/radio combination. ("That wasn't easy," says Denon's Ken Furst. "We had to find a way to park and lock the CD's laser automatically when the unit was removed.") Almost as many companies now use security codes, which render the protected units unusable after power is disconnected and reconnected, until the code is punched in on the station buttons. On Blaupunkt, Carver, Pioneer, and Sansui units the owner can set the code to any number he or she can easily remember; the others use factory-set codes. Sansui's RX-550 (\$400) has a factory-set code which must be entered when power is disconnected and reconnected, and also has a user-set code for disarming its built-in alarm. The RX-550's alarm can also be linked with other alarm systems in the car.

A simpler security device, a gadget which locks into the cassette slot to render the stereo useless, was introduced by Blaupunkt last year. This year, similar devices are available from Audiovox and from two accessories suppliers, Laser Corp. (Swede-Lock) and Top Sound International.

In amplifiers, one trend is a revival—if two companies offering tube amplifiers constitute a trend. Milbert announced a tube amp last year for \$1,395. Now Vacuum Tube Logic is offering one for \$900, including either a 12-V d.c. or 110-V a.c. power supply; with both supplies, it's \$1,200. Both amplifiers are rated at 30 watts per channel.

Altec Lansing's new ALA-435 power

The **Boston** Acoustics

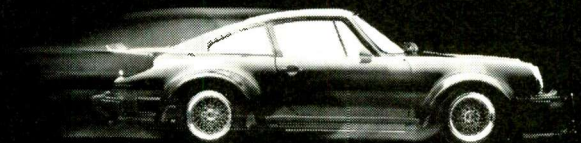
Installation of the Month Contest

Win a cruise for two to the Caribbean

Let's face it. No matter how good your car's audio system is, it can only sound as good as the speakers. As the designer and manufacturer of some of the best selling home loudspeakers in history, our design goals have always been superb accuracy, realism and imaging. Our engineers have successfully incorporated these virtues into a full line of tough automotive speakers that look great and sound even better. These Boston automotive speakers can improve the sound of any car system.

Because a picture is worth a thousand words, we want pictures of your Boston Acoustics Highway Hi-Fi to show the world. Everyone who enters the contest will be eligible for a drawing to win a cruise for two to the Caribbean. In addition, each month from May through December, we will select an Installation of the Month. The winning system will be featured in Audio Magazine, and the owner will win a pair of our newest tower design home loudspeakers, the T830s (suggested retail \$500.00).

If you're proud of your Boston Acoustics car system, let's see it. See below for contest details, or visit your Boston Acoustics dealer for your entry blank.



Contest Requirements

1. All Speakers used must be Boston Acoustics (of course).
2. Please give us:
 - Your name and address
 - Year, make and model of your car
 - Your dealer's name and address
 - Your salesperson's name
 - Your installer's name

3. Your photography is important. Photographs must be high quality black and white prints, minimum size 3" x 5".

For the best results they should be well illuminated. All materials become the property of Boston Acoustics. Please no Polaroids, negatives, color prints or slides. Submit as many photos as you wish for best representation. Include one external view of your car.

4. Please describe your system.

5. All decisions will be made by Boston Acoustics and will be final.

6. The contest is open to all residents of the U.S.A. and Canada except employees of Boston Acoustics and CBS Inc. and their families. Void where prohibited by law.

7. There will be no prize substitutions.

8. Send to: Installation Contest
Boston Acoustics
247 Lynnfield Street
Peabody, MA 01960

For the name of the Boston Acoustics Car Speaker dealer nearest you, call or write:

Boston Acoustics

247 Lynnfield Street, Peabody, MA 01960 (617) 532-2111

The trend in speakers is toward models made for specific vehicles or vehicle types, especially vans and light trucks.

amplifier (\$400) is doubly trendy. It follows Proton's DPD amplifier in offering high (5-dB) dynamic headroom. And it's one of several new multi-channel amps. handy for systems with four speakers and preamp-output head units. The ALA-435 provides four bridgeable channels, each delivering 35 watts per channel (into 4 ohms, 20 Hz to 20 kHz, at 0.1% THD), or 70 watts per channel in stereo mode. Other new four-channel models were announced by ADS, Blaupunkt, Soundstream (500 watts, 125 per channel, with frequency-adjustable bass boost), and Rockford-Fosgate (rated at twice the power of the Soundstream unit). Denon's DCA-3500 (\$470) is a five-channel amp, with four 40-watt channels and a built-in crossover feeding lows to the 80-watt fifth channel; bridging transforms the amp into a 3 x 80-watt unit. If you need even more channels, ADS has two six-channel amplifiers, the PH12 (20 watts per channel, \$320) and the PH15 (40 watts per channel, also bridgeable for 5-, 4-, or 3-channel use; \$560).

Linear Power had an interesting demonstration at CES of their Model 1752 S servo subwoofer amplifier (about \$1,000). When used with a dual-voice-coil woofer, this 175-watt mono amp feeds power to one coil while using the voltage generated by the other as a feedback signal. In the demo, two identical woofers were mounted in boxes of identical size, with one box open at the rear and the other box sealed. As the amplifier was switched between the open- and closed-box systems, the bass output remained constant, both to the ear and to a pair of Audio Control real-time analyzers.

In the field of crossovers, Altec Lansing's ALC-10 (\$65) has a dynamic bass control which, like a loudness control, boosts bass at low signal levels, and cuts bass at high levels to protect the woofers. The ALC-10 also has a variable boost/cut which operates at selectable frequencies from 30 to 200 Hz.

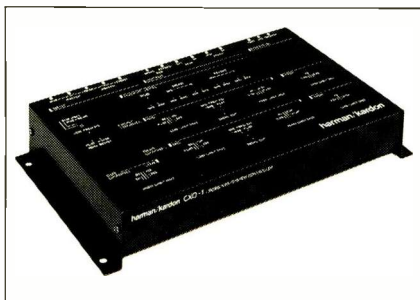
Harman/Kardon's CXO-1 crossover, for two- or four-channel triamp systems, has independently selectable low- and high-pass frequencies for each crossover point and for the front and rear mid and high channels. It also

has adjustable 200-Hz cut in front and rear and 50-Hz boost in the subwoofer and rear channels, plus level controls for every output. It is priced at \$250.

The 642CSi crossover from ADS (about \$230) has several neat tricks. In systems with four satellites plus a subwoofer or two, it feeds constant bass to the subwoofers regardless of the fader setting. In systems without subwoofers, it can provide a "subwoofer sound" by feeding the speakers mono bass below 85 Hz (boosted, if need be) and full stereo above 170 Hz. Between those frequencies, the sound is blended, with its level reduced to counteract the resonance most cars have in or near that frequency range. The 642CSi can also continue feeding bass to the rear speakers even when their treble and midrange have been turned off by the system's fader control. Adjustable shelving controls can be used to boost bass or to limit woofer excursion. And the unit can automatically switch between signals from cas-



Altec Lansing's ALA-435 amp has 5 dB of dynamic headroom on each of its four channels.



Harman/Kardon's elaborate CXO-1 crossover can handle four-channel systems plus a subwoofer.

sette and CD head units, provided one source uses the crossover's high-level inputs while the other uses the low-level jacks. High- and low-pass filter settings are independently adjustable for front, rear, and subwoofer outputs.

Also from ADS is the EQ1 equalizer (about \$200), an eight-band parametric model that is not adjustable by the user. Instead, the installer programs it semi-permanently by plugging in 16 filter modules, one for each frequency band (eight front and eight rear). A design and installation center now being set up by ADS will develop module specifications and crossover settings for most popular cars (applying, of course, only to systems using specific ADS speakers). The center's "Application Specific" design approach was used in developing ADS's under-\$10,000 car-sound system for the Porsche 911 Slant-Nose Turbo.

Audio Control has adapted its Phase Coupled Activator bass enhancer for car use, calling the result the Epicenter. Its main chassis can be installed in the trunk, leaving only a remote-control knob and a pilot light in the passenger compartment.

Mainstream car-stereo manufacturers have developed a sudden interest in speakers for light trucks and vans: Jensen, Sparkomatic, Pioneer, and Philips have all entered this area of the market. Other new models for specific vehicles or vehicle types include units from Boston Acoustics and Visonik designed specifically for European cars, and models from Sabre Sound and from Classic Research and Engineering specially designed for Firebirds, Trans-Ams, and Camaros.

I was intrigued by a new tweeter from KEF. The KAR33A (part of a new separate-component car-speaker system) has a domed grille allowing the tweeter to sit at an angle; for systems where the highs should be aimed straight out of the mounting panel, a flush-mount version of the tweeter (KAR33F) is available.

Between now and the Summer Consumer Electronics Show, I hope to try out a few of these new products, and report on them. By then, there should be a lot more to say about DAT—either a page or so of new product details, or an explanation of why those new products still haven't arrived.

Boston Acoustics

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with music.



With the new Boston 360 Designer Series speaker system, you can enjoy high fidelity music everywhere in your home. It mounts flush in walls or ceilings, to blend unobtrusively into any room setting. And unlike a conventional speaker, it takes up absolutely no shelf or floor space.

As a main, surround or extension speaker system, the 360 gives you the accurate, uncompromised sonic performance you've come to expect from Boston Acoustics. Its 6 1/2-inch woofer is specially engineered to provide full bass performance without need for a special enclosure. Its CFT4 tweeter, of a quality not

normally found in built-in speakers, is a new version of the one-inch dome used in our finest home systems.

The clean, perforated grille and trim are finished in matte white. If desired, the 360 can be painted any color - to match or complement its surroundings. Since the woofer and tweeter diaphragms are waterproof, you can confidently install the 360 in kitchens and bathrooms, even boats.

For a 360 Designer Series brochure, just send us your name and address. Boston Acoustics, Inc., Department A36, 247 Lynnfield Street, Peabody, MA 01960. (617) 532-2111.

SURROUNDED ON ALL SIDES



It begins to look as though we are going to be surrounded again. That's what some hot new developments, including Dolby Surround, say to me. This Dolby is for surround sound *in the home*, with or maybe even without the boob tube. I'll have to take another look at Dolby, but first. . . .

A dog's age ago, an indignant reader wrote to us to say that I had "failed"—the classic term of political rhetoric—because I had fallen for an audio dead duck called quadraphonic. Yes, that duck was dead, all right, and I had indeed been enthusing. But I did not fail! I merely put the whole thing aside for better times.

Matter of fact, at about the time quadraphonic sank to the bottom, I proceeded to upgrade my home system from merely four to six channels, thanks to some handy new developments in digital delay that I could add to what I already had. I used that six-channel system, with minor modifications, until a few months ago.

The whole ill-fated quadraphonic movement, too soon and too confused seemed destined from its start to bog down in a welter of petty warfare and overzealous claims by competing commercial interests, until the differ-

ences between incompatible Systems A, B, C, and more were exaggerated beyond any compromise. The producers of consumer audio are not pleased when things go wrong in this dismal way. The easiest thing is to pretend the whole business didn't ever happen.

And so four-channel audio suddenly de-happened. Within months you would not have known that it had ever existed.

I could give you a list pages long of other formidable non-happenings in the audio and video fields which "never existed" to the tune of millions of bucks. I've been close to a few of them which now seem almost like dreams. I suspect that historians looking into these dreams will find the going rather difficult, especially if they consult the companies involved. No comment? Probably. In most cases, that is just as well; in their original form, none of these great projects is likely to return.

And yet we have to keep in mind that almost always there is a residue, a latency, a potential, which those who are reasonably objective can't quite forget. In all due time, might we not be able to try again, with better guidance, newer technology, and of course new names? The old names are tainted.

It's like the Maxwell. Of course, you don't remember the Maxwell. It was a car of the very early '20s, and it had problems so serious that there was a crisis (we would say a recall) which involved major rebuilding of the production vehicle before it was salable. So Maxwell sold out—to a man named Chrysler. Mr. C. had ideas and he saw potential. He "beefed up the frames" of the Maxwells, and proceeded to rid himself of this annoying backlog of cars at a sometime profit and with no serious complaints. And then there was the Chrysler, with innovations like four-wheel brakes, built, so to speak, on the remains of the Maxwell.

New ideas, left behind! In every case they must wait, first for the negative impact to go away and second for technology to develop—under a new name—and for market interest to rekindle. Walter P. Chrysler moved fast; his competition was mainly the ancient Model T, and *he* wasn't responsible for the Maxwell, after all. But the bigger the fiasco, in most cases, the longer the wait. Quadraphonic was a mess and left a very bad taste in a lot of mouths. Its special residue had to lie low for years, until it could carefully sneak back, sideways—not to the scene of the disaster, consumer audio, but in the movies, of all things. And thence to video. And thence? Where else but home again! As Dolby Surround makes practical.

At the time quadraphonic began never to have happened, I was at last beginning to understand how much surround sound could do for my own home listening. This took a long time because of all those years of high-flying industry hyperbole, both from public relations gone rampant and, alas, also from the technicians, the engineers, who became so emotionally involved in their various points of view that normal scientific objectivity simply faded into passionate jargon. Or so it seemed to those who were merely hopeful listeners—and buyers. Remember that this furor was aimed at what had to be in the end an *artistic and musical* impact. Most of us thought we had some idea of what music listening should be. Did these engineers?

The hotter the fight became, the heavier the math, as we on the outside tried to untangle the arguments. We

Illustration: Bob Scott

WINNER, AGAIN?



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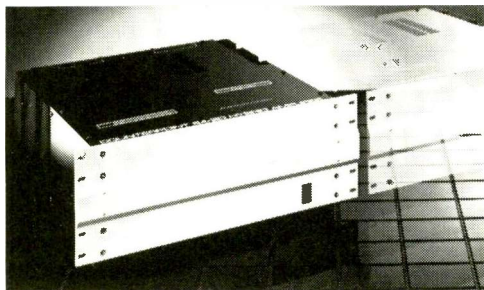
Says who?

In the audio world, it seems most everyone claims ultimate quality. Luckily, there are three proven ways to sort the wheat from the chaff:

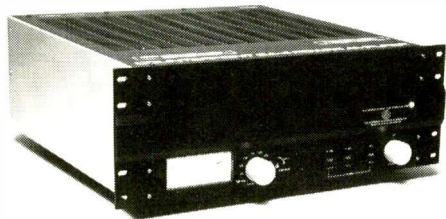
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For the past 3 years, each new Counterpoint product has won a prestigious award—both at home and abroad. For instance, our SA-20 Power Amplifier just won Japan's Component of the Year Award (not too bad these days, for a designed-and-made in the USA product!)

SA-20 Power Amplifier... hybrid technology at its best



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Recent Counterpoint Awards — (clockwise from bottom) Golden Sound Award, SA-4. Class 1A Rating, IAR, SA-2. Class 1A Rating, IAR, SA-12. Component of the Year, SA-5. Component of the Year, SA-3. Component of the Year, SA-20. Design & Engineering, SA-1. Design & Engineering, SA-4. Innovations '86, SA-9/11.

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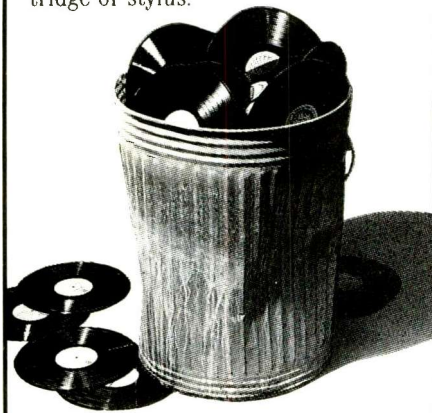
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Quadraphonic was a mess, and it left a bad taste. It had to lie low for years until it could carefully sneak back, in the movies.

were deluged with king-size geometry all the way 'round the listening room: Sines, cosines, tangents, circular degrees in minuscule increments (do you bother about angular degrees at a live concert?), not to mention LF, RR, carriers, quadrature, and more. It was bewildering, and notably to the press, which had to absorb and supposedly pass judgment—as if we could!

What bothered me most was a fundamental axiom in engineering, that math isn't supposed to contradict itself. It is truth, it is the ultimate in reasoning, yet here was the algebraic battle of the century. We could take the advertising with some benevolence, but all that heated math was really something else.

Don't think this is an anti-math crusade—far from it. Like the typewriter, the word processor and the ruler, math in engineering terms is a universal tool, and no artist or literateur, including this one, has any business running it down. It was the way that this tool was entangled in personalities, in corporate pressures, in unseemly public debates, that was distressing. And rather confusing.

I once sat next to Ben Bauer (inventor of SQ) at an AES meeting at the height of the big fights between him and, I think, Michael Gerzon from England (inventor of the Ambisonic sound system and of a subset of Ambisonics called UHJ). They got into a verbal and blackboard battle that might have been two Jima or Trafalgar or the Battle of Marathon, except every bit of it was in mathematical symbols. Gerzon, if it was he, was up front and sputtering. Bauer, sitting next to me in the audience, was seething. He kept rising up to "respond" to Gerzon, and Gerzon departed from his prepared exposition to "respond" to him. Normally a genial and friendly soul, this time Bauer kept up a hoarse muttering next to me, "He's wrong! That's not true!!" The large audience between these two was decidedly unhappy, more shocked by the passion than edified by the arguments. We could admire the fluency with which both spoke the language of math like a mother tongue, but it was a regrettable occasion even so, and, I think, the beginning of the end. Things could go no further with quadraphonic.

We cannot blame either of these brilliant men, looking back, for that intensity, nor were their mathematics so dismally far apart, as I think we might admit today. Just two different concepts as to what *musical* effects were desirable in our living rooms. And the argument was but the visible portion of that ugly fight between corporations big and small—inevitably reflected at the individual level—which had led to rigidity, ruthlessness, the impossibility of any rational compromise. How could it be otherwise, if you had the brains and the responsibility—and you cared?

Many another confrontation took place, of course, but most were safely in front offices, behind closed doors. We only knew of the catastrophic results. I remember, earlier on, the quiet enthusiasm of the quadraphonic team at Electro-Voice out in Michigan, who gave me a whole day's thoughtful exposition of their "matrix" system down to the last technical detail. That left me bemused; I could appreciate the sound but would never dare judge the musical results purely by looking at the formulas! Yet I felt strongly that there was commitment here and reason, too. It was a good development, if moderately different from other similar good developments.

As you can guess, I later discovered that this day in my life had never happened. There was no E-V matrix. The team did not exist. No point casting blame in any direction. These are the things that went on in those unpleasant times.

Oh yes (just to show you I am aiming to be objective)—there was, maybe, Acoustic Research. Or was there? Memory tells me that the very first press demo I ever heard of any type of four-channel sound was put on by AR. Whoever did it, I remember that demo as one of the finest ever, simply in terms of showing us what surround sound could do to enhance the experience of listening to recorded music. That event was produced long before the quadraphonic discs; they used specially made tapes. Well, it now seems that this memorable experience of mine also never happened. It sticks in the memory, even so.

I do think that today, with our vast wealth of new technology (both audio

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.

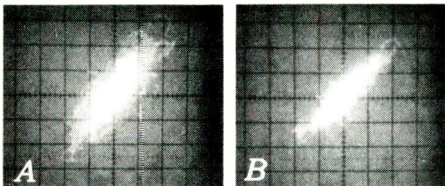
TIME DOMAIN CORRECTION. The Carver DTL-200 incorporates an important new computer logic innovation that monitors the incoming digital signal for imperfections and "glitches" caused in recording and production. Such errors are immune to conventional error-correction processes because they are actually 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 exten-

sive 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 spatial 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.

Carver's 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 uninterrupted 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.

HEAR THE CARVER DIGITAL DIFFERENCE.

Just as all CD's are not created equal, neither are Compact Disc Players. Of all the models currently available, only the new DTL-200 (and DTL-50) have the innovative and exacting Bob Carver touches that can substantially enhance your enjoyment of the digital medium.

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, ± 0.2 dB Total Harmonic Distortion, 0.007% S/N, 100db, Channel Separation, 90dB \cdot 1kHz, Dynamic Range, 96dB Wow & Flutter, unmeasurable. Programming, 12-track remote and manual



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We didn't know what we wanted from quad. Did we want a theater in the round, or did we primarily want hall ambience?


and video) in digital techniques, optical circuitry and computer analysis with abundant chips (a fatal lack in the old quadraphonic—they came too late), and with a very much wider variety of audio/video/film entertainment, we are a lot nearer to a consensus on how we can use surround sound for

each type of entertainment. Which is what really matters. We didn't know what we wanted from quadraphonic! We were way off base in the listening itself, in just about every area. Did we really want a musical "theater in the round," with things coming at us from every point on the compass? (Not,

surely, in a Mozart or Beethoven symphony!) Or did we want primarily surround *ambience*, the music in front of our ears, the feeling of the "hall" realistically behind us? And where did pop and jazz and rock come in? We did not remotely agree.

I know for a certainty that this time around we can do all that deciding with much less fuss and a lot more listener interest. The listener knows more, too. For once, we can bless the movies and video for bringing surround to millions on an impressive scale—bigger than anything in audio by itself. And we can hope that the trickle-down, from giant movies to littler movies, to videocassettes and even to ordinary day-to-day TV (where surround sound is virtually useless—who needs it?) will in the end benefit our own smallish corner of the entertainment world, audio for the consumer's personal use, minus pictures.

At that point, you see, we are back to the beginning where quadraphonic started. Do you think that Dolby Surround for the home is much different from the fought-over "matrix" systems of a decade and more back? Scarcely different at all, except in its provenance, its immediate origin, which is, providentially, big-time movie sound. Dolby Surround depends on the same basic patents as the former SQ and all its relatives, licensed then as now from the work of Peter Scheiber, who is still in the thick of it all. Please note well that Scheiber, the technological granddaddy (at a young age) of so much in surround sound, was and is a trained musician. We are still dealing very largely with the reproduction of *music*. And note also that Ray Dolby is almost awesomely respected for having an incredible finger on the audio pulse and a sense of timing that has made him an engineering winner time and again, as anybody knows. So—keep watching for developments.

Whoa—do I hear somebody out there preparing to do battle with the Dolby camp? *Has the war already begun?* Of course. But it isn't very big yet. Plenty of time for everybody to bargain a bit, for us to be reasonable and elastic, including Dolby, until things sort themselves out. *There's room*. There's space for bargaining. Ask Peter Scheiber. 

Get Active...

Every audiophile dreams of having a music system which includes a pair of loudspeakers driven by four or six power amplifiers separated by an electronic crossover. In such an active system, the amplifiers operate within a specific portion of the frequency spectrum providing a detailed and articulated sound. The electronic crossover defines the role of each driver and amplifier precisely, resulting in more accuracy, greater efficiency and lower distortion than is possible with typical passive crossovers. Meridian integrates carefully matched active electronics into each of their loudspeakers giving them the ability to retrieve more realism in a reproduced musical event than any comparable passive design.

The third generation of active loudspeakers from Meridian allow your audiophile dreams to come true at a price much lower than you would expect. When you hear how much musical enjoyment you can have, we're sure you'll get active.

BOOTHROYD STUART
MERIDIAN

Pictured is the Meridian M30 biamplified active loudspeaker. Also available are the larger biamplified M20 and the triamplified M100 models.

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—REVUE DU SON, foremost French stereo magazine.

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BERT WHYTE

NEON NOTIONS



If you can believe official figures, more than 103,000 people attended the Winter Consumer Electronics Show in Las Vegas. Insiders say these numbers are optimistic. The same sources indicate that this WCES was another "wheel-spinning," "marking time" type of show.

Oh yes, there was a lot of hype and hoopla about R-DAT. The "in" joke in the audio press corps was the bulletin we all received from a manufacturer who urged us to "be sure and hear our second-generation prototype R-DAT recorder"! To be sure, there were quite a number of R-DAT prototypes displayed, and some were even demonstrated. Sony, in fact, was playing prerecorded R-DAT tapes with music supplied by Sheffield and Telarc. I spoke to Jack Renner of Telarc and Doug Sax of Sheffield; both indicated that if a market developed, they would offer prerecorded tapes in the R-DAT format. Their attitude would seem to reflect the opinion of most of the smaller independent record labels. This is in marked contrast to the major labels, who are vehemently opposed to prerecorded R-DAT tapes. As usual in the ongoing R-DAT saga, none of the companies showing prototype recorders at the CES would commit themselves to

furnishing prices or delivery dates. However, this time around, there were enough signs and portents to indicate that at the Summer CES, R-DAT recorders will be swarming like locusts . . . and in some circles, they'll be just about as welcome!

In the midst of all this R-DAT hoopla, Compact Disc continues to flourish. New models of CD players offer some worthwhile refinements, and there have been some significant advances in CD technology as well. For example, GE has found a way to considerably reduce the problem of birefringence in the injection molding of Compact Discs. It seems that the polycarbonate from which CDs are molded can cool too rapidly, shrinking away from the sides of the mold and creating stress marks. These marks cause the birefringence, a refraction of the laser beam, bending it away from the digital signal pits and thereby causing mistracking. GE has developed a mold which senses the degree of cooling and automatically adjusts mold diameter to avoid shrinkage and stress marks.

Among the more notable CD players was Denon's \$1,600 Model DCD-3300. Denon considers this unit their "reference" model, and they have made an all-out effort to make it a major compet-

itor in the high-end market. Particular attention has been paid to the suppression and diffusion of resonances. Thus, a subchassis of steel and plastic is copper-plated and then enclosed in a thick, extruded-aluminum chassis. This assembly is then suspended on heavy brass isolation feet. The laser tracking mechanism is suspended with coil springs and visco-elastic dampers, while the mechanism itself uses ceramics, high-density polymers and synthetic rubber to reduce resonance. The DCD-3300 uses one of Denon's proprietary "Super Linear" D/A converters for each channel. Digital and analog sections are completely separated, each with its own transformer, and they are coupled by fiber optics. In addition to fixed and variable analog RCA output jacks and a digital output port, the DCD-3300 features balanced 600-ohm XLR outputs for professional use. Deliveries of this CD player should have commenced by the time you read this.

Sony made a continued big commitment to CD with the introduction of 16 new CD players in the portable, automotive, and home-component categories. Among the more interesting models is their CDP-C5F "DiscJockey" CD changer. This unique unit incorporates a carousel in its front-loading drawer; it can be loaded with up to five CDs for nearly six continuous hours of unrepeated music. Any of the discs can be changed within 2 to 3 seconds. Up to 32 selections can be programmed in any sequence, and the unit also has a "Shuffle" mode that can randomly play disc tracks with endless variations of sequence. A wireless remote control is provided. The CDP-C5F will be available this spring at a price of \$450.

As always, Sony's top-of-the-line model is a distillation of their research at the cutting edge of the art. I read a Sony "white paper" about the research involved in the development of the CDP-705ESD, and the thoroughness of their investigation into every parameter that can affect CD playback is mind-boggling! The new \$1,500 player is a technological tour de force, with features that reflect some very basic changes in the company's CD design philosophy. For example, Sony now employs 176.4-kHz quadruple oversampling along with their 16-bit quanti-

Photograph: COMSTOCK, INC./Hartman-Dewitt

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An actual photo taken through the voice/grid diaphragm of a Magneplanar loudspeaker

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zation. They have also eliminated the sample-and-hold circuit usually employed after D/A conversion. In addition, new materials have been developed for this player. Its "G-Chassis," made of a nonmagnetic calcium-carbonate compound reinforced with glass fiber, is claimed to have great rigidity and low resonance. Sony has also developed new C-MOS digital LSI chips, and is using new D/A converters in dual configuration. There is a new aspheric lens, an ultra-lightweight laser pickup, a new servo system, a new "Error Prediction Logic" circuit, and a new transport-sled design. Even the digital output port has been changed to incorporate time-base error correction for any "jitter" that may be present.

One cannot summarily dismiss the bright ideas and dedication of original thinkers, so the brainchildren of The Mod Squad and Analogic deserve consideration. Essentially, the CD players shown by these companies at CES are extensively modified Philips units which are highly regarded by the high-end fraternity. I will be auditioning these players in the near future, and a comparison should be interesting.

As a final note on CD, and apropos to testing, I visited the high-end specialty group at the Golden Nugget. There I found Bob Stuart demonstrating his innovative new Meridian 207 CD player, which he tells me is now in full production. Also at the Golden Nugget, the Levinson folks were showing their new No. 23 amplifier, which may reasonably be thought of as two No. 20s on a single chassis. The 23 is a completely independent dual-mono design, including the power supply, and forgoes some of the sophistication of the No. 20s to achieve the more efficient and cost-effective package. And Doug Sax of Sheffield Lab was kind enough to play digital tapes of the remarkable recordings his company made in Moscow last August with the Moscow Philharmonic Orchestra. As you can imagine, the vicissitudes of recording in Russia make quite a story, so all the more credit is deserved for the stunning sound and exemplary performances of these recordings. I hope to give you a full report on them very soon.

Conrad-johnson was proudly displaying their new flagship preamplifier,

the Premier 7. Designed with an open disregard for cost, the unit is intended to be the ultimate expression of a pure tube preamplifier. It has separate mono left and right preamplifiers, and each has its own outboard power supply. No details yet on circuit topology. The Premier 7 should be available this summer for around \$6,000.

At Audio Research, Bill Johnson was demonstrating his massive M-300 monoblock power amplifiers. Using his renowned SP-11 preamp with a Well Tempered arm and turntable and a van den Hul cartridge, Johnson had these 300-watt, \$4,900 amplifiers driving Infinity RS 1B speakers, and I must say this was clearly the best reproduction I have ever heard from these particular loudspeakers.

Another new amplifier, the Hafler XL-280 Excelinear, was used to drive the remarkable new Acoustat Spectra 3 loudspeakers, which would seem to be the answer to a lot of the problems that have plagued electrostatic designs for many years. Most specifically, electrostatic loudspeakers have been limited in dynamic range, have had trouble playing at high levels, and have had notoriously poor low-frequency response. Acoustat engineer Jim Strickland has taken an idea that is more than 50 years old, and by applying some modern technology has finally made it work. The principle involved is what is known as "variable area" or "variable width" electrostatic transduction. It has many theoretical advantages, but apparently no one ever succeeded in driving this type of electrostatic element to practical sound pressure levels, and low-frequency response was very limited. The Spectra 3 is 5½ feet high, 31¾ inches wide, and 2½ inches deep. An array of three electrically independent electrostatic panels are used; these measure 9 inches wide and 46 inches high, and have sheathed conductors. They are driven by Acoustat's Magna-Kinetic 2000 interface transformer and an appropriate amplifier, in this case the new Hafler XL-280, which into the 4-ohm impedance of the Spectra 3 delivers 200 watts. In this "variable width" electrostatic configuration, the entire area is driven at the lowest frequencies; as frequencies rise, the driven area continuously becomes smaller, until at the



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Acoustat's Spectra 3 may be the answer to a lot of the problems that have plagued electrostatic speakers for many years.


highest frequencies only a 3-inch strip at one side is driven. This is why the Spectra 3 is made in mirror-image pairs. The electrostatic array sits on top of a curved base which contains an integral subwoofer. The subwoofer operates below 100 Hz and can be selectively employed.

What I heard, using some Telarc organ recordings, was solid, immaculately clean bass from the big pedals below 30 Hz. Bass drums tuned at 31 to 35 Hz were reproduced with impressive impact and accurate timbre. The midrange was well projected into the rooms, and high frequencies had that

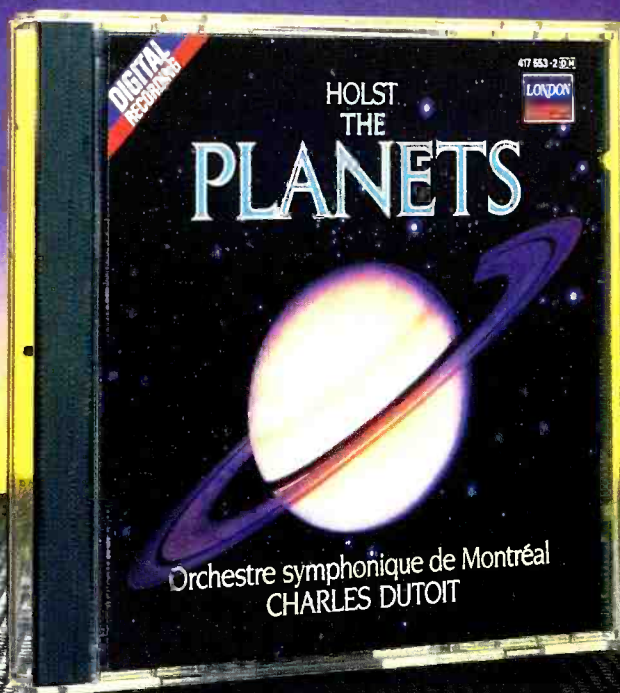
crystalline clarity of which aficionados of electrostatic loudspeakers are so enamored. Imaging, stage width, and the sense of depth provided by these speakers gave music a most pleasing three-dimensional quality. In short, this Acoustat Spectra 3, at \$3,000 per pair, sets a new high standard for electrostatic transducers.

Many people who read my November 1986 column about the Duntech Sovereign 2001 loudspeaker have subsequently auditioned a pair. Many whom I met at the CES were kind enough to tell me they concurred with my findings but said that the Sovereigns were too big or too costly to install in their homes. Thus they were very pleased to find that Duntech was demonstrating a junior version of the Sovereign, the Crown Prince. This speaker certainly is more physically manageable than the Sovereign. It is 71 inches high, 12 inches wide and 19 inches deep, obviously rather columnar in shape. This column rests on an 18-by-24-inch base and has a wood "cap." The base and cap are available in white ash or African rosewood, and the acoustically transparent wrap-around fabric grille is available in black or off-white. The speakers weigh approximately 130 pounds each.

The characteristics of the Crown Prince are very much like those of the Sovereign. It works on the same waveguide principles and has the same ultra-flat frequency and phase response, time path alignment, diffraction suppression, and point-source radiation pattern. Power handling is almost on a par with the Sovereign. While bass response extends well below 30 Hz, the Crown Prince doesn't probe the sub-basement of the musical spectrum. Still, driven by a Rowland Coherence One preamp and Model 7 monoblock amplifiers, and using the new Analogic CD player, the Crown Prince almost mirrored the performance of its big brother, reproducing music with majestic power and convincing accuracy.

Happily, consumers will find that the Crown Prince is also more financially manageable than the Sovereign. Selling at \$5,975 per pair (and available through W & W Audio of Charlotte, N.C. as you read this), they represent a most viable alternative to the Sovereign 2001 loudspeakers. 

REACH THE SONIC LIMIT



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stereophile

"Can two preamplifiers costing \$500 offer \$2000 worth of sound?"

**Anthony H. Cordesman
Stereophile, Vol. 9 No. 7**



Adcom GFP-555 Preamplifier

Total harmonic and IM distortion: 0.005%. S/N ratio: better than 85dB (phono), 100dB (line). Frequency response: 1Hz-100kHz, ± 0.1 dB. Input sensitivity: 40mV (line), 0.4mV MM phono, 0.13mV MC phono. Maximum output: 10V. Input impedance: 47k (MM phono), 100 ohms (MC phono). Output impedance 470 ohms. Phono overload at 1kHz on MM phono: 140mV. Phono input capacitance: 100pF, 175pF, or 275pF. Size: 17" W x 3 $\frac{1}{4}$ " H x 12 $\frac{3}{4}$ " D. Weight: 14lbs. Price: \$499.99. Rack mount adaptors: Model RM-3, price \$20. Manufacturer: Adcom, 11 Elkins Road, East Brunswick, NJ 08816. Tel: (201) 390-1130.

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"... it is one of those preamps that really stand the test of time. You can go back to it after a few weeks and still feel it to be basically right; It reveals most associated equipment as more colorful than itself."

There is very little constriction or compression: music sounds open and dynamic. You not only can listen to loud passages and enjoy them, you get most of the impact from sudden changes in musical dynamics.

The soundstage has good depth, width, and height. It is only very good, not excellent, but the centerfill is stable and the instruments spread out in a natural arc with very good depth. Only a small number of units do better.

The Adcom preserves these virtues whether you use the moving-coil gain, the magnetic-cartridge gain, or the line-gain stages. There are many step-up devices in high-end systems that cost twice as much as the entire GFP-555 and sound only half as good. It's a pity that proper loading has to be through external shunt resistors, but if you keep those obscene post cards coming, perhaps the folks at Adcom can be persuaded to change.

This does not mean that the Adcom is a totally neutral device or rivals the Motif, Audio Research, and CAT preamps I've reviewed in this issue, nor the Krell I've mentioned in the past. There is a consistent loss of information that the very best preamps let through. The loss of transparency, however, is minor: the GFP-555 does everything at least well, and most things very well. As a result, it is one of those preamps that really stands the test of time. You can go back to it after a few weeks and still feel it to be basically right; it reveals most associated equipment as more colored than itself. Were it not for the near-simultaneous appearance of the PS Audio 4.5, I would say there is nothing competitive under \$1000.

The Adcom GFP-555 and PS Audio 4.5: The Issue of Value for Money

It should be obvious from the above reviews that both the Adcom GFP-555 and PS Audio 4.5 offer outstanding value for money in two very different forms. Which is best for you? Well, if the above descriptions of features and sound characteristics don't provide a guide, nothing more I can say will help. You may actually have to break down and listen to both units before you choose which to buy!

If you do, I think you will agree that both of these preamplifiers are Class B by any standard, and push hard at the performance levels set by their much more expensive competition. While I suspect that top firms like Audio Research, Conrad-Johnson, and Krell can sleep soundly in their beds tonight, very good firms like Klyne, Mark Levinson, and Perreux have reason to be a bit restless. In fact, I offer the following challenge: A/B either the Adcom or PS Audio against any competing transistor preamplifier at any price. You may well find that you just saved \$1500 to use on new speakers, turntables, CD players, or wine.

"... A/B either the Adcom or the PS Audio against any competing transistor preamplifier at any price. You may well find that you just saved \$150 to use on new speakers, turntables, CD players, or wine."

I would also suggest that some of our Asian friends rush out and buy both preamplifiers for their design engineers. There is no reason that the world's main source of stereo equipment cannot copy something good for a change, and break away from the monotonous search for more brand-specific, trick-circuit features, extra switches, and controls. The world deserves a better quality of clones.

MANUFACTURER'S COMMENTS

Editor:

Thank you for AHC's thoughtful and positive comments on the new Adcom GFP-555 preamplifier. To avoid a deluge of obscene cards and letters, we would like to clarify the cartridge loading possibilities in the GFP-555.

Impedance: A 47k load is not only available, but standard on the "high" MC/MM input. While high output moving-coils will provide greater dynamics through this input, many low-output MC cartridges can be operated, although with somewhat reduced voltage driving the power amp. When more gain is required, the "low" MC position adds an additional gain stage for increased output voltage, and then has an input impedance of 100 ohms. This isn't really an "official" standard, but is the load most frequently recommended by makers (Japanese and others) of these devices. If unsuitable for any *Stereophile*

ophile reader's cartridge, most Adcom dealers and the factory's service department will provide a lower value impedance on request. We don't encourage your readers to negate the mandatory electrical safety warnings by going inside the unit themselves, and don't find the idea of infinite variability, achieved by internal friction posts and a bag of loose resistors, very appealing.

Capacitance: Our choice of added capacitance values, which affects the linearity of MM, IM and variable-reluctance type cartridges, evolved from the many hours of listening and testing of hundreds of new cartridges on the market, not just "ancient Shure cartridges." As *Stereophile* is aware, Adcom has one of the most sophisticated cartridge development and testing laboratories to be found anywhere, and our tests indicated that his feature is still desirable—at least until all your readers own an Adcom Crossover, a Koetsu or a Dynavector.

"Tone controls, filters, loudness contour... who needs them?" Our feeling is that many *Stereophile* readers can use some of these features some of the time. In an imperfect world where so little recorded material is really flawless, we'd rather have the options than not. The adjustment range is subtle enough to permit use of the controls, on command, without disfiguring the musical forms and shapes. We know that critics and reviewers learn at an early age to disdain these perks, but we hoped you'd try ours out, notice that they're not only different but better, and love us for it. Think about this the next time you're playing a CD with a jagged and irritating top end that's laser-drilling your eardrums, and can't find a way to tame it.

ADCOM
—East Brunswick, NJ

Stereophile is published monthly, except January, April, July, and October for \$24.00 per year by *Stereophile*, 1107 Early Street, Santa Fe, NM 87501.

ADCOM

11 Elkins Road, East Brunswick, NJ 08816 USA
Telephone: 201-390-1130

Distributed in Canada by PRO ACOUSTICS INC.
Pointe Claire, Quebec H9R 4X5

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UP THE D/A STAIRCASE

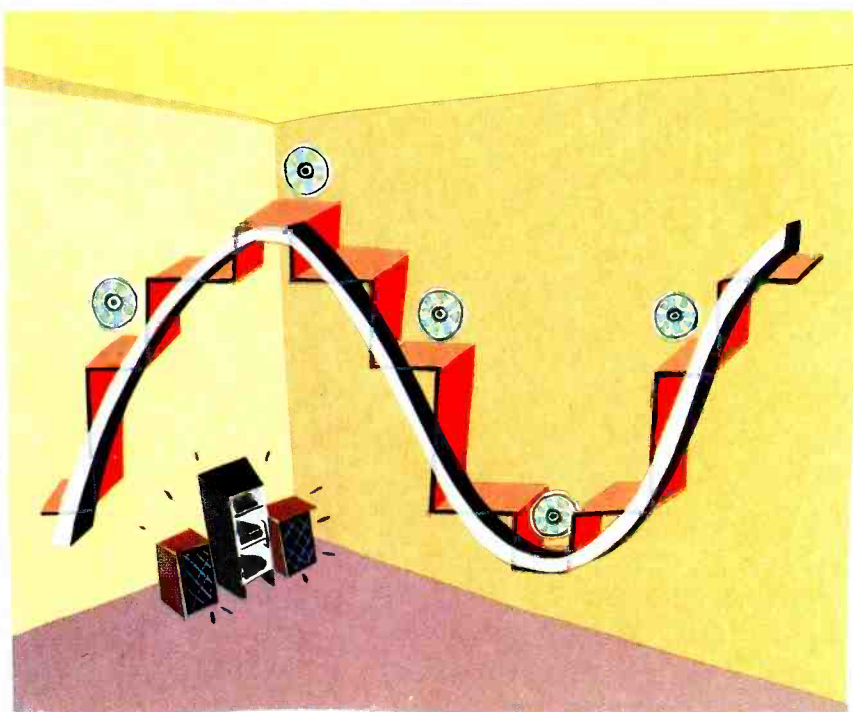
All Compact Disc players have digital-to-analog converters, otherwise known as DACs or D/As, to convert the digital bit stream to an analog signal that analog preamplifiers, power amps and speakers can process. Eventually that will change: CD players will output their information, still in digital form, directly to your all-digital stereo system. The analog signal that our ears require will not appear until the last possible moment, at the loudspeaker.

Sure, some CD players today have digital outputs, but they usually just feed bits to a box which has a D/A in it. So far there's not much else to accept that output (though at least two integrated amps, Luxman's LV-109 and Kenwood's KA-3300D, have built-in D/A converters and digital inputs). But wherever the D/A is located now or in the future, it has to be someplace.

Not a single one of the bits flying off a disc at a rate of 1.4 million per second escapes the system without passing through the D/A. It is thus an important component in a digital audio system. Let's check out the basic designs for D/A converters and tackle a true fisticuffs-generating question: Should a good CD player have one D/A or two?

The digital-to-analog converter is one of the hardest working components in a Compact Disc player. The pickup reads the channel bits from a disc, and they are demodulated. The audio data is separated from the control data; errors are detected, then corrected or concealed. The fast-moving audio bit stream is then fed to the D/A converter, which must produce an analog voltage corresponding to each digital audio sample. (In CD and DAT, each sample is expressed as a 16-bit word.) The sample voltages ultimately create two analog waveforms, one for each stereo channel.

The analog signal output from the D/A is equivalent to the signal appearing at the output of the sample-and-hold circuit on the recording side of the chain. Specifically, it's a pulse-amplitude-modulation waveform, easily spotted by its staircase appearance. Also, you may recall that a filter is required, to remove unwanted supersonic frequencies (manifested as the staircase's sharp edges) from the D/A's output.



There are several excellent ways to accomplish D/A conversion. Designs that use resistor-ladder networks (Fig. 1) are classics, used widely in many CD players. The reference voltage source produces a voltage along the ladder, which is converted to a current by the resistors. Each successive rung of the ladder taps off half as much current as the preceding rung, corresponding to the binary value of the bits in the digital word. The bits of the word are used to open and close switches, turning their appropriate currents on and off. For example, a word with all zeros would keep the switches open, and no current would flow. A word with all ones would close all the switches, and maximum current would flow. The output current, proportional to the value represented by the input binary word, is then converted to a voltage, completing the D/A process.

Other D/As differ significantly in design but accomplish the same task. For example, an integrating D/A passes current at a constant rate but does so for a variable period of time per sample. The time period is controlled by the digital input, as shown in Fig. 2. A small digital value yields a small amount of time for current flow, whereas a large value produces a longer

time period. By measuring the amount of current which has flowed, and converting that current to a voltage, we come up with a voltage which corresponds to the input word. In practice, to achieve conversion speed without sacrificing accuracy, two current sources are used. The current sources have a precise ratio of 256:1, corresponding to the ratio between the values represented by the eight most significant bits of the input word and the eight least significant bits. The larger current source is controlled by the eight most significant bits and the smaller source by the eight least significant bits.

Another D/A technique, called dynamic element matching (DEM), uses the principle of current adding (Fig. 3). A series of current sources with binary-weighted values are selectively summed, with the value of each bit controlling one source. When the result is summed and converted to a voltage, the D/A process is completed. In practice, an accurate current source is obtained by dividing a reference current source with a pair of resistors, then averaging their outputs with a pair of switches and capacitors. By cascading these or other types of current-dividing stages, a binary-weighted se-

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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† and delivers 800 W/CH of dynamic power at 2 ohms! 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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Resistor-ladder D/A designs are classic, but Sony likes the integrating method and Philips prefers dynamic element matching.

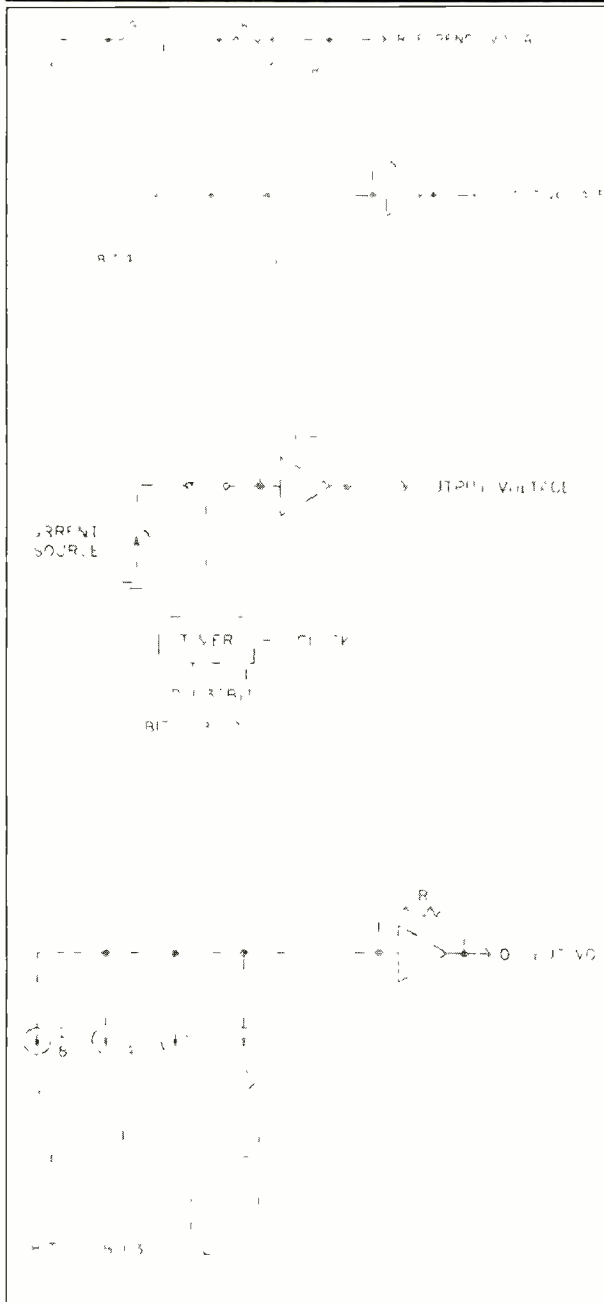


Fig. 1—
In a D/A converter which employs a resistor-ladder network, digital switches control current flow in proportion to the signal value encoded in each sample's bits.

Fig. 2—
In an integrating D/A converter, the bits of the sample control the time during which current flows, and hence the total current per sample.

Fig. 3—
In a dynamic element matching D/A, which uses the principle of current-adding, binary-weighted current sources are switched in and out by the bits in the sample, and the currents are summed together.

of a sampling period. Reconstruction at the low-pass filter, however, theoretically requires impulses of infinitely short duration. But infinitely short impulses are impossible to achieve because they would, among other things, require infinitely large current flow. Due to the finite duration of the output impulses, a filtering effect occurs in which the amplitude response gradually falls to zero at the sampling frequency, as shown in Fig. 4. This is because the frequency response is the Fourier transform of the sample period. A plot of this transform takes the shape of the curve labelled $(\sin x)/x$ in the figure.

As a result, supersonic frequencies are partly attenuated, but so are the highest audio frequencies, which are rolled off by about 4 dB per octave. (Oversampling reduces the loss only slightly.) This is known as aperture error. To minimize this high-frequency loss, the impulses can be narrowed to more closely match the duration of the original sample width. Shorter pulses produce a different Fourier transform and a flatter frequency characteristic for the pulse amplitude signal, as shown in Fig. 5. Fortunately, circuit designers recognize the problem of aperture error and are able to compensate for its effects with a complementary high-frequency boost in the output conversion stages.

One issue over which circuit designers (or at least their company's accountants) disagree is the number of D/As to use in a CD player. Until all-digital systems become commonplace, and CD players omit D/As altogether, they can have either one or two of them.

At first glance, two D/As might appear necessary. Since Compact Disc is a stereo playback medium, two audio channels are reproduced. As Fig. 6 indicates, the digital data stream can be demultiplexed to left and right channels and fed to two D/As, resulting in two audio outputs. However, strictly for reasons of cost, most players employ one D/A, as shown in Fig. 7. The multiplexed data of the two audio channels goes to this single D/A, which must operate twice as fast as dual D/As. Only after D/A conversion is performed is the data separated into left and right channels.

ries of currents can be obtained. Their selected summation accomplishes the task of conversion. A DEM converter is cost-efficient because it requires no calibration.

Sony's engineers like the integrating D/A method and often use it in their CD players. Philips engineers, on the other hand, prefer the DEM design, so many Philips-made players (such as Magnavox units) employ this technique.

Whichever method is employed, the 16-bit D/A converters in most players do not pose major design problems.

Yet there is one problem that seems insoluble. The output from any D/A is a pulse-amplitude staircase. (In practice, a sample-and-hold circuit is usually inserted to prevent switching glitches from leaving the D/A.) The duration of each impulse in the output staircase wave is equal to the duration

Your loudspeakers may well have some of the most advanced drive units and crossovers in the whole world.

Even so, something is still standing between all the natural sound they produce and your ears.

The loudspeaker cabinet walls.

When the drive units vibrate, they will make the cabinets vibrate as well. Stopping the complete sound spectrum that comes from the drive units from ever reaching you.

This effect is known as colouration. And it's the reason you're always conscious that you are listening to music produced by two loudspeakers rather than a truly live concert performance.

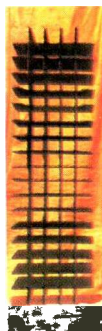


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Colouration is a great barrier to pure sound reproduction. Loudspeaker manufacturers all over the world have been searching for a way to break through it.

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It's the Matrix series of new digital monitors. The first ever loudspeakers to totally eliminate the colouration from the loudspeaker cabinet.



The bass has depth and body and no resonant boom.

The mid- and high-frequencies have a new sparkle and definition.

And, for the first time ever, the natural decay of reverberation is heard exactly as it's heard in a live performance.

The familiar, but greatly unloved hangover effect is dead. Long live the Matrix.

This revolution was achieved with an idea so very simple that B&W practically invented the Matrix by accident.

They discovered that all that

is required to virtually eliminate unwanted sound radiation from the cabinet is a honeycomb-like structure of unique design inside it.

They also discovered that this so improved the performance of the cabinet that they also had to improve the quality of all the drive units.

Consequently, as well as the drivers with homopolymer cones manufactured under licence from CBS Inc., Matrix also features a newly designed ferrofluid tweeter.

The new Matrix series itself features three digital monitors.

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Each has a different size, maximum acoustical output and bass extension. All have the same enhanced stereo imagery, improved transient response, low distortion and total freedom from colouration.

The Matrix series takes its place in the B&W range, succeeding loudspeakers that in their time have made history. You just cannot miss them at your B&W stockist.

They are truly the only loudspeakers that are seen but definitely not heard.



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Two D/As might appear to be necessary, but most CD players use just one, for reasons of cost.

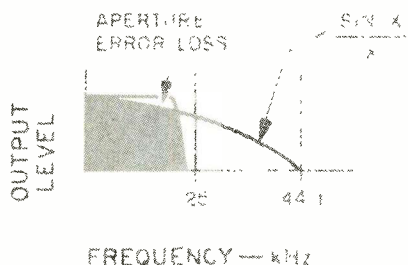


Fig. 4—The finite duration of output pulses causes aperture error, a roll-off that reaches zero at the sampling frequency, and causes losses in the audio band as well.

Although the results of each conversion method are apparently identical, small differences are introduced. Specifically, the single D/A design creates several anomalies in the signal. While the data bits from different channels are easily split apart in the dual D/A design, the interleaved segments of analog voltages produced from single D/A designs are not so easily separated. A switch must be used to route

those pieces of waveform (at a rate of 88,200 per second) to the correct output channel. There is a chance that the switch will cause distortion as it flips back and forth.

In addition, the single D/A design introduces a slight time difference (11.34 μ S) between the two audio channels. In a dual D/A design, the demultiplexed data appears at the two converters simultaneously, exactly as it

appeared at the A/D converters of the digital recorder. The output analog channels are thus exactly in phase—that is, exactly matched in time. In a single D/A design, one output channel must wait for the other channel's sample to be converted. Therefore, it is always one sample behind, unless it incorporates a delay line that's just long enough to hold the leading sample until the trailing sample is able to catch up to it.

The 11.34- μ s interchannel difference produced by a single D/A design is equivalent to a 0.1-inch difference in the distance from two stereo speakers to a listener. Theoretically this doesn't do stereo imaging any good, but in practice it's harmless. What's *not* harmless is the effect the time offset can have on stereo broadcasting. For example, cancellation could result in high-frequency roll-off in the L + R component, and reinforcement of the L - R component. Monophonic reproduction from a single-D/A CD player would produce the same high-frequency roll-off. The interchannel difference in a single D/A design can be partly compensated for, but this is difficult to achieve over the entire frequency range. Dual D/A designs avoid all of these switching-distortion and delay liabilities.

Unfortunately, not everything is sunny in dual D/A land. A pair of converter chips might mistrack due to fluctuations in their reference voltages or anomalies in the chips themselves; the result could again be phase error. Some manufacturers have solved both problems by offering dual D/A converters on a single chip, a nearly ideal solution. Philips, for example, has gone this route in the dual D/A chip used in their new 16-bit, four-times-oversampling chip set.

Until the all-digital audio system makes its debut, D/A converters will continue to provide the crucial interface between digital and analog parts of an audio system. Here's one trend you can watch for: The D/A converter will be pushed farther and farther downstream as more and more of the components in the audio chain go digital. Eventually, pulse-width-modulation power amplifiers may alleviate the need for a D/A altogether. But that's another story.

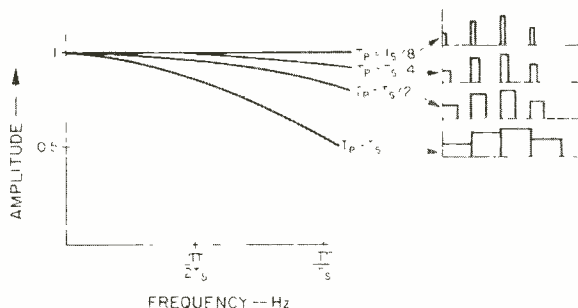


Fig. 5—Aperture-error roll-off decreases with shorter pulse durations (shown at right). Aperture is calculated as T_p divided by T_s , where T_p equals pulse duration and T_s equals sample period.



Fig. 6—Signal path with dual D/A converters.

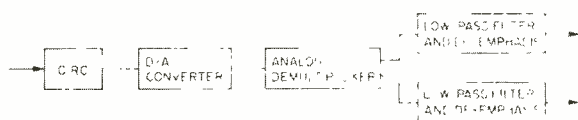
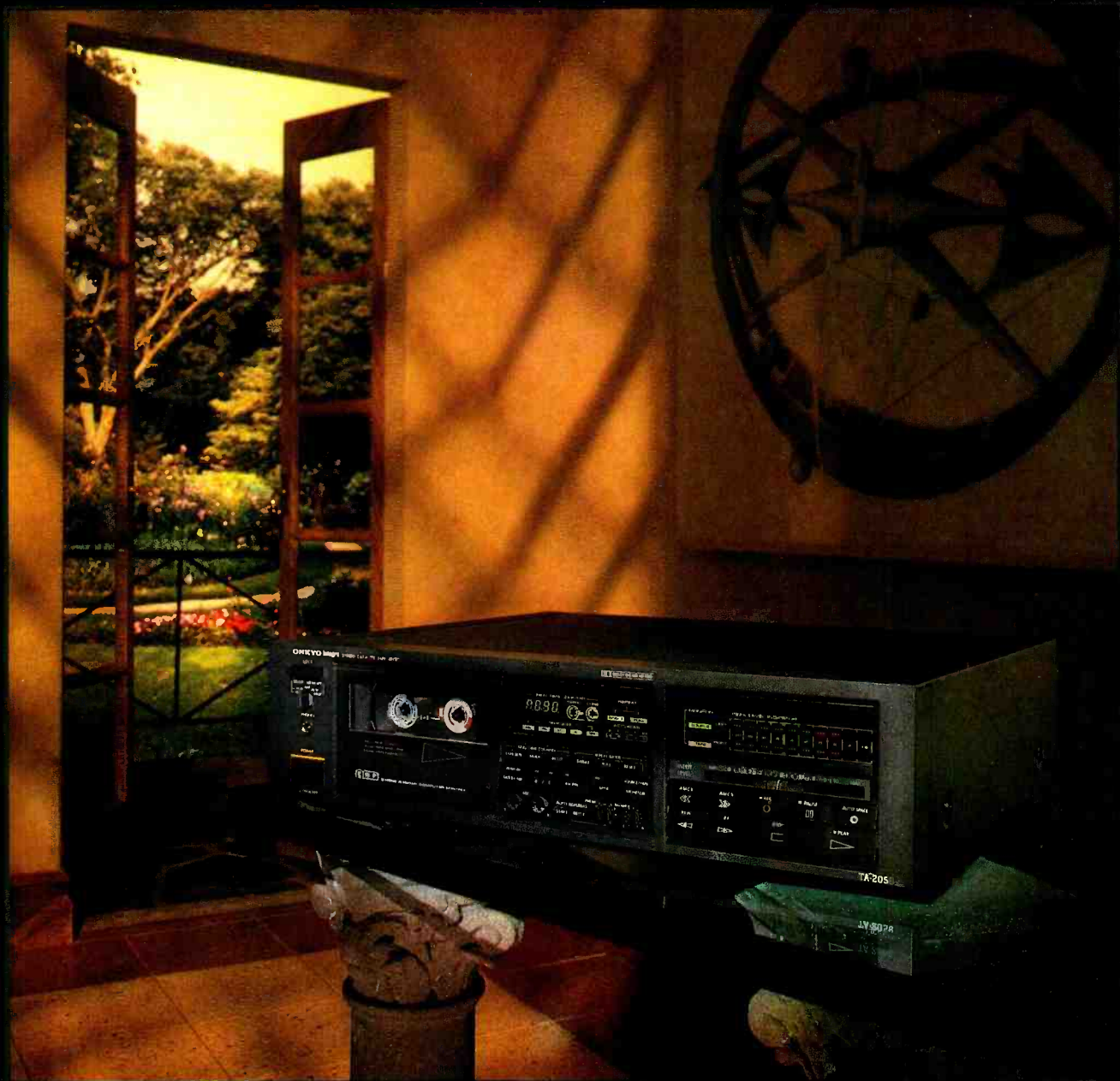


Fig. 7—Signal path with single D/A. In some players, an 11.34- μ S delay line in the earlier channel (not shown) is used to maintain synchrony.

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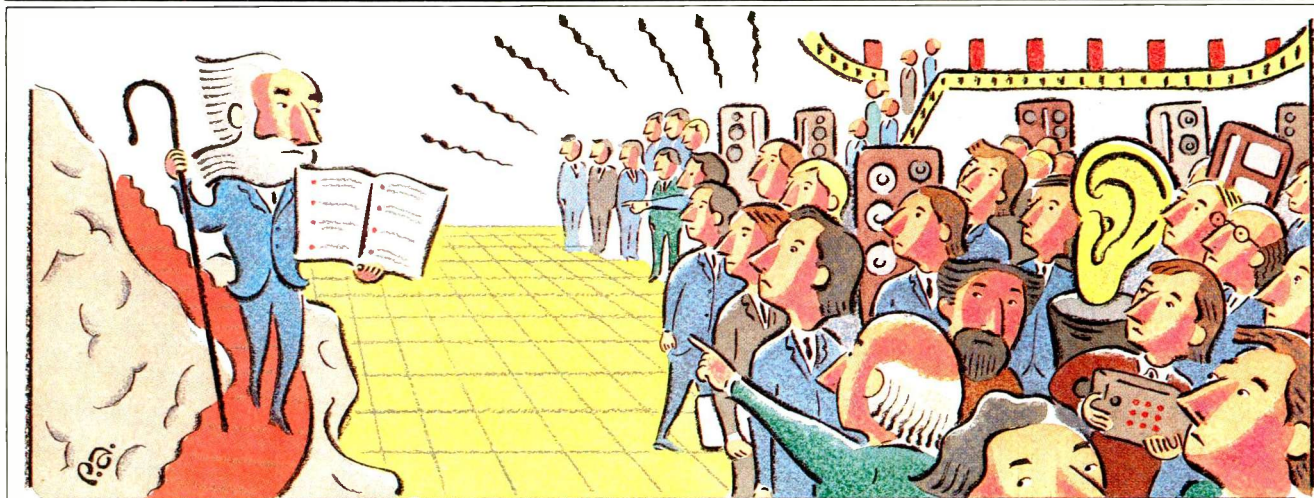


Illustration: Philip Anderson

Editor's Snivel: Within the industry, it is well known that Consumer Electronics Shows are the equivalent of Sartre's *No Exit* or Kafka's *The Castle* to hi-fi editors. Ordinarily, we simply grin until we are grinning idiots, but this year, over breakfast, we plotted our revenge. Thus, new rules for the next show.—E.P.

For many readers, the idea of wandering the halls of a Consumer Electronics Show or CES may seem to be the spiritual equivalent of a child's visit to a candy factory. In practice, however, we brave reviewers and editors run the grimmest of gamuts to scout out the latest in audio equipment. Far too often, the sound demonstrations are more for "iron ears" than "golden ears" and could stun a half-deaf rock star at 100 meters. Worse, the alternative to a bad demo is often audio politics, which has all the light humor and elfin touch of the Third Reich.

Yes, there are bright spots. A few firms like Audio Research consistently demonstrate real music. Counterpoint once hired a string quartet to entertain the weary. Arnie Nudell of Infinity can never resist showing off his latest top-of-the-line equipment with really good master tapes. Thiel always has pleasant chamber music or jazz and a decent glass of wine. Noel Lee of Monster Cable earned the gratitude of everyone attending this year's Las Vegas show by sponsoring a concert by Amanda McBroom, the First Lady of the High End. Many manufacturers do

confine their remarks to their own lines, and each show reveals at least a few exciting new products.

Far too often, however, any real audiophile or music lover is driven right out the door by truly awful sound demonstrations. At least a voting majority of the demonstrations at a CES fall into one of three categories: Unpleasant sound, unpleasant bad-mouthing of the competition or anyone else in the audio business, or both. As a result, the somewhat shell-shocked editor of this magazine has directed me to write a set of rules for future audio shows. These will be enforced by a carefully chosen band of subjective reviewers, technical testers, and A/B statisticians armed with the power to force contributions to a fund for the performance of live music. You, as audiophiles, should be as aware of these new regulations as manufacturers, reviewers, and dealers:

Entry Requirements: No one may attend a show who has not heard at least one hour of live acoustic music without artificial amplification in the preceding six months. In order to minimize the shock of coupling hi fi to music, *Audio* will fund therapy for any established manufacturer, dealer, or reviewer who cannot recover from the experience of hearing live music, naturally reproduced, for the first time.

Alternative Physics: All technical claims for or against audio products and technologies must be made in writing, and submitted for approval six months before the show. Those which are sufficiently weird and unstructured,

or which are simply absurd, may be distributed only in the new CES Alternative Physics Room (not to be confused with the Press Room). Proponents of these theories can speak only during working hours and only in this room. They may not corner anyone in the halls.

Urine Testing: All audio designers and reviewers must have their urine tested one week before the show. Those whose test results indicate they are totally deaf will be precluded from lecturing other attendees on sound quality.

Adult Hours: The periods of 11:00 to 12:00 a.m. and 1:00 to 3:00 p.m. will be reserved for adult listening (not to be confused with Adult Movies). Musical material will be limited to chamber music, small jazz groups, and ballads.

SPL Limits: No audio demonstration will exceed an average level of 95 dB or a peak level of 103 dB, or raise the sound level in any adjoining room by more than 5 dB.

Audio Politics Room: The CES will provide a large, unfurnished room for spreading rumors, attacking other people in the audio industry, and criticizing competing products. This room will be open 24 hours a day. Anyone with compulsive bad manners and taste must use this room for audio politics, and no audio politics can be discussed outside it. Videotaping facilities and foam truncheons will be available.

Unbearable Upper Midrange: All demonstrations must have their upper midrange approved during the day before a show. No demonstrations of

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Audio shows open to the public would unite those who care about good audio equipment and those who love music.

hard, glaring upper midrange will be tolerated.

Reference Blacklist: A list of the world's most unpleasant audiophile demonstration records will be prepared before the show, and none may be used at any time. Examples include the Sheffield *Drum Record*, Reference

Recordings' *Dafos*, and Telarc's digital cannons, but there will be many others.

Boom Time: Demonstrations of deep bass at deafening levels will be limited to the two minutes before the close of the Show each day. In the interest of objectivity, *Audio* is developing a special CD with a standard "boom" for

reference purposes. This CD is being developed in cooperation with the Iran/Iraq War and a group of audiophiles in the PLO, together with Challenger technicians from NASA's Cape Canaveral facility.

Real Products: All products that are nothing more than shells, or which will not be on the market in the exact form shown at the show within the next three months, must be labelled with the word "Dummy" or "Phony" in 12-inch letters. All magazine reports will use these words in describing the product.

Real Reviews: To eliminate audio prostitution, there will be a ban on specially arranged "reviews" of prototypes or limited production runs that appear at the show before the product is in final form. The reviewers and their publications will also be banned.

At-Show Reviews: Those who wish to review the sound quality of products at shows will be limited to noting those products that really sound good, with the careful qualification that no one can accurately evaluate the sound of a product in a hotel listening room. No product will be criticized for bad sound, although manufacturers may be criticized for poor demonstrations.

Technology Demonstrations: All "gee whiz" descriptions of technology, particularly future technology, that has not had successful demonstration on a really good high-end system will be qualified with such terms as "undemonstrated," "demonstrated only on a low-quality system," "partially demonstrated," "unheard," or "of unknown potential." All technologies will be assumed guilty until proven innocent, including DAT.

These rules may well take much of the fun out of audio shows—at least for the funnier (funny peculiar) portion of those who attend. On the other hand, the fines involved should pay for a lot of live music and possibly for a few audio shows open to the public.

Such public shows would help unite those who know about, and care about, really good audio equipment and those who love music—a union which trade shows do nothing to promote. After all, the point of good audio equipment is not electronic incest between manufacturers, dealers, and reviewers—it is to make good sound available to all who love music. **A**



The Next Logical Step . . .

Meridian, the company which led the way in demonstrating the true sonic possibilities of the CD medium, continues to lead the industry with the introduction of their new model 207 Professional compact disc player.

The 207 is built on two chassis. The transport and all mechanical components are housed in a chassis which offers front loading convenience while carefully isolating both the disc drive and laser mechanism from external vibrations. A separate chassis containing the audio and control electronics is entirely free of the electromagnetic radiation of the transport motors and any microphonics that might be introduced by their operation. These factors contribute to the 207's ability to reproduce the more subtle nuances of a musical event.

The full function remote control capability of the 207 includes a recently designed circuit for controlling the output level. This revolutionary electronic gain control provides the highest audible quality ever available with a remote control, allowing the 207 to be conveniently used to directly drive active loudspeakers or a power amplifier without requiring a preamplifier.

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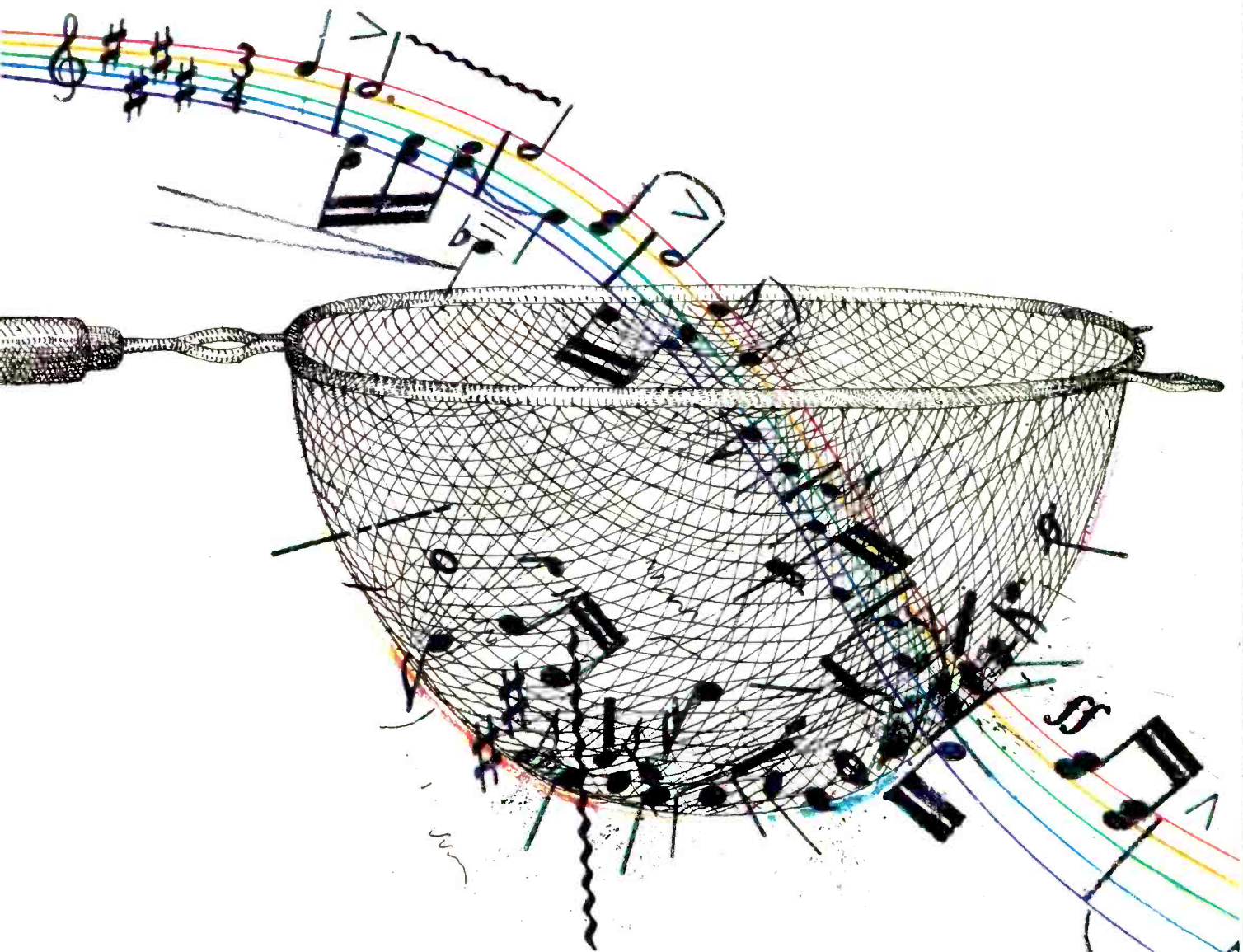
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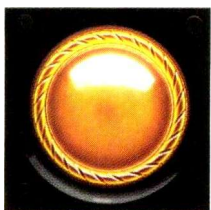


EVEN THE FINEST LOUDSPEAKERS
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Many of today's more expensive loudspeakers have impressive specifications that may look great on paper, but do not necessarily sound great in your home. For instance, they boast frequency ranges that extend well beyond the limits of human hearing. But while these loudspeakers may be sensitive to the musical extremes of the spectrum they are often insensitive to the subtle details in between. Details that create the finer musical nuances within the mid-range.

At Altec Lansing®, on the other hand, we've designed our new line of loudspeakers to recreate every subtlety of recorded music. To give not only the highs and lows but everything in between.

The secret of Altec Lansing's extraordinary timbre, texture and detail? A polyimide mid-range that produces an expansive stereo image to give you pure uncolored sound. In fact, Altec Lansing loudspeakers are so uncompromising, so revealing, they prompted J. Gordon Holt of *Stereophile* magazine to write, "I have been hearing more going on in (the mid-range of) old, familiar recordings than I have ever heard before...instrumental sections are suddenly resolved into many individual instruments rather than a mass of instruments," and they compelled him to add that Altec Lansing's speakers have "high end sweetness and openness... with astounding inner detail."



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Mid-range

What's more, our woofers provide unparalleled low frequency definition that beautifully complements the flawless performance of our mid and high frequency drivers. How? With woven carbon fiber cones that are rigid yet lighter than paper or

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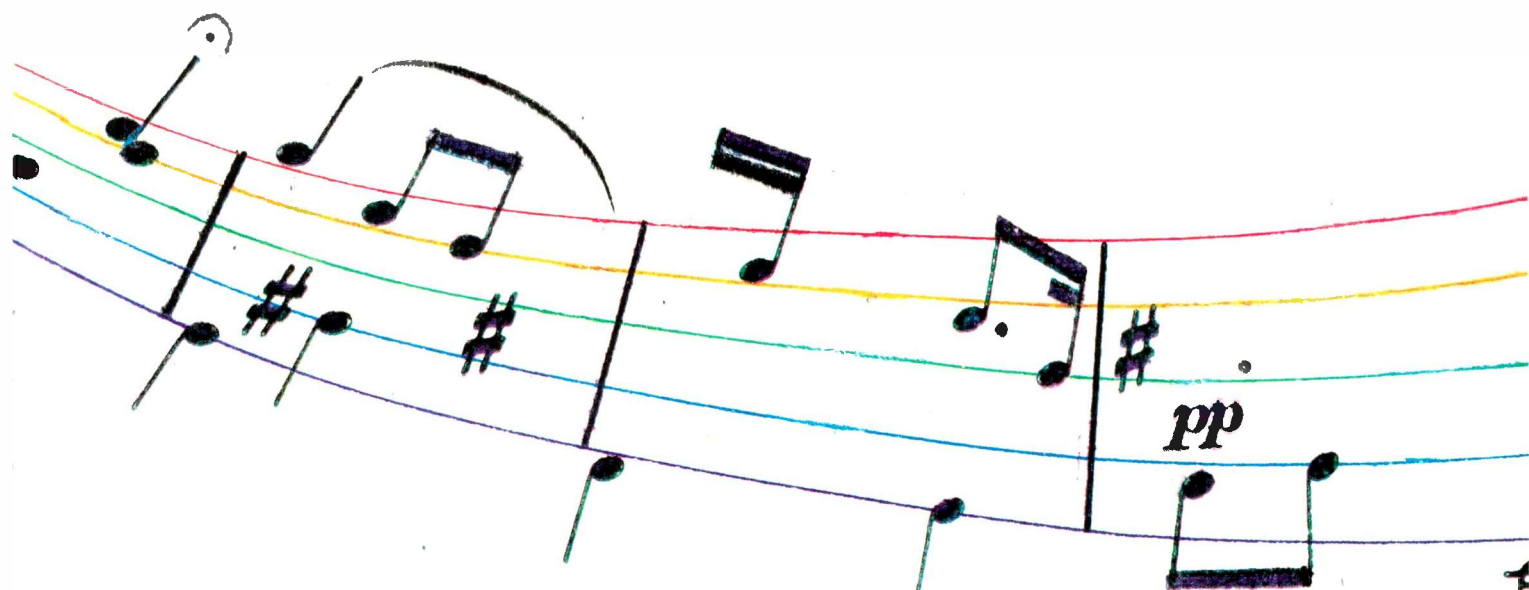
Carbon Fibers in Woofer Cone

The unique features like these, that make our home loudspeakers so impressive, also extend into our automotive loudspeakers. In addition, our automotive loudspeakers have features like Thermoisolate™ construction and high temperature resistant materials to assure lasting performance even in the extremes of a demanding auto environment. As a result, you'll capture the same details in your car as you do at home.

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Theory, Ingenuity, And Wizardry In Speaker Design

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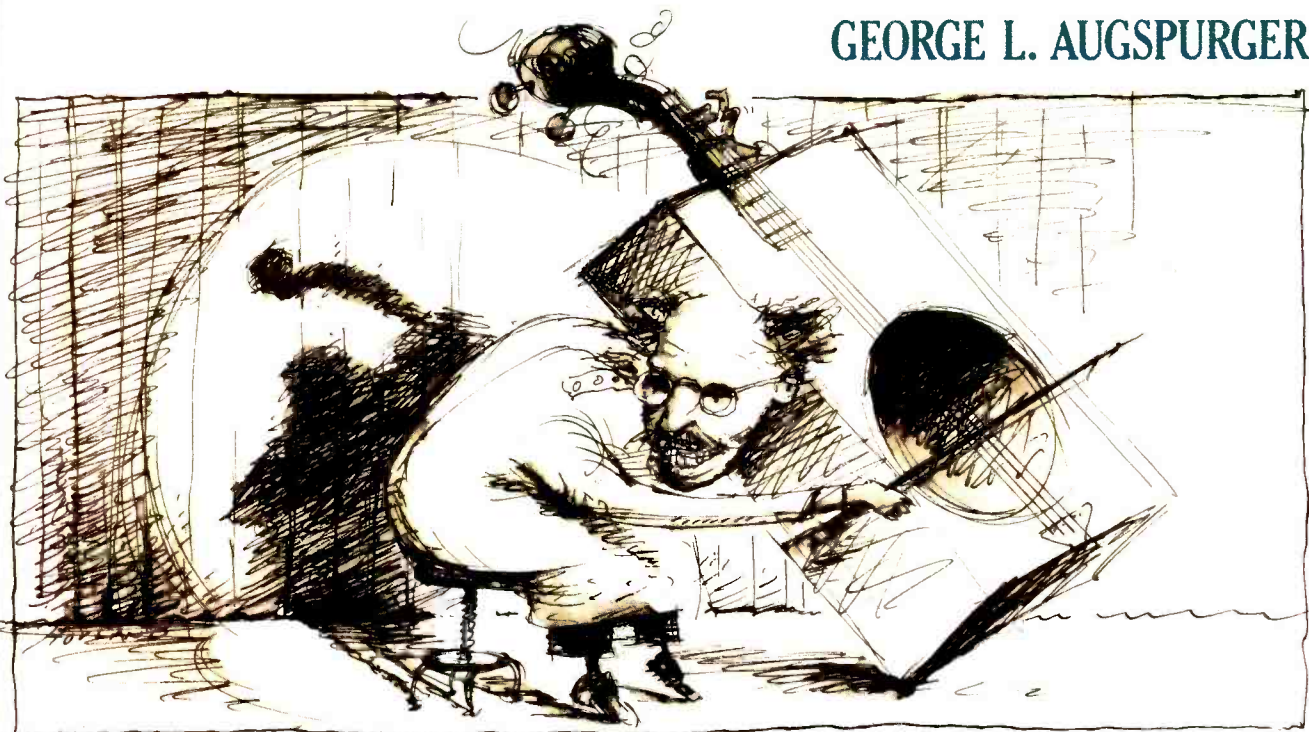


Illustration: Gary Hovland

George L. Augspurger has reviewed new patents relating to loudspeaker design for the Journal of the Acoustical Society of America and for the Journal of the Audio Engineering Society for the last six years. His knowledge of the literature and tongue-in-cheek writing style have made what might be a boring column into a well-read feature section.—E.P.

Contributions to the art of loudspeaker design are well documented in technical literature, but for the most part only if intended for professional or commercial application. Fifty-odd years of home high-fidelity loudspeaker development are known mainly by product reviews in consumer publications and a few landmark products that serve as continuing standards. Countless others have disappeared. The following presents a brief personal view of what took place in high-fidelity loudspeaker design from the 1940s to the present. State-

ments of fact have been verified from printed sources wherever possible. Implied value judgments are the author's own and may be freely contested by the reader.

The term "high fidelity" came into vogue in the late 1940s. It was used to describe a new generation of products aimed at a new segment of the consumer market. Within the high-fidelity clan, potential buyers of this exotic equipment came to be called audiophiles. To the general public they were described, more aptly, as hi-fi nuts. At that time, high-fidelity components were as expensive and addictive as are personal computers today.

Loudspeakers and loudspeaker systems have always enjoyed a certain romantic appeal not found (until recently, anyway) in more mundane

hardware such as cable and connectors. Over the past 50 years, the variety of devices sold as high-fidelity loudspeakers is truly amazing. If one includes designs patented but not marketed, the category becomes chaotic. As in all creative endeavor, loudspeaker designs tell us a lot about their designers. These people, some well known but mostly obscure inventors, can be classified on the basis of their designs into three broad categories. I have chosen to label the archetypes of the three categories as the elegant theoretician, the inspired tinkerer, and the wishful wizard.

In surveying the development of high-fidelity loudspeaker design, one occasionally comes across a novel and beautiful expression of fundamental physical principles. A good exam-

This article was originally published as "Theory, Ingenuity, and Wishful Wizardry in Loudspeaker Design—A Half-Century of Progress?" in the *Journal of the Acoustical Society of America*, Vol. 77, No. 4 (April 1985), pgs. 1303-1308. Reprinted with permission. ©1985, American Institute of Physics.



ple is the very first loudspeaker to deserve a place on the list. I refer to the classic Rice-Kellogg electrodynamic loudspeaker which appeared in 1925. The realization that a mass-controlled piston exactly compensates for decreasing radiation loading at lower and lower frequencies was a masterful insight that remains a cornerstone of extended-range loudspeaker design. It reveals its inventors as worthy examples of the elegant theoretician.

At the opposite end of the spectrum is the loudspeaker design that could work only if the laws of physics were rearranged to suit the whim of the designer. One example enjoyed considerable popularity in the 1950s and went by the trade name "The Perfect Baffle." It was a small cube, no larger than necessary to mount a loudspeaker of the desired diameter. Inside was an unadorned wood cavity without padding or bracing. The secret to perfection was found on the back panel. Here a small trapdoor hinged at the top was free to swing to and fro in response to the relative forces of gravity and air pressure. Thus relieved of back pressure, the loudspeaker cone was allowed to follow the subtle nuances of the electrical signal.

The notion that back pressure is an evil force that can somehow be bled off through valves, vents, or permeable membranes is one that crops up again

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and again in loudspeaker patents. However, The Perfect Baffle is the first example that I have found and certainly the most inspired in its simplicity. Its unknown inventor serves as the godfather of all wishful wizards.

I hesitate to single out any particular designer as the epitome of an inspired tinkerer. Anyone thus labelled may think that his accomplishments are being slighted. To the contrary, this category contains the great majority of successful loudspeaker designs. Consider for a moment that most cone-type loudspeakers operate as rigid pistons through only a portion of their useful frequency range. A really good cone negotiates the transition from piston operation through various breakup modes in a way that maintains relatively flat frequency response, and achieves reliable uniformity from one unit to the next. The process defies analysis, yet the inspired tinkerers of loudspeaker design have produced numerous examples proving that it can be done. A case in point is JBL's Model LE8T designed by the late Edmond A. May.

It seems to me that most of the successful loudspeaker designs of the past 50 years owe at least as much to inspired tinkering as to their theoretical foundations. Of these products, a few have had lasting influence substantially greater than that of their contemporaries. They serve as milestones that have marked new directions in home loudspeaker design. Five of these trend-setting designs are described here because they give a useful insight into the twists and turns of consumer acceptance.

(A) The first milestone has already been mentioned. The Rice-Kellogg moving-coil loudspeaker was the forerunner of today's direct-radiator designs. It was introduced in 1925 as a home loudspeaker system and en-

joyed almost immediate commercial success. The goal of every man's home, a concert hall, seemed to be just around the corner.

However, in the years following, an interesting dichotomy developed. Commercial loudspeakers, primarily those used to reproduce motion-picture sound, became bigger and better, while loudspeakers provided in consumer radios and phonographs got smaller and cheaper. In the decade from 1930 to 1940, there was no such thing as a home high-fidelity loudspeaker. Those who wanted something better than the narrow frequency range and muffled tonal quality of a console radio had to seek out commercial sound products and adapt them to a home "custom installation."

(B) The second milestone was such a product: The Altec Lansing Model 604 duplex radiator was introduced in the early 1940s and described by James B. Lansing in a paper published in 1943 [1]. The 604 combined a highly efficient 15-inch woofer with a high-frequency compression driver and horn. The high-frequency driver was planted onto the back of the woofer magnet, and the horn throat travelled through the woofer's center pole piece.

When it was introduced, the 604 was intended primarily as a broadcast and recording-studio monitor speaker, in which capacity it became an established standard. However, Altec Lansing also provided recommendations for installation in home music systems. (You may remember seeing a 604 and associated electronics mounted to the back of a closet door.) The 604 was the loudspeaker system installed in early Fisher consoles and was one of the most important reasons that the Fisher sounded audibly superior to almost any other all-in-one package available at the time.

When high fidelity became a consumer fad, other coaxial loudspeakers appeared. By 1956 one could choose from the Jensen, Stephens, General Electric, or RCA variants in the U.S. and the Tannoy in England. Like the Altec geometry, Tannoy and Jensen used a through-the-woofer high-frequency horn. Jensen even added a separate horn-loaded super tweeter to make a "Triaxial" system. On the other hand, the RCA LC-1A was an all-direct radiator design, a pet project of Harry F. Olson.

The 604 evolved through a number of alphabetical changes and one brief numerical increment, the 605A. Forty years after its introduction, it is still go-

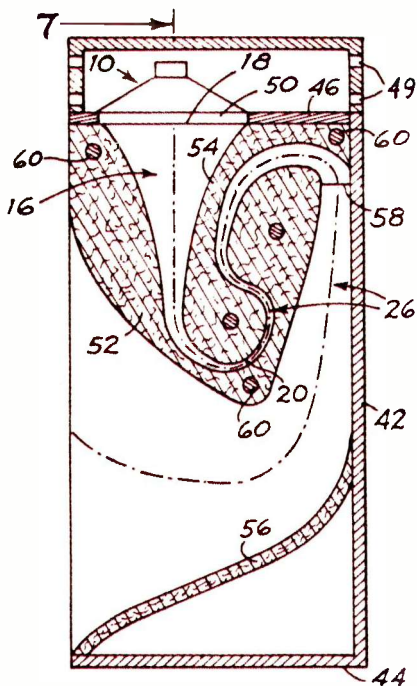


Fig. 1—A patented folded horn featuring a gradually decreasing, then increasing, cross-sectional area.

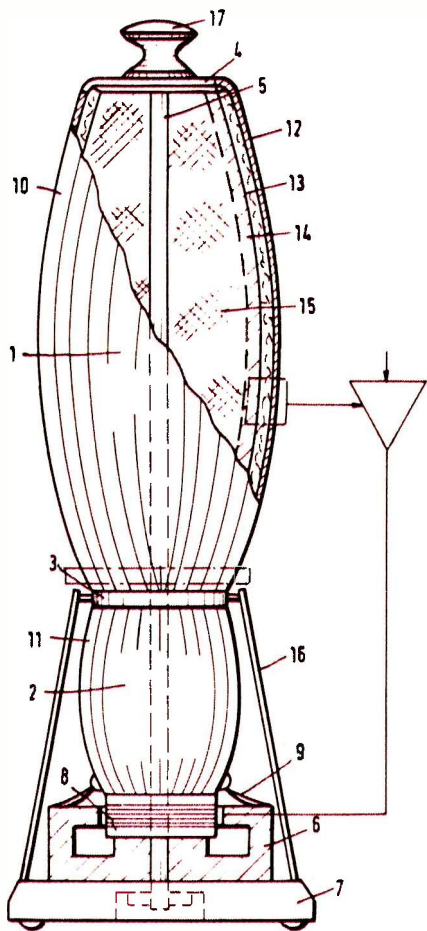


Fig. 2—A European "barrel stave" loudspeaker that includes motion feedback taken from a sensor in the back chamber.

ing strong as the Model 604-8G. Of the other coaxial designs mentioned, all are also-rans except the Tannoy Dual Concentric, which enjoys a good reputation both as a consumer product and a recording-studio monitor speaker.

(C) The Klipsch corner horn was described [in January 1946] by its inventor as "a high-quality loudspeaker of small dimensions" [2]. It too was an overnight success that remains a contemporary standard. The design is a beautiful example of good theory combined with sudden insight. A high-quality horn designed to stand in a corner had already been produced by P.G.A.H. Voigt. But Paul Klipsch realized that the room boundaries themselves would serve as a horn mouth; all that needed to be done was to design a suitable folded throat section.

In contrast to the large theater horns of the time, the Klipschorn was about a tenth the size and had powerful low-frequency response that extended about an octave lower. Audiophiles

were thrilled to discover that there was music below 55 Hz (and sound effects, and the "1812 Overture").

The Klipschorn inspired countless other folded horn designs that still keep evolving. Figure 1 illustrates one of the scores of patented variations. It would seem that there must be a finite number of ways that an expanding air column can be squeezed and folded, but armchair horn designers have not yet reached that limit. Only the advent of stereo reproduction and the need for smaller, more versatile loudspeaker systems finally diminished the corner horn's status as the ultimate home loudspeaker system.

(D) The fourth milestone is the vented box enclosure, popularized by Jensen in the early 1940s as the "bass reflex" loudspeaker system. Now here was something that even the nontechnical enthusiast thought he understood. Patented variants of the vented loudspeaker enclosure have pushed the limits of man's imagination to new frontiers, as we will see later in this article.

Because of its simple geometry, the vented box became a favorite of home constructors, but results were often disappointing. Consumer magazines were full of advice on various methods for properly tuning vented enclosures. These varied from the simple "click-boom" test to complicated analysis of measured impedance. They all had one element in common: Their proponents (including myself) really didn't know any more on the subject of loudspeaker-box-vent interaction than the people being instructed.

Primarily through the use of electrical analog circuits, the behavior of vented systems became better understood. Locanthi's 1952 paper on electrical analogies [3] was used by at least two manufacturers to design better vented systems. In 1961, specific loudspeaker driver parameters and appropriate enclosure "alignments" were described by Neville Thiele [4] and later refined by Richard H. Small. Today, Thiele-Small parameters are routinely published by loudspeaker-driver manufacturers and used by consumers to design systems with predictable low-frequency characteristics. The loudspeaker experimenter who dismissed vented enclosures as boom boxes a few years ago is now proud to demonstrate his "computer-aided augmentation of the classic number five B-4 alignment."

Two of the many vented designs that have come and gone are interesting

enough to deserve mention. The R-J enclosure introduced in 1951 [5] deliberately increased mutual coupling between the loudspeaker cone and the enclosure vent. The result was a sort of brute-force acoustic low-pass filter. Although the technique is a practical one to use in certain situations, the R-J enclosure was only moderately popular for a short time and then disappeared from the market.

At about the same time, an interesting and popular vented box design was developed by John E. Karlson. Its theory owed more than a little to wishful wizardry, being based on the notion that an exponential slot somehow resonates over a broad band of frequencies [6]. The enclosure really seems to have functioned as a three-chamber vented box with increased mutual coupling between speaker and vent.

Although high-fidelity showrooms of the 1950s were filled with various kinds of audibly resonant horns, pipes, prisms, and labyrinths, the nonresonant school of loudspeaker design had its adherents as well. Wharfedale promoted enclosures using sand-filled walls to damp out panel resonances. The Hartley Baffle, along with a few transmission-line designs, attempted to dissipate the backwave through purely resistive loading. The Klein lonophone [7] did away with any moving mechanical system by exciting air

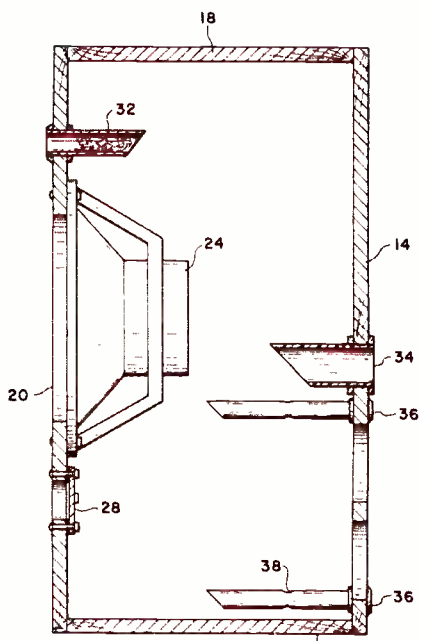


Fig. 3—One of the scores of patented variants of the vented box. This one appears to include vents, valves, and whistles.

molecules directly, as did the corona wind loudspeaker [8].

Some designers tried to eliminate resonance by eliminating the loudspeaker enclosure. The Quad electrostatic speaker consisted of a large, un-baffled diaphragm operating as a dipole radiator. It established its own cult following (using that term in a favorable sense) and was quickly joined by a number of other electrostatic speakers. In its current version, the Quad remains a standard to which other high-quality speakers are compared. I have not included it in this list of milestones only because the influence of electrostatic designs has not extended beyond a relatively small group of high-end product buyers.

The coming of stereo disc recording prompted a mad scramble among loudspeaker manufacturers. Designs as widely different as the Quad and the Klipschorn were nevertheless both finicky in terms of room placement and large enough to give pause to the stereo equipment buyer.

One answer was to retain the snob appeal of sheer bulk, but to put two loudspeaker systems into a single enclosure. The most successful example of this philosophy is probably the JBL-Ranger Paragon. The visual impressiveness of the Paragon as styled by Arnold Wolf has probably not been equalled by any other loudspeaker system.

Harry F. Olson developed and patented an interesting variation of the all-in-one concept [9]. To gain maximum speaker separation in a cabinet of minimum width, Olson put the speakers at the ends of the cabinet and then added acoustic prisms in the form of

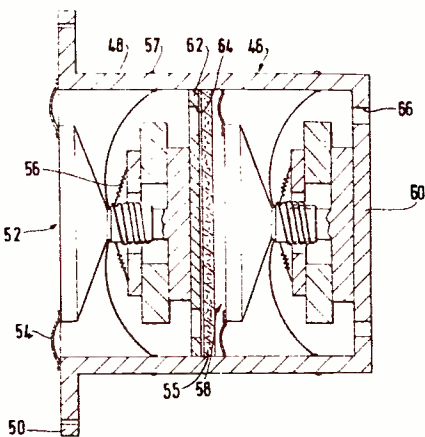


Fig. 4—A compound speaker system in which the second driver maintains constant rear volume for the first.

In the '60s and '70s, the appeal of high fidelity spread. Everyone wanted a good system, and to most people this meant a good small system.

waveguides. Sound seemed to originate from virtual images hovering in space beyond the ends of the system. To the best of my knowledge, the concept was never developed into a commercial product.

Even under the best of conditions, big, impressive loudspeaker systems appeal primarily to people with big, impressive rooms to put them in. During the 1960s and 1970s, it became apparent that the appeal of high fidelity was not limited to the wealthy or to classical music buffs. Everyone wanted to own a good stereo system. And for most people, this meant a good small stereo system.

(E) As it happened, there was already a battle underway between advocates of big, efficient, powerful speaker systems and those who took up the banner of the "revolutionary" loudspeaker designed by Edgar Villchur in 1954 [10]. Villchur's "acoustic suspension" design was a true milestone. Within a half-dozen years, its introduction had turned the loudspeaker industry upside down. As far as the buyer was concerned, bigger was no longer better.

In Villchur's design, most of the restoring force acting upon a loudspeaker in a closed box is supplied by the stiffness of the air in the box rather than the mechanical centering system. The effective change in air volume resulting from the motion of the cone is relatively small, and over this range the air acts as a nearly linear spring. In a number of papers and articles, the inventor documented a substantial reduction in low-frequency distortion as compared with other loudspeaker-system designs of the time.

What really caught the public fancy, however, was the fact that the original Acoustic Research AR1 was a *small* loudspeaker system having essentially flat low-frequency response down into the 40-Hz region. Other manufacturers

were quick to point out that the AR1 gobbled up about 10 times the electrical power needed by larger, more efficient systems. With 40- and 50-watt amplifiers becoming available, this turned out not to be a major drawback, and the trend toward smaller, less-efficient home loudspeaker systems was firmly established.

Today we can choose from a variety of mini-loudspeakers that are only about one-tenth as efficient as the original Acoustic Research model. Small acoustic suspension systems coexist peacefully with small vented systems. But the Klipschorn retains its title as the smallest practical low-frequency horn. As Paul Klipsch is fond of saying, no one has yet figured out how to miniaturize a 32-foot wavelength.

At this point, I would like to describe a few of the more fanciful loudspeaker designs that have been patented but somehow failed to impress the fickle public.

Omnidirectional radiation is a performance goal sought by many designers. A popular design approach in Europe seems to be what I call the barrel stave loudspeaker. Figure 2 illustrates a recent example. The method of operation can be understood by visualizing what happens if you squeeze a football between its tips. For all I know, such a mechanism can be made into an acceptable loudspeaker, but no commercial version has been marketed in the United States.

The compulsion to turn a simple vented enclosure into something much more complicated has already been mentioned. A review of loudspeaker patents reveals multiple chambers, flexible walls, F-slots, slits, "laminar

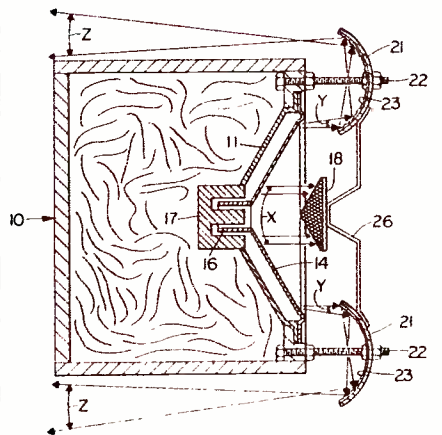


Fig. 5—A patented system for separating out distortion products and directing only pure sound to the listener.

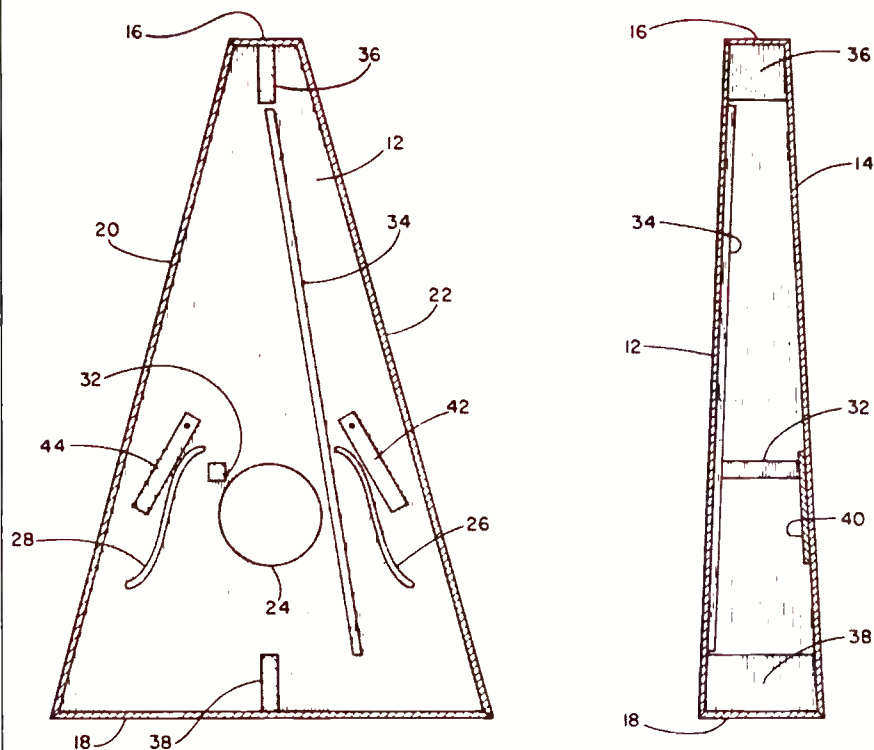


Fig. 6—This loudspeaker enclosure looks like a musical instrument.

flow vents," "Venturi-effect" ducts, and adjustable valves, among other variants (see Fig. 3). Such patents usually start out with an overview of the state of the art, but often what is actually revealed is a profound ignorance of how vented boxes really work.

The phase-inverting property of a vented speaker enclosure seems especially hard to grasp. One inventor, upset by both the "varying back pressure" and the necessity for resonance in a conventional vented system, relieved the backwave by mounting a second, downward-firing loudspeaker in the bottom of the cabinet and connecting it in opposing polarity. Sound waves from the second speaker were then redirected forward off the face of a 45° reflector to invert their phase. One just cannot argue with logic like that.

Another design that uses a second loudspeaker to relieve back pressure is shown in Fig. 4. The right loudspeaker, with its own rear chamber, acts to provide a constant back volume for the main speaker ... a sort of electro-acoustic bootstrap circuit. The interesting thing about this idea is that, with proper design, it can be made to work. A complete analysis is found in Chapter 6 of the 1957 edition of Olson's *Acoustical Engineering* [11], published about 10 years before the patent in question was issued.

Yet another obsession of many ama-

teur loudspeaker designers is the Jekyll-Hyde theory of speaker operation. If one could just identify the parts of a speaker cone that generate distortion and somehow render them impotent, one would be left with a perfect sound transducer. A most intriguing design is illustrated in Fig. 5. This section view shows conventional loudspeaker 17 mounted on the back panel of sealed box 10. Distortion products X are generated near the apex of the cone and soaked up by absorber 18. Undistorted waves Y from the perimeter of the cone are redirected into the listening area by what appear to be thrust reversers 23. Resulting sound Z is therefore a true replica of the original electrical signal. Of course, one of the most popular approaches taken by wishful wizards is the musical instrument analogy. Loudspeaker enclosures are designed to simulate the shape and sound of harps, chimes, kettledrums, organs, and bass viols, as in Fig. 6.

A number of years ago, my friend Antony Doschek became upset by the number of loudspeaker-enclosure designers who purported to have discovered the secrets of Stradivari and applied them to the art of loudspeaker cabinetry. Being wise in the ways of violin design, Doschek wondered what would happen if someone who really knew something about the subject built a speaker enclosure of multi-resonant plates, and proceeded to do so. The

resulting system sounded so good that many listeners refused to believe they were hearing a highly resonant device. To demonstrate that his loudspeaker enclosure in fact behaved as a respectable musical instrument, Doschek attached the neck, bridge and strings from a bass viol and actually played the hybrid creation at a local meeting of the Catgut Acoustical Society.

This overview of consumer loudspeaker history has necessarily omitted more interesting designs than it has described. I hope that it has given an insight into the rapid changes and proliferation of new ideas that characterized consumer loudspeaker development in the 1950s. We shall not again see such a profusion of approaches to supposedly accurate sound reproduction. But the perfect loudspeaker remains a challenge, and the theorists, tinkers, and wishful wizards continue to pursue that dream. Δ

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DIRECT METAL

Creation of the DMM "mother" by cutting the signal into the copper-covered blank is the first step in this new process.



MASTERING— A New Art In LP Records

B. V. PISHA AND GEORGE ALEXANDROVICH

On the evening of November 2, 1920, radio station KDKA in East Pittsburgh, Pa. broadcast to a tiny but eager national audience the results of the Harding/Cox presidential election. That is the date given in history books as the official birthday of commercial radio broadcasting. As other stations followed suit with national hookups, the word was that the phonograph record, a mere 43-year-old, had not long to live. Why listen to "canned" music on phonograph records when you could hear live orchestras playing from hotel ballrooms, symphony orchestras performing in concert halls, and operatic personalities singing from famous opera venues? Despite these divinations, the phonograph record endured, and in fact it became even more popular as a direct consequence of radio broadcasting.

Introduction of the monophonic reel-to-reel tape recorder in the American marketplace back in the late 1940s, and its growing popularity in the '50s as a stereo sound format, sparked another flurry of predictions that the phonograph record was doomed. But those predictions turned out to be similarly incorrect.

Enter North American Philips to spread the gospel of the audio cassette, at first in a mono format which evolved into stereo. Following improvements in blank-tape technology and the advent of Ray Dolby's consumer noise-reduction system, the cassette moved up the scale to establish itself as a true high-fidelity medium. Recently, just a couple of years ago, sales of prerecorded cassettes topped those of LP records. Rumors again flowed rampant and the doomsayers had another field day, proclaiming that the phonograph record was heading for the graveyard. Not so!

Comes the digital Compact Disc with all its technological bravura, and the rumors are *again* flying that the phonograph record is about to die. (We amend that; people are saying the *analog* phonograph record is about to die.) But as Bing Crosby crooned in his days with Paul Whiteman (on Columbia picture record 1444-D), "'Tain't So, Honey, 'Tain't So."

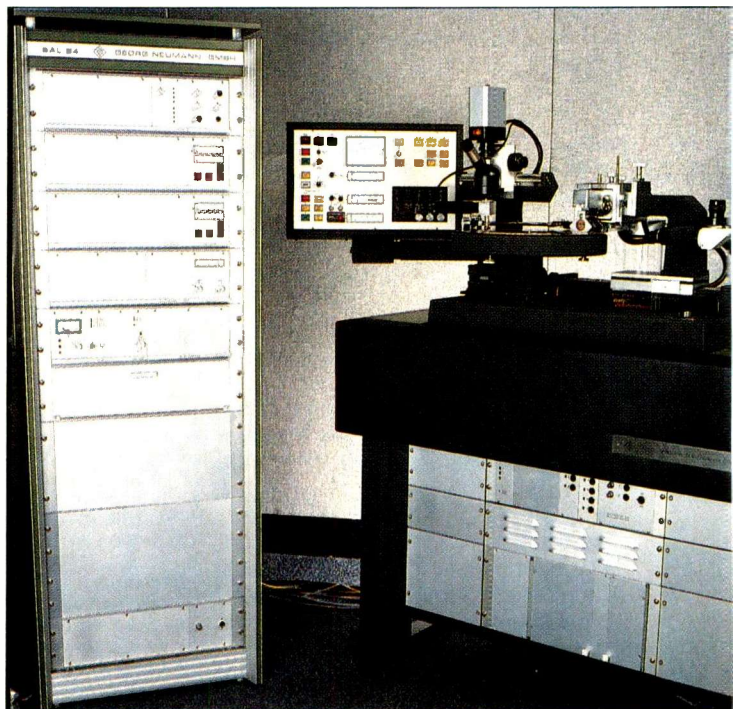
During this half-century plus, the makers of phonograph records were not sleeping. They moved from the Acoustical Era, with its 78-rpm shellacs (actual speeds ranged from 67.92 to 87.80 rpm), to the Electrical Era, then into the Vinyl Mono LP Era, then the Stereo LP Era. Then came the Direct-to-Disc Era (a new version of the old direct-to-disc recording approach that

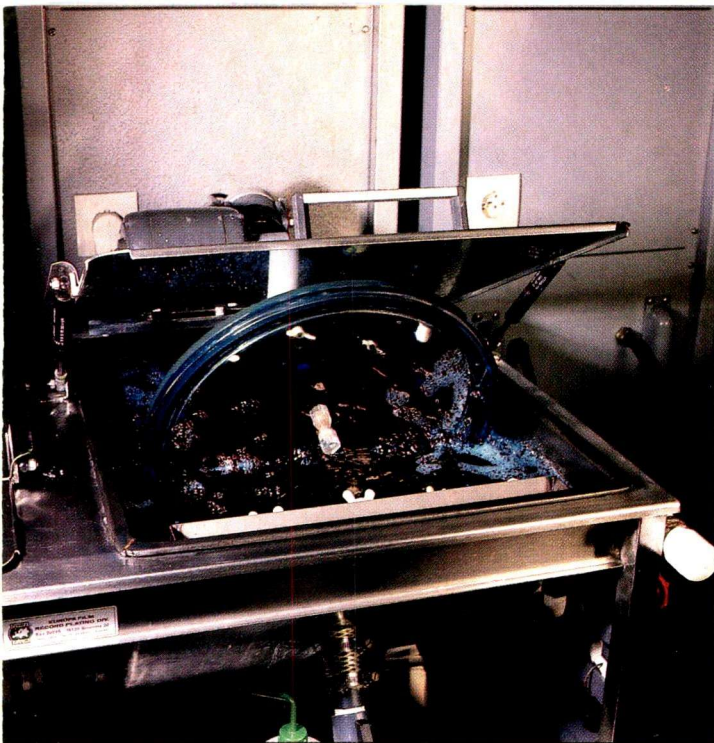
was used in the days of 78s) and finally the Digital/Analog Era.

Concurrently, during that half-century, audio equipment manufacturers were also not sleeping. R&D labs kept busy, designing better record-playing equipment—namely automatic changers, then better turntables and tone-arms, and along the way, better cartridges. Manufacturers stopped producing steel and cactus phonograph "needles," replacing them with sapphire-tipped styli. These evolved into models with multi-faceted diamond tips, some costing hundreds of dollars.

And now, we predict—with perhaps a trace of trepidation in our temerity—that *the analog record will survive! Away with ye, doomsayers!* What is the basis for such defiance of the estab-

The equipment used in the DMM system includes a Neumann VMS 82 lathe with an SX 82 cutterhead, TV groove monitor, SAL 84 cutting amps, and a computer to control the variable pitch and depth.





Europadisk does both cutting of masters and plating in near clean-room conditions, which keeps possible contamination of the record groove down to the minimum.

- Faster stamper production (as a consequence of bypassing two plating steps).

In effect, DMM is analog gone state-of-the-art, or the highest form of analog phono record. While DMM technology is not perfect—and neither is CD technology at its highest point yet—DMM records can be said to be at the same level as CDs in terms of their ascendancy toward the goal of perfect sound reproduction.

Just as some golden-ear audiophiles continue to tout vacuum-tube equipment, so too are many golden-ears claiming that analog LPs sound far more natural than CDs, despite all the attributes of the CD format. Do DMM LPs live up to the claims made by the recording fraternity? We say yes—with an exclamation point. If anything, we feel that the claims for DMM are somewhat understated.

On comparing DMM discs with traditionally produced records, we first no-

Photographs: Robert Lewis

lishment? A simple acronym—DMM. DMM stands for Direct Metal Mastering (or Direct Metal Master), a technology introduced in 1981 that effectively moves the analog phonograph record into a new era. First came tinfoil (circa 1877) as the mastering material, then beeswax shortly thereafter, then shellac somewhat later, then finally lacquer (acetate). DMM technology moves the phonograph record into the Copper Master Era.

That in itself might not seem like an important change, but its significance lies in what copper mastering means to the listener/consumer. According to Europadisk, Ltd., the first DMM licensee in the United States, DMM leads to finished phonograph records which have:

- Up to 15% more playing time (as much as 40 minutes total per side);
- Substantially reduced noise and distortion (10 dB less over the entire frequency range). The signal-to-noise ratio is typically 75 dB;
- Noticeably improved high-frequency and transient response;
- Improved groove depth and spacing between grooves, to prevent stylus "skipping";
- A marked increase in stereo separation, particularly in the low frequencies (e.g., greater than 20 dB at 100 Hz and below); and
- Cleaner, tighter bass response.

Additionally, it provides these benefits at no increase in price. (The retail cost differential between analog and CD continues to be in favor of analog, even when DMM is used.)

To the recording fraternity, says Europadisk, DMM means:

- Elimination of lacquer-related problems such as swishes, echo, tickiness, and other sound blemishes;

- No cutting "horns";
- No lacquer-plating or lacquer-aging problems;
- Virtual elimination of the need for recuts; and

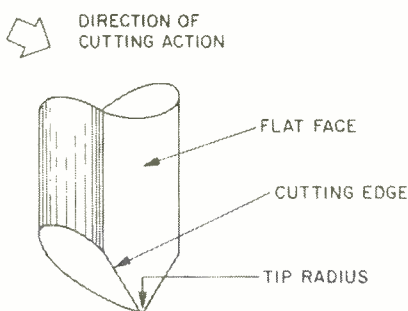


Fig. 1—Cutting stylus for Direct Metal Mastering.

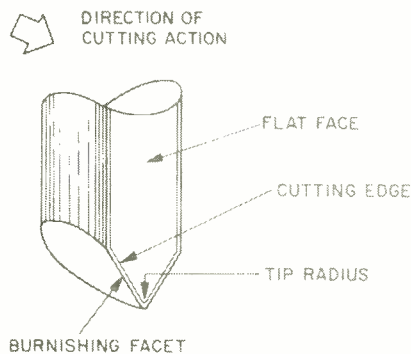


Fig. 2—Cutting stylus for conventional lacquer mastering.

Table 1—Performance data for playback of DMM masters, measured by Teldec, using a Shure V15 Type V pickup.

Frequency Response: 20 Hz to 20 kHz, ± 1 dB, over entire cutting radius from outer rim to innermost allowable modulation diameter. No losses up to wavelengths of 10 μm
FIM (DIN 45511): Less than 0.3% (315 Hz/3.15 kHz, 4:1) for 5 cm/S peak recorded velocity, re: RIAA equalization for 1 kHz. (Note: Distortion is for single-channel recordings at 11-inch/280-mm recording diameter; distortion will be higher for playback at smaller diameters.)
THD (DIN 45503): Less than 0.5% for 5 cm/S peak recorded velocity at 1 kHz. (See note above.)
Twin-Tone IM (DIN 45503, IEC 268): Less than 0.1% for 1,000 and 1,200 Hz at 5 cm/S peak recorded velocity. (See note above.)
S/N: Greater than 70 dB (typically 75 dB), A-weighted (per DIN 45633, IEC 179), re: 10 cm/S peak recorded velocity. See Figs. 3A and 3B for spectral distribution.
Groove Echo Attenuation: Greater than 65 dB for 10 μm land between grooves and greater than 75 dB for 150 μm land, re: 8 cm/S peak recorded velocity at 1 kHz, single channel.
Recording Losses for Small Wavelengths: See Figs. 5 and 6.
Transient Response: See Figs. 7A and 7B.

ticed the extreme quiet in the lead-in grooves and during pianissimo passages. The minimal remaining noise is totally free of annoying ticks and pops. Additionally, there are no pre- or post-echoes on DMM discs, such as can be heard on traditionally mastered LPs. The suppression of groove deformation noticeably improves the impulse response, so that instruments rich in harmonics remain free of coloration even at high levels. Frequency response ranges from 2 Hz to 23 kHz—with extremely little roll-off. (For readers interested in DMM's more technical details, the data presented in Table I were provided by Teldec.)

About the only negative comment we can make is that occasionally one will hear a slight "edge" or "sizzle" in high-frequency sounds (the same sort that one hears, *but more often*, on early Compact Discs). This anomaly is easy to put up with, since it generally occurs for only brief periods in most music. While CDs are superior in their dynamic range, which can go up to 90 dB, the DMMs provide an easily accepted 75 dB (versus less than 60 dB for "old" analog-type records derived from lacquers). It is conceivable that DMM can go a bit farther in dynamic range as more and more companies get involved with it and put their collective minds to extending that range. In the meantime, many music lovers who have been able to make direct comparisons between DMM analog and CD versions of favorite works frequently prefer the DMM analog version.

The DMM process was developed, under the aegis of technical director Dr. Horst Redlich, by Telefunken-Decca Schallplatten GmbH (Teldec) of West Germany, in conjunction with Georg Neumann GmbH, the latter owned 25% by Teldec.

The DMM process is based upon Teldec's pioneering work, done in connection with their videodisc research, to develop a copper deposition, on a stainless-steel substrate, that would be suitable for cutting. The TED disc, introduced by Teldec in 1976, was the first commercial videodisc, and it used the DMM manufacturing process.

Since the initial development of the DMM process, continued research has brought further improvements. In order to meet the requirements for analog

Separation of the plated stamper from the metal master reveals the surface which will actually do the work.

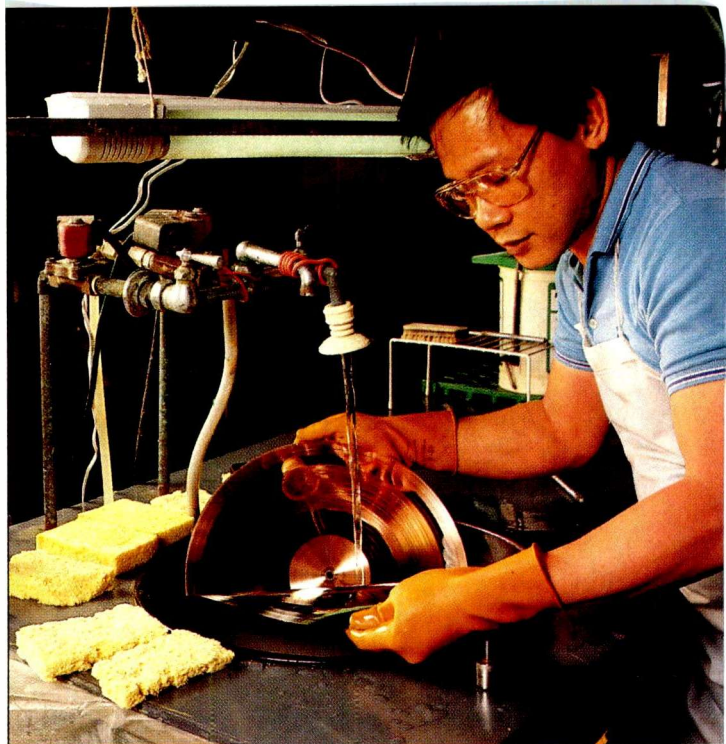


Fig. 3—Noise spectrum of unmodulated groove of a DMM mother (0 dB = 10 cm/s).

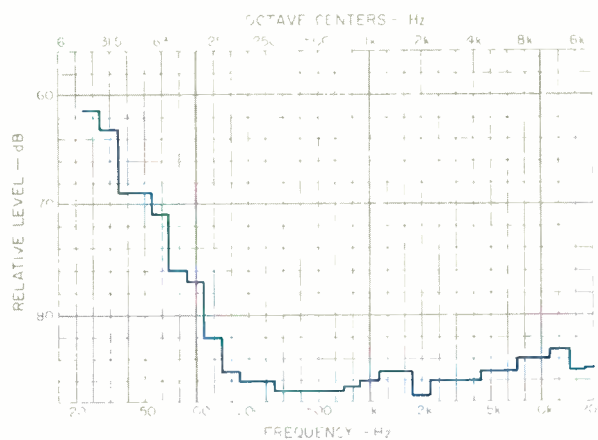
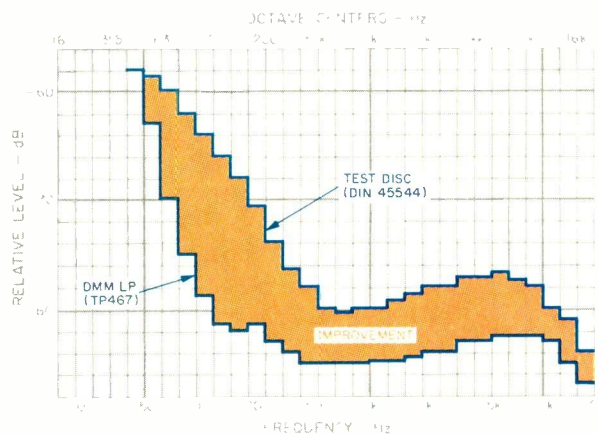
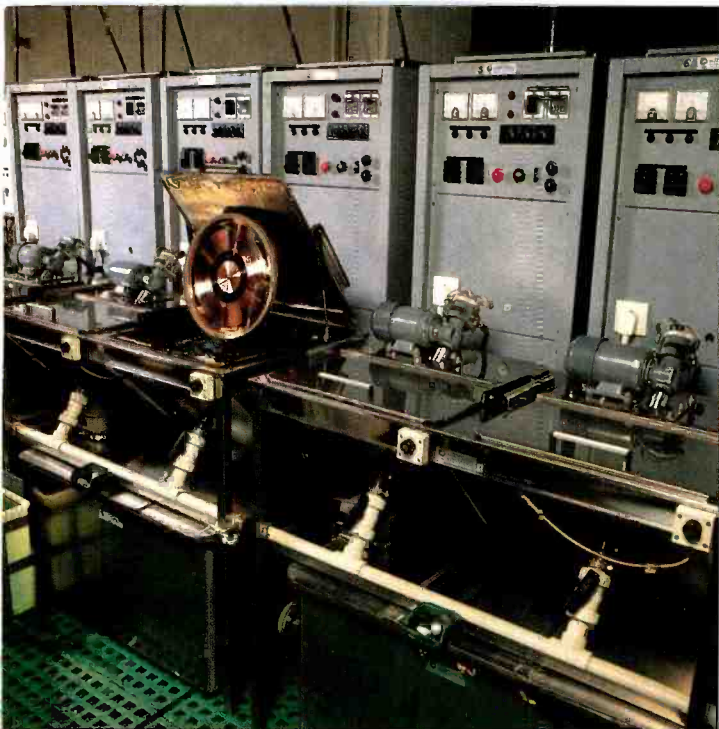


Fig. 4—Comparative noise spectra of test discs cut from lacquer master (top curve) and DMM master (bottom curve).



audio LPs, an improved copper was introduced. This "Type 2" copper, yielding a signal-to-noise ratio in excess of 70 dB for a 40-micron groove, has been adequate for most types of programs. However, for certain difficult programs (containing large amounts of out-of-phase, low-frequency information) it was desirable to make further

refinements, and so an improved copper per deposit was developed which yielded signal-to-noise in excess of 75 dB. An additional advantage has been an increase in the uncut masters' shelf life (recrystallization time) from several weeks to many months. (This is not a concern once the master has been cut.) Europadisk will now produce both



Europadisk is also licensed to produce the blank copper masters in addition to doing the cutting, plating and pressing.

"Type 2" and "Special" copper carriers. "Special" carriers will be more expensive than "Type 2" because of an increase in plating time and greater expense in maintaining the electroforming bath in which the copper is deposited.

Since the introduction of DMM, at least 40 record producers around the world have begun to use DMM-equipped lathes. While DMM is only a

recent "happening" in the U.S. (where there are more than 20 companies in DMM production, and others about to start), well over 100 million records pressed from DMM masters have been sold worldwide. (Teldec's DMM equipment is imported and distributed in the U.S. and Canada via Gotham Audio of New York City.)

Because the DMM processing system differs markedly from that of lac-

quer-master processing, and the resultant "family relationship" nomenclature is also different, a delineation of those differences is in order.

It is possible to produce only a single negative (the master mold or "father") from each cut lacquer master. Since a large number of pressing stampers are needed for producing the records themselves, this master mold must, in turn, provide several "mothers" (positive, playable metal parts), which then create the "sons" (pressing stampers/negatives). The record which is sold is therefore actually the "granddaughter" of the lacquer original. A cut copper master, on the other hand, can create numerous "fathers" which may be used directly as the pressing stampers. The purchased DMM record is then a "daughter" of the DMM original. This shorter path not only speeds the process up, but precludes quality deterioration.

To permit the previously mentioned "father" to be made from a lacquer, its surface must be made conductive and this process must not alter the modu-

DMM FOR CDs TOO!

LEONARD FELDMAN

Although CD players are in ample supply (some say oversupply), CDs themselves have not kept pace with demand. This accounts, in part, for the fact that prices of CD players have plummeted faster than anyone would have predicted a few years ago, but prices of discs have gone down only marginally or not at all.

Among other things, one prerequisite for more economical manufacturing of Compact Discs would be the economical production of masters and stampers for pressing them. To date, laser recording technology has been the only method available for manufacturing CD masters. This technology makes use of a photoresist method derived from semiconduc-

tor manufacturing techniques. Although this technology lends itself to recording and subsequent molding of the kind of signal that is read by laser-beam pickups, it is extremely expensive. In fact, it has been estimated that the investment a record company has to make to produce CDs is 10 times greater than that for an equivalent installation to produce vinyl analog records. Part of the increased cost is because all major manufacturing steps must be performed in a clean-room environment. Furthermore, the personnel working in most disc-cutting facilities and pressing plants don't have the background or experience needed for this type of technology. Therefore, CD mastering is presently performed in comparatively few locations around the world.

Given these facts, it is not surprising that the most exciting development at the last AES convention was Teldec's announcement that they had extended their system of Direct Metal Mastering (DMM) so that it could be applied to Compact Discs, just as it has been applied to analog LP production, to the earlier Telefunken videodisc, and, more recently, to the

RCA SelectaVision videodisc. In short, as Bert Whyte reported in "Behind the Scenes" in February, the Teldec DMM method makes it possible to record information on a CD master in much the same way as it is done on an analog record master—by mechanical means, employing a piezoelectric transducer with a bandwidth of several MHz.

Conventional Disc-Mastering Techniques

In order to understand the new Teldec DMM system, it will be helpful to review some of the more common methods used to mechanically cut the vertical modulations on analog master discs. (We'll ignore how the analog masters' lateral modulations are cut, since CDs have no lateral component.) Figures B1, B2, and B3 illustrate three different principles. In Fig. B1, the cutterhead is fastened to an arm which moves the head across the disc; this arm is also pivoted vertically, permitting it to follow variations in the height of the disc surface. Pressure is applied to the head. While cutting a stereo groove, the pressure is varied by the signal so that the groove's depth is proportional to the signal's amplitude. This will prevent the stylus from rising out of the groove when heavy vertical modulation increases its vertical travel in relation to the cutterhead.

Editor's Note: We are indebted to the Audio Engineering Society, Messrs. Horst Redlich and Guenter Joschko, and to Teldec for allowing us to quote extensively from their preprint (No. 2372) from the 81st AES Convention.—E.P.

lated grooves. The conductive surface (of silver) must be extremely thin and must not attack the lacquer surface. Furthermore, the silver molecules must be evenly applied to minimize the creation of impulse-type interference, which can no longer be corrected. Nickel is plated onto the silver surface, and this can seriously deform the grooves in the lacquer through mechanical stress. Therefore, the mastering engineer must make the groove walls thicker than really necessary because of the instability of the lacquer coating, on the one hand, and the danger of deformation resulting from the nickel-plating process on the other. This reduces playing time. But despite this precaution, pre- and post-echoes are still audible in classical records.

The metal cutting surface of DMM avoids all of these disadvantages. For the tape-to-disc cutting room, DMM provides a distinct advantage: The 20% rejection rate which has been traditional in lacquer cutting and subsequent plating is reduced to less than 2% with DMM. Further, the 10 to 20%

Table II—Standard data of DMM technology.

Maximum Recording Level:	As for lacquer cutting.
Maximum Groove Width During Modulation:	180 μm .
Cutting Stylus Utilization Period:	20 LP sides per repolishing.
Cutting Stylus Life Time:	50 repolishings, minimum.
Storage Time of Copper Blanks Before Recording:	3 months.
Storage Time of Copper Master After Recording:	No limit.
Number of Stampers by Direct Matrix:	20, minimum.
Number of Stampers by Three-Step Plating:	Equivalent to standard processing.
Groove Integrity:	High, due to fact that formation of "horns" is completely avoided.

rejection rate in choosing lacquer discs *suitable* for cutting is bypassed.

The overall DMM system is a complex one, involving many interrelationships among chemical, thermal, electrical, electronic, and mechanical processes as well as human judgment factors. We'll attempt to delineate them by recounting what we learned during a trip through the facilities of Europadisk, in downtown Manhattan. Our guide was James P. Shelton, the company's president. (For additional details, see Table II, provided by Teldec.)

Before the tour got underway, we were told that Europadisk is, in effect,

a "one-stop" operation in that it is licensed for all DMM processes—mastering, plating, and pressing, as well as the production of master discs (copper blanks) for use by Europadisk and other DMM licensees. In fact, Europadisk is the only source in the U.S. and Canada for the copper master-disc blanks. (Of course, they can also be bought directly from Teldec.) To earn the right to place the DMM logo on a record album, a record company must have all the DMM work done by licensees, such as Europadisk.

The first thing that Shelton pointed out was the "clean-room" ambience

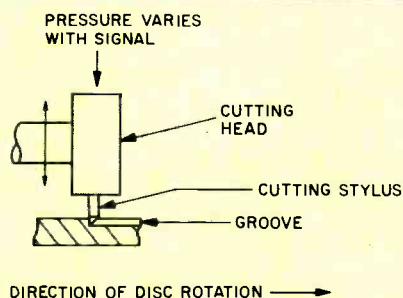


Fig. B1—In this analog disc-cutting system, groove depth is controlled by pressure applied to the cutterhead.

Figure B2 shows an older arrangement. Here, the pressure is applied so that an adjustable support (the "advance ball") rests on the surface of the blank disc. The cutterhead follows the medium's surface, and the groove depth is determined by the support's height relative to the adjacent cutting stylus; vertical adjustment for groove amplitude is accomplished within the cutterhead. This method and the one described above are used primarily for recording phonograph discs.

Figure B3 shows a cutting system for high-density storage, such as videodisc recording; it was used to cut grooves only 0.1 μm deep for the Teldec and RCA

videodisc systems. In contrast to the other two arrangements, the cutterhead is held at a fixed height. Since this prevents the disc's surface from following motions of the disc's surface, its height is set so that the tip of the cutting stylus will always be below that surface. Thus, more material than necessary is removed in the cutting process, generating an entirely new surface. Here, the groove depth depends only on the height of the cutterhead; the groove width depends upon the groove depth and the included angle of the bottom facets of the cutting stylus tip. While this method allows very high precision, it is applicable only if the distance between grooves is constant

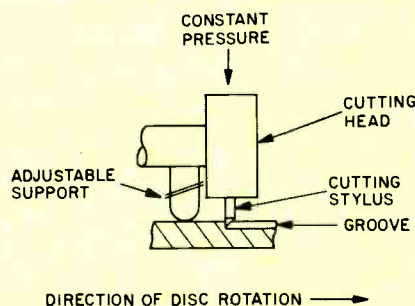


Fig. B2—In the "advance-ball" method, groove depth is controlled by the height of the adjustable support.

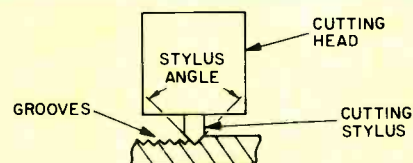


Fig. B3—In this system, used for videodiscs and other high-density recordings, the cutting head is set at a constant height; the stylus cuts away the original disc surface to create an entirely new surface.

and if no "land" is required between adjacent groove segments. Neither of these requirements is met by the CD format.

Mastering the Pits

The pits on a CD can be thought of as constituting a spiral groove which is interrupted according to the digital data stream applied. In other words, it consists of very short groove segments of different lengths. At first glance, one might think that the arrangement of Fig. B2 could be modified for this type of recording. That is, the difference in height between the support and the cutting tip could be adjusted so that the cutter would dig into the surface when a pit was required and lift off the surface when a land or absence of pit was called for. Unfortunately, because of

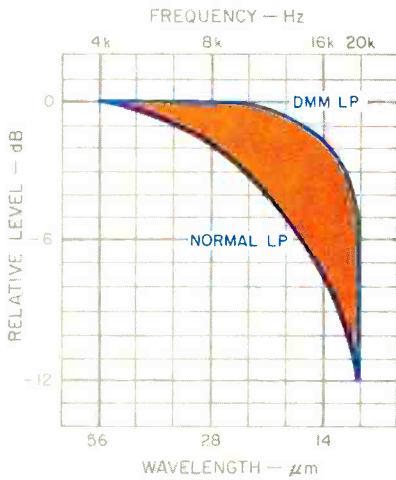


Fig. 5—Comparison of frequency response for small wavelengths on LPs pressed by Teldec from lacquer and DMM masters, at 130-mm groove diameter, using Shure V15 Type V cartridge.

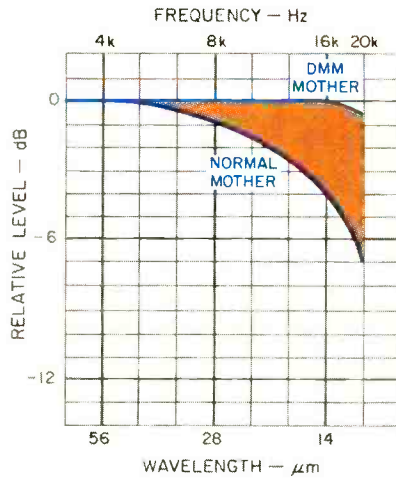


Fig. 6—Same as Fig. 5 but for playback of DMM and normal (lacquer) mothers.

typical of well-run establishments producing high-tech products. "It's only natural," he stated. "If you've seen the clean-room surroundings where digital Compact Discs are produced, and if you want to compete with the CD people, you should be as good as they are in terms of your own production facilities or even better. Maintaining a clean operation means that the possibility of record-groove contamination in cutting, plating, or pressing is almost eliminated."

The main area that we visited was the cutting room, where the required equipment was housed. It included a Neumann VMS 82 cutting lathe with an SX 84 cutterhead, a TV monitor for viewing the cut groove, SAL 84 cutting amplifiers, and a variable pitch and depth computer. Some DMM licensees utilize VMS 80 cutting lathes, which can be upgraded, if desired, to VMS 82 equivalents.

The SAL 84 amplifier drive system used for DMM is completely free of transformers. The frequency response of the system extends to 2 Hz on the

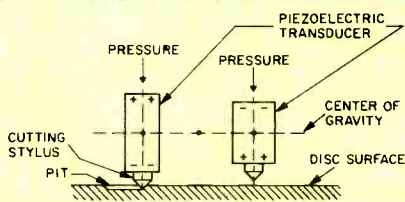


Fig. B4—In the DMM system, the expansion and contraction of a piezoelectric transducer raises and lowers the cutting stylus rapidly, creating pits in a CD master.

the microscopic dimensions of the pits involved in the CD format, it is a practical impossibility for the support to follow variations of the disc exactly without causing damage to the surface structure.

Figure B4 illustrates a possible solution to the problem. A piezoelectric transducer has a cutting stylus attached to it. When a positive potential is applied to the upper electrode and a negative potential is applied to the lower electrode, the piezoelectric element expands (as shown at the left). Conversely, with reverse potentials applied, the piezoelectric element contracts (as shown at the right). The force needed to produce this dimensional change is very great and is generated by an electrical field. The assembly rests on

the disc, and the cutting stylus enters into its surface due to gravity. The gravitational force required to cut sufficiently deep into the surface of the disc is very small. Since the piezoelectric element contracts more rapidly than gravity can shift the cutting stylus, the stylus lifts off the disc temporarily. The pulses are so short that the stylus does not have time to fall to the disc's surface during a negative pulse. Instead, it cuts into the disc during a positive pulse, generating the desired pattern of pits in the master.

Of course, the piezoelectric element can't be suspended in midair and held at its center of gravity, so a support (shown in Fig. B5) was developed. The transduc-

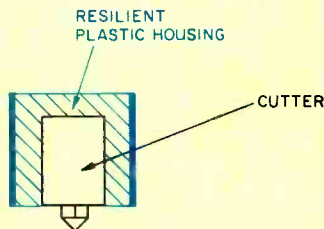


Fig. B5—A resilient plastic housing holds the piezoelectric transducer in position while accommodating the transducer's changes of shape.

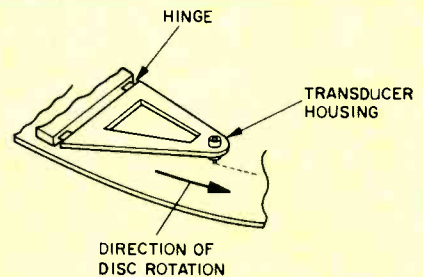


Fig. B6—A DMM cutter assembly for Compact Discs, showing the transducer housing and floating support.

er element is embedded in a plastic material which is soft enough at the operating frequency of the transducer to permit the expansion and contraction described. Effectively, this plastic structure provides a "floating" support. The complete assembly takes the form shown in Fig. B6. The floating transducer is mounted in a triangular bracket which is secured on one side and is free to move in a vertical direction. The tip rests with some of its weight on the disc. Dynamic parameters of the assembly are carefully sized so that the housing of the floating transducer follows vertical changes in the surface of the disc over a range of several μm .

low end. This expansion of the frequency response by about two octaves (compared to the older lacquer system) is not meant for cutting signals in that portion of the spectrum but rather serves to linearize the phase response in the audio range, which lies quite a bit above this frequency. The practical result is significantly higher feedback at low frequency, thus improving the phase response and also improving crosstalk between channels. Phase shift at 20 Hz is less than 20°, and stereo separation at 100 Hz is greater than 30 dB. At the high end of the spectrum, the frequency response extends to 23 kHz, with a gentle roll-off above that.

Separation between channels below 100 Hz is also much better than lacquer, due to differences in the DMM lathe's electronic control system. The conventional cutterhead suspension, engineered to appear stiff at frequencies above 20 Hz, allows the cutterhead to float at frequencies below that point in order to follow variations in the surface of the master blank. Unfortu-

Here the stamper is being centerpunched for an accurate location on the pressing machine.



nately, this floating effect reduces channel separation at low frequencies. In DMM systems, special circuitry applies a counteracting depth-control force which is in proportion to the low-frequency signal amplitude. The result is that the cutter remains stiff for all audio signals, even below the suspension resonance point. This yields 20 dB of channel separation to 20 Hz and lower, which is far superior to conven-

tional lacquer cutting. In fact, the low-frequency stereo separation is one of the first things people notice about DMM masters.

DMM technology is centered on the ability of the Neumann cutting lathes to cut into a 4-mil-thick (100-micron) coating of amorphous copper layered onto a 300-mil stainless substrate, instead of the traditional aluminum-base/lacquer-coated disc. Shelton ex-

Embossing Rather Than Cutting

Using DMM to cut pits into the surface of the CD metal master creates a problem: The chips created by the cutting are too small to be vacuumed off the disc surface during cutting (as is done when cutting analog masters). Teldec therefore suggests embossing the signal pits into the surface of the master disc, rather than cutting them in. The diamond tool attached to the piezoelectric transducer is of a different shape for embossing than for cutting. Although pits generated by the embossing process create a different modulation of the reflected laser beam as received by the optical system during playback, the method fulfills the most important prerequisite for Direct Metal Mastering technology as applied to the Compact Disc, namely full compatibility with conventional CD players.

Making a DMM CD Master

Since a metal surface is used as the original recording medium, final pressing tools or stampers can be generated directly in a galvanic process without any intermediary steps. A round glass disc is prepared with a thin separation layer. A layer of copper approximately 300 nanometers thick is evaporated onto the disc. The pits are recorded onto this copper surface as previously described. Because

the pits are generated directly, it is possible to control them more accurately than is the case with the photoresist/laser cutting method used until now.


Once the copper layer is embossed with the required pit pattern, the copper surface is coated with a thin layer of precious metal. This metal package is then reinforced in a nickel bath until a thickness of about 0.25 mm is achieved. The metal package can now be used as a "father" (from which "mothers" and stampers will be produced) or, if the number of CDs required is not too large, the package can itself be used as a stamper, good for anywhere from 10,000 to 15,000 pieces. In the latter case, according to Manfred K. Atzert, managing director of Teldec, CD pressing can begin within about two hours after completion of the mastering process.

The thin separation layer on the glass disc allows the metal package to be removed easily from the glass, which can be used again. The recording itself is completely protected between the copper and precious-metal layers. This galvanic "sandwich" technique therefore provides an excellent and safe medium for storage and shipping.

The last step in the DMM-CD process is the release of the electroplate from the sandwich. Both the separation layer and

the copper layer consist of nonprecious metals, so it is fairly simple to remove them without damaging the precious-metal surface on the nickel backing. Then, using the metal backing as a "father," more "mother" and stamping tools can be manufactured using the same galvanic process.

Breaking the Cost Bottleneck

Teldec, in describing this new technique, cited five major benefits that accrue from the DMM-CD method. First, the expensive clean-room environment is not required when making a master recording. Accordingly, less physical space is needed for the mastering process. There are fewer production steps, and production is therefore more efficient. A faster turnaround is possible, which should help make the number of CD titles equal to the number available in black vinyl in a shorter time period. Finally, the entire process is easier to handle. It all adds up to a lower investment for the software makers. So if you have been holding off on the purchase of a CD player because of unavailability of your favorite records in CD format, you won't have this excuse to fall back on for quite as long as you may have supposed. All of which bodes well for the future of audio, graphics, video, and text data storage in the CD format. 



The last step before mounting the stamper in the record press is to form its shape so that the proper record profile will then be pressed.

ton, "The deviation from the usual value of the vertical tracking angle is corrected by means of an electronic delay equalizer that is part of the system's electronics. It is called a Vertical Tracking Angle Converter, and it provides the correct playback angle for a typical phono cartridge through time delays."

Shelton went on to explain that there is a marked difference between the styli and between the procedures used in cutting lacquer masters and DMM masters. "In creating a lacquer master, the sapphire cutting stylus must be heated to reduce hiss noise during cutting. The recording engineer must strike a compromise between too little and too much heat. Too little increases noise, while too much erases the highest frequencies as they are cut and generates 'horns' [crests on the groove edges]. Horns degrade the quality and complicate the production of stampers, and create molding problems at the record press that lead to waste and higher production costs."

Styli designed for lacquer cutting incorporate burnishing facets which smooth the groove wall for a quiet cut (Fig. 2) but also erase and distort high-frequency content on inner diameters.

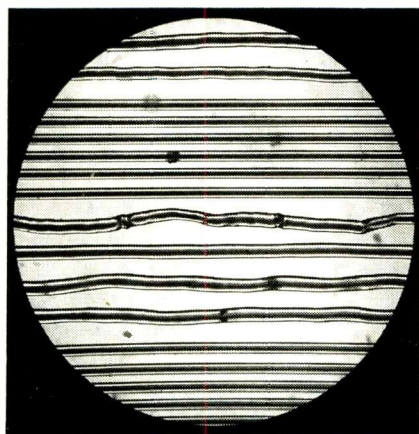
By employing copper material, eliminating cutting-stylus burnishing facets and doing away with stylus heating, the DMM process avoids the horns that can cause the clicks common to lacquer mastering. This simplifies both plating and pressing of DMM product, since the costly and potentially degrading horn-removal treatments (polishing/buffing) used in lacquer master production can be bypassed.

Although copper as a mastering medium presents significant advantages, it also presents difficulties to the master-cutting lathe, Shelton observed. "Despite its apparent hardness, copper exhibits a viscous-like behavior in regard to cutting tools, tending to stick to them. Teldec has overcome these difficulties by imposing supersonic vibrations (mechanical chatter) in the 60- to 80-kHz range on the cutting stylus, which has a feather edge. The ultrasonic oscillations also ease the movement of the cutting stylus through the copper carrier. This action, similar in basic principle to ultrasonic cleaning, separates the copper chip residue

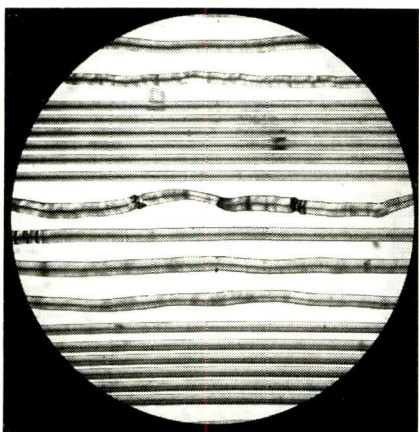
plained that cutting copper masters is substantially different from cutting those with a lacquer coating. The material is much harder and is five to 10 times more resistant to the cutting stylus than lacquer. "It would be impossible to cut a copper disc at 20° off perpendicular, the angle that is appropriate to lacquer mastering and which is the standard for playback tracking relative to consumer phono cartridges. The stylus would 'ride' the groove it was cutting, in effect not cutting deep enough. Therefore, Teldec designed the VMS 82 to cut a master at a near-0° angle—about 5°." This approach reduces the required cutting force to an adequate level so that the cutter needs only normal cutting-amp power. Essentially, the rotational force of the VMS 82 turntable is concentrated against the face of the cutting stylus, attempting to break it rather than to push it up and away from the master surface.

Helping to keep the rotational force within normal cutting-amp power limits is the shape of the new Teldec diamond cutting stylus (Fig. 1). This stylus has no burnishing facets and thus avoids the high-frequency amplitude losses that occur at the innermost grooves of LP records.

While a 5° cutting angle is employed, the IEC standard playback angle for consumer phono cartridges is 20°, and this must be factored into the DMM process. In addition, the grooves must be cut to meet that standard; otherwise, playback would be severely distorted. Teldec gets around this dilemma by adding a tracking-correction element to the cutting signal. Said Shel-



A



B

Fig. 7—Mothers from lacquer (A) and DMM (B) masters. Note rounding off of transients in (A) due to heating and burnishing facets required for lacquer masters. Sharper transients in (B) result from "feather edge" on DMM cutting stylus.

from the diamond cutting stylus and results in a smooth, gleaming, high-definition groove wall that guarantees a high signal-to-noise ratio."

It is important to note that while the DMM process is beneficial to performing artists and the listening public, it also holds important economic advantages for record manufacturers. In fact, several of the largest European pressing plants have converted completely to DMM and no longer accept lacquer masters. The economic benefits include the following:

- The expensive, complicated, and hard-to-control silvering and nickeling processes required for lacquer masters are completely eliminated. Savings in the plating process alone amount to between \$40 and \$60 per record side;

- The 20% rejection rate common in lacquer master production is reduced to less than 2%;

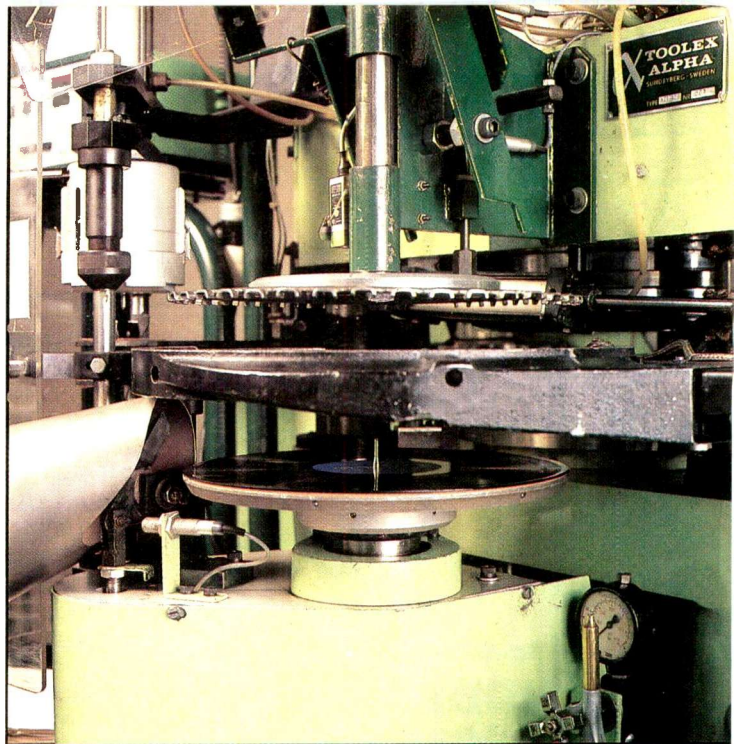
- Twenty or more stampers can be made directly from a DMM master, with no reduction in sound quality. Considering that an average stamper has a life of 1,500 pressings, the DMM process is particularly economical for releases of up to 30,000 LPs; and

- First pressings can be made in less than two hours after conclusion of the cutting process.

Shelton pointed out that, during the cutting stage, the Neumann VMS 82's computer translates the preview cutting signal into lateral and vertical (groove width and depth) signals for control of depth and pitch. This precise control increases the potential for additional grooves per record side. In operation, the computer is, in effect, sampling the preview signal and then storing, summing, and calculating the next groove position. Often the "land" space between grooves can be reduced remarkably, to a width of virtually zero, permitting recording times of up to 40 minutes per side. Additionally, since the cutting-depth corrections are necessary only for short, lateral signal bursts, the DMM system permits cuts with a smaller basic groove depth than in the lacquer mastering process, for better transient response and greater dynamic range.

Shelton said that an attribute of interest to record producers is that after DMM mastering and a protective pro-

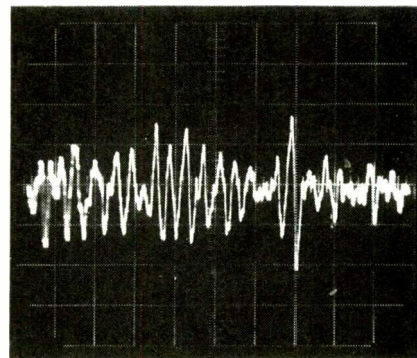
Actual pressings of standard LP discs can be out of the press in less than two hours following cutting of the DMM copper master.



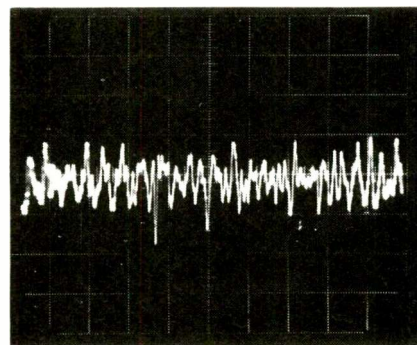
cess called "passivation," the cut-copper discs have a virtually unlimited shelf life because the amorphous copper surface returns to its original crystalline state. "On the other hand," he added, "the optimum time to plate a lacquer disc after cutting is more on the order of a few hours. Otherwise, high-end losses may occur, in addition to pre- and post-groove echo. If a lacquer master is not plated within one week, it may have degraded to such a point that it is not feasible to plate it."

In a parting comment, Shelton declared, "No matter how much time and care and effort you put into mastering—be it lacquer or state-of-the-art DMM copper—the ultimate record quality hinges in large part on the quality of vinyl used in the final stage. Here at Europadisk, for our 'Ultimate Audiophile' designation, we use at least 150 grams of virgin Teldec vinyl to make a dense, elegant pressing at least 30% heavier than ordinary records. It's equal or superior to any LP pressing made anywhere." The firm also offers two series weighing in at 130 grams, one called "Audiophile" and the other "Europa-Classical." Both use Teldec vinyl.

Notwithstanding all the recent gains in phonographic technology such as digital sound, DMM, and the Compact Disc, the audio industry has not been able to annihilate an old bugaboo that has plagued records since their advent, first as Edison cylinders, then as flat Berliner discs, et al. That bugaboo is none other than dirt and grime. Whether one opts for standard analog, DMM, or CD, there's no choice but to keep those discs *clean!* **A**



A



B

Fig. 8—Rumble recorded on a standard LP test record (A) and DMM test record (B). Records are DIN 45544 and DMM TP467, respectively.

1

TANDBERG TCA 3018A PREAMP AND TPA 3026A AMP

Manufacturer's Specifications Preamplifier

Frequency Response: Phono, RIAA ± 0.2 dB; high level, 20 Hz to 20 kHz, +0, -0.1 dB.

THD (20 Hz to 20 kHz): Phono, less than 0.009%; high level, less than 0.005%.

Input Sensitivity (For 0.5 V Output): MM phono, 1 mV; MC phono, 60 μ V; high level, 90 mV.

S/N (A-Weighted): MM phono, 78 dB; MC phono, 74 dB; high level, 90 dB.

Maximum Input Voltage: MM phono, 290 mV; MC phono, 14 mV; high level, 20 V.

Maximum Output Voltage: Main, 5 V at 0.006% THD, 10 V at clipping; tape, 7.5 V; headphone, 20 V unloaded.

Crosstalk: Less than -70 dB.

Separation (100 Hz to 10 kHz): Phono, greater than 53 dB; high level, greater than 58 dB.

Output Impedance: High level, 47 ohms; headphone, 150 ohms.

Minimum Headphone Load Impedance: 4 ohms.

Subsonic Filter: -3 dB at 15 Hz, 12 dB/octave.

Phase Shift, High-Level Inputs: $\pm 0.5^\circ$.

Power Requirements: 115/230 V a.c., $\pm 10\%$; 50/60 Hz; 55 watts.

Dimensions: 17 $\frac{1}{8}$ in. W \times 3 $\frac{1}{2}$ in. H \times 13 $\frac{3}{4}$ in. D (43.5 cm \times 8.9 cm \times 35 cm).

Weight: 12.5 lbs. (5.7 kg).

Price: \$1,695.

Power Amplifier

Power Output: 150 watts per channel, 20 Hz to 20 kHz, into 8-ohm loads; 210 watts per channel, 20 Hz to 20 kHz, into 4-ohm loads.

Rated THD: 0.05%.

S/N (A-Weighted): 94 dB re: 1 watt output; 115 dB re: rated output.

Frequency Response: 20 Hz to 20 kHz, +0, -0.1 dB; 0.07 Hz to 1.5 MHz, +0, -3.0 dB.

Input Sensitivity: 110 mV re: 1 watt output; 1.4 V re: rated output.

Output Impedance: Less than 0.01 ohm.

Wide-Band Damping Factor: Greater than 800.

SMPTE IM: Less than 0.05%.

IHF IM: Less than 0.05%.

Channel Separation: Greater than 80 dB.

Slew Rate: 240 V/ μ S.

Rise-Time: 0.4 μ S.

Pulse Power: 1,000 watts into 1-ohm load.

Power Requirements: 115/230 V a.c., $\pm 10\%$; 50/60 Hz; 110 to 830 watts.

Dimensions: 17 $\frac{1}{8}$ in. W \times 8 $\frac{11}{16}$ in. H \times 13 $\frac{3}{4}$ in. D (43.5 cm \times 22.1 cm \times 35 cm).

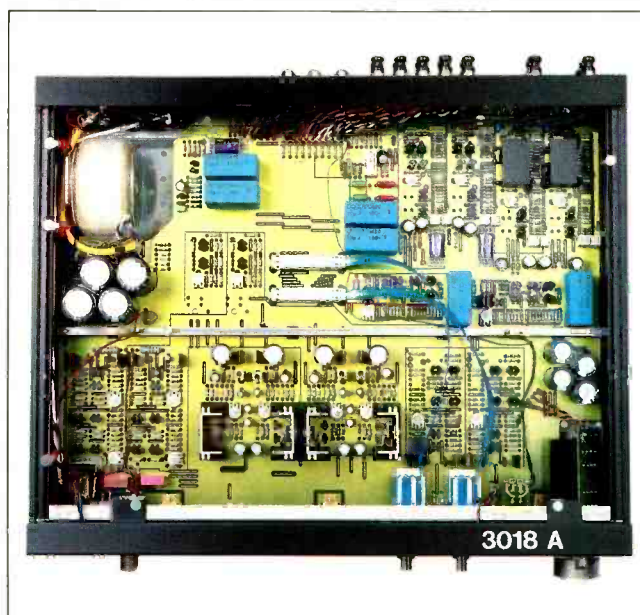
Weight: 30.4 lbs. (13.8 kg).

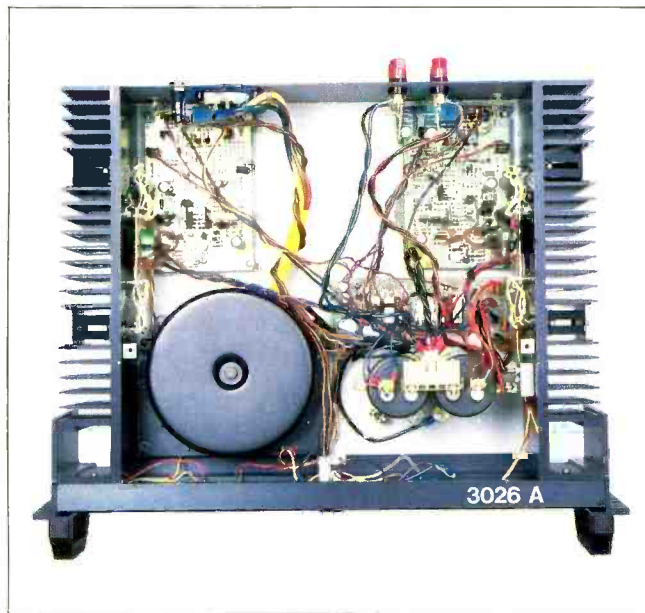
Price: \$1,695.

Company Address: Labriola Court, Armonk, N.Y. 10504.

For literature, circle No. 90

If you have \$3,000+ to spend on a separate preamplifier and power amplifier, I can't think of a better way for you to spend your money than to purchase these two Tandberg components. The Norway-based company that brought us one of the first truly high-quality open-reel tape decks for serious home recordists has come up with another couple of winners. Indeed, the TPA 3026A power amplifier is actually the "junior" member of the latest family of Tandberg amps. Its big brother, the TPA 3016A, produces a couple of dB more power, can deliver up to 50 amperes of continuous current per channel (100 amperes peak), and is able to drive 0.5-ohm loads! Considering that the more powerful 3016A has a price tag of \$3,295 all by itself, I'd be perfectly content with the combination I chose to test for this report, thank you. After all, 150 watts of power—especially the kind of clean power delivered by the TPA 3026A, with its high current capacity (more than 45 amperes per channel) and its total elimination of overall negative feedback loops—does not leave one feeling deprived. At that power level and with that current capacity, the need for *long-duration* dynamic headroom is not particularly important, which is why Tandberg chose to use a very tightly regulated power supply in this amplifier.





I'll get to the TCA 3018A preamplifier presently, but first let's have a look at the heart of this two-piece system, the TPA 3026A power amplifier.

Amplifier Circuitry and Control Layout

To understand why anyone would pay \$1,695 for a conservatively rated 150-watt-per-channel power amplifier, you need to understand the design philosophy behind the product. You also need to understand the new demands made upon a power amplifier by today's dynamic program sources and by some of the more popular loudspeakers currently favored by knowledgeable listeners. To begin with, the TPA 3026A, while rated at 150 watts per channel into 8 ohms and at 210 watts per channel into 4 ohms, can in fact produce short-term peaks of nearly 1,000 watts into 1 ohm. Speaker impedances, far from being constant, vary with frequency, and it is not uncommon for the impedance of some speakers to dip well below 4 ohms when reproducing specific tones or frequencies. When this happens, an amplifier must be able to supply high current levels if it is to deliver its rated power at such low impedances. The TPA 3026A has an impressive peak-current rating of 45 amperes per channel, and it is this enormous current capacity that

The amp's enormous current capacity allows it to play highly dynamic music on speakers with difficult impedances.

gives the amplifier the ability to play highly dynamic music on speakers with difficult impedance characteristics.

This kind of performance is made possible by the use of a tightly regulated power supply that has a toroidal transformer and large current-storing capacitors, and by the use of MOS-FET output devices whose operating characteristics obviate the need for signal-degrading protection circuits.

In terms of circuit design, the amplifier employs no negative feedback anywhere in the system. When only the static performance of amplifiers was measured, feedback was thought of as a distortion-reducing cure-all. However, excessive negative feedback has more recently been considered to produce subtle but nevertheless audible forms of

distortion when reproducing actual music signals. A proprietary circuit which Tandberg has dubbed a Thermic Servo Loop keeps speaker-damaging d.c. components from reaching the output terminals, without interfering with the actual audio signals.

The TPA 3026A is attractively finished in matte black with optional rosewood end panels or 19-inch rack-mounting adaptors. Heavy metal structures at each end of the chassis serve as heat-sinks. There are no user controls on the front panel other than a large rocker-type power switch; this is flanked on either side by left- and right-channel peak clipping indicators and thermal overload indicators. The clipping indicators glow when output levels exceed the amplifier's rating. The overload indicators illuminate when safe operating temperatures have been exceeded; when this occurs, a thermal switch disconnects the speaker terminals from the output stages. When safe, normal operating temperatures are restored, the output is automatically reconnected to the speakers.

On the rear panel, input jacks are located at the extreme left and right, and polarized speaker terminals are at the center. A fuse-holder containing an 8-ampere fuse is accessible from the rear, as are a line voltage switch and a connector for the separately supplied power cord.

Preamplifier Circuitry and Control Layout

Tandberg describes the chassis of the TCA 3018A as a "highly refined purist version of Tandberg's innovative and widely acclaimed TCA 3008A preamplifier." The TCA 3018A is a "direct path" preamplifier without tone controls. Discrete circuitry, including polypropylene capacitors and metal-film resistors, are used throughout. Like the TPA 3026A power amplifier, the TCA 3018A employs no negative feedback. Its high-level inputs use no capacitors in the signal path and have a signal headroom of 20 V before any evidence of overload. There are buffer stages between the high-level inputs and the volume control so that input signal sources see a constant load impedance regardless of master volume control settings.

Separate six-position "Record" and "Program" selector switches are provided, and bidirectional dubbing between two connected tape decks is possible. No negative feedback is used even in the phono preamplifier/equalizer section; instead, passive networks provide the required RIAA playback characteristics. Separate power-supply sections for right and left channels, each fed by a separate winding on the power transformer, are used to provide maximum interchannel isolation.

Tandberg has given special attention to this preamp's circuit-board design as well. Possible r.f. interference and audio noise levels are reduced to a bare minimum by a glass epoxy motherboard which is copper plated on its reverse side to form a ground plane for maximum shielding. Also, as you might expect, input and output jacks are all gold plated for long-term, low-resistance contact reliability.

The TCA 3018A is finished in matte black and is available with optional rosewood and black Lucite end panels. The front panel has a bare minimum of controls. The power on/off pushbutton is at the extreme left, with a headphone output jack and its associated volume control nearby. Large mas-

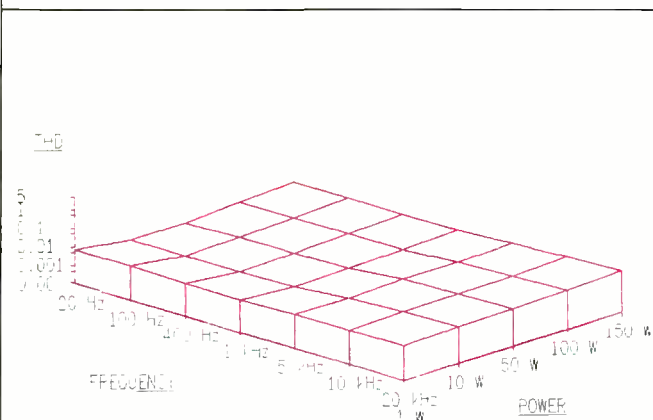


Fig. 1—THD vs. power and frequency, TPA 3026A amplifier driving 8-ohm load. THD scale is logarithmic.

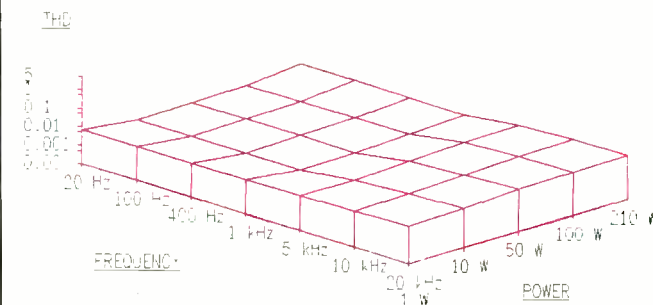


Fig. 2—Same as Fig. 1 but with 4-ohm load.



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AUDIO SYSTEMS

Tandberg has paid special attention to the preamp's circuit board, reducing r.f. interference and audio noise to a bare minimum.

ter volume and balance rotary controls are concentrically mounted at the extreme right of the panel. To their left is a subsonic filter on/off switch and the separate six-position selector switches for "Program" and "Record" modes.

Separate input jacks are provided on the rear panel for a moving-magnet and a moving-coil phono cartridge. Accordingly, if you own two turntables (one with an MM cartridge, the other with an MC pickup), it is possible to connect both to this control amplifier. Switching between the two types of cartridge is done by means of a rear-panel slide switch. The input impedance for the moving-coil cartridge is 50 ohms, while the input impedance for the moving-magnet cartridge is 47 kilohms, in parallel with either of two switch-

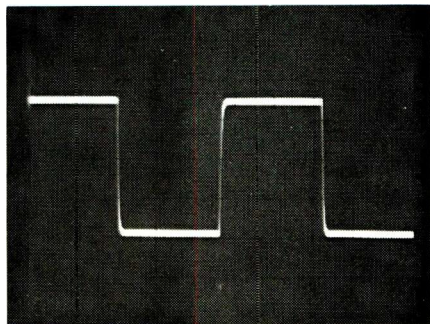


Fig. 3—Response to 20-kHz square wave, TPA 3026A amplifier.

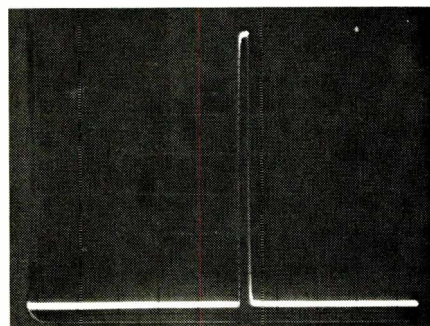


Fig. 4—Repeating pulse output into 2 ohms, TPA 3026A amplifier. Peak-to-peak amplitude of this 10- μ S pulse was 80 V!

selected capacitances (150 and 330 pF) or with no extra capacitance at all. Should you find it necessary to substitute other impedance values to match your cartridge, the owner's manual provides very explicit instructions on performing the required "minor surgery." If you are handy with a soldering iron and other tools of the electronic technician's trade, you can tackle the modifications yourself. Otherwise, Tandberg recommends that you have an authorized service shop do it. Tandberg's booklet even tells users how to short out the output coupling capacitor if your power amplifier has an input capacitor for d.c. isolation.

The remaining high-level inputs and two sets of tape outputs are neatly arranged across the rear panel. Tandberg still refers to the CD input as a DD (Digital Disc) input, but the intended purpose of these input jacks is clear. In a sense, I have always sort of wished that the rest of the industry had settled on "digital disc" instead of "Compact Disc," which doesn't really tell the most important part of the story to uninitiated music lovers. After all, the old 45-rpm records were also "compact."

Amplifier Measurements

The amplifier produced quite a bit more than its rated power when driving 8-ohm loads: 181 watts per channel at mid-frequencies and more than 170 watts per channel at 20 Hz and 20 kHz for its rated harmonic distortion of 0.05%. When connected to 4-ohm speaker loads, the amplifier delivered an impressively high 280 watts per channel, as against 210 watts claimed by Tandberg. At maximum power output, the TPA 3026A consumed in excess of 800 watts; when not delivering power to speakers, it consumed just over 100 watts.

Figures 1 and 2 show how harmonic distortion varied with frequency and output power level when the amplifier was driving 8- and 4-ohm loads, respectively. At rated power of 150 watts per channel into 8 ohms, distortion measured a negligible 0.006%, and SMPTE-IM and IHF-IM distortion were both under 0.03%.

Frequency response was absolutely flat within the audio range from 20 Hz to 20 kHz. I couldn't detect so much as one-tenth of a dB of variation! Of course, response extended way beyond the audible range—out to well over 1 MHz, in fact, for the -3 dB cutoff point. To appreciate just what this means in terms of rise-time and slew rate, look at Fig. 3. The input was a 20-kHz square wave; there is barely any curvature evident in the rising portion of that waveform. Or consider the output pulse shown in Fig. 4. The peak-to-peak amplitude of the pulse was around 80 V, and for this test the load resistance was reduced to 2 ohms. During the instant of time when the pulse was being reproduced, peak instantaneous current drawn from the amplifier was therefore 40 amperes per channel.

A-weighted signal-to-noise ratio, referred to 1 watt of output, measured an outstanding 95 dB, and input sensitivity for that same output level was 110 mV, exactly as specified. Translated to rated output, the noise level was -116 dB, and 1.4 V of input signal would be required to drive the amplifier to its rated output. Damping factor was probably well above the 500 which I measured, since my setup required several feet of 14-gauge wire between the amplifier

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and the loads. That bit of cable probably presented more of an impedance than the entire internal impedance of the amplifier. The high damping factor is all the more remarkable when you consider the fact that there is absolutely no negative feedback used in the TPA 3026A. Normally, high damping factors (which aid in suppressing extraneous speaker vibrations or "overhang") are achieved by using great amounts of negative feedback; Tandberg has obviously gotten the same results without the deleterious effects of such feedback.

Preamplifier Measurements

Frequency response for the TCA 3018's high-level inputs was flat within 1.0 dB from 5 Hz to 500 kHz. An attenuation of 3 dB was reached with input signals at 2 Hz and above 1.0 MHz. Total harmonic distortion, with a 1-V signal applied and with the volume control set for 1 V output, was 0.005% at mid-frequencies; this increased slightly to a still-insignificant 0.008% at 20 Hz and 0.007% at 20 kHz. SMPTE-IM distortion measured only 0.005%. With gain set to maximum, 1 V of input signal applied to the high-level inputs resulted in an output level of 6.3 V for a gain of approximately 16 dB. At this higher output level, THD was still a very low 0.017%. (Bear in mind that no power amplifier I know of can handle so high an input signal level unless it is equipped with its own input attenuator.) Maximum output level at clipping was 12.0 V, 2 V higher than spec.

For standard output conditions (0.5 V), input sensitivity measured 1.0 mV for the moving-magnet phono inputs, 55 μ V for the MC phono inputs, and 80 mV for the high-level inputs. Signal-to-noise ratio for the MM phono inputs was 80.5 dB referred to 0.5 V output and with 5 mV of input applied. Amazingly, the MC signal-to-noise was almost identical to the MM figure; it measured 80.0 dB referred to 50 μ V input and 0.5 V output. This is the first time I have encountered a preamplifier whose MC S/N measured this way was as low as the MM S/N measured in accordance with the accepted standard. Users of MC cartridges can, at last, overcome one of the disadvantages ascribed to their pickups in the past: Higher noise levels. Moving-magnet phono input overload was 260 mV at 1 kHz, marginally short of the 290 mV claimed, but overload for the MC inputs was 20 mV, considerably higher than claimed.

It was pretty clear from my measurements that Tandberg must be using components of extremely tight tolerance in their passive RIAA equalization networks. It's not too difficult to achieve accurate RIAA curves using negative feedback equalization. However, it is quite an achievement to come within 0.2 dB of the precise RIAA characteristic over the entire audio range, as this preamp does, using fixed, passive "losser" networks. I might mention, too, that both channels were measured and both were equally accurate.

Assuming that your other stereo components are well balanced from channel to channel and that your listening location is well centered between your loudspeakers, you are not likely to need the balance control on the TCA 3018A regardless of where you set your volume control. That's because the tracking of the master volume control's two sections proved to be accurate within 0.4 dB from maximum down to a -60 dB setting.

Use and Listening Tests

Tandberg's typically modest claims for the TPA 3026A amplifier are exceeded by far, not only in terms of specifications but in terms of sound quality. With this amp coupled to a pair of high-quality loudspeakers, and with appropriate program material fed via a suitable preamplifier such as the TCA 3018A, any serious music lover would be hard pressed to find a better-sounding amplifier at any price.

Having lived with these two Tandberg components for several weeks now, my reaction to them can best be summed up by the fact that I am very reluctant to return them. Though my own reference power amplifier delivers considerably more *continuous* power to my low-efficiency speakers than does the TPA 3026A, I never encountered amplifier overload during my auditioning of this system. Transients were unmistakably superb.

Since Tandberg boasts about the "straight-line" design philosophy of the TCA 3018A, I rigged up a little switching arrangement which allowed me to bypass the preamplifier entirely and to compare sound obtained that way against sound quality when the signal was passed through both components. Having an output level control on my reference CD player made this A/B comparison practical once the preamplifier settings were adjusted for unity gain. Admittedly, the test was not strictly a double-blind experiment, but I could hear *no* degradation of musical sound quality when the TCA 3018A was in circuit.

My record collection has been collecting dust lately, but for the purpose of these tests I resurrected some of my old favorites, plus a couple of recent additions that I commend to you. Try listening, through this Tandberg pair, to the digitally mastered London LP of *Blue Skies* (414666-2), in which Kiri Te Kanawa sings some Cole Porter classics. The clear and utterly velvet-smooth voice of my favorite New Zealander never sounded better. Or mount the Classic Masters *Christmas at the Church of St. Luke in the Fields* (CMS-1006), which was mastered using Teldec's DMM (Direct Metal Mastering) technique, if you want to hear organ and choral sounds that bring you as close to "being there" as anything I've yet heard played on an analog turntable. Using both my favorite moving-magnet cartridge and a long-idle moving-coil pickup, I was impressed by the ultra-low noise of the preamp during my listening tests. But the sound quality of these Tandberg components goes beyond low noise and wide frequency response. There is a purity and overall clarity of sound that is evident on all of the several program sources I used.

Many readers and others interested in audio ask me if there's really an audible difference between run-of-the-mill (a substitute phrase for "medium-priced") components and high-end (read "high-priced") components. There's no general answer to this question; some high-priced components have little to recommend them except the fact that they were produced in small numbers by inefficient production methods. Others, like these units, offer sound quality and reliability that fully justify their price. Tandberg had an advertising campaign a while back that talked about the "Scandinavian Alternative." If money were no object, I'd look upon the TCA 3018A/TPA 3026A combination not as an alternative but as a "first choice."

Leonard Feldman

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SHURE D6000 COMPACT DISC PLAYER

Manufacturer's Specifications

Frequency Response: 5 Hz to 20 kHz, +0.5, -1.0 dB

Dynamic Range: Greater than 90 dB

S/N: Greater than 90 dB

THD: Less than 0.01%

Separation: Greater than 80 dB at 1 kHz

Output Level: Fixed, 2.0 V rms; variable, 0 to 2.0 V rms

Number of Programmable Selections: 15

Average Access Time: 3 S

Power Requirements: 120 V a.c., 60 Hz, 49 watts

Dimensions: 16.9 in. W x 3 in. H x 12.6 in. D (43 cm x 7.5 cm x 32 cm)

Weight: 11 lbs. (5 kg)

Price: \$599

Company Address: 222 Hartrey Ave., Evanston, Ill. 60202

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One of the questions I am asked most often when I give a talk about digital audio is, "How long will the laser diode of a CD player last?" There's no single answer, since not all laser pickups are of equal quality. It is of some significance, therefore, that Shure now offers a five-year warranty for laser replacement. They state that the laser diode used in the D6000, their latest CD player, will last for a minimum of 8,000 hours.

The D6000 certainly has plenty of features to boast about as well. Full 16-bit processing with two-times oversampling is combined with an effective digital filtering system that provides more than 80 dB of out-of-band attenuation. Gentle post-D/A analog filters are employed above 30 kHz in order to preserve phase integrity and tonal balance within the audio range. As is true of most higher quality, late-generation CD players, the D6000 uses a three-beam laser pickup,

which is said to do a better job of compensating for vibrations and disc imperfections. To ensure against future obsolescence, the designers of this unit have included a digital subcode output terminal so that when the long-awaited peripheral "black boxes" for graphics finally arrive, you'll be able to connect one to the D6000 and to your video screen.

As for user convenience features, the D6000 comes with a 19-function wireless remote control which has a 10-key layout for selecting and programming tracks. Up to 15 tracks can be programmed, in any order. You can even use the remote to control output levels to the variable output terminals or to the headphone jack. The front-panel controls as well as buttons on the remote let you perform an audible search at two speeds, in either direction, to find a desired point on a disc. You can also skip ahead or backwards from track to track, and quickly access any of up to 99 tracks by

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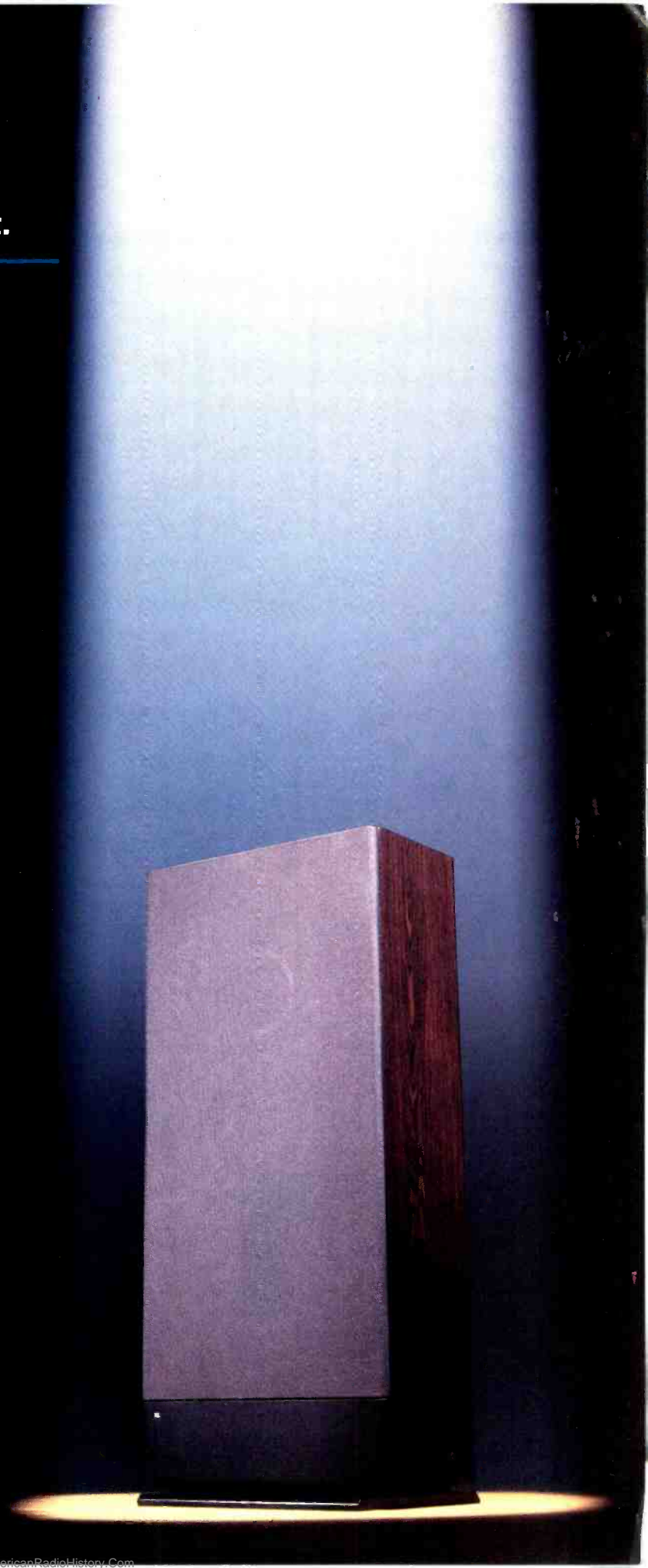
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Being able to adjust the volume from a distance is very worthwhile, as CDs can show substantial average level differences.

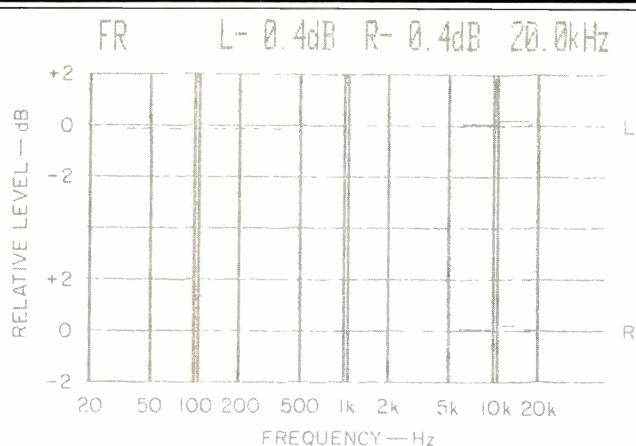


Fig. 1—Frequency response, left (top) and right channels.

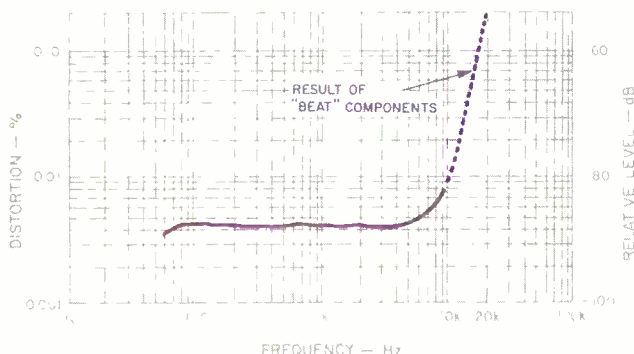


Fig. 2—THD vs. frequency at maximum recorded level (0 dB).

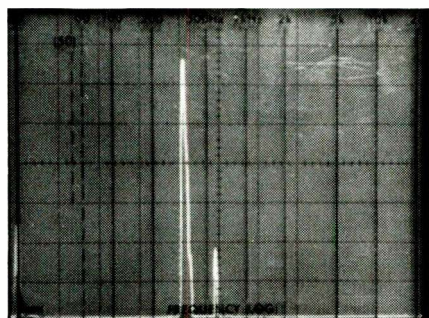


Fig. 3—Spectrum analysis of reproduced 20-kHz test signal.

using the number keys on the remote control. There are four repeat-play modes: Repeat of an entire disc, a track, a sequence of tracks, or a track segment. For those who simply want to play a disc from start to finish, there's automatic one-touch load and play. You simply load the disc and touch the "Play" button; the tray closes automatically. In short, Shure's D6000 incorporates just about every convenience feature you would want. The only feature that I found lacking was direct access to specific index points on a disc (when such index points exist). The multi-function digital display does indicate which index point within a given track is being played, however.

Control Layout

The "Power" switch and disc tray are at the left end of the D6000's front panel. The "Open/Close" button to the right of the tray can be used during loading and unloading, but insertion and playing of a disc once the tray is opened can also be done by pressing the "Play/Pause" button. A multi-purpose display area to the right of the "Open/Close" button provides a wide variety of indications including track and index numbers during playback, elapsed time from the beginning of the current track, repeat-play mode, memory cue (used during programming), and the number of the programmed selection. Additional indications illuminate to show that a disc has been loaded, that a disc is being played, or that the player is in the pause mode. Below the "Open/Close" button is a "Stop/Clear" button, and to the right of this key are buttons for forward and reverse scan, forward and reverse track skip, and "Play/Pause." By combining play and pause functions in one button and stop and program-clear functions in another, Shure has avoided the "busy" look common to some high-end, high-performance CD players.

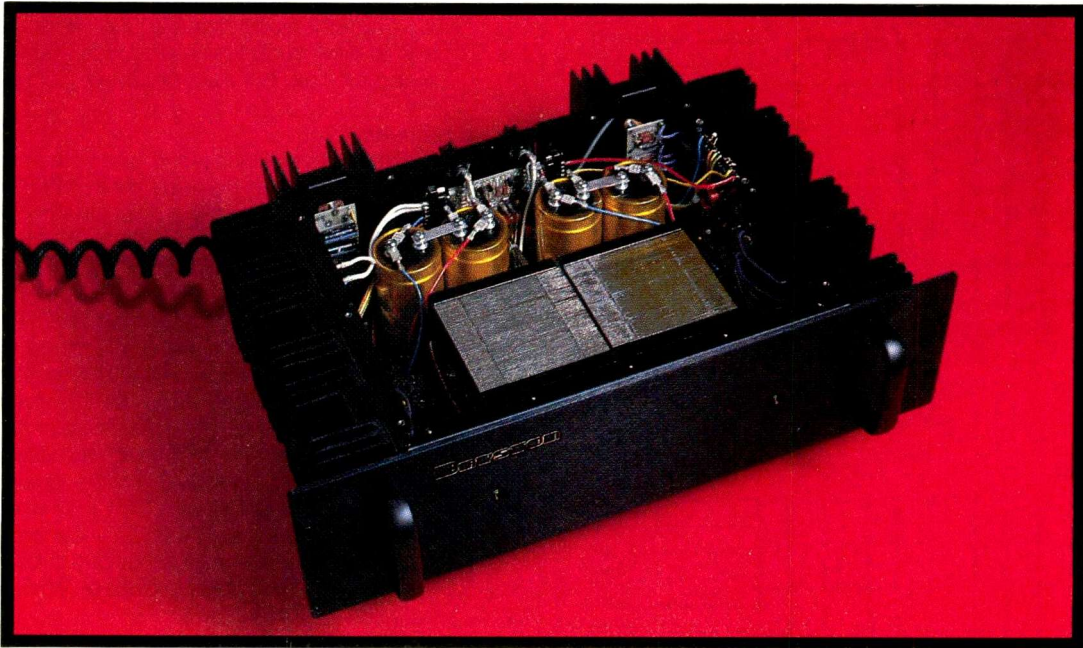
Three small buttons arranged one above the other near the right end of the panel handle repeat programming functions and memorization of up to 15 track selections. At the extreme right end, a small rotary control adjusts level at the variable output terminals as well as at the headphone output jack located below the control.

Pushbuttons on the remote control duplicate all of the front-panel functions except power on/off, even including opening and closing of the disc tray. I'm not quite sure what practical purpose is served by being able to open and close the disc tray from the comfort of your easy chair, since you would have to get up to load a disc anyway (unless you are a basketball star or, better still, a Frisbee champ), but I guess this feature does no real harm either. On the other hand, being able to adjust volume from a distance is a very worthwhile feature. I have noticed that there are rather substantial differences in average level among CDs in my collection. Some recording engineers push maximum record levels right up to the highest bit available, while others seem to prefer to remain a bit (or a few bits) below that maximum allowable level.

The rear panel of the D6000 is equipped with the fixed and variable pairs of output jacks mentioned earlier, and with a multiple-pin connector identified as the subcode output terminal. Concerning this extra connector, the owner's manual simply states that it is "for future use of video

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Bryston design philosophy incorporates three general concepts.

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2. Long term reliability
3. Product integrity

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Musical accuracy is reflected throughout all Bryston power amplifiers and includes the necessity for wide-band transient accuracy, open loop linearity ahead of closed loop specifications, and power supply design as an integral part of the overall sonic and electrical performance of a power amplifier.

We have found that a simple carbon film resistor can contribute more static distortion to a signal than the entire remainder of the amplifiers circuitry combined.

We discovered that some parameters of transistors must be controlled as much as 1000 times more closely before their contribution to audible distortion is rendered negligible.

We discovered that under certain actual conditions of speaker loading amplifiers were incapable of yielding high-power transients without distortion.

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input signal, and set at slightly under clipping for a period of 100 hours. During this time, the input signal is cycled three hours on to one hour off, to exert additional thermal stress.

As may be seen, Bryston takes very seriously the correct functioning and long term reliability of its products.

INTEGRITY

Bryston contends that the term 'best' should apply to the honesty pride and courage with which we conduct our business, as well as to the performance of our products.

For this reason, you will not find Bryston's products being cosmetically "updated" on a regular basis merely in order to keep the customer's interest in something 'new'. If we make a change in the circuitry, it will be because, and only because, it yields a worthwhile performance or reliability improvement.

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Unweighted S/N measured as high as the *weighted* figure of many players, and A-weighted S/N was an outstanding 102 dB.

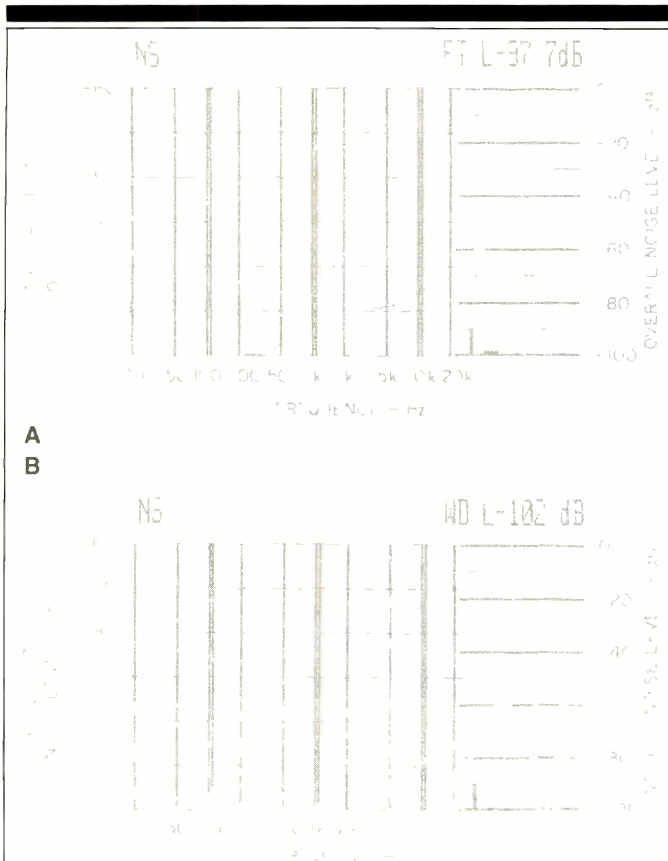


Fig. 4—S/N analysis, both unweighted (A) and A-weighted (B).

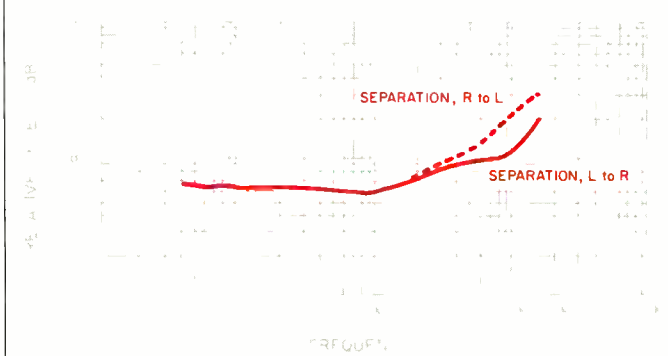


Fig. 5—Separation vs. frequency.

image subcodes, i.e., video signals recorded on the Compact Disc along with audio signals." No mention is made of the fact that to view such future graphics you'll need some sort of an add-on box, but that, of course, is the case.

Measurements

The advantages of digital filtering and two-times oversampling were apparent even from my measurements of audio frequency response. Since the output analog filter's cutoff point could now safely be moved up to 30 kHz, response was flat within ± 0.4 dB to 20 kHz for both channels, as shown in Fig. 1. Harmonic distortion at maximum recorded level was just under 0.005%; more important, it remained at that low, low level over most of the audio range, as shown in Fig. 2. As usual, the dotted-line extension shown in the region above 10 kHz in Fig. 2 does not represent harmonic distortion. Rather, it arises from the presence of a single inaudible "beat" above the audio band, as illustrated in Fig. 3. Unlike the results obtained with poorer quality CD players, this beat, occurring at around 24.1 kHz when a 20-kHz test signal is reproduced, is of relatively low amplitude. Nor is it accompanied by other in-band or out-of-band spurious outputs which have been commonly observed on CD players of lesser quality.

If I had followed the recommendations of the EIAJ and had employed a 20-kHz low-pass filter when making these distortion measurements, THD would have remained around 0.005% over the entire range of frequencies measured. It is my feeling (and that of the EIA committee which has been laboring to come up with a more meaningful CD measurement standard) that out-of-band spurious products should not be obscured by the addition of a low-pass filter in the signal-measurement path.

Figures 4A and 4B show the analyses of unweighted and A-weighted signal-to-noise ratios for the D6000. The unweighted S/N measured a very high 97.7 dB (which is as high as the *weighted* figure I have obtained for many CD players), and the A-weighted S/N was an outstanding 102 dB below maximum recorded level. Dynamic range (the difference between maximum [zero] recorded level and the THD amplitude for a 1-kHz tone at -60 dB) was an equally superb 102 dB. Linearity was nearly perfect all the way from maximum recorded level (nominal 0 dB) to -80 dB. De-emphasis, when activated by a disc which had been recorded with pre-emphasis (only a few discs make use of this additional noise-reduction technique), was accurate to within 0.3 dB over the entire audio frequency range. Since both the EIAJ and the proposed EIA CD measurement standards call for a test of wow and flutter, I went through the motions of trying to ascertain this parameter. If there was any flutter, it was too low for my test instruments to read. SMPTE-IM distortion measured less than 0.01%. CCIF IM was even lower, with readings of 0.004% at maximum recorded level and 0.003% at -10 dB recorded level.

Stereo separation, plotted in Fig. 5 as a function of frequency, was close to 85 dB at mid-frequencies, decreasing to a still very high 71 dB at the treble end of the spectrum. Maximum output level from the player was 2.50 V, and the difference in output between channels was only 0.03 V. Short-term access time (the time it takes for the laser pickup

The D6000 sounded great! There was none of the abrasive raspiness I've heard on other players, and bass was awesome.

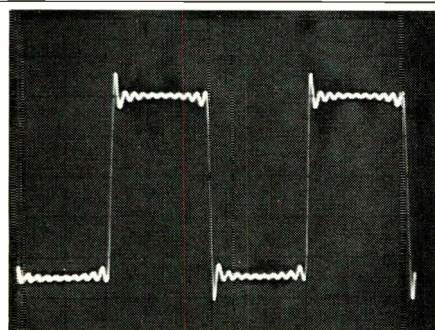


Fig. 6—Reproduction of a 1-kHz square wave.

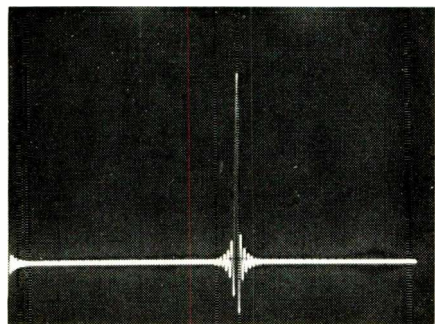


Fig. 7—Single-pulse test.

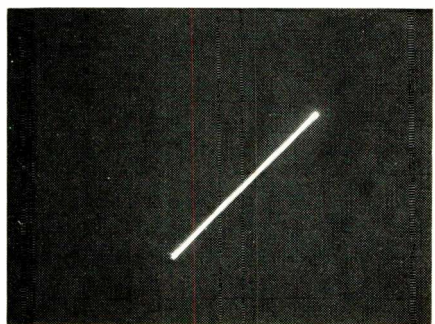


Fig. 8—Interchannel phase comparison at 20 kHz. Absence of interchannel phase error is indicated by 45° angle of Lissajous pattern on 'scope.

to move from one track to the next) was no more than 1 S, and long-term access time (the time it takes to get from an inner track to an outer track) measured approximately 6 S.

A 1-kHz square wave, as reproduced by the D6000, is shown in the 'scope photo of Fig. 6. It is as close to perfect as I have seen from any CD player. The departure from a perfect "flat top" in the reproduced waveform is due almost entirely to the absence of higher order harmonics and not to any "ringing" or overshoot that might be present if steep analog low-pass filters had been used. The impulse signal shown in Fig. 7 further confirms the fact that excellent digital filters have been used in this player.

Figure 8 reflects my new method of measuring time delay or phase error between left and right channels. Instead of superimposing two 20-kHz sine-wave signals from the two output channels, I now apply the output of one channel to a 'scope's horizontal (X-axis) input and the output of the other channel to the vertical (Y-axis) input. If the signals from both channels are perfectly in phase, the screen should show a straight line tilted 45° from lower left to upper right—which, as you can see from Fig. 8, is exactly what it did show.

Use and Listening Tests

The D6000 zipped through my old defects disc without a single glitch or moment of mistracking. What's more, it operated flawlessly even when tilted at angles that were not recommended by the manufacturer. The unit was also very resistant to external shock and vibration. I had to tap its sides and top far harder than anyone is likely to do in actual use before any muting took place. When I finally did upset the player enough for it to mute, play resumed, after the momentary mute, very near the spot where it had been interrupted.

A more important test, of course, is how the D6000 sounded when reproducing some of my favorite CDs. In a word, it sounded great! There was none of the abrasive raspiness I've heard from low-priced players when playing the same discs. Bass reproduction was awesome and full-bodied. Transients were reproduced without a trace of hangover. Quiet passages of music did not suffer from the kind of distortion that I have heard from players that use inferior digital-to-analog converters whose linearity near the least significant bits left something to be desired.

It is to Shure Brothers' credit that, as a major phono-cartridge manufacturer, they have had the foresight to move into the world of digital audio in anything but a perfunctory manner. Their D5000 CD player was a good first effort. The D6000 surpasses that earlier player in almost every way. What the two units do have in common is the excellent and very logical front-panel layout that makes operation almost self-evident even if you fail to read the owner's manual. What sets the D6000 apart from the earlier model (and from much of the low-cost competition) is its superb sound reproduction and its stable tracking mechanism.

With the addition of the D6000 to their line of "Ultra" products, and the continued success of their HTS5000 surround audio processor, Shure shows every indication of remaining a vital force in the world of digital audio—just as they have been for more than 60 years in the world of professional and home analog audio. *Leonard Feldman*

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3

RANE PE 15 MONO EQUALIZER

Manufacturer's Specifications

Type: Single-channel parametric.
Frequency Response: 20 Hz to 20 kHz, ± 1 dB.

Total Harmonic Distortion: Less than 0.02%, 20 Hz to 20 kHz, at +4 dBm output.

SMPTE-IM Distortion: Less than 0.009% at +4 dBm output.

Signal-to-Noise Ratio: 92 dB below +4 dBm at unity gain with boost/cut controls centered; 89 dB below +4 dBm at maximum gain with boost/cuts centered; 89 dB below +20 dBm at maximum gain with boost/cuts at maximum.

Frequency Ranges: Band 1, 20 to 300 Hz; band 2, 60 Hz to 1 kHz; band 3, 150 Hz to 2.5 kHz; band 4, 450 Hz to 8 kHz; band 5, 1 to 20 kHz.

Gain: Variable, +20 dB to $-\infty$.

Maximum Boost: +15 dB.

Maximum Cut: -20 dB.

Bandwidth Range: 0.03 to 1.5 octaves.

Maximum Input/Output Level: +20 dBm (7.7 V).

Input Impedance: 20 kilohms.

Output Impedance: 100 ohms.

Dimensions: 19 in. W \times 1 $\frac{3}{4}$ in. H \times 5 $\frac{1}{4}$ in. D (48.3 cm \times 4.5 cm \times 13.3 cm).

Weight: 5 lbs. (2.3 kg).

Price: \$389.

Company Address: 6510 216th St. S.W., Mountlake Terrace, Wash. 98043.

For literature, circle No. 92



The Rane PE 15 is a single-channel (monophonic) five-band parametric equalizer which offers great flexibility in creating corrective filter responses. Rane is not well known to most audiophiles, but they are very well established as a manufacturer of products for studios and sound reinforcement. Equipment for sound reinforcement may have been lacking in basic performance in comparison with home high-fidelity products in the past, but that is no longer true. There are many examples that show wide response, very little distortion, and low noise. Studio and sound-reinforce-

ment equipment, of course, is designed for specific applications, but the PE 15 is a flexible equalizer wherever it is used. It does have input and output connections required for professional use, but they present no problem in interfacing with other equipment in an audiophile's home system.

Control Layout

The front panel, complete with rack ears for mounting in a standard 19-inch rack, is dark brown with white designations, which makes for easy reading in almost any normal

lighting. The rocker-type power switch and its associated green LED are at the very left; to their right are five filter sections that are basically the same in appearance. Each section is outlined in white with the frequency range imprinted at the top. From left to right, these are: "20 Hz-300 Hz," "60 Hz-1 kHz," "150 Hz-2.5 kHz," "450 Hz-8 kHz," and "1 kHz-20 kHz." At the center of each section is a "Level" knob whose white cap and black-line index aid in easy setting. There is a center 0-dB detent with boost values shown for "3," "9," and "+ 15" dB and cut settings for "4," "12," and "- 20" dB. Offering different maximum values for boost and cut is certainly unusual for a high-fidelity equalizer, but there are some advantages in having greater cut available, and these will be discussed later.

To the left of each level control is a bandwidth control which has a "BW" designation at the top and an "Oct." (octave) unit label at the bottom. The scale from minimum (counterclockwise) to maximum (clockwise) is labelled ".03" to "1.5" for all of the filter sections. (On the unit I tested, the first section's bandwidth minimum was ".15," but this has since been changed to match the others.)

To the right of each "Level" pot is the frequency ("Freq") control which, like the one for bandwidth, has a knob that is really too small for easy turning. Personally, I would have preferred a larger knob, at least for "Freq," even if that meant reducing the size of the "Level" knob. There are five frequency settings shown for each band. To give just two examples, they are, in Hz, for band 1: 20, 32, 65, 175, and 300, while for band 2, they are: 60, 93, 190, 550, and 1k. Each of the bandwidth and frequency knobs has a small white index for ease in selecting any one of the labelled frequencies or any point in between. Small dots between the bandwidth and frequency numbers are also of some help.

At the lower right of each filter-section control group is a "Bypass" pushbutton which illuminates an adjacent red LED when actuated.

The first (lowest frequency) and fifth (highest frequency) sections can also be made to function as shelving filters by a simple pull of the bandwidth knob. When that is done, the bandwidth control is no longer operational, and the frequency knob sets the shoulder frequency. In the shelving mode, the maximum boosts and cuts are increased to about + 18 and - 24 dB. The designation "Pull Shelf" below each of those two bandwidth knobs reminds the user of this potentially very useful function.

The "Master Level" control is at the right end of the front panel. Its position might make some think that it operates on the output of the filters, but actually it is an input-level pot for the filter sections. It has no effect on the bypass level, which is a hard-wire connection. Just to the left of the pot is a green LED "Sig" indicator which turns on whenever the input signal is greater than - 20 dBm (0.077 V); this can be helpful to any user. Above it is a red LED overload ("OL") indicator which will turn on when the signal level is within 4 dB of clipping at the input or output stage or at any of the five equalizer stages. This is a desirable feature and is very well configured. To the right of the input-level control is a pushbutton which can be used to bypass all of the equalizer sections. There is no method or indication for matching equalization in/out levels. However, Rane states that without

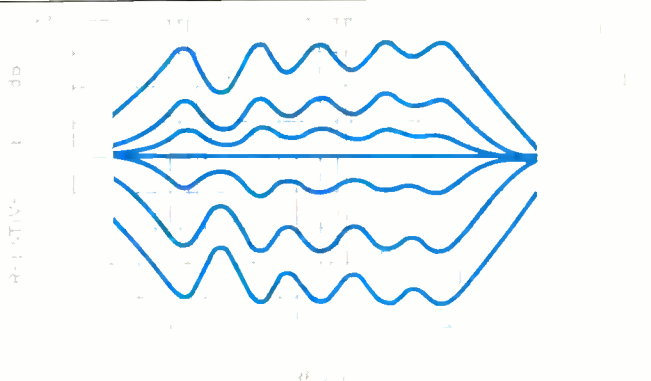


Fig. 1—Swept-frequency responses with filter bandwidths set at 1.0 octave and each filter set at the middle of its frequency range (65, 190, 510, 1,500, and 3,500 Hz). Level controls were set at (top to bottom) + 15, + 9, + 3, 0, - 4, - 12, and - 20 dB.

sizable boosting or cutting the match will be around 12 o'clock on the "Master Level" knob. Because this control can set the equalized level anywhere from 20 dB higher than the input level to fully off, there can be tremendous jumps in level when switching equalization in and out. Therefore, caution is in order.

On the back panel are input and output connectors of two types: XLR-style three-pin connectors and three-conductor, tip-ring-sleeve phone jacks. Regular two-conductor phone plugs can be used for both the input and output. Rane's instructions point out that when such plugs are used in the output, the cable shield must be disconnected from the plug at the equalizer end to minimize noise. A wide range of plug configurations are possible, and these are spelled out, together with advice on which ones provide lowest noise, in another booklet furnished with the unit.

I removed the top and bottom covers of the PE 15 to examine the full-chassis p.c. board. It was of high quality—much better than those in many high-fidelity equalizers. The soldering was excellent. All switches and pots were mounted directly to the circuit card, with the exception of the power switch. None of the parts were identified on the card, but the supplied manual provided all such information. There was one fuse, which was mounted in clips, and a board-mounted switch which could be set for either 120 or 240 V (this has since been eliminated by the manufacturer, which now ships the units as 120 or 240 V only).

Measurements

Careful setting of the controls resulted in reasonably accurate selection of level, frequency, and bandwidth—much better than most parametric equalizers. The maximum boosts and cuts were almost exactly the specified + 15 and

Selection of frequency, level and bandwidth was reasonably accurate—much better than that of most parametric equalizers.

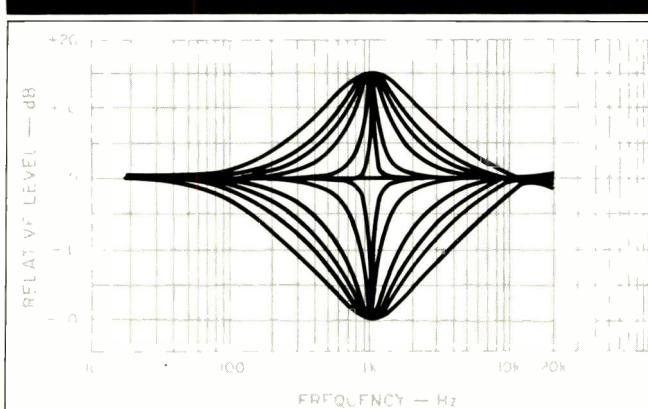


Fig. 2—Range of bandwidths at maximum boost and cut for filter 3. Bandwidth settings were 0.03, about 0.1, 0.33, about 0.5, 1.0, and 1.5 octaves.

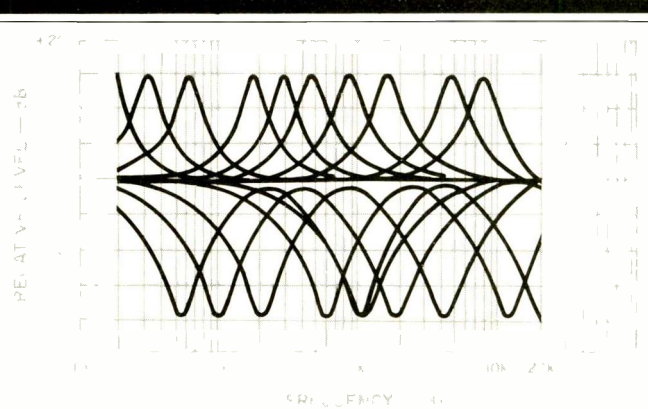


Fig. 3—Effects of varying frequency with constant (0.33-octave) bandwidth and maximum boost or cut. Only four filters are plotted (see text).

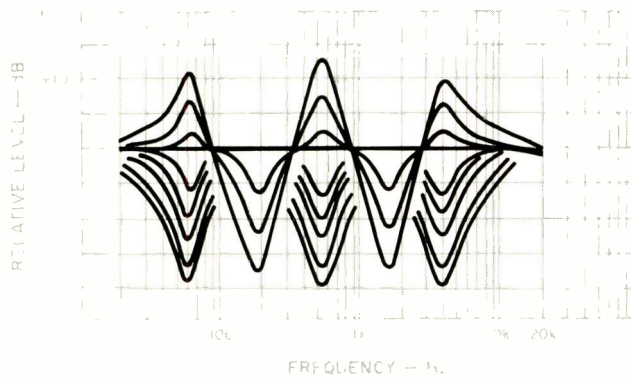


Fig. 4—Effects of various boost and cut settings with constant bandwidth (0.33 octave) and frequency settings. Continuous curves show all five filters at same frequencies as in Fig. 1. Discontinuous curves show effect of varying cut settings (–4, about –8, –12, about –16, and –20 dB) for three non-adjacent filters.

–20 dB; the total spread in values in each case was only 0.2 dB. The bandwidths were also very close to what was indicated. I did measure the minimum bandwidth as 0.05 octave rather than 0.03 octave, but this is really a minor discrepancy, in practical terms.

The –3 dB points were reached at 10.9 Hz and 36.4 kHz

with equalization switched in and all filter-level pots at the center detent. The response was up 0.6 dB at 20 Hz and down 1.2 dB at 20 kHz with a 100-kilohm load, and was actually flatter than this with the standard 10-kilohm load. Without equalization, the response appeared to be perfectly flat from 20 Hz to 20 kHz, with the –3 dB points at below 0.2 Hz and above 1 MHz, showing the benefits of the hard-wire bypass.

Figure 1 shows the swept-frequency responses with the five filter frequencies set roughly to the center of their ranges; sweeps are shown for three settings each of boost and cut. One should be aware that the waviness in the plots is not filter ripple but the result of accurate filter shapes for the five sections.

Figure 2 presents the results of multiple sweeps with the band-3 filter set first at maximum boost and then at maximum cut, with the bandwidth varied in steps. Bandwidths shown are 0.03, about 0.1, 0.33, about 0.5, 1.0, and 1.5 octaves. The 5-dB additional cut at the maximum setting, in comparison to maximum boost, is the major reason why the responses with cut are wider near the 0-dB line than those with boost. Any bandwidth between the limits shown is possible by simply turning a knob on the PE 15.

Figure 3 shows the effect of varying the frequency parameter. The reason for this diagram's asymmetry is that, because of overlaps between the filter ranges, I had to set two of the filters (20 to 300 Hz and 450 Hz to 8 kHz) to maximum boost and two others (60 Hz to 1 kHz and 1 to 20 kHz) to maximum cut. I then swept each from its minimum to its maximum frequency setting. The filter covering the range from 150 Hz to 2.5 kHz is not shown, as its response would have overlaid the response of other filters. However, its plotted response would have been similar.

Next, the five filter sections were set for alternating boost and cut with 0.33-octave bandwidths. There was some

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Little interaction is seen between adjacent sections because of the filters' constant-Q design.

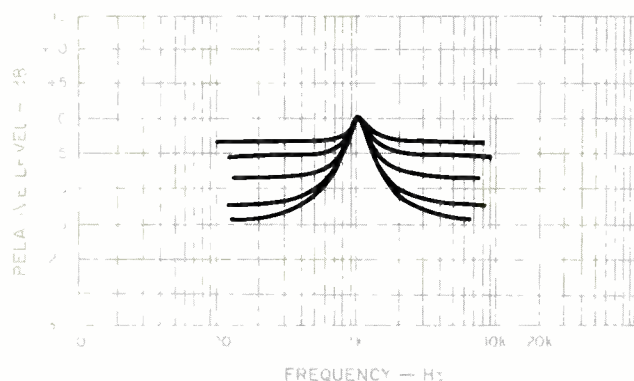


Fig. 5—Swept responses of 1-kHz filter with 0.33-octave bandwidth, with each sweep referred to maximum level over its available range of boost. Note the constant-Q characteristics (see text).

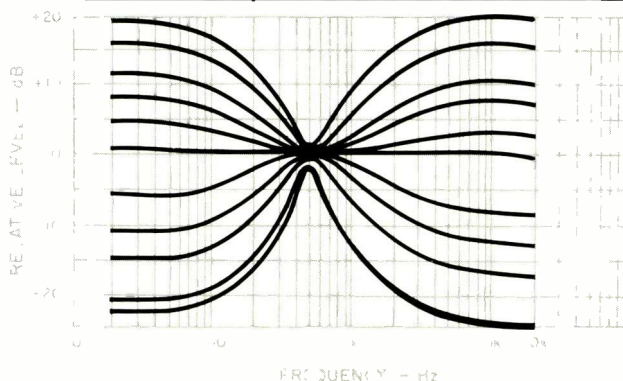


Fig. 6—Range of boost and cut with filters 1 and 5 in shelving mode. Shoulder frequencies were 300 Hz and 1 kHz.

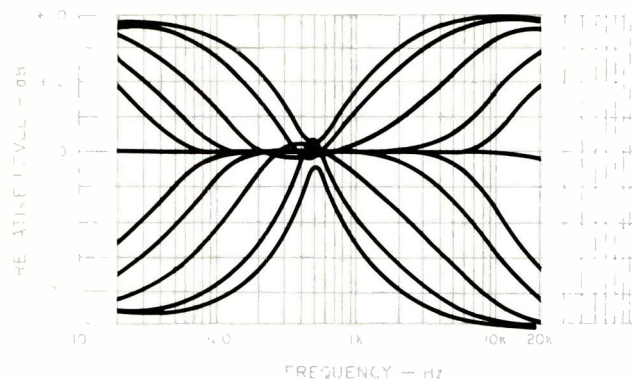


Fig. 7—Effect of varying shoulder frequency of shelving filters at maximum boost and cut. Shoulder frequencies for filter 1 were set at 20, 32, 65, 175, and 300 Hz; shoulder frequencies for filter 5 were 1, 1.7, 3.5, 11, and 20 kHz.

interaction between adjacent filter sections (Fig. 4), but the maximum boosts and cuts were reasonable approximations of the indicated values. I should note that these settings would be most unlikely in actual use. Also shown in Fig. 4 are the responses with three of the non-adjacent bands set successively at -4 , about -8 , -12 , about -16 , and -20

dB. In this case there was little interaction among the filters, and the cut values were close to the values indicated on the front panel.

The fundamental reason why the PE 15 shows less interaction between adjacent filter sections than many other equalizers is that its filters are a constant-Q (constant-bandwidth) design; they maintain the same filter shape regardless of boost or cut setting. I ran a series of swept responses to demonstrate this characteristic: With a 0.33-octave bandwidth, the boost was increased to maximum with the filter set to 1 kHz, but with the position of my plotter's pen shifted for each sweep so that the maximum point was always the same on the paper, regardless of how much boost there was. Figure 5 shows quite clearly that the filter shape remains consistent and that the filter skirts do not change shape or slope with different settings. This reduces the skirts' extent as boost or cut is reduced. Thus, the boost (or cut) rises (or dips) from the 0-dB level without affecting a broader range of frequencies—as would be the result when using filters of non-constant Q.

Filter sections 1 and 5 were switched to shelving response, and plots were made over the range of boost and cut settings (Fig. 6) and shoulder-frequency settings (Fig. 7). In shelving mode, the maximum boost becomes about 18 dB and the maximum cut about 24 dB, more than the legends on the panel indicate. This difference between indicated and actual response is most obvious with filter section 5 set to cut.

The response curves of Fig. 6 were made with the low-frequency filter at its maximum shoulder frequency, 300 Hz, and the high-frequency filter at 1 kHz, its minimum shoulder frequency. Figure 7 shows the shelving responses with both sections at maximum boost and at maximum cut, with the shoulder frequencies stepped from maximum to minimum for the successive sweeps. This selectable shelving re-



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There was a very obvious difference when the PE 15 was used to flatten the already-good response of a tape recorder.

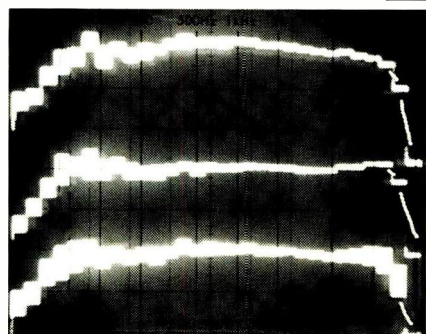


Fig. 8—One-third-octave response of tape recorder before (top trace) and after (middle) equalization. The difference between the two (bottom) shows the small amount of adjustment needed; see text. (Vertical sensitivity: 5 dB/div.)

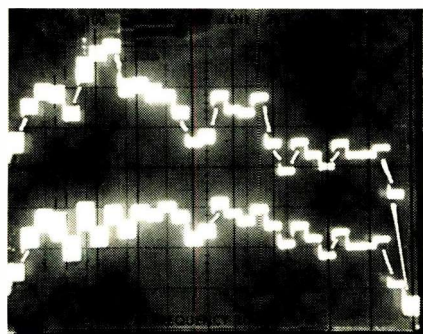


Fig. 9—One-third-octave response of small monitor speaker before (top trace) and after (bottom) equalization. All five filters (one in shelving mode) and three different bandwidth settings were used, showing the versatility of parametric equalization. See text. (Vertical sensitivity: 5 dB/div.)

sponse is a definite benefit to the user, and the Rane is the only unit I know of that offers it.

The maximum input and output voltages measured very close to 9.0 V across the band, dropping to 8.8 V at 20 Hz and 20 kHz with a 10-kilohm load. The input impedance was 21.6 kilohms, and the output impedance measured 100 ohms. Distortion was 0.007% or so across most of the band, rising to just 0.028% at 20 kHz. There was no slew-rate limiting observed with 2 V input out to 100 kHz, at which point there was 16 dB of roll-off. The signal-to-noise ratio was 87.5 dBA relative to 1 V; that figure decreased but slightly, to 85.0 dBA, with various combinations of typical equalization. All of the above figures are excellent—better, in general, than those for most high-fidelity equalizers.

I measured a 19.9-dB higher level relative to bypass with the level pot at its maximum. With a sine-wave test signal, the overload indicator lit at 3.8 dB below clipping (at 9.0 V). With a 20-mS tone burst and the on-level 1 dB above threshold, the indicator was quite bright. It was noticeable at 10-mS duration and still could be seen at 4 mS. The signal-present LED lit with a 12-mS tone burst whose level was 1 dB above the indicator's 0.077-V threshold.

Use and Listening Tests

As its front page indicates, the PE 15's owner's manual is an operating and service manual, for it includes schematics and board layouts as well as the usual how-to-use-it material. The text is clear and succinct with a touch of humor: it contains excellent details on input and output connections and choices among balanced and unbalanced configurations, floating output, etc. There is a lack of instructions on the process of choosing equalization settings, and statements to the effect that this cannot be taught in print is a bit of a cop-out. Rane recommends using an RTA to aid in the equalization process, and I would agree with that. Rane also supplies much helpful information in its technical notes on input and output standards and sound-system interconnections—much more than is supplied by a number of other manufacturers of professional equipment.

The controls were all completely reliable throughout the testing, and I liked the flexibility that they all offered. I did think, every so often, that the frequency and bandwidth knobs were too small for easy adjustment. The status LEDs were helpful many times in actual use.

I incorporated the PE 15 into a sound-reinforcement system for a barbershop group's performance. I used the three-band equalizers in each of my mixer's input channels for mike/performer matching, and used the PE 15 to adjust the basic character of the overall sound. A couple of the filter sections were used to control feedback; the full 20-dB cut was used at one point, in one section, when mike gain was set high to compensate for a weak voice. Because the filter was set to its narrowest bandwidth, there was no observable effect on the music.

Figure 8 demonstrates how the PE 15 was used to flatten the response of a tape recorder. The original response was fairly good (top trace), but equalization made it flatter (middle). The amount of equalization actually used was not great (bottom), although the difference in overall response was very obvious when listening to recordings made from high-

The PE 15 offers excellent electronic performance, and it stands as my first choice in equalizers.

quality sources. Just three filter sections were used, all set for a bandwidth of 1.5 octaves. I set one filter for 2 dB of boost at 50 Hz, another filter for 1 dB of cut at 800 Hz, and the third for 2 dB of boost at 20 kHz. Note that these frequencies and bandwidths would not be available on conventional graphic equalizers.

Figure 9 shows the original and equalized responses of a small monitor speaker. The original response (top) is certainly not smooth: there is a large peak near 100 Hz and a much lower level above 2 kHz. The sound of the pink-noise test signal was very obviously non-flat. The final result (bottom) still shows a lot of jaggedness, perhaps made worse by some reflecting surfaces near the speaker-to-microphone path. Still, the overall variations were reduced greatly, and the perceived sound was much smoother, both with pink noise and with music. The equalization settings used were -8 dB at 100 Hz (0.33 octave), $+4$ dB at 550 Hz (1 octave), -5 dB at 1.5 kHz (0.25 octave), $+8$ dB at 3 kHz (1 octave), and $+4$ dB shelving with a 1-kHz turnover.

As the listening material changed, I varied the amount of boost at 3 kHz to get the effect I found most pleasing. The equalization I used is possible only when using a parametric equalizer with shelving, which restricts this particular improvement to the Rane PE 15 and perhaps a few other professional equalizers. It is true, however, that a good part

of this same correction could be supplied by a tone control with the right shape or by an added graphic equalizer.

The possible disadvantages of the Rane PE 15 for the audiophile are its higher cost relative to octave-band equalizers (two PE 15s are needed for stereo), its lack of easy level matching, the slightly limited frequency overlapping of its filter sections, and possible difficulties in stacking it with other equipment because of its limited depth.

The Rane PE 15 has several advantages relative to octave-band (and most other) parametric equalizers: It has five filter sections; each section has a four-octave frequency range; the filters have a broad range of bandwidths; the bandwidths agree with the panel indications, whatever the level settings; low- and high-frequency shelving is available simply by pulling a knob, and the input and output configurations are flexible enough to satisfy all sorts of interconnection requirements. The PE 15 also delivers excellent electronic performance, and this is not to be disregarded.

Parametric equalizers can accomplish many things that graphic-type equalizers cannot. With practice, the use of a parametric equalizer becomes more natural, and the ability to control frequency, bandwidth and amplitude separately can very well become both addictive and essential after a while—at least it has for me. Overall, the Rane PE 15 stands as my first choice in equalizers. *Howard A. Roberson*

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4

MONSTER CABLE ALPHA 2 CARTRIDGE

Manufacturer's Specifications

Type: Moving coil.

Frequency Response: 10 Hz to 60 kHz; 20 Hz to 20 kHz, ± 1 dB.

Stylus Rake Angle: 0° , $\pm 2^\circ$ with VTA set at 19° to 22° .

Channel Separation at 1 kHz: Greater than 30 dB.

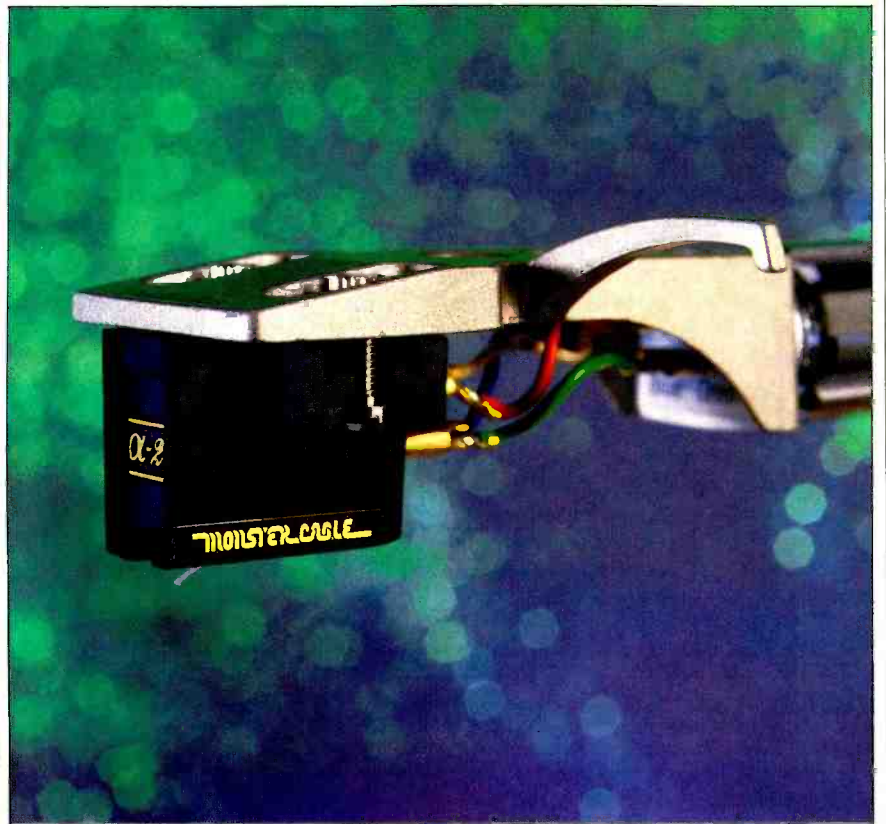
Vertical Tracking Force: 1.75 grams.

Channel Balance: 0.2 dB.

Stylus Shank: Nude, square, 0.1 mm.

Stylus Tip: Micro-Ridge, 3×80 microns.

Cantilever: Thin-wall hollow sapphire; 0.33-mm outer diameter, 0.26-mm inner diameter, 5.8 mm long.



Recommended Load Impedance: 30 ohms (optimum) to 80 ohms.

Internal Impedance: 4 ohms.

Compliance at 11 Hz, 70° F: 15×10^{-6} cm/dyne.

Output Voltage at 1 kHz, 5 cm/S: 0.3 mV.

Weight: 6.5 grams.

Price: \$650; replacement stylus, \$390.

Company Address: 101 Townsend St., San Francisco, Cal. 94107.

For literature, circle No. 93

Since my review of the Alpha 1 cartridge (*Audio*, January 1984), there seems to have been no diminution of the number of new, high-end phono cartridges. It also appears that the makers of these cartridges are not alarmed by the rise of CD. Monster Cable certainly isn't; they have since introduced the Alpha 2 in both the low-output version reviewed here and a high-output version.

The new cartridge uses the "magnetic feedback control" circuit Monster Cable introduced in the Alpha 1 to eliminate unwanted Foucault or eddy currents which usually develop in magnetic circuits. The Alpha 2 also incorporates a hollow, tube-type cantilever, made of sapphire, upon which is mounted an extended-footprint stylus. The stylus is the Namiki Micro-Scanner, which is said to have a relatively constant tip radius of between 2 and 3 microns to allow better tracing of inner and outer grooves, with very low distortion. The manufacturer recommends that the cartridge be broken in for about 10 hours to realize full performance.

The Alpha 2 comes packaged in a beautifully machined, black-anodized aluminum "pill box" with walls $\frac{1}{4}$ inch thick. Besides the cartridge, the package contains various screws and tools that are needed to mount the cartridge, plus a vial of Stylast. The aluminum container is located within the two halves of a styrofoam box, which in turn is enclosed in a nice-looking display box.

Measurements

Due to the minute size of the moving coils, the direct signal output is very low, i.e., 0.38 mV; thus, a step-up device is necessary to raise the output voltage to a level high enough to work with the usual preamplifier phono gain stages. Accordingly, most of the measurements reported here were made using my measuring amplifier and rechecked with an Electrocompaniet MC-2 pre-preamp or with a Technics SH-305MC step-up transformer set to 30 ohms. The frequency response of the transformer has been

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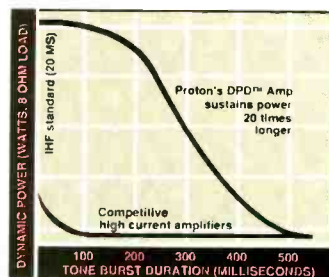
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The violin that had sounded strident and harsh before demagnetization suddenly sounded like a true violin. Black magic?

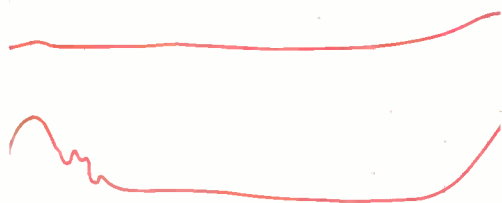


Fig. 1—Frequency response (top curve) and separation (bottom curve), after phono cartridge was demagnetized. Test record is CBS STR-170.

measured as ± 0.5 dB from 40 Hz to 50 kHz. However, all musical evaluation was done with the Electrocompaniet MC-2 pre-preamp.

The Alpha 2 was mounted in a Technics magnesium headshell and used with a Technics EPA-250 interchangeable tonearm. The arm was attached to a Technics EPA-500 tonearm base mounted on a Technics SP-10MK2 turntable. The Alpha 2 was oriented in the headshell and tonearm with the Dennesen Geometric Soundtracktor. All laboratory tests were conducted at an ambient temperature of 73° F (22.78° C) and a relative humidity of 80%, $\pm 3\%$.

I performed my usual pre-testing listening evaluation, which normally runs about 10 hours, in order to determine whether to continue the review and, at the same time, to complete the recommended "break-in" time prior to making any laboratory measurements. Initially, I found that the optimum tracking force for this cartridge was 2.8 grams rather than the recommended 1.75 grams, and that the optimum anti-skating force was 3.0 grams. I also found that the cartridge performed surprisingly poorly on the three Shure Audio Obstacle Course test records. I then requested a second sample, which did manage to pass a number of the Shure test bands at a satisfactory level but still required a 2.8-gram tracking force.

While I was pondering this turn of events and wondering how I should present this review to the readers of *Audio*, I received a telephone call from an audiophile friend, Sherwin Janows, of Chicago. He called to tell me about a new gadget from Sumiko, the "Fluxbuster" FB-1 demagnetizer,

which actually demagnetizes magnetically permeable components of a transducer. Sumiko's David Fletcher claimed that the Fluxbuster actually restores a cartridge's loss of dynamics. My first thought was to ask Mr. Janows if he would loan me the Fluxbuster to try on the Alpha 2.

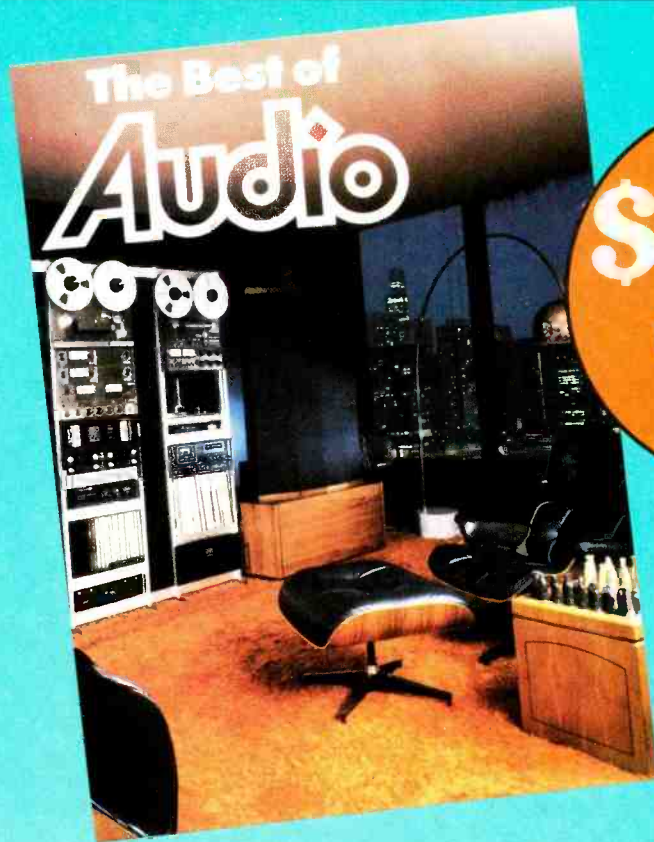
In due course the Fluxbuster arrived. Before I used it I rechecked the Alpha 2 and got the same results. Then I demagnetized both cartridges, using the Fluxbuster three consecutive times to be certain that all unwanted magnetism was removed. I was not certain that the cartridges were magnetized but wondered if somehow they had developed eddy currents in their circuitry despite the control circuit which was designed to eliminate them.

When the process was completed, I inserted the cartridge and headshell into the tonearm, made the necessary adjustments, and proceeded to listen to the Shure Audio Obstacle Course test records once more, expecting to declare the Alpha 2 unacceptable for true high-fidelity use. Suddenly the solo violin, which had previously sounded unbelievably strident and harsh, sounded like a true violin. As I listened, in a state of disbelief, I thought this bordered on chicanery—that I had performed some black magic and that in the morning everything would return to its original state of poorly reproduced music. However, I couldn't let go of the cartridge, and continued to search for the answer to what had happened with the Fluxbuster. Further, I now found that the optimum tracking force had gone from 2.8 grams down to 1.8 grams (close to the recommended tracking force of 1.75 grams) with an optimum anti-skating force of 2.1 grams. Every test record was passed by the rejuvenated Alpha 2 except for the Telarc "1812 Overture" (matrix 11), where three of the cannon shots were impossible for the Alpha 2 to track. However, I consider this a fantastic achievement, especially as that disc had proved impossible for the cartridge to handle before demagnetizing.

After I had reassured myself that the Alpha 2 moving-coil phono cartridge was going to maintain its new characteristics, I discussed the matter with Monster Cable's president, Noel Lee. He was astonished by my findings and by the solution to the problem. He immediately told me to tell our readers that anyone owning an Alpha 2 which they believe is magnetized should return it to Monster Cable for a free demagnetization. In the future, Monster Cable will demagnetize all their cartridges before shipping.

The tracking force for all reported tests was set at 1.8 grams, with an anti-skating force of 2.1 grams. During the past decade or so, a well-known reviewer and I have always stated that the anti-skating setting for any cartridge should be greater than the tracking force. On occasion it was only a few milligrams greater, but greater it was! Finally, a manufacturer has acknowledged this: Monster Cable has packaged a note with each Alpha 2, stating that it requires more anti-skating compensation than most tonearms indicate because of its unique stylus shape. The company recommends an increase of about 30%, which they say will provide "unparalleled low distortion" in tracking high-velocity grooves. I question this statement (for one thing, I found the optimum anti-skating to be only 17% more than indicated), but since I do not wish to engage in any unresolvable discussions, I will "pass" on this subject.

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The Alpha 2 was very revealing and free of coloration. It possessed excellent clarity and depth, and tight bass.

To continue, then, the load resistance was 47 kilohms and the load capacitance was 70 pF. As is my practice, measurements were made on both channels, but only the left channel is reported here unless there is a significant difference between the two channels, in which case both channels are reported for a given measurement.

The following test records were used in making the reported measurements: Columbia STR-100, STR-112, and STR-170; Shure TTR-103, TTR-109, TTR-110, TTR-115, and TTR-117; Deutsches HiFi No. 2; Nippon Columbia Audio Technical Record (PCM) XL-7004; B & K QR-2010; and Ortofon 0002 and 0003.

Frequency response using the Columbia STR-170 test record (Fig. 1) was -0.5 , $+5.5$ dB from 40 Hz to 20 kHz. Response was ± 1 dB from 40 Hz to 5 kHz, $+2.5$ dB at 10 kHz, $+4.5$ dB at 15 kHz, and $+5.5$ dB at 20 kHz. Separation was 23.75 dB at 1 kHz, 25 dB at 10 kHz, 22 dB at 15 kHz, and 18 dB at 20 kHz. (The rise in the frequency response from 6 to 20 kHz is typical of most moving-coil phono cartridges.)

The 1-kHz square-wave response (Fig. 2) is consistent with that seen for most moving-coil cartridges, when there is a large overshoot (equal in amplitude to that of the square wave itself) followed by a low-level ringing that decays rapidly. The ringing is undoubtedly due to a relatively undamped stylus resonance that takes place at about 37 kHz. To measure the arm/cartridge low-frequency resonance, it was necessary to disable the tonearm's anti-resonance device. The arm/cartridge low-frequency lateral resonance for the left channel was at 8 Hz. Vertical resonance was at 9 Hz. Neither the lateral nor the vertical low-frequency resonance was measurable when the tonearm's anti-resonance device was used.

Using the Dynamic Sound Devices DMA-1 analyzer, the arm/cartridge dynamic mass was measured as 21.5 grams and the dynamic vertical compliance as 25×10^{-6} cm/dyne at 8 Hz. The vertical stylus angle measured 22° .

Other measured data are: Wt., 6.25 grams. Opt. tracking force, 1.8 grams. Opt. anti-skating force, 2.1 grams. Output: 0.11 mV/cm/S measured directly, 1.7 mV/cm/S using the pre-preamp. IM distortion (200/4000 Hz, 4-to-1): Lateral ($+9$ dB), 1.7%; vertical ($+6$ dB), 6.0%. Crosstalk (using Shure TTR-109): Left, -28 dB; right, -28 dB. Channel balance, 0.25 dB. Trackability: High freq. (10.8 kHz, pulsed), 30 cm/S; mid-freq. (1000 and 1500 Hz, lateral cut), 31.5 cm/S; low freq. (400 and 4000 Hz, lateral cut), 24 cm/S. The Deutsches HiFi No. 2, 300-Hz test band was tracked cleanly to 86 microns (0.0086 cm) lateral at 16.20 cm/S at $+9.66$ dB and to 55.4 microns (0.00554 cm) vertical at 10.32 cm/S at $+5.86$ dB.

The demagnetized Alpha 2 played all the test bands on the Shure Obstacle Course Era III musical test record. On the Era IV musical test record, the Alpha 2 passed all the test bands except for the flute and the harp-and-flute bands, where it passed the fourth level. All six levels of the Shure Obstacle Course Era V test record were tracked without a mishap. I might add that it is a rare cartridge that is able to track all the peak recorded velocities on these records, some of which exceed 50 cm/S. (The peak recorded velocities of analog records average about 15 cm/S).

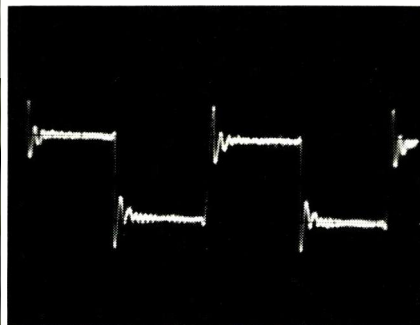


Fig. 2—Response to a 1-kHz square wave.

Use and Listening Tests

As is my practice, I performed listening tests both before and after the laboratory measurements. Normally, the results of my first two hours of listening would have been sufficient for me to disqualify the cartridge from further testing. I made an exception in this instance, however, because the earlier Alpha 1 was above average. As the results grew progressively worse, curiosity made me decide to continue with the testing.

Since one does not listen to laboratory measurements, it is very important to evaluate a cartridge by listening to a wide variety of recordings over a reasonable length of time. Accordingly, I listen mostly to unplayed or virgin records for about 10 hours before making any measurements. Should a phono cartridge be defective, its problems will generally show up during this time.

As I have stated before, my philosophy regarding the testing of phono cartridges is that the listening evaluation should be the final criterion by which a cartridge is judged. After all testing is completed, I spend at least another 10 to 25 hours (sometimes as much as 40 hours) evaluating the cartridge with a large variety of recorded music from my vast library. It is during this listening evaluation that I reach a conclusion on the merits of a given cartridge. I strongly believe in the axiom put forth many years ago by the late C. J. LeBel: "If it measures good and sounds bad, it is bad."

The equipment used in the listening evaluation included the aforementioned Technics turntable and tonearm, an Audio-Technica AT666EX vacuum disc stabilizer, a Levinson ML-1 preamplifier and ML-3 amplifier, speaker and interconnecting cables from Discrete Technology and Monster Cable, the Discrete Technology LSI CD player, a pair of B & W 801F speakers, and a pair of Janis W1 subwoofers, each located next to one of the 801Fs. (The Interphase 1A amplifier/crossover units for the W1s are located in the laboratory.) The speakers are located in the dead end of my listening room, positioned for optimum response as deter-

With all Alpha 2s now being demagnetized before shipping, I can recommend this cartridge without hesitation or reservation.

mined by measurements made with the Tecron TEF-10 system.

I compared several analog discs with their CD versions when both had been derived from the same digital master tape. One of the recent releases I listened to was the Telarc *Bachbusters*, DG-10123 on DMM vinyl, CD-80123 on CD. Somewhat to my surprise, I preferred the DMM vinyl version as played by the Alpha 2. Possibly because of the Alpha 2's rising high-end response, the sound came through more distinctly and clearly on the LP than on the CD. However, it must be understood that after repeated plays (about six), the vinyl record will progressively lose its high end while the CD will suffer no alterations. The DMM recordings give the CD versions some very tough competition, but they have to lose in the end.

During the listening evaluation, the Alpha 2 was very revealing, was free of coloration, and possessed excellent clarity and tight bass. The depth of image was also excellent. The sound of the Bösendorfer Imperial piano on my test disc came through beautifully, as did the general resolution of the various other musical instruments. Applause definition was excellent.

After I had demagnetized the Alpha 2, it was able to handle almost any high-velocity recorded material. However, it was unable to negotiate three of the cannon shots on

the Telarc "1812 Overture" (matrix 16) and the flute and the harp-and-flute combination on the Shure Era IV Obstacle Course musical test record. These are difficult tests.

I should recommend the following superb recordings (in addition to the aforementioned *Bachbusters*) which were culled from the numerous records I auditioned in connection with my review of this cartridge: Rachmaninoff's "Piano Concerto No. 2" (The Royal Philharmonic, Horenstein, Chesky Records CR 2, DMM); Berlioz's *Requiem* (Boston Symphony Orchestra, Munch, RCA Red Seal ATL 2-4269); *Still Harry After All These Years* (Harry James & His Big Band, Sheffield Lab 11); Beethoven's *String Quartets, No. 11 and No. 12* (Smetana Quartet, Denon OF-7021); *Marni Nixon Sings Gershwin* (Reference Recordings RR-19); Gershwin's "Rhapsody in Blue" and "An American in Paris" (Cincinnati Symphony Orchestra, Kunzel, Telarc DG-10058); *Live at the London Palladium* (Judy Garland and Liza Minnelli, Mobile Fidelity Sound Lab MFSL 1-048); *Back to Birdland* (Freddie Hubbard, RealTime Records RT-305, digital); and Beethoven's "Sonata in G Major, Op. 96" and Enescu's "Sonata No. 3, Op. 25" (Wilson Audio W-8315).

With every Alpha 2 moving-coil phono cartridge now being demagnetized prior to shipping, I can recommend it without hesitation or reservation to all serious music lovers.

B. V. Pisha

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MCA Records has embarked on a musically exciting and corporately creative venture, issuing previously released jazz in digitally remastered form on its MCA/Impulse! label. (Impulse! was one of the premier jazz labels of the '60s.) All the releases are in three formats—LP, CD, and cassette—and all feature outstanding musicians and music. There are re-releases from Count Basie, *Count Basie and The Kansas City Seven*; Sonny Rollins, *On Impulse*; Charles Mingus, *The Black Saint and the Sinner Lady*; Art Blakey, *A Jazz Message*; Gil Evans, *Out of the Cool*; Benny Carter, *Further Definitions*; John Coltrane, *John Coltrane and Johnny Hartman*, and others.

The band members involved in these historical sessions are all Hall of Famers; they include Eric Dolphy, McCoy Tyner, Coleman Hawkins, Jo Jones, Freddie Hubbard, Sonny Stitt,

Jackie Byard, Elvin Jones, Ron Carter, Thad Jones, and Freddie Green. Nearly all the music was produced by "The Flying Dutchman," Bob Thiele, except for Oliver Nelson's *The Blues and the Abstract Truth* and Evans' *Out of the Cool*, which were produced by Creed Taylor. Many of the sessions were engineered by "the genius from Jersey," Rudy Van Gelder.

Almost needless to say, the re-released music is classic, having withstood the test of time. But what of the sonic quality of the three formats? Does it match the quality of the music?

MCA/Impulse! has been meticulous in its preparation of this series. Care has been taken to not abuse or drastically alter the original ¼-inch, two-track, stereo master recordings. No equalized or safety copies were used in the remastering process—just the original tapes. For transferring, the original two-track masters were re-

equalized as digital copies were made; lacquer parts were cut simultaneously. Equalizer settings were the same for the digital copies as for the lacquer master. Recording and mastering engineer Greg Fulginiti was responsible for the re-equalization and remastering, which was done at Artisan Sound recording studios in Hollywood. Overseeing the project was MCA's vice president of recording and quality assurance, Gene Wooley.

Since there were three formats to be delivered, and no major discrepancies could exist among the formats, MCA used the same digital copies as masters for the Compact Disc preparation as for the cassette duplication; the only difference was that the master digital copies subsequently went through the additional preparation and verification processes needed for Compact Disc manufacturing.

As might be expected, the sonic

COMPELLING REISSUES

MCA'S JAZZ CLASSICS

HECTOR G. LA TORRE



Among the artists getting renewed exposure in the digital spotlight are John Coltrane and Johnny Hartman (top), Coleman Hawkins (above), and Sonny Rollins (right).

AUDIO/APRIL 1987



Photograph: Frank Driggs Collection



Count Basie (far left), Art Blakey (left), and Charles Mingus (below) are some of the other jazz greats to benefit from MCA's remastering work.

quality of the CDs is excellent. The careful remastering of the analog tapes into the digital format resulted in a quiet, dynamic product. The worst that can be said of all the formats is that a slight degree of limiting can be heard (manifested as a very mild "pumping" or "breathing") on the quiet passages of certain tracks, specifically where bass and drums (or cymbals) are without accompaniment or where bass and drums are backing a piano or saxophone solo. This minor drawback certainly should not affect anyone's listening pleasure, however.

The albums, pressed on KC 569 blend premium virgin vinyl, are also very quiet and dynamic. Jazz listeners who have the original releases of these tracks will love hearing the digital remasters, especially if they don't yet own a Compact Disc player. New listeners will have to get used to the '60s idea of stereo as it is presented on these recordings. Many solos are recorded far left or right, as the bass and drums often are. The stereo method of that period—especially in jazz—paid more attention to where a musician physically stood in relation to other musicians in the studio and in the stereo field. If the sax player set up next to the drummer, or the bassist next to the guitarist, then that's where you would hear them on record. Today we use

close-miking and multiple-miking techniques to create a more dramatic stereo spread. The rhythm section (bass, drums, rhythm guitar, piano), the lead vocal, and often the lead solo instrument are usually placed in the center, regardless of where the musicians set up. (Of course, because of present-day overdubbing capabilities, many band members today don't even show up on the same days to record!)

The most challenging of music formats is the cassette. Many things can adversely affect the production process—poor tape or cassette-shell quality, azimuth problems, tape machine incompatibility, etc. And since listeners have a tendency to inadvertently mistreat the convenient cassette in the home or the car or in portable decks, any problem, even a minor one, can be quickly aggravated. MCA has put a lot of thought into its digitally remastered cassettes, using a new technology which they call "HiQ." This involves using Dolby B noise reduction and Dolby HX Pro technology in the mastering process, and HX Pro again during "slave" duplication, to create the quiet yet hot levels necessary for outstanding cassette reproduction. The cassette shell used is the clear Shape sonic Mark X.

I played the cassette tapes on approximately 20 different decks to get a general feel for their sound. Some of the machines had been freshly serviced, while others had been purposefully left alone; after all, most consumers don't have their cassette decks tweaked and coddled once a week, as recording studios do. The playback results, as one might expect, varied slightly according to the individual deck. Best results were obtained on machines equipped with Dolby B NR. The tape type used in the cassettes is a cobalt formulation which seems to provide a mixed result. While it certainly seems able to handle higher recording levels, and therefore deliver higher

playback levels than most commercially available cassette tapes, it also generates slightly more noise between tracks and during quiet music passages if played without Dolby B NR. This is a fair trade-off which consumers should be aware of, especially if they play back these tapes without Dolby B decoding. If at all possible, try to use the Dolby B NR to get the excellent benefits. Even if you cannot, you will see that, once the music kicks in, the increased levels more than overcome any increased tape noise. The final cassette product is very good, good enough to surprise even the "golden-eared" audiophile. MCA's cassette duplication technique is one which other record companies would do well to emulate.

One gripe I do have with the cassettes concerns their packaging: There is hardly any information on the inserts. The cassette format will help to introduce this music to new and younger audiences, and these audiences need information. There is plenty of room on the inside of a cassette label to provide names, dates, instruments, and related recording data. It would take just a little more time and money to make the packaging as informative as the tape is sonically hot.

As a final note, I also listened to two recently recorded MCA/Impulse! releases: Pianist Henry Butler's *Fivin' Around* and flugelhornist/trumpeter Mike Metheny's *Day In-Night Out*. These are digitally mastered—*Fivin' Around* was digitally recorded and mixed—and are excellent examples of digital recording technology. Musically, the Butler album (also in CD and cassette form) stands out as an experience not to be missed. The accompanying players (Charlie Haden, bass; Billy Higgins, drums; Freddie Hubbard, trumpet; Azar Lawrence, tenor sax; Steve Kujala, flute; and Jeff Clayton, oboe) create a beautifully strong album filled with varying musical layers, expressions and changes. Recording engineer Bernie Kirsh, known best for his work with Chick Corea, and one of the finest engineers around, has done a sterling job. A



Photographs: Frank Driggs Collection

**THIS MONTH'S
BIG EVENTS
ON CBS
COMPACT DISCS.**



A P R I L

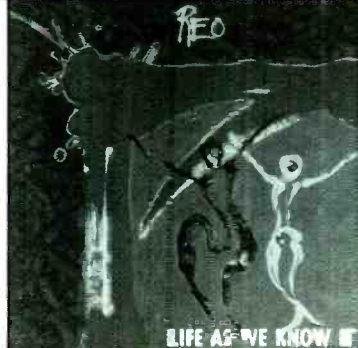
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COLUMBIA
YEARS
1943-1952**

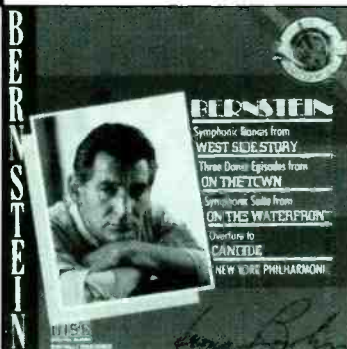
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AND MORE!



8

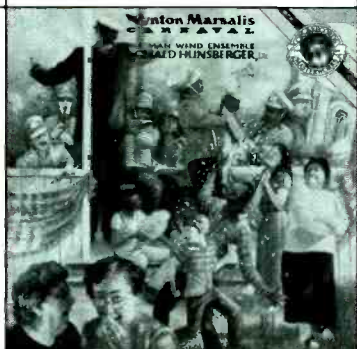
12



14

15

18



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CHOPIN: Piano Concerto No. 1: Fantaisie,
Op. 49; Barcarolle; Berceuse Perahia;
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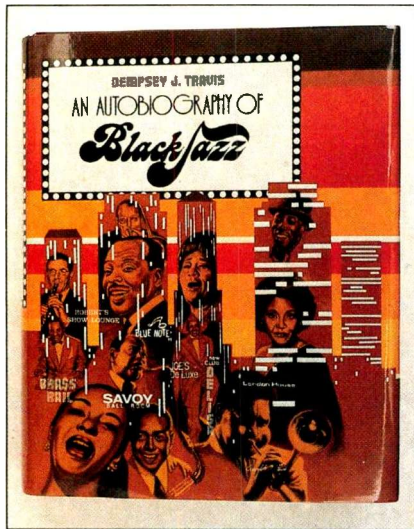
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SOUTHSIDE STORIES



An Autobiography of Black Jazz by Dempsey J. Travis. Urban Research Institute, 543 pp., \$22.50.

Former pianist and bandleader Dempsey J. Travis, now a successful real estate entrepreneur, has compiled a unique history of Chicago jazz which ought to satisfy almost anyone interested in that city's tumultuous past.

Privately published and distributed originally by Academy Chicago in 1983, *An Autobiography of Black Jazz* has proven difficult to find in bookstores. I learned about it from my good friend, jazz author and producer Stanley Dance, and luckily was able to locate a copy in a Manhattan bookstore. (Editor's Note: The book can now be ordered from the Urban Research Institute, 840 East 87th St., Chicago, Ill. 60619.)

Through Mr. Travis' eyes and ears, as well as those of his parents, dozens of veteran black Chicago jazzmen, and black pioneers from the world of real estate and finance, the South Side of Chicago almost literally jumps off the page into one's mind, as the jazz world of Hentoff and McCarthy's *Hear Me Talkin' to Ya* did 30 years ago. *Black Jazz* covers only Chicago, but that is quite enough for one book. So much happened there that it takes the memories of dozens of behind-the-scenes people to tell the story of how nightclubs, ballrooms, and theaters important in Chicago's jazz history developed.

More than 200 photographs, most of which I've never seen before, are in-

cluded, with one showing legendary boxing champion Jack Johnson leading his band at the Cabaret de Champ. This club, the author tells us, was filled with Rembrandts and rare and valuable objets d'art. Pictures of the floor show at the Rhumboogie, a nightclub that drained a great deal of boxer Joe Louis' money in the '40s; the show at the Club DeLisa; street scenes, and so on all help bring the South Side alive to those of us who weren't witness to the vital years of Chicago's growth.

The freedom of movement which most blacks take for granted today was somewhat of a rarity back then, as the author illustrates in a story of how some key players in Earl Hines' band left to join Don Redman in Detroit in 1931. On their arrival, they found that they were to return forthwith to the Hines band, as the Mob did not permit any such casual leave-taking. Hines himself was under lifetime contract to manager Ed Fox, and in the event of Fox's death, to his son and subsequent heirs, for \$150 a week. It would take Hines nearly a decade to break that contract.

Men unknown to the vast majority of jazz lovers regularly emerge from the pages of *Black Jazz*. Bassist Harry Gray, who played in many big and small bands in a lifetime on the South Side, was known as "Fearless" in his role as president of a black union, Local 208. He never once hesitated to walk into the offices of the toughest gangsters, alone and unarmed, to demand that they pay up for services rendered by the hard-working members of his local.

The author relates how leading white theatrical stars like Sophie Tucker, Fanny Brice, and Al Jolson were in regular attendance at the Dreamland Ballroom, attempting to learn the unique styles of the performers who appeared there. One of them was Alberta Hunter, who constantly refused Miss Tucker's blandishments to teach her "Someday Sweetheart."

The building up of one neighborhood and subsequent relocation to another is detailed in the old financial records of lawyers and bankers who helped bring about black urban prosperity. For instance, as the entertainment center shifted to South Park (now Martin Luther King Drive), the huge,

ornate Regal Theatre and Savoy Ballroom complex opened with tremendous fanfare in 1928. However, it enjoyed only a short period of prosperity before the Depression hit. The ballroom, built by the same people who established Harlem's Savoy in 1926, was forced to cut back to one or two nights of music per week, with boxing and later roller skating and other functions helping to keep it in operation. In 1936, we are introduced to Dr. Jive Cadillac—not a disc jockey, but a member of the *Chicago Defender* newspaper's advertising staff. Dr. Cadillac helped rebuild the Savoy as a major attraction by starting a policy of booking "name" bands.

We learn too about Garfield Boulevard, where Sam "Golf Bag" Hunt, Mob operations boss for the South Side, ran the gambling action at Dave's Cafe. Dave's, a miniature Caesar's Palace with the best jazz units, ran successfully through the worst years of the Depression. Hunt, a leading executioner for Al Capone, acquired his name because he carried his submachine gun in a golf bag. During this stage he was content to take black union leaders' collection dues in thousand-dollar-a-point blackjack games.

There is far too much detail for me to go into here, but the book reads the way a superb storyteller relates his tales around the dinner table or at the neighborhood tavern. Names of club owners, managers and bouncers, details of exterior and interior decor, and other small facts abound throughout *Black Jazz*, allowing the reader to press his or her nose up against the windowpane of Chicago's colorful past.

I have a few minor misgivings. I wish the photographs weren't so poorly reproduced. And there are some interviews in the second half of the book—with Dizzy Gillespie, Clark Terry, Max-

Audio began publishing interviews of record producers, by Ted Fox, in our January 1985 issue. Twelve of these interviews have been compiled in Mr. Fox's recently published book *In the Groove: The People Behind the Music* (St. Martin's Press, 361 pp., \$18.95).

ine Sullivan, George Kirby, et al.—which, while interesting enough, add little to our knowledge of Chicago's jazz story. Nonetheless, they do not detract from the tremendous vitality of *Black Jazz*, which brings Chicago's past to life as no other work I've ever read.

Black Jazz is a follow-up to the author's 1981 *An Autobiography of Black Chicago*, which, while more of a sociological and anthropological study, had plenty of interest from a jazz historian's point of view. *Black Chicago* and *Black Jazz* may not please the strict sociologist, but it makes—for this reviewer—endlessly fascinating reading. It pulls one back to the records of King Oliver, Louis Armstrong, The Dodds Brothers, Albert Ammons' Rhythm Kings, Roy Eldridge, Horace Henderson, and so many more who were the life force of an entire generation. *Frank Driggs*

The Penguin Guide to Compact Discs, Cassettes and LPs by Edward Greenfield, Robert Layton, and Ivan March. Penguin Books, paperback, 1,217 pp., \$14.95.

The very title of this 1,200-plus page guide sets its tone: The LP is played down, while the CD takes the spotlight. The cassette comes in somewhere between the two, as the medium which has bridged the old and new eras.

The authors of this impressive and highly readable book out of Britain are Edward Greenfield, Robert Layton, and Ivan March, all of whom have top credentials in various areas of music: Criticism, broadcasting, journalism, and performance.

Just about every classical-music CD available at the time of editorial sign-off has been included in the authors' coverage. As they state in the preface, the CD catalog has only now attained a size large enough to warrant the kind of full-blown treatment that it receives here. Even so, there are many works that have not yet made it onto CD, either because they are far from the musical mainstream or because they were written by composers currently out of vogue. Therefore, the authors have supplemented their CD (and cassette) listings with coverage of the best LPs of the past. Still, it is easy to get the feeling that the LP is virtually obso-

lete and that, in only a few years, all great legacies of recorded sound, whatever their vintage, will become available on CD.

The book opens with a detailed description of the CD in terms any layman can understand. The authors do not downplay the sharp criticism aimed at early CDs by those who heard strident violins and general harshness in some of the first discs. The authors blame these early problems, rightfully, on the industry's rush to get product into the field. In doing so, they used master tapes that had been "shaped" for analog LPs. The extent of such shaping is variable, and of course it was done to compensate for some of the inherent nonlinearity in the LP medium. When such a master is transferred directly to the digital medium, the shaping of the signal will be evident in the final product, inasmuch as there are no equivalent nonlinearities in the CD. The industry eventually realized its error and went back to the earliest sources available for CD remastering.

The engineering community has also gone back to saner and simpler microphone techniques, realizing that the added power bandwidth of the digital medium, not to mention its virtually inaudible noise floor, has created almost a direct connection between the control room and the listener's living room. The inevitable conclusion is that if the recording sounds "right" at the time of recording, then it is that sound which the consumer deserves to hear.

The authors also observe the striking similarities between the birth of the CD and that of the stereo LP. Both events were revolutionary, pointing the way for key recordings by the great artists of the day and, coincidentally, the exercising of newly gained technical prowess on the recording side. At the same time, each new medium was used to maintain the best of the previous epoch, and we see that today in the generous reissue of recordings by Reiner, Walter, Szell, and Klemperer.

In the body of the guide, the authors use a simple three-level grading of performances and recordings; these can be roughly translated as excellent, good, and fair. On rare occasions, a special accolade is given a recording which the reviewers consider superlative in all respects.

In the case of multiple recordings of the same work or groups of works, all the listings are made first, followed by a general discussion and comparison of the recordings. Quite often, the authors will refer to an older LP issue, not presently available on CD, and these may be listed along with the current CDs and cassettes.

The authors make many references to cassette quality, especially if they consider the transfers to be noteworthy. Let the reader beware, since quality control in cassette duplication is one of the embarrassments of the industry, both here and in Europe.

It is interesting to see how the authors cope with those composers who, at least at press time, were not represented on CD. Arensky, Arne, Arriaga, and Auber, for example, are given one LP entry each, and their presence in this guide is basically for the sake of completeness. In the case of Hindemith, whose star is presently down, there were no CDs at sign-off time. The authors include two LP entries—a little short, I would think, for such an important composer. Henri Dutilleux, the important contemporary Frenchman, does not show up in the guide at all. There may be no CDs, but there are certainly important LPs of his work. Many apparent omissions are, of course, due to taste and preference, and for the most part I am in close agreement with the authors. Fortunately, the present rapid CD release rate is correcting many of the omissions, and we can all be happy to note that Hindemith and Boulez, neither of whom had CDs at press time, are now beginning to be represented in the catalog.

Several items reviewed in *The Penguin Guide* had not yet made it to the record stores in my area (Los Angeles) by the time I received my copy. For instance, the Erato recording of Honegger's Second and Fourth Symphonies (with Charles Dutoit leading the Bavarian Radio Symphony Orchestra) was distributed here some three or four months after its release in Europe. Such delays will unfortunately be with us always.

The great bulk of *The Penguin Guide* is devoted to major works organized by composer. Additional sections include listings of multi-composer collections, with sections given to orches-

While the business end of broadcasting is the focus of *The Continuous Wave*, great engineering pioneers do not get short shrift.

tras. instrumentalists, and vocalists/choral groups.

In every regard the writing is lucid, to the point, and perceptive. It is often entertaining and always interesting. Anyone who is committed to the CD and is actively building a collection should not be without this important reference.
John M. Eargle

The Continuous Wave: Technology and American Radio, 1900-1932 by Hugh G. J. Aitken. Princeton University Press, hardback. 588 pp., \$67.50; paperback. \$19.95.

The Continuous Wave is not unlike several other books that have come out over the years in which audio or related industries have been chronologically explored in detail. One of the first of the genre that I was exposed to as a high-school "hi-finatic" was *From Tin Foil to Stereo*, by Read and Welch. That book did not explain the details of phonograph construction from an engineering point of view, but rather explored the impact of the phonograph on business, commerce, and the way customers reacted to the new wonder of the age. Another, similar book, *Saga of the Vacuum Tube*, by Tyne, took a similar tack in dealing with the development of the amplifying-tube industry. That book, in fact, is cited in the footnotes of *The Continuous Wave*.

This book deals with the earliest days of radio communications. The very first radio transmitters were more or less electrical noise generators, producing the sort of noise that your radio picks up when you run a blender or a vacuum cleaner. The output of these transmitters was pure hash—but it could be controlled, turned on and off, keyed by means of a telegraph key. There were no transistors, crystal diodes, or tubes to receive the earliest signals. What many pioneers used was a sort of electrostatic relay called a coherer, a mechanical device which responded to radio signals by becoming a good conductor which could make a telegraph sounder "clap." Unfortunately, when the signal went away the coherer remained cohered and the telegraph sounder remained clapped! Ways were found around this problem, but radio was plagued by susceptibility to extraneous noise interference.

The system, being based on a transmitter that essentially generated hash, was unable to transmit meaningful sound. What was required for voice and music transmission was a generator of pure sinusoidal waves, continuous waves.

What Aitken does in this book is to delve into how technological change and organizational change influence each other and how the government influences both. We see the various small, then large, wireless communications companies form, merge, disappear. The book details the formation of the Radio Corporation of America (RCA) from American Marconi and Federal Radio, with the help and power of General Electric and the influence of various departments of the American defense agencies.

While the business end of the broadcast industry is the focus of the book, the great pioneers of broadcast engineering are not given short shrift. The contributions of Reginald Fessenden, developer of the heterodyne receiver, are explored in some detail. We are told of his disdain for spark transmitter technology and of how he got GE interested in developing high-frequency alternators to produce r.f. signals, with the ultimate goal of voice transmission. Similarly, the development by Cyril F. Elwell of an arc transmitter, another generator of continuous r.f. waves, is detailed: we are told of his huge, 60- to 80-ton arc transmitters and the eventual formation of Federal Telegraph Co. The great accomplishment of Dr. Lee DeForest, the invention of the vacuum tube, is also given a chapter. One of DeForest's contributions to radio communications that I was not aware of was the simple (for now) concept of receiving radio telegraph messages not via mechanical printing devices or telegraph sounders but by means of the earphones of a headset. The ability of a radio operator to use his brain to filter out static and electrical noise allowed DeForest's communications system to be far more accurate than that of his competition.

Thus this book details the lives of many of the pioneers of continuous (as opposed to spark) wireless technology, those who sought the transmission of the sound of the human voice and music rather than telegraphic

communication. It shows their developments, the companies formed by them, and the eventual shakedown into America's first radio communications company, RCA.
Mike Stosich

Acoustical Measurements, Methods and Instrumentation edited by Harry B. Miller. Hutchinson Ross Publishing Co., 410 pp., \$57.

The title of this volume might lead you to believe that it is a "how to" book, but it isn't. A collection of papers by scientists and experimenters who merit being called "masters" of the art of acoustics, it is more like a history book—and an exciting one at that!

The book, part of a series called *Benchmark Papers in Acoustics*, is divided into six sections. Part I is called "Nonelectroacoustic Oscilloscopes, Wave Analyzers, and Microphones." This might sound a little heavy, but I assure you that it is really worth investigating. The first paper, "Mémorial on the Optical Study of Vibratory Motion" by J. Lissajous, is a classic, originally published in 1857. I'll bet not many audio engineers have seen the original before, even though they have used the results in their lab work. This paper is the basis for the modern electronic oscilloscope technique used to determine the frequency of any sound. The book reproduces a series of Lissajous patterns from the original plate, as well as drawings of the instruments used by Lissajous to gather his data.

The second paper in Part I, "On the Sensations of Tone" by Hermann Helmholtz, is also a classic, derived from the Helmholtz book which bears the same name. In this excerpt, the vibration microscope, which Helmholtz derived from Lissajous' vibration comparator, is illustrated, and some of his original investigations into the vibratory motion of stringed instruments are described.

The fourth paper, "Sound Waves: Their Shape and Speed" by D. C. Miller, shows the waveforms of tones produced by musical instruments. The asymmetrical nature of the various sounds is easy to see and gives some weight to the argument that maintaining the absolute polarity of acoustical signals is important. There are eight other papers in Part I, filled with gems

This book is not just a compendium of old papers; the editor has gotten to the meat of the material while removing the fat.

of information such as the shapes of different sound waves, measuring devices, horns and diaphragms, etc.

Part II, "Electroacoustic Microphones and Closed-Cavity Calibrations," consists of four papers which are historically very interesting. The excerpts from papers by E. C. Wentz of Bell Labs, which deal with the absolute measurement of sound, contain drawings of the condenser transmitter he used for his experiments and details of the design.

I found Part III, "Direct Visual Observation of Sound Waves," the most interesting section of the book. There are excerpts from nine papers which describe various methods for making sound waves visible. The first, by A. Toepler, describes an optical method of observing sound. The term "schlieren" is used to describe the "streaks" which result from a change in the density of the medium; the paper goes on to describe the method Toepler used to see sound waves. It was done by taking advantage of the diffraction of light caused by the change in air density which sound waves produce. In "Wave Propagation" W. E. Kock of Bell Labs shows the effect of an acoustic lens upon sound waves. Many other interesting photos showing sound waves also appear in Part III.

Part IV deals with free-field calibration methods and includes excerpts from papers by such famous acousticians as Ballantine, Wiener, and Lord Rayleigh. Excerpts from the paper by Wiener called "Sound Diffraction by Rigid Spheres and Circular Cylinders" contain graphs of these effects, and they should be of interest to anyone who uses microphones or builds loudspeakers. Also included in this section of the book is an excerpt from the famous paper by Hanna and Slepian, "The Function and Design of Horns for Loud Speakers."

Part V has papers on sound absorption and acoustic impedance. These topics should prove to be very interesting to anyone who is concerned about the effects of the listening environment upon the quality of sound reproduction.

The last section is titled "Phase Distortion and Transient Distortion in Electroacoustic Systems." Its first paper is "Measurement of Phase Distortion,"

first published in 1930 by Nyquist and Brand. Yes, this is the same Nyquist whose sampling theorem is used today as the criterion for digital recording. Corrigton's classic "Transient Testing of Loudspeakers" is here also. Last (but not least) is the trend-setting paper by *Audio*'s Senior Editor Richard C. Heyser, "Loudspeaker Phase Characteristics and Time Delay Distortion: Part I," which appeared originally in the *Journal of the Audio Engineering Society* in 1969. This is the paper that made some of us loudspeaker designers pay more attention to the time offset between different ranges of the sound spectrum caused by time delays in the loudspeaker drivers and crossover network.

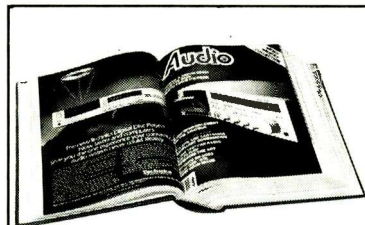
I would like to make it clear that this book is not just a compendium of old papers. The editor, Harry B. Miller, has done an excellent job of getting to the meat of the material while removing the fat. In the case of the Lissajous paper, he also translated from the original French. Mr. Miller is considered by many to be a "master" in his own right, and I think he has, with this book, done a great service to anyone interested in audio and acoustics. Throughout, he has added notes which help clarify some of the more obscure points which might otherwise be missed by nonspecialists. This is especially true in the very early papers, where rather imprecise or archaic language is sometimes used. I'm not faulting the early originals. You must remember that they were written many years ago, by pioneers who had to invent not only their own instrumentation and procedures, but their own descriptive terms as well. Some of these terms have been altered in meaning with the passage of time, and the editor does a good job of bringing out the original meaning in his notes.

Acoustical Measurements, Methods and Instrumentation is filled with information that is not only interesting but valuable. It might even help you to make changes in your music-reproducing system or listening room which will render your music listening more enjoyable. If you have any interest in the technical aspects of sound, either live or reproduced, then I think you will find that this book is worth having.

Edward M. Long

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Mr. Eargle's chapter on stereo imaging should be required reading for all who can't see beyond the multi-track recorder.

Handbook of Recording Engineering by John Eargle. Van Nostrand Reinhold Co., 405 pp., cloth, \$54.95.

Little more than a decade ago, the reader in search of a good text on sound recording didn't have much to choose from. Of course, there was the

famous *Audio Cyclopedia* and a handful of classics, but some of these were beginning to show their age. As for coverage of such newly emerging topics as multi-track technology, it was slim pickings indeed.

Then, in 1976, the first edition of John Eargle's *Sound Recording* came

out. A second edition followed in 1980, and the book quickly established itself as one of the definitive college-level texts in the field. This should come as no surprise, since among the author's many other credentials (as a recording engineer, pianist, Audio Engineering Society past president, and too much more to mention here), he has served on the faculties of the Aspen and Eastman Schools of Music.

In between everything else he does, Mr. Eargle has found the time to write the *Handbook of Recording Engineering*, which he describes in the preface as a logical outgrowth of his earlier work. Like *Sound Recording*, it begins at the beginning, with a very basic treatment of the concepts of vibration and noise. Then it's on to the decibel and sound-pressure measurements. By the end of the first chapter, the reader should have a very good idea of the behavior of sound.

The next five chapters treat the various devices and techniques of recording, in more or less the order in which they are encountered: Microphones, stereo imaging techniques, audio transmission systems, monitors and monitoring, and then back to signal processing.

I especially liked the chapter on stereo imaging, which should be required reading for all those who can't see (or hear) beyond the multi-track recorder. Although some of the author's phasor diagrams and polar patterns have not been reproduced as carefully as they should have been, the reader does get an excellent overview of the various stereo microphone techniques that have been developed, with particular attention paid to the M-S system.

The chapter on audio transmission systems may be a little rough going for the nonspecialist reader. It begins with brief discussions of equivalent input noise and load bridging/matching, followed by a more detailed account of gain structure and audio-system architecture, mostly as it relates to the ongoing struggle between signal and noise. This is followed by a rather quick run-through of console functions, including a conceptual look at automation and the SMPTE time code.

The chapters on recording techniques for classical and popular music should give the amateur recordist

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enough pointers to keep busy for a very long time indeed. As for the former, it seems that the emergence of digital technology is being accompanied by a return to "simpler" recording techniques. The only trouble is, simple isn't so simple after all; it's easy enough to get everything on tape when there are more tracks and microphones than musicians. Or, as everyone knows, one can always "fix it in the mix." Recording it so that it doesn't need that mix-fixing is quite another matter. As well as can be done on paper, Eargle shows us how.

Of course, there are times when multi-tracking is the best way to record—if not the only way. The production advantages are obvious, especially given the current rates for studio time and talent. Even for the home recordist, the author's pop-music recording techniques can be put to good use: since few of us have the luxury of an acoustically ideal environment in which to record, there's often a good reason for more microphones, even if no more than two tape tracks are available. Home recording doesn't always have to sound like everyone phoned in their parts, and Eargle offers a wide variety of tips and techniques.

After the chapters on recording techniques, it's back to hardware again, with chapters on analog magnetic recording and disc recording. In the discussion of analog magnetic recording, Eargle reviews bias, recorder equalization, and magnetic tape itself, and offers a quick look at the tape transport and azimuth alignment. Multi-track sel-sync is briefly mentioned but is not covered in great detail. Here, the focus is on the details of optimizing the machine for the tape in use, leaving the day-to-day production details for others to discuss. The disc-recording chapter confines itself to the long-playing record and does not discuss the Compact Disc. Surprisingly, Eargle gives this chapter considerably more space than he devotes to the chapters on the analog tape recorder and on digital recording.

Eargle winds things up with a chapter which provides an overview of the low-cost studio. This combines notes on preparing a business plan, some practical suggestions ("Take careful note of who your neighbors are"), a

few tips on budget acoustics, and a brief look at low-cost hardware.

Here and there, Eargle's treatment assumes the reader already has a more-than-casual knowledge of the subject. But for any interested reader—student or otherwise—who is prepared to give the subject a little serious

attention, the *Handbook of Recording Engineering* will be a welcome addition to the audio library. Its price is getting up there, but if Eargle shows you how to get by with even one fewer microphone, he's saved you a lot more than you paid for the book. In that case, it's a bargain. *John M. Woram*



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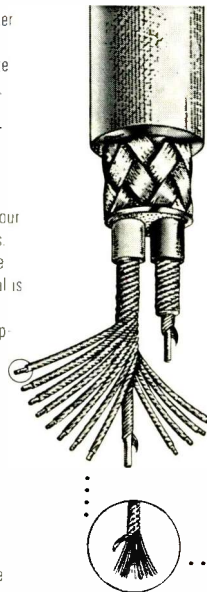
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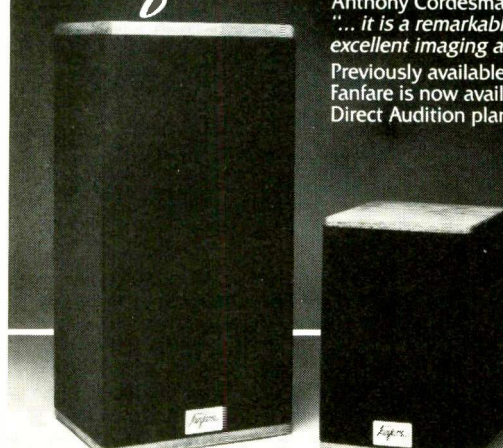
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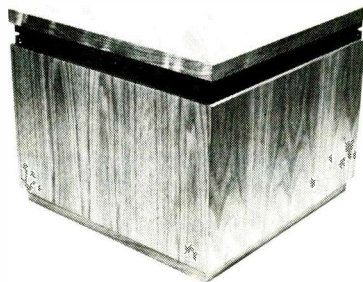
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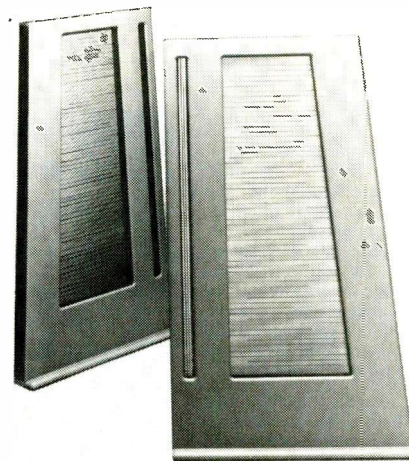


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1.8	.30	.88	3.5	12.40
2.0	.31	.88	3.5	13.00
2.25	.33	.88	3.5	13.80
2.5	.36	.88	3.5	14.60
2.75	.39	.88	3.5	15.30
3.0	.42	.88	3.5	16.00
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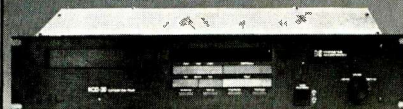
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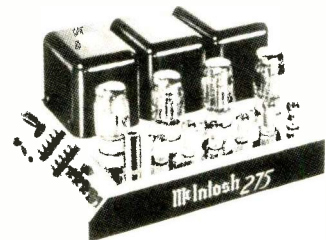
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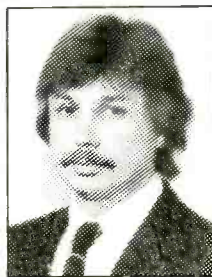
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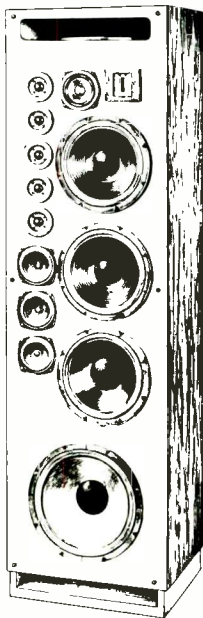


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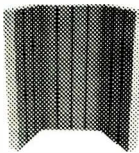
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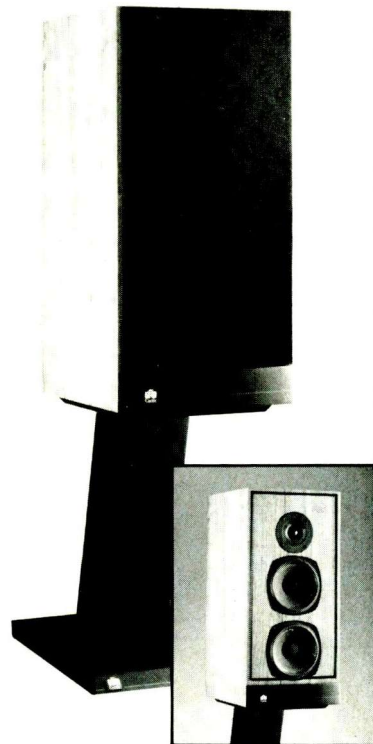
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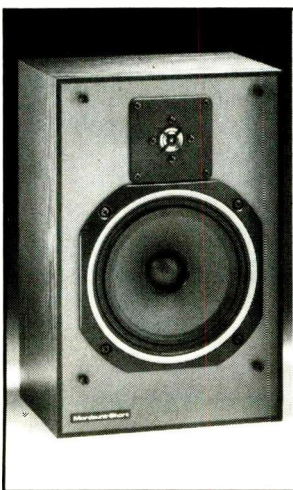
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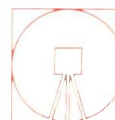
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