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IN CHINA

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## ACCUPHASE G-18 EQUALIZER

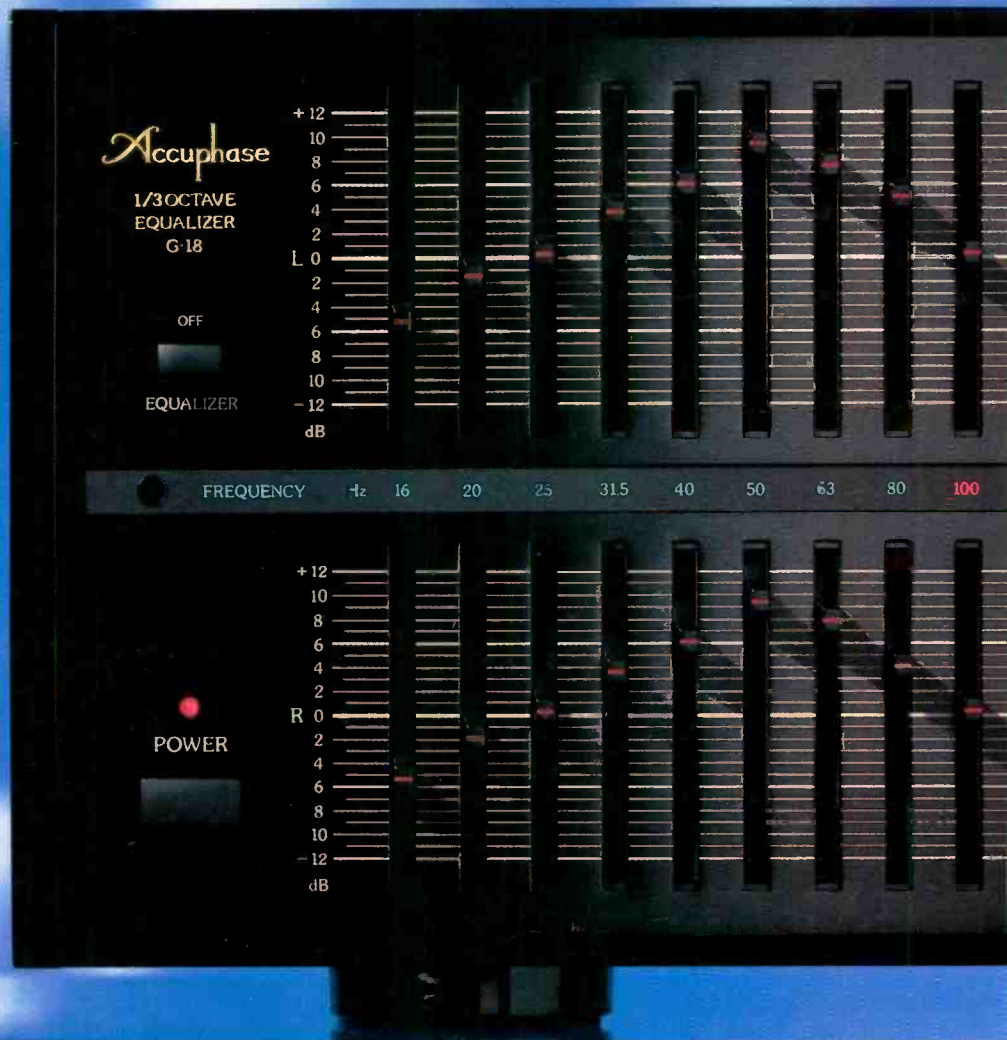
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absolute  
control*

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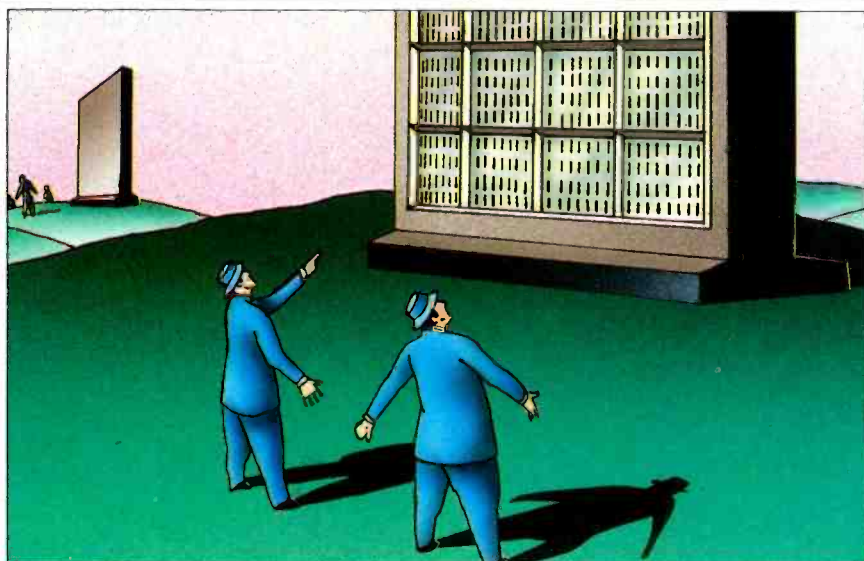


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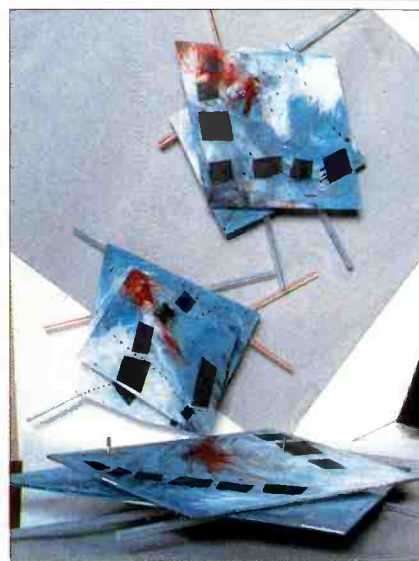
# Audio

APRIL 1989

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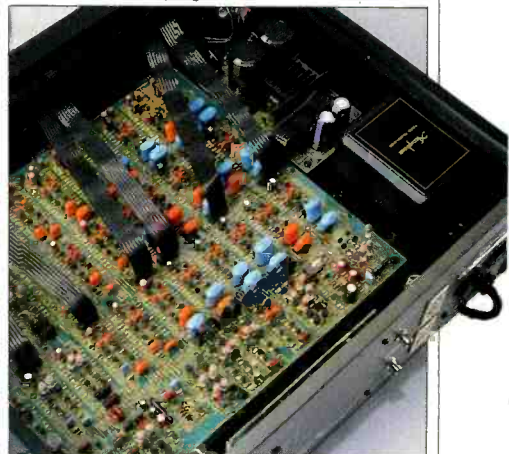
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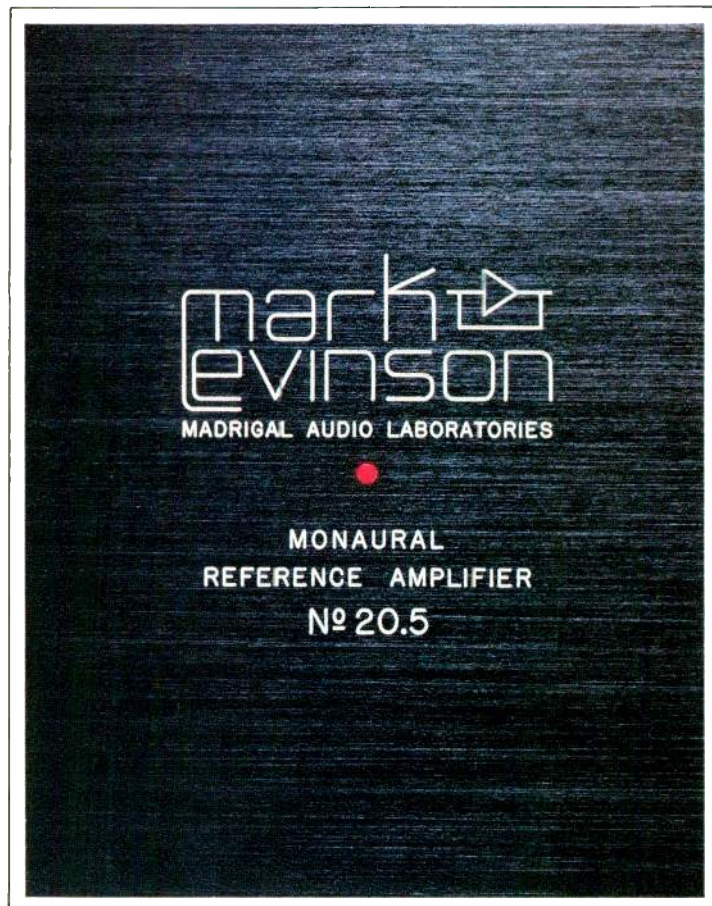
The Cover Equipment: Accuphase G-18 third-octave equalizer.  
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ENGRAVING — January 1989

In the three years since the Introduction of the Mark Levinson No. 20 Monaural Reference Amplifier, advances in circuit topologies and components available to the Madrigal design staff have made it possible to produce a new reference. The No. 20.5 Monaural Reference Amplifier is an ultimate statement of our craft and a benchmark for future designs.



It enables you to achieve emotionally complete musical reproduction in your home. Owners of the No. 20 may incorporate these advancements through an exchange of modules. Mark Levinson products are handcrafted in limited quantities to ensure their high standards. Visit your Mark Levinson dealer to hear how good music can sound in your home.

## Denon introduces Pre-Mote Control.



Finally there's a remote-control component that didn't forget why audiophiles buy separates in the first place. Better sound.

The Denon DAP-2500 Pre-amplifier incorporates push/pull digital-to-analog converters that will improve the sound of the CD Player you have now... and the digital tuner and tape deck you may have soon. Denon's MM/MC phono inputs reveal more of the music that's on your LPs. But the practical beauty of the DAP-2500 is its Integral System (IS) Remote Control, which also operates audiophile-grade Denon Cassette Decks and CD Players.

Sure, the Denon DAP-2500 stacks up favorably against the most vaunted audiophile preamps. But from now on, there's more to choosing a pre-amp than meets the ear.

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DESIGN INTEGRITY

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**The Lirpa of Luxury**

Dear Editor:

Readers of your magazine who are interested in acquiring DAT recorders may be interested in Lirpa Travel's all-inclusive three-day DAT shopping tours to Tokyo's glamorous and exciting Akihabara electronics store district. There, *Audio* readers will have the choice of more than 30 home, portable, car stereo, and professional models to choose from, and more than 2,000 shops to visit—all within walking distance of their hotel—and for prices lower than you'd expect to pay for a DAT recorder at your neighborhood audio specialty salon.

For example, a Sony TDC-D10 portable sells in some American shops for \$3,500. But you can take our DAT shopping express, arranged in conjunction with Kintetsu International Express, have dinner at your hotel in Tokyo, and return with a TDC-D10 for an all-inclusive price of \$2,700—a savings of \$800. Or if you're in the market for a Technics Model SVD-1100 home deck, the savings over the U.S. retail price of \$4,000 is \$900. Tour prices are good for April 1 only and are based on double occupancy. Departure will be from New York's John F. Kennedy International Airport, on All-Lirpa Airways. The actual price of each tour depends on the make and model DAT unit you select.

Here's the itinerary: Check in at ALA's departure terminal at JFK on April 1. Your Boeing 747 Skyliner will whisk you to Tokyo's new Narita airport, landing at 4:15 the following day. (En route, you cross the International Date Line, an experience savored by all world travellers.) After clearing immigration and customs, board an air-conditioned Airporter coach for a trip to the downtown T-CAT terminal, a few minutes by taxi from your hotel, the Washington, located in the heart of bustling Akihabara.

There's time for a leisurely dinner in the hotel coffee shop before turning in for a good night's rest. The following morning, after a typical Japanese breakfast, our experienced guide will direct you through the maze of electronics specialty shops which make up Akihabara, to the one which offers you the best deal on the make and model you have selected. You are, of course,

free to do any other shopping you wish in this audiophile's bargain paradise before grabbing a cab back to the T-CAT terminal for your return, via Airporter coach, to Narita airport. Thanks to the International Date Line, you arrive back at JFK only moments after you left Narita—on the same day! The only difference is that you now own the DAT recorder of your choice and have enjoyed a unique shopping experience! Total elapsed time: Just over 72 hours.

Side trips and extensions in Japan are, of course, available from our office—if booked at the time of the initial reservation.

Irene Lirpa  
Member, A.S.T.A.  
Lirpa World Tours  
New York, N.Y.

**Remote Control Life Preserver**

Dear Editor:

Leonard Feldman's review of the Yamaha CDX-1110U CD player (September 1988) makes note of the seemingly useless remote open/close drawer feature. My Denon DCD-900 also has this feature, and I have always been amused by its presence. However, I thought your readers would like to know that this feature does have an extremely vital function.

One evening a few weeks ago, I had dozed off in my listening chair during Vivaldi's "Four Seasons." I awoke to find a young and rather nervous burglar standing beside my component cabinet, pointing a small-caliber handgun at me. He half-heartedly squeaked out: "Hold it right there, mister," with a lump in his throat larger than the one that was in my own.

Because I had the remote control for the CD player in my right hand, I quickly remembered the drawer open/close button. I gently pressed it while staring the intruder in the eye. As the drawer opened, it hit the smoked glass door of the cabinet with a loud "thunk" and proceeded to push the door all the way open. The opening door tapped the burglar on the elbow, startling the hell out of him. He turned so quickly that he smashed his thumb against the edge of the glass and dropped the gun on the rug. I shouted, "Get him, Ed," although no one else was in the house. I leaped from my chair to the floor. Ex-

pecting Ed, the bewildered prowler turned toward the door; meanwhile, I reached the gun and trained it on him.

A prompt response from the police had the culprit on his way to the hoosegow in less than 10 minutes.

So, when you smirk at the drawer open/close feature on your CD's remote control, remember that it might save your life some day!

Prof. I. Lirpa  
Horse's Breath, Mont.

**Quip of a Quote**

Dear Editor:

I enjoyed Leigh Silverman's article, "Earning a Deaf Ear: Loud Music and Hearing Loss" (January). However, the lead quote that was attributed to me was a humorous remark of a friend, Dr. Dixon Ward, during one of our ragtag barbershop quartet practices. (Dr. Ward is now a leading researcher in noise-induced hearing loss but worked his way through college by playing piano in a band.) As best I can recall, what he said was: "I think God must protect musicians, or they would have much greater hearing loss than they do." If I didn't attribute the quote to Dr. Ward, who knows a hell of a lot more about hearing loss than I do, I should have.

Mead C. Killion  
Elymotic Research  
Elk Grove Village, Ill.

**Dubber's Delight**

Dear Editor: ;

"EQ and NR: Striking a Balance" (August 1988) finally answered some tape deck questions which had been bothering me. First, why didn't Nakamichi provide automatic EQ/tape switching on the BX-300? (Your review of the similar Nakamichi CR-4A deck, in the same issue, emphasizes the freedom-of-choice versus responsibility-for-setup question.) Second, if I still intend to listen to a tape at home, should I record in Dolby B or Dolby C NR for a car deck equipped with only Dolby B NR? (Answer: Use Dolby C NR.) Third, is there a lot to be gained by combining Dolby C with dbx NR? (Answer: Advantages are slight.) A great article for button-happy, NR-conscientious tape-ophiles. Thanks!

David Ochroch  
Arlington, Va.

# MCINTOSH is

## EQUIPMENT FOR PROJECT RENOVATION

### AREA #1 LIVING CENTER

#### EQUIPMENT FOR AREA #1

- 1-MC 334V AUDIO-VIDEO CONTROL CENTER
- 2-MC 2500 AMPLIFIER
- 3-MC 7007 COMPACT DISC PLAYER
- 4-MR 7082 TUNER
- 5-CR-7 REMOTE CONTROL
- 6-XRT-22 LOUDSPEAKERS
- 7-B-MQ 107 EQUALIZERS
- 8-TURNTABLE
- 9-CASSETTE DECK
- 10-R-607 SENSOR

### AREA #2 ROOMS TO BE COVERED:

- 1-RECREATION ROOM
- 2-WORKSHOP
- 3-LAUNDRY
- 4-BARRIROOM

#### EQUIPMENT FOR AREA #2

- 1-MC 7270 AMPLIFIER
- 2-XR 1092 FOR REC ROOM
- 3-3 PAIR WMS-1 (N WALL SPEAKERS FOR OTHER ROOMS IN AREA #2)
- 4-MR 7082 TUNER (FOR STATION SELECTION THAT IS INDEPENDENT OF THE MAIN AREA)
- 5-CR-8 AREA CONTROLLER

### AREA #3 MASTER BEDROOM SUITE

#### ROOMS TO BE COVERED:

- 1-MASTER BATH
- 2-MASTER SITTING AREA
- 3-SLEEPING AREA

#### EQUIPMENT FOR AREA #3

- 1-MC 7270 AMP-LIFIER
- 2-XR 717 LOUDSPEAKERS FOR SITTING AREA
- 3-XL 10 LOUDSPEAKERS FOR SLEEPING AREA (N/ N WALL VOLUME CONTROL)
- 4-PAIR WMS-1 IN WALL SPEAKER FOR BATH (W/ N WALL VOLUME CONTROL)
- 5-CR-8 AREA CONTROLLER
- 6-2-R607 REMOTE SENSORS (W SWITCHING TO ALLOW TV SOUND TO COME THRU THE XR 717 SPEAKERS)

### AREA #4 OTHER BEDROOMS

#### EQUIPMENT FOR AREA #4

- 1-MC 764 AMPLIFIER
- 2-WMS-1 LOUDSPEAKERS IN EACH ROOM (N/ VOLUME CONTROL IN EACH)
- 3-CR-8 AREA CONTROLLER
- 4-R607 REMOTE SENSORS

### AREA #5 GROUNDS AREA

#### INCLUDES:

- POOL
- PATIO
- TENNIS COURTS

#### EQUIPMENT FOR AREA #5

- 3-MC 764 AMPLIFIERS
- 2-CR-8 AREA CONTROLLER
- 3-R607 SENSORS
- 4-R606 MULTIPLE SENSOR ADAPTER
- 5-WMS-1 LOUDSPEAKERS
- 6-OUTDOOR LOUDSPEAKERS

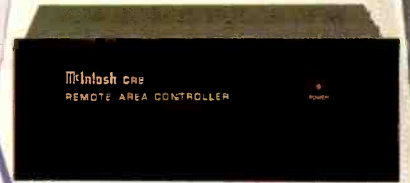
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WHOLE HOUSE  
REMOTE  
CONTROL  
SYSTEM**



**Handcrafted with pride in the United States  
by dedicated, highly trained craftspeople.**



# the answer!



## McIntosh CR7/CR8 Remote Control System

The McIntosh infrared Remote Control System provides unusual versatility with operating simplicity. It is a system which provides remote control in one listening area, yet can be expanded to provide individual source selection with independent volume settings in up to five additional areas. In each of these areas, when connected to a McIntosh tuner, designed to connect to the infrared remote control system and a McIntosh compact disc player:

- 1) you can turn on the AC power to the local area or turn off the AC power for the local area only, or for all areas;
- 2) you can select the listening sound source (tuner, compact disc, or preamplifier) for the local area while other

areas can choose their listening source independently;

- 3) you can adjust the volume in the local area and not affect the volume in other areas;
- 4) when the tuner is the sound source, you can select the stations you wish to hear on either AM or FM and depending on the tuner, scan the preset stations on either AM or FM or search the entire AM or FM band;
- 5) when the compact disc player is the sound source, you can put the CD player in the play mode, shift to the next track or the preceding track on the disc or stop the play from the disc; or you can select the preamplifier as a program source with all of its connected sources.



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C34V Audio/Video Control Center

MCD 7007 Compact Disc Player with  
18-Bit dynamic range

*McIntosh is the answer! Best sound, technological superiority, versatility, quality construction and long life.*

*McIntosh is the answer! Best sound, ease of use, quality performance, technological leadership plus long life.*

The C34V Audio/Video Control Center is the distillation of more than 30 years of technological progress. It is mind boggling in its usefulness and flexibility.

After all, it's really two preamplifiers; it includes:

- The most flexible, complete stereo preamplifier
- The most flexible, complete, separate stereo recording preamplifier
- The most flexible, complete program compressor and expander that can operate in either the listen or record preamplifier
- High quality, high performance distortion-free five band, tone shaping controls that can be used in either the listen or record preamplifier
- High quality, high performance monitor power amplifier that protects your speakers and your music with the exclusive McIntosh Power Guard and Sentry Monitor Circuits.

With the MVS-1 Video Selector, the C34V will provide both audio and video control.

It has a dual preamplifier system that provides separate listen and record program control. You may listen to one program while you are recording a different program. With the McIntosh MVS-1 Video Selector, the C34V will switch

video and audio signals for viewing, listening and recording.

A low noise, electronic input switching system adjacent to the input jacks gives greater source-to-source isolation, low audio distortion, and freedom from noise and hum pick-up.

A five band program equalizer adjusts and improves the loudness contrast of the five most important frequency ranges. Musical balance can be adjusted to compensate for listener preferences.

A precision volume control is electronically trimmed during manufacture to maintain channel balance accuracy to a fraction of a decibel (dB). This high order of accuracy assures continuing program balance as the volume is changed.

An active circuit loudness control is electrically independent of the volume control. Close conformity to the Fletcher-Munson equal loudness curves can be attained, regardless of the volume control position.

A compandor expands or compresses the dynamic range of the program material. Compressed recordings and broadcasts can be expanded to restore dynamic range. Tapes can be compressed and replayed using expansion to improve signal-to-noise ratio.

The third generation Compact Disc player continues the world-wide McIntosh reputation for technological advancement as the reason for a new model. In the MCD 7007, every advanced aspect of performance is improved.

New integral massive cast disc drive platform whose variable reluctance suspension system is adjusted and tuned to reduce or eliminate both high and low frequency resonances, and the impact of vibrations and shock

A low mass, low inertia, high compliance single beam laser pen. The laser pen assembly achieves exceptional radial trackability through a sub-miniature, resonance damped, precisely balanced rigid system design.

The single-spot laser - which was already recognized for its readout purity - stays even more precisely on track and in focus, and the digital signal that is read out is processed even more truthfully. Even in the face of disc eccentricity and warp and of disc defects or dirt that would interrupt play in the majority of players, the sound of the McIntosh MCD 7007 Compact Disc player sets superlative standards of purity.

The focus and collimator lenses, the receiver and transmitter faces employ flat glass replica technology.



A large FIFO memory can adsorb any data stream fluctuations with adaptive error corrections which can handle bursts to 15 audio frames.

The full 18-bit dynamic range is derived from matched linear input to output dual 16-bit digital to analog converters with 4-times oversampling.

The single DAC chip - specifically selected for high specification - incorporates separate 16-bit converters for left and right channels. There is no multiplexing, no delay time between channels, but an extra 4 dB of channel separation.

Both high-precision servos are integrated to a higher degree than ever, embodying many functions that have to be performed with discreet components in other players. For these functions, there is no wear, no deterioration with time no setting-up adjustment to go wrong. Thus a permanent improvement in readout accuracy.

Enhanced performance CIRC provides maximum error detection and correction. Error correction has soft muting reenforced with enhanced error concealment of up to 8 uncorrectable samples.

The motorized front-loading tray is designed to be anti-jamming and protected from damage by forced closure. It will close directly to play the disc or to stand by for additional instruction.

Volume can be controlled from either the hand held remote or the front panel touch buttons.

The 10-key access pad permits direct access to the track desired, any sequence of selected tracks, preprogramming by track, index, time or combination of these.

Three speeds are used to search forward or backward with the sound muted only in high speed mode in either direction.

The MCD 7007's all-integrated system is configured to lay down a new standard for compact disc performance and sound.



McIntosh MR 7082 AM/FM Tuner

*McIntosh is the answer! Best sound, more stations, easier to use, cutting edge technology, plus long life.*

McIntosh has earned world renown for its technological contributions for improved sound. The FM/AM McIntosh MR 7082 Tuner is continuing evidence of McIntosh technological superiority and integrity and the McIntosh reputation for durability, long life, and best sound. In a McIntosh you get user-oriented facilities and appearance, and a design that provides for ease of maintenance or repair. These fundamental elements are incorporated in the McIntosh MR 7082 FM/AM Tuner, the easiest to operate yet with extensive useful features.

Some of the features that set the MR 7082 apart from the ordinary are:

The advanced FM/AM tuner design of the MR 7082 displays the station frequencies digitally. Stations are selected easily by use of the manual tuning knob, use of the SCAN up or down touchbuttons, use of the preset station touchbuttons, or use of SEARCH, which will preview the preset stations for 5 seconds each.

Once tuned, AUTOMATIC FREQUENCY LOCK assures rock solid adherence to the center of the station's broadcasting frequency by tracking any variations that might occur on either FM or AM.

The sound enhancing MONOPLUS audio processor presents, on AM, an aural picture that is more

'stereo-like' in quality and dimension. On noisy, weak FM stations, MONOPLUS provides reduced noise and retains a broad stereo-like sound.

Virtually automatic tuning on AM. The ease of FM tuning has been extended to AM with a new, McIntosh exclusive, AM automatic center tuning circuit.

As in FM, when using the present touchbuttons, the auto-tune circuit searches for the center of the AM broadcast frequency. When there, AM-AFL locks to that center point for drift-free, distortion-reducing, center channel tuning.

The most useful and flexible AM antenna system will suit your particular installation. In noisy AM locations, a noise reducing, noise cancelling, shielded loop will provide an ideal input signal. In a remote location, a conventional 'long wire' antenna can be used, and in strong signal areas, a simple short piece of wire (6' long) will be adequate.

A unique Phase Locked Loop Multiplex decoder delivers STEREO FM with lower distortion, lower noise, and better separation.

A rear panel connector provides adaptability for complete remote control with the addition of a McIntosh infrared REMOTE CONTROL system.



McINTOSH MC7270 POWER AMPLIFIER

**POWER OUTPUT  
IN STEREO**

270 watts minimum sine wave continuous average power output per channel, both channels operating across 1 ohm, 2 ohms, 4 ohms, or 8 ohm loads.

**AS A MONO BLOCK**

540 watts minimum sine wave continuous average power output into 2 ohms, 4 ohms, 8 ohms, or 16 ohm loads.



McINTOSH MC754 POWER AMPLIFIER

**POWER OUTPUT  
IN STEREO**

100 watts minimum sine wave continuous average power output per channel with both channels operating across 8 ohm or 4 ohm loads.

**AS A MONO BLOCK (Bridged)**

200 watts minimum sine wave continuous average power output across an 8 ohm load.

*McIntosh is the answer!  
Best sound, unequalled  
technology, highest  
quality, long life.*

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## Right-Channel Problem

*Q. When playing a cassette, my deck's left channel seems clearer than its right. After cleaning and demagnetizing the heads and checking all connections in my stereo system, the problem remains. I tried switching the interconnects between the deck and receiver—that is, left output of the deck to right input of the receiver, etc.—but then the left channel sounded poor. The problem only affects the high frequencies. All my recorded tapes exhibit the same problem, although they sound fine on other decks. Do you have any idea what is wrong?—Mike Cherepkai, Terre Haute, Ind.*

A. It appears that the problem is in your deck's right playback channel. A variety of things could be responsible. The right (lower) gap of the playback head may have worn excessively, causing treble loss. The right section of this head may have an internal defect, such as a partly shorted coil. There may be a defective transistor, capacitor, or resistor in the playback electronics of the right channel. Finally, a component in the playback equalization circuit for the right channel may have appreciably changed its value.

I doubt that you personally can do anything to remedy the problem, other than to take your deck to a competent service shop. Check with the deck's manufacturer, if possible, to find the names and addresses of the authorized service shops in your area.

## Inputs and Impedances

*Q. A tape deck was recently passed on to me. It has two inputs marked "Right Line Input" and "Left Line Input." What value is line impedance? I can arrange any source needed.—Alexander Bell, Bala-Cynwyd, Pa.*

A. Your question is not quite clear to me. Therefore, I will discuss the subject in general terms, quite possibly beyond your area of interest. Hopefully, you will find your answer somewhere in the discussion.

Line inputs are designed for relatively large signals, typically 0.5 V, and ranging from about 0.1 to 2 V. In contrast, low-level inputs are designed for relatively small signals, typically about 5 mV (0.005 V), and ranging roughly from 1 to 50 mV. Low-level tape deck inputs are intended principally for dy-

amic or capacitor microphones, and similar types with relatively low output. Low-level (mike) inputs are found on about one-third of cassette decks. In the case of receivers, low-level inputs are intended for moving-magnet phono cartridges, while extra-low-level inputs (sometimes furnished) are intended for moving-coil cartridges having an output about one-tenth that of a moving-magnet type.

The line inputs of a cassette deck usually have a load, or input, impedance of 20 kilohms or more—perhaps up to 50 kilohms. Sources such as preamps (tape outputs), receivers (tape outputs), equalizers, noise-reduction devices, tuners, CD players, etc. typically have a source, or output, impedance of about 2 kilohms or less; 500 ohms to 1 kilohm is quite common. The ratio between load impedance and source impedance should be about 10:1 or greater, in order to avoid distortion and significant aberrations in frequency response. Hence, even if the source impedance is fairly high as such impedances go (say, 2 kilohms) and the load impedance is a relatively low one (say, 20 kilohms), there should ordinarily be no problem of a mismatch.

To round out this discussion of impedance matching between sources and the components they feed, it may be mentioned that moving-magnet phono cartridges generally require a load impedance of 47 kilohms and a capacitance in the vicinity of 200 or 300  $\mu$ F; moving-coil cartridges need about 10 to 100 ohms.

## Taping 78s

*Q. I am planning to purchase a cassette deck and to partially use it for taping 78-rpm records. Given the normal variation in starting, stopping, and getting up to speed, it seems to me that many difficulties loom ahead. Is there a reasonably simple method of taping these records?—B. Carlat, Maplewood, N.J.*

A. I see no problem. A tape deck usually starts up quite rapidly. Just after you place the cartridge stylus in the lead-in groove, start up the cassette deck. Many decks have a pause mode, which keeps the deck in record function, but the tape is not running. Simply push the pause button to start

up the deck or push it again to stop the deck. When one side of a disc has been recorded, push the pause button to stop the deck. If you make a mistake, you can erase that part of the tape which contains the error and try again. Every deck has a counter, which can help you to identify the section of the tape on which you wish to record, erase, etc. While the counter may not be 100% accurate, it is usually accurate enough for working purposes.

## Why Not dbx NR?

*Q. I have never seen any prerecorded tapes using dbx NR. Is there any reason for this?—Dan Rasmussen, Marango, Ill.*

A. Dolby noise reduction is almost universally available in cassette decks with the least pretension to quality, whereas dbx noise reduction is available only in some of the better decks. (This does not mean, however, that a deck must have dbx in order to fall into the "better" class.) Hence, prerecorded tapes favor Dolby noise reduction—usually Dolby B NR, because many of the cheaper decks have only Dolby B and not Dolby C NR.

*Editor's Note:* Actually, there were some tapes issued with dbx encoding approximately a decade ago, about three or four dozen in all. There were also some LP records released as well. As I recall, the sound on some of these tapes and discs was pretty good. The problem the folks behind this introduction and use of dbx NR encountered was a sort of chicken and egg situation. Why, the big record and tape firm executives would question, should we put the money into equipment to make up tapes and discs in this format when Dolby NR is so much more popular, at least in tape? If the resulting tapes would be incompatible, they said, why should we pay any attention to this at all? As I understand it, the question of whether the resulting decoded tape (or disc) was quieter in playback was ignored in favor of these marketing questions.—E.P. A

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



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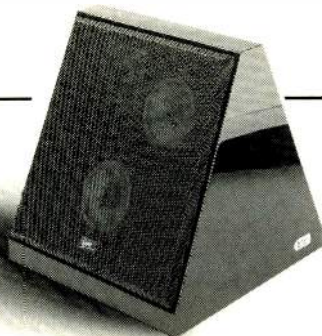
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# AUDIOCLINIC

JOSEPH GIOVANELLI

### Sampling Rate Explained

*Q. What is sampling rate; what does it have to do with frequency?—Tony Perkins, Los Angeles, Cal.*

A. Digital recordings are made by "sampling" the signal's voltage many thousand times per second and then storing these measurements as "samples" consisting of binary numbers represented by pulses. In theory, the maximum frequency a digital system can accurately record is one-half its sampling frequency. CDs, which use a sampling frequency of 44.1 kHz, therefore have a theoretical limit of 22.05 kHz; DATs, recorded at 48 kHz, have a theoretical 24-kHz limit, and satellite and 8-mm video systems are limited to 16 kHz by their 32-kHz sampling rate.

In practice, the limits are even tighter. The actual top audio frequency allowable on CD is about 20 kHz, and for DATs, it's about 22 kHz.

Higher frequencies must be filtered out of the signal before it is recorded. Otherwise, the recording will contain spurious tones, a phenomenon called "aliasing."

### Cleaning Up Broadcast News Recordings

*Q. One of my job functions is the production of radio news releases, usually including recordings and interviews made in the field. From time to time, I need to get such recordings and interviews over the phone, which, as you know, is not a superior audio source. At other times, even reports which arrive on tape may sound indistinct or muddy. Can I improve their audio quality by using a graphic equalizer, either during the original recording or in post-production? If so, how much "cleanup" is possible?—John T. Sulzmann, Corvallis, Ore.*

A. "Cleaning up" recordings made via ordinary telephone circuits is not really possible, at least in terms of high fidelity. Sometimes, small improvements can be made at frequencies in the range from 250 Hz to 2.7 kHz, and that's about it. The higher and lower frequencies passed by the phone seldom surpass these limits.

The "muddy" live recordings may sometimes be improved by rolling off some bass and the extreme highs—perhaps completely. You then boost frequencies in the range of 2.7 to 5

kHz. Although this technique will not produce a superior recording, it will sometimes produce one which is at least understandable to most listeners. Where a news event or on-the-scene interview is impossible to recapture, this may well be better than an unusable recording.

### Transparent Phonograph Records

*Q. Some time ago, I received a mailing about a record collection of the type they sell on TV through "800" numbers. These records, the mailing claimed, were of high quality because the vinyl was so pure that you could see right through it. Does this transparency really have anything to do with sound quality?—Ki Suk Hahn, West Covina, Cal.*

A. Phonograph records are black because lampblack or similar material is added to the vinyl mix. This material is added mainly for appearance's sake. I recall that some record manufacturers attempted to produce transparent records, only to meet with consumer resistance to those products. I have to believe that record pressers would love to get rid of the lampblack because of the mess it can make.

Some authorities say that lampblack is also included in the mix because of its lubricating properties, though I've always thought it somewhat abrasive. If my observations are correct, then eliminating lampblack should reduce friction of the stylus against the groove, thus reducing both stylus and record wear. Further, if lampblack is not properly dispersed within the vinyl, it can increase the record's noise level. Leaving out the lampblack would probably result in a slight improvement in background noise.

### Automotive Engine Noise

*Q. My new car stereo system (which includes a cassette-player/radio combination, a car amplifier, and a car equalizer) picks up engine noise. A stereo shop advised me to hook up a noise filter for both the amp and the equalizer, but this did not help. Next, I*

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was told to install resistive spark plugs and resistive spark-plug wires. I changed only the plugs; do you think I should also change the wires?—Name withheld

A. The noise you are hearing basically comes from a sparking somewhere in your car's engine, probably

with the ignition wiring acting as a broadcast antenna and the input of your cassette-player/radio combination picking it up.

You definitely should use resistive spark-plug wires, and it is also possible that filtering the power input to the system will help. Perhaps you can ac-

complish this with the same filter for both the radio and the equalizer. Special automotive noise-suppressor kits will sometimes help. These can be found in auto supply shops, though probably not in a stereo dealership.

Because of the manner in which the accessory contacts of your automobile are set up, it is sometimes necessary to wire audio equipment directly to the battery, using suitably heavy-gauge wire. In this case, the filters should still be used, but the ignition will not turn off the equipment.

I would also write to the maker of your car stereo equipment, detailing both the noise and the automobile involved. Ordinarily, these firms have a specialist on staff whose job it is to help with such questions. Often, their experience is such that they can pinpoint the difficulty simply because of the particular combination of car and components.

You should also be aware that there are literally thousands of possible sources of this noise, and a similarly large number of ways to suppress it. Unfortunately, it is beyond the scope of this column to attempt an exhaustive answer to your question.

#### Defining AM Suppression

Q. What is "AM suppression" as applied to FM reception?—Robert Beiswinger, Townbank, N.J.

A. In FM (frequency modulation) broadcasting, the strength, or amplitude, of the transmitted signal never changes, but its frequency shifts up and down in accordance with the program signal. In AM (amplitude modulation), the frequency of the signal never changes, but its amplitude varies with the program signal.

While the amplitude of the signal leaving the FM transmitter never changes, the amplitude of the signal reaching your antenna can change, due to multipath, signals bouncing off airplanes, and noise bursts from passing cars' ignition systems. If the signal's overall strength is not great, or if an FM set cannot reject these forms of inadvertent "AM," the program will be disturbed by effects which range from flutter to noise bursts. The better the AM suppression, the less the tuner or receiver will reproduce these unwanted sounds.



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By looks alone you know this is no ordinary speaker. The Silver Edition trades a bulky, boxy cabinet for unfettered musical freedom. Its full-range ribbon transducer is open to the room, projecting seamless 25 Hz to 40,000 Hz sound both forward and back, creating near-photographic imaging and realistic spatial ambience. Its three enclosureless, twelve-inch subwoofers deliver bass that's tactilely tight and deep.

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Up to this point we've described a brilliant, unconventional and yet proven dipole speaker design. One which offers openness, detail and sonic impact far in excess of its modest price. And which solves inherent problems plaguing far more expensive ribbon transducer designs.

But in order to fully earn the title "Amazing Loudspeaker," Bob Carver has endowed the new Silver Edition with even more technology.

At its heart is an Electronic Control System. Not an "equalizer" to compensate for shortcomings, but three dramatic sound enhancement circuits, plus bass "Q" and high frequency trim adjustments in a single compact component.

Select *Sonic Holography®* for the spectacular, 3-dimensional imaging *High Fidelity* described as seeming to "open a curtain and reveal ... musical forces extending behind, between and beyond the speakers." With any CD, record, tape or video sound source.

Add ultra-low fundamentals below 20 Hz with a *Sub Bass* generator that detects and enhances existing low level information. On bass-shy recordings, it takes advantage of the Silver Edition's long-throw free-air subwoofer system to restore bone-shaking musical reality.

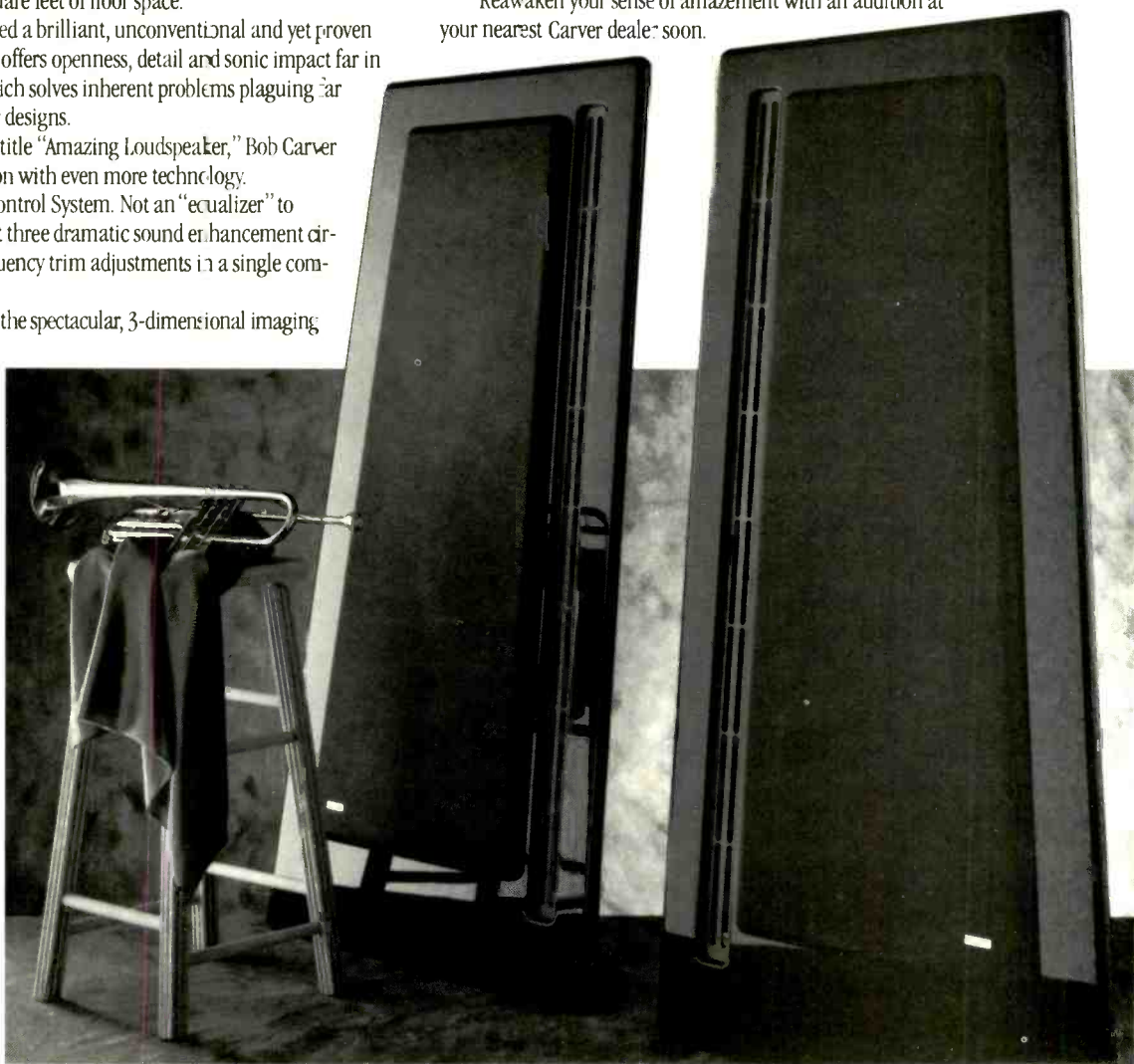
There's even a unique circuit

that psychoacoustically "zooms" you back from the speakers. Called the *Gundry Perspective*, this effect creates the illusion of concert hall depth ahead of you without disturbing overall frequency balance. Combine it with *Sonic Holography®* Sub Bass generation and the Silver Edition's own innate ability to create a vast, open listening space, and you have a truly amazing aural phenomenon.

More than just a reproducer of music, the Amazing Loudspeaker Silver Edition becomes a restorer of sonic reality. In its most minute, organic detail.

Finally, there is one more very realistic thing about this new Amazing Loudspeaker model. Its price. Far less than you might pay for conventional loudspeaker designs which can't begin to match the Silver Edition's warmth, vitality and spaciousness.

Reawaken your sense of amazement with an audition at your nearest Carver dealer soon.



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**A**RIA. SUMO proudly introduces a revolutionary new planar loudspeaker, Aria, which after years of development promises to change our conception of reproduced music.

Aria provides a remarkably coherent, almost tactile, soundstage. A presentation so natural, so believable that we are left without adjectives – or words. Only the experience of having heard what is truly one of the most important loudspeakers to be offered in decades.

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Aria reproduces sound the way it occurs in nature. Much the same way that a pebble thrown into a still pond spreads waves across the water's surface. As a single element full range loudspeaker, its design is also a clear departure from approaches that have gone before. There are no crossovers. There are no delay lines. There is no response shading; nor are there associated electronics, either active or passive. Aria breaks new ground to such an extent that patents have been applied for and are pending worldwide.

Designed and manufactured exclusively for SUMO by Highwood Audio in Canada, Aria will be available at only a few very select dealer locations. Among those dealers displaying Aria are:

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## THE HEAR AND HOW

*Perception of Reproduced Sound*, edited by Soren Bech and O. Juhl Pedersen. Symposium on Perception of Reproduced Sound, 165 pp., hardback, \$35. (Available from Old Colony Sound Lab, P.O. Box 243, Peterborough, N.H. 03458.)

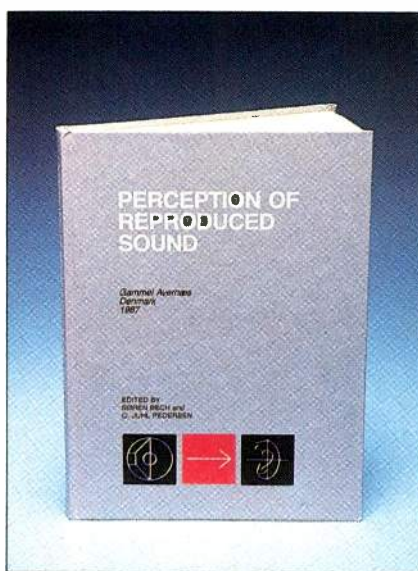
Lord Rayleigh had the right idea, in 1877, when he said that all questions concerning sound must come to the ear for decision, and from it there can be no appeal. The quest for high-fidelity sound reproduction is, at long last, turning toward subjective evaluation, with the goal of full correlation of listening tests and objective measurements.

While Americans have only tentatively dipped their toes into the waters of subjective evaluation of loudspeaker performance, the Europeans represented here seem to have enthusiastically dived in and come up with smiles on their faces. One of the contributors, Nils Kousgaard, was bold enough to state that "the inference drawn from the qualitative approach is at least as precise as the inference drawn from the quantitative approach." If properly conducted subjective tests on a speaker are as precise as properly conducted objective measurements, perhaps we are close to attaining the goal of close correlation between the two.

This book is the outgrowth of a symposium held in mid-1987 at Gammel Avenaes, Denmark. It contains 16 papers, with two more in a loose supplement slipped into the back. (One is tempted to guess that this supplement was made necessary because a couple of the authors failed to meet the manuscript deadline.) The papers are not exhaustive (nor exhausting) treatments of the various fields of specialty, but rather are relatively short summaries of theory or work in process. This makes the book especially valuable for a bird's-eye view of the complex field of psychoacoustics.

The first four chapters alone are worth the asking price. The first is "Application of Psychoacoustic Methods," by Torben Poulsen of the Acoustics Laboratory of the Technical University of Denmark. This chapter summarizes the statistical aspects of subjective measurements in a clear, understandable way. Next come "A Review of Basic Research on Timbre," "Evalua-

tion and Scaling of Timbre in Listening Tests on Loudspeakers," and "Some Fundamentals of Auditory Spaciousness," all by noted authors. The first paper is by Reinier Plomp of the Netherlands, famous for his outstanding work on consonance and dissonance. The second is by Henrik Staffeldt of the Danish Engineering Academy, and the third is by Jens Blauert, well known in this country for his excellent book, *Spatial Hearing* (MIT Press, reviewed



here January 1985). This group of three papers gives one an enlightened appreciation of the importance of the concepts of timbre and auditory spaciousness. Staffeldt observes that "the reviewers of the audio magazines have developed a rich timbre-related vocabulary which sometimes is more florid than informative." He also refers to Floyd Toole's paper (delivered at the 1987 AES convention), which considers that individual listeners or groups of listeners, or even loudspeakers having ratings with 5% standard deviations may be characterized as "a subjective measuring instrument having a measuring uncertainty of less than 1 dB."

The next three chapters deal with the planning of listening tests. Toole, in treating the effects of technical and environmental variables, comments that "precise localization of specific auditory images seems to benefit from placing the listener in a predominantly direct sound field" and that "a sense of

spaciousness appears to benefit from fairly energetic lateral reflections in the listening room, just as it does in the concert hall." Alf Gabrielsen of Sweden's Uppsala University considers the myriad of perceptual variables which can affect the results of subjective testing of loudspeakers. For example, if judgments of "brightness" of the music are required, just what is the reference "brightness" to assure that all judges use the word in the same way? He also introduces different approaches to subjective tests: The use of descriptive ratings which require judgments of such things as clarity, fullness, and spaciousness, and the "pairwise" approach, in which judgments only of similarity between two presentations are required. Soren Bech discusses the choice of rating scale and test procedure in planning a listening test.

The next paper is "The Application of Binary Paired Comparisons to Listening Tests," by Nils Kousgaard of the University of Copenhagen. He gives reasons to support the conclusion that substitution of paired comparisons for the more common rating test carries with it no loss of precision and results in a test much easier to administer.

Michael Williams, a French sound recording engineer and instructor, states that the phrase "carefully selected program material" can be, in fact, "a convenient way of hiding almost every vice that we are trying to get rid of." He reviews the almost infinite number of variables in the recording and reproduction chain.

Villy Hansen recounts his experience at Bang & Olufsen in developing a reliable panel of listeners for evaluating B & O's products and those of their competitors. This company would seem to be leading the way in committing time and money to the training of listeners. In 1984, they chose eight employees and released them from normal duties for fixed weekly training periods. In order for panel members to obtain experience in critical listening, the company even supplied each listener with a complete audio system and software for home use, as well as the opportunity to experience the real thing at live concerts. Such trained listeners are making great contributions to product development.



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If you'd like the full story of this remarkable preamplifier and the review from *Stereophile*\*, please write. Of course, the fastest way to hear its demonstrably superior combination of sonic performance, flexibility and value is to visit your nearest Adcom dealer.

\*Vol. 9 No. 7 (Nov. 1986)

## ADCOM®

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This stimulating and concise volume is strongly recommended, both to those familiar with the field and those with less experience.

"Inadvertent Bias in Listening Tests," by S. K. Pramanik, who is also with B & O, makes the point that listening test results may be questioned if each listener exercises the same set of faults. For instance, why are there references to "British sound" or "Japanese sound" or "American sound" in

regard to the performance of equipment? National and other biases, says Pramanik, must be eliminated in the successful listening test.

Two authors are brave enough to tackle the sticky problems facing the technical reviewer who stands in the no-man's-land between the manufac-

turer and the consumer. Martin Colloms of Colloms Electroacoustics, London, writes on "The Technical Press, Reviewing, and the Loudspeaker Manufacturers," and Michael Madsen of the Copenhagen *high fidelity* magazine treats "The Technical Press and the Consumer."

Floyd E. Toole draws upon the work of his own division of Canada's National Research Council in the brief summary, "Correlation Between the Results of Objective and Subjective Tests."

"Listening Rooms for Test of Loudspeakers," by Henrik Møller of Aalborg University in Denmark, starkly reveals the urgent need for standardization of the listening environment. This is a beautiful overview of almost everybody's ideas on how to build a listening room. Møller summarizes room specifications recommended in five European organizations' publications and follows with brief descriptions of the listening rooms used by six Danish companies.

Gunther Theile of Germany's Institut für Rundfunktechnik writes on the theory of "Stereophonic Imaging of Natural Spatial Perspective via Loudspeakers." Much of his paper is given over to objections to the summing theory of stereo localization. Theile would instead urge the "association model," which envisions two separate processes acting on the signals received by the outer ear: First, a location-determining stage, and second, a gestalt-determining stage.

The general theme of the book is carried forward in the two papers offered in the supplement: "Psychoacoustic Problems in Listening Tests on Loudspeakers" and "Subjective Testing—A Manufacturer's Approach." The first is a statistical analysis by Staffeldt, the second a description of facilities and experiences at KEF by Laurie Fincham of KEF Electronics Limited, Kent, England.

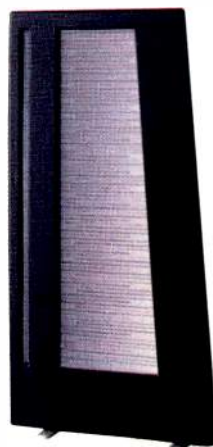
This volume and its supplement are strongly recommended to those involved in evaluating loudspeakers or other electroacoustic transducers. To those familiar with the field, it will be a stimulating and concise review of subjective measurement problems; for those with less experience, it will be an excellent overview. *F. Alton Everest*

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# Magnificent Reception.

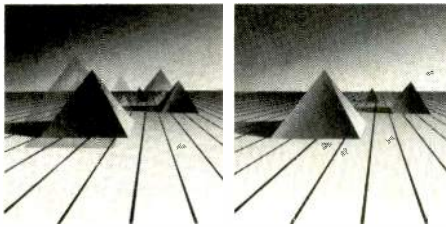
## THE TX-11a COMBINES CARVER'S REVOLUTIONARY ASYMMETRICAL CHARGE COUPLED FM DETECTION CIRCUITS WITH AN AM STEREO SECTION CAPABLE OF FM-QUALITY RECEPTION.

The Carver TX-11a Stereo AM-FM Tuner is the most complete high fidelity broadcast reception component ever offered. It is a technical tour-de-force which further distances Bob Carver's unique products from traditional electronic components. First, by eliminating forms of FM distortion and interference that even the most expensive tuners available can't correct. And second, with a unique additional tuning section capable of making AM stereo sound as good as FM!

**THE SILENT TREATMENT.** While AM stereo may not yet be available in your area, you can receive FM stereo. Including stations so fraught with interference and distortion that you may be tempted to return to mono AM. That's why the TX-11a includes the first circuitry to remove hiss, "picket fencing" and the myriad other unpredictable noises which often disturb FM listening. Without reducing stereo imaging, frequency response or dynamic range.

Part of the FM signal, the left minus right portion, is extremely prone to "ghosting," or multipath interference caused by hills, buildings and other obstructions. Bob Carver's Asymmetrical Charge Coupled circuitry cancels distortion-causing "dirty mirror" images before they can reach your ears. It filters out noise and restores the part of the signal

needed by our ears and brain to construct stereo imaging. Reintroduced into the mono (L+R) signal matrix, a net reduction of 93%—or better than 20dB of noise reduction—is achieved. All ambient and localizing information is recovered. Only hiss and



distortion are left behind. Or, as *High Fidelity* magazine put it, "...clean, noise-free sound out of weak or multipath-ridden signals that would have you lunging for the mono switch on any other tuner."

*Ovation* magazine observed that the circuit, "...may well mean the difference between marginal reception of the station signals you've been yearning to hear and truly noise-free reception of those same signals."

*Audio* magazine called it, "An FM tuner breakthrough."

**THE FIRST AUDIOPHILE AM STEREO CIRCUITRY.** Contrary to popular belief, most AM stereo stations have frequency response (20-15kHz), separation (35dB) and signal-to-noise ratios (70dB) audibly indistinguishable from FM stations of equal strength. But only Carver offers the technology to appreciate this hidden performance.

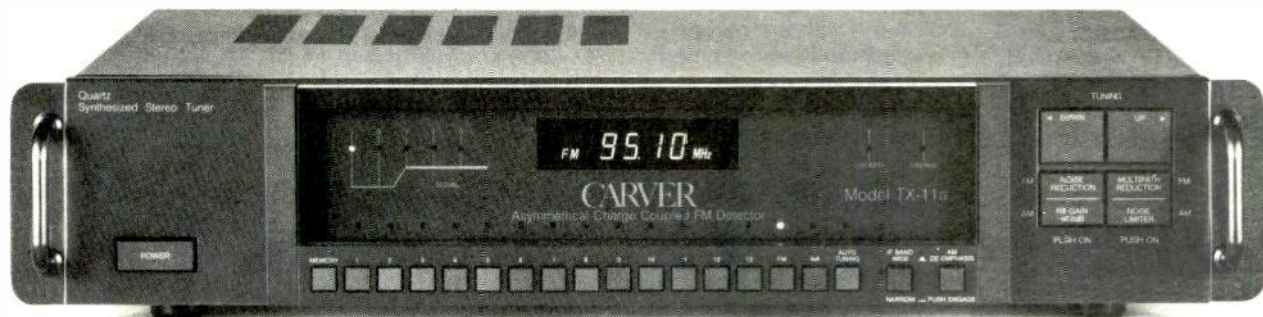
At a press conference in front of America's top stereo writers, Bob Carver unveiled a low powered C-QUAM format AM stereo broadcast transmitter with a Carver Compact Disc Player as a source. The CD source and the TX-11a were also routed directly to a preamplifier and speakers for comparison.

When Bob switched back and forth, most listeners had difficulty distinguishing between the straightwire CD player and the TX-11a's over-the-air AM stereo reception! Many could tell no difference at all!

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The TX-11a is designed to make enjoying FM and AM easy, not dazzle you with flashing light and complex programming. Thirteen presets, wide/narrow band selection, automatic/manual scanning as well as Multipath and Noise Reduction buttons are inset into the burnished anthracite metal face. Full instrumentation including digital display, 6-step signal strength LEDs and other monitor functions are tastefully recessed, visible but not garish. The result is performance without theatricality, access without complication.

**CLEAR THE AIR** by visiting your nearest Carver dealer. Ask to hear the most expensive tuner they sell. (It probably won't be the Carver TX-11a). Tune a multipath-ravaged, hiss-filled FM station on it; then the same station on the TX-11a Stereo AM-FM Tuner. Now press the Carver Multipath and Noise Reduction buttons. You'll hear why *High Fidelity* Magazine called it, "By far the best tuner we have tested..."



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### SME Tonearm

Unlike the SME Series IV and V tonearms, whose design it echoes, the Model 309 has interchangeable, die-cast magnesium headshells which are held on by a new clamp designed for maximum rigidity. The arm is internally damped, and has

adjustable vertical and horizontal tracking angle. All wiring is linear-crystal, oxygen-free copper, and a swivelling, damped socket for the audio leads is designed to minimize vibration transmission. Price: \$995. For literature, circle No. 100



### Yamaha Truck Speaker

Built specifically for trucks and recreation vehicles, the Pulsator line handles high power and tough road conditions. Designed for installation in hatchbacks, vans, jeeps, or RVs, the YHB-A8 is a single-enclosure system which houses two 8-inch polycarbonate cone woofers, two 2 x 5-inch ceramic horn tweeters, and

a 10-inch passive radiator. Frequency response is 40 Hz to 20 kHz. Installation is easily accomplished with metal double-hook and slot pieces which Yamaha engineers claim will not dislodge with the bumps and jolts that are common in trucks and RVs. Price: \$250 to \$300. For literature, circle No. 101

### Kenwood Graphic Equalizer

The GE-87 is a seven-band, two-channel graphic equalizer with five user-programmable and five factory-programmed curve presets. The unit is unusually flexible: Control range can be switched from the usual  $\pm 12$  dB to

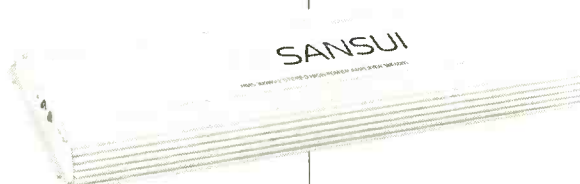
$\pm 6$  dB for more precise control, and the right and left channels can be equalized independently.



### Precise Acoustic Labs Loudspeaker

Using a separate enclosure for its 10-inch woofer, the Monitor 10 is a three-driver system designed to maximize bass performance while preserving midrange clarity and stereo imaging. The 6½-inch midrange driver and 1-inch soft-dome tweeter are housed in a separate, nonresonant enclosure. Designed to minimize cone-surface standing waves, the midrange driver uses a curved conical design. Vibration-absorbing material on the baffle board surrounding the tweeter prevents reflections from the enclosure, allowing an open, extended treble response. The Monitor 10's frequency response is specified as 20 Hz to 35 kHz. Finish is natural oak veneer. Price: \$1,600 per pair.

For literature, circle No. 102



### Sansui Car Amp

Styled in white instead of the usual black, the SM-6000 amplifier provides 300 watts per channel with less than 0.05% THD. Frequency response is

rated at 20 Hz to 20 kHz,  $\pm 1$  dB, and rated S/N is greater than 100 dB. The 13-pound amp measures 24 in. W x 2½ in. H x 8 in. D. Price: \$1,149. For literature, circle No. 104

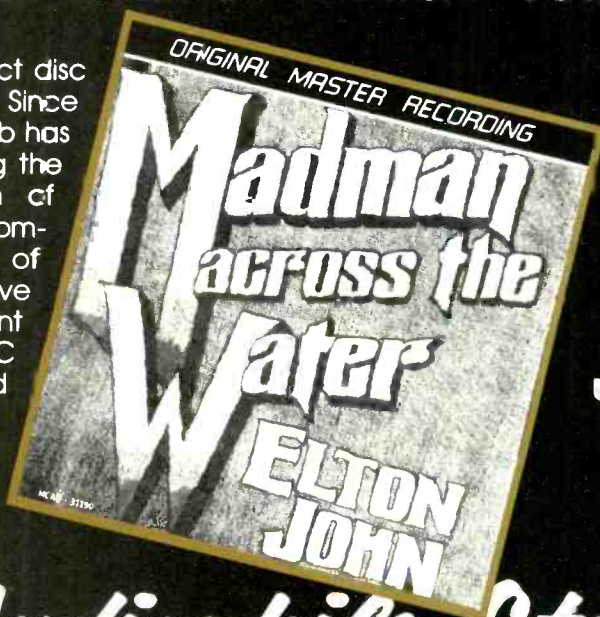


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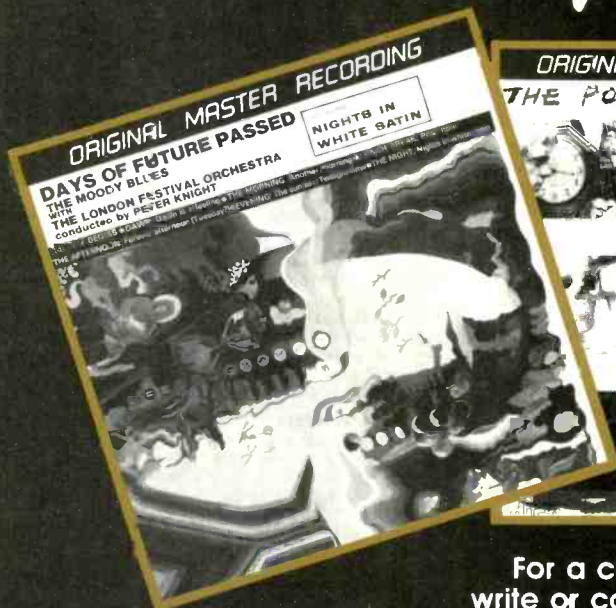
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**PRO-CONTROL FOUR** Preamplifier, with digital CMOS switching. Ten total inputs, 5 tape monitors, 2 signal processing loops. Direct mode, Auto-Bridge circuitry, Bass and Treble Controls.  
19" W x 3 1/2" H x 11" D, 15 lbs. .... \$699

**PRO-CONTROL THREE** Preamplifier, similar to above, with 2 tape monitors, 1 signal processing loop. .... \$549



**DX4200 Preamplifier/Equalizer**, with Compact Disc Player and Video/Audio inputs. Phono preamp has Variable Cartridge Loading (50-800 pF, 100/47,000 ohm); phono level controls for adjustable  $\pm 20$  dB gain; MC variable reluctance or MM cartridge inputs; 3-way Tape Dubbing; 2 external Signal-Processor Loops; conventional line outputs plus separate Autobridge Line Outputs for Mono Bridging of Most Amps; EQ S/N 114 dB; Passive-Coil filter with 15 dB boost or cut for each octave, max 22 dB; Differential Comparator circuitry for True 0.1 dB Unity-Gain EQ balancing; includes Frequency Spectrum Analyzer test record and instant reset Computone Charts.  
19" W x 5 1/4" H x 11" D, 20 lbs. .... \$749

**DX4000 Preamplifier**. Same as DX4200 without phono cartridge matching controls and Equalizer, but with 3 external loops.  
19" W x 3 1/2" H x 11" D, 15 lbs. .... \$439



**DX3000 Preamplifier**, Inputs for CD player, Video/Audio, Tuner, Phono, Two Tape Decks with dubbing, Bass and Treble controls, and signal processor loop. THD -0.01%, S/N 95 dB.  
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### Power Amplifiers

**PCR800 Power Amplifier, MOSFET** stereo. 205 watts per channel continuous RMS 20-20,000 Hz into 8 ohms < 0.05% THD; TIM unmeasurable; S/N 105dB.  
8 1/2" W x 5" H x 12" D, 22 lbs. .... \$539



**PRO-REFERENCE TWO**, Studio Monitor quality MOSFET Stereo Amplifier. LED Meters monitor output of each channel in dB from -40dB to +3dB (200 Watts per channel into 8 ohms). True Clipping indicators, switching for two pairs of speakers. **Power Output:** 100 W/ch into 8 ohms, 190 W/ch into 4 ohms continuous RMS, 20-20kHz at < 0.05% THD.  
19" W x 5 1/4" H x 10 1/2" D, 30 lbs. .... \$699

**PRO-REFERENCE ONE**, Same as above except no meters and no speaker switching, 28 lbs. .... \$599

### Power Amplifiers



**PRO-POWER FOUR, MOSFET** stereo power amp 300 Continuous RMS Watts per channel @ 4 ohms, 205 Continuous RMS Watts per channel @ 8 ohms, 20-20kHz, 450 Watts RMS @ 2 ohms, 900 Watts RMS @ 4 ohms Bridged. THD < 0.05%, Hum and Noise: -105 dB, Front Panel switching for 2 pair of speaker systems. 40-LED 0-1600 Watt Power Meters.  
19" W x 5 1/4" H x 11" D, 30 lbs. .... \$849

**PRO-POWER THREE MOSFET** stereo power amplifier, same as Pro-Power Four, except no 40-LED power meters. 30 lbs. .... \$749



**PRO-POWER TEN MOSFET** stereo amp 205 watts per channel (4-channel) 8 ohms, 20Hz-20kHz, at less than 0.05% THD... 300 watts per channel (4-channel) @ 4 ohms, 600 watts per channel (2-channel) @ 8 ohms... IM Distortion: less than 0.05%... Frequency Response: 20Hz-20kHz,  $\pm 0.1$ dB... Signal to Noise Ratio: -105dB... Slew Rate: 50 volts/microsecond.  
19" W x 5 1/4" H x 12" D, 55 pounds .... \$1,299

**PRO-POWER ONE MOSFET** stereo, features no-current-limiting power supply, 300 w/p/c RMS into 4 ohms; 450 w/p/c RMS into 2 ohms; 205 w/p/c into 8 ohms @ < 0.05% THD; Freq. resp. 20 to 20,000 Hz  $\pm 0.1$ dB; S/N > 105dB; slew rate 50 V/microsec; TIM unmeasurable; damping factor 200.  
8 1/2" W x 5" H x 12" D, 22 lbs. .... \$579



**A5002 Power Amplifier, Class-H** Vari-Proportional circuitry and Autobuffer for continuous operation into 2 ohms. Features auto crowbar protection circuit for output protection without current limiting; 40-LED 0-1,000 Watt power output Meters; Front-Panel switching for 2 pairs of speakers; True Clipping indicators; Input Level controls. Output power 250 W/ch into 8 ohms, 375 W into 4 ohms continuous RMS, 20-20,000 Hz at < 0.09% THD; S/N > 105dB; slew rate > 50 V/microsec; TIM < 0.02%.  
19" W x 7" H x 12" D, 50 lbs. .... \$949

### Tuners

**PRO-TUNER FOUR Stereo Digital Tuner** Digital quartz PLL tuner with 16 Station presets, 5-digit Station Readout, Auto-Scan tuning, active High Blend filter. Broad-Band AM switch, 19" rack-mount front panel, IHF sens 1.6  $\mu$ V; S/N 75 dB; distortion 0.08%.  
19" W x 2 3/4" H x 12" D, 10 lbs. .... \$379

### COMPACT DISC Player



**NEW CD750 COMPACT DISC PLAYER** with our exclusive Made-in-U.S.A. "DIFFERENTIAL/COMPANDER" circuitry. This newly developed circuit was designed by Soundcraftsmen to provide the utmost flexibility for the Compact Disc Format... High Dynamic Range for serious listening pleasure... or Optional Dynamic Compression/Expansion for background listening, for recording cassettes where the recorder is incapable of recording a 95 dB Dynamic Range, or for recording cassettes for playback on Car Stereos. Another Innovative Feature is our "SPECTRAL GRADIENT" circuit. This variable control enhances the listenability of Discs with hard or harsh high frequency characteristics. Both of these circuits are completely bypassable. The CD750 has all the most desired features, plus many additional advanced Hi-Tech features such as Indexing, Digital Filter, All-Metal Chassis, Audible Scan, Random, Passage-Repeat, 3-Beam Laser, Wireless full function infrared Remote Control, Over-Sampling, complete Multi-Function Fluorescent Display, variable volume control Headphone Jack, Gold-Plated output jacks, **RACK-MOUNT FRONT PANEL**, and Ultra-Shock-Mounted Super-Soft Disc-handling  
19" W x 3 1/4" H x 12" D, 16 lbs. .... \$599

### Signal Processors



**AE2000 Real Time Analyzer/Equalizer**, World's most accurate (0.1dB) Real-Time Analyzer/Equalizer. The first and only analyzer with: Two independent real-time analysis systems, (a Direct 100-LED display with 2dB readout and a 0.1dB readout Differential/Comparator) Pink-noise generator, 10-octave Real-Time display with Adjustable Decay rate, Mic. preamp. input for analysis for any Signal Processor, Autocan mode.  
19" W x 5 1/4" H x 11" D, 21 lbs. .... \$849



**DC4415 Third-Octave Equalizer**, stereo with EQ defeat; Infrasonic filter; Tape Monitor and Tape Record; Differential/Comparator<sup>®</sup> circuitry for Unity Gain setting to within 0.1dB accuracy for highest Dynamic Range capability. THD and IMD 0.01% at 2 V; S/N 114dB at full output; input imp 47,000 ohms.  
19" W x 5 1/4" H x 1" D, 16 lbs. .... \$749

**DC2215 Differential/Comparator<sup>®</sup> Equalizer**, Stereo 10-band, with Differential/Comparator<sup>®</sup> True-Unity-Gain circuitry for Input-to-Output balancing accuracy to within 0.1dB. Equalizer filter circuits use precision wire-wound Passive-Coil inductors for high gain, low noise and distortion.  
19" W x 5 1/4" H x 11" D, 17 lbs. .... \$449

**DC2214 Differential Comparator Equalizer**. Same as DC 2215 except equalizer filter circuits have op-amp synthesized inductors. THD and IMD < 0.01% at 2 V; S/N ratio 106 dB at 10 V; boost/cut range  $\pm 12$   
19" W x 3 1/2" H x 9" D, 13 lbs. .... \$299

### CUSTOM-17 MODELS SHOWN BELOW FEATURE A STANDARD 17" PANEL, OTHERWISE IDENTICAL TO THE PRO-19 MODELS



◀ **POWER FOUR-17, MOSFET** stereo power Amplifier 17 3/16" W x 5 1/4" H x 11" D, 30 lbs. .... \$799

**CONTROL THREE-17**, Digital C-MOS Preamplifier 17 3/16" W x 3 1/2" H x 11" D, 15 lbs. .... \$499 ▶

**CD750-17 COMPACT DISC PLAYER** 17 3/16" W x 3 1/4" H x 12" D, 16 lbs. .... \$549 ▶

◀ **TUNER FOUR-17, AM/FM** Digital Quartz Tuner 17 3/16" W x 2 3/4" H x 12" D, 10 lbs. .... \$329





# COMMENTS FROM OUR CUSTOMERS

EXCERPTS BELOW ARE FROM RECENT WARRANTY CARDS ON FILE AT SOUNDCRAFTSMEN

**"EXTENDED-WARRANTY" Registration Card**  
 must be mailed **WITHIN 10 DAYS** of purchase to validate **2-YEAR** warranty  
 Fill out and Mail at Once. Warranty is **ONLY 90 DAYS** if not properly Registered.

Model Number: **PRO POWER 4**  
 Date Purchased: **JANUARY 9, 1979**  
 Owner: \_\_\_\_\_  
 Address: \_\_\_\_\_  
 City: **BROOKLYN** State: **NEW YORK** Zip: **11214**

Please list any suggested improvements, changes, or other comments:  
**GREAT MUSICAL SOUND AND DEPTH. NOW RUNS BAIRED WITH OTHER POWER 4! HEAVY DUTY!**

Please list any suggested improvements, changes, or other comments: **THIS UNIT BEING USED WITH ACR 800 SOUND CRAFTSMAN AMP. VERY PLEASD. DXR 200 REPHAS NAD 1020 PURCHASE PRIOR EXPERIENCE WITH SOUNDCRAFTSMEN BASED ON a. Saw it advertised in \_\_\_\_\_ magazine. b. Test report \_\_\_\_\_**

Please list any suggested improvements, changes, or other comments: **2215 World Class, ESSENTIAL for all Resposable Audio Systems**

Please list any suggested improvements, changes, or other comments: **PRO CONIAZ FOUR IS THE TOP LEARNING HERE AND IN MARKET. I HAVE PURCHASED ALMOST SIX OF FOR 10 FRIENDS.**

Satisfied? Me? **I am impressed! Outstanding Product!**

Please list any suggested improvements, changes, or other comments: **I Love it!!! Super Clean and Powerful**

**H S 49637**  
**DX**  
**FE**  
**P7**

Please list any suggested improvements, changes, or other comments: **I HAVE USED SOUNDCRAFTSMEN EQUIPMENT FOR NEARLY 3 YRS I MUST SAY THIS IS THE BEST POWER AMP YET!!! PURCHASE AMERICA MAKES THE BEST AMPS!!! THANKS FOR MAKING AN EXCELLENT PRODUCT!**

Please list any suggested improvements, changes, or other comments: **NONE This equalizer is incredible!**

Please list any suggested improvements, changes, or other comments: **This Amp is just what my POLK SDA SRS's needed!**

Please list any suggested improvements, changes, or other comments: **CHOSE OVER CARVER, NAD, MSINTOSH**

Please list any suggested improvements, changes, or other comments: **DRIVES THE BIG POLKS WITH INCREDIBLE EASE. A VERY IMPRESSIVE PERFORMER. SOUNDS GREAT WITH SDA.**

Please list any suggested improvements, changes, or other comments: **Beautiful equipment - IT IS a great value for the money. You prove "MADE IN U.S.A." means THE BEST!**

Please list any suggested improvements, changes, or other comments: **This thing is a beefy powerful unit at a fair, reasonable price, making it affordable for me (an amateur). I applaud your company.**

Please list any suggested improvements, changes, or other comments: **VERY PLEASED WITH PERFORMANCE. IT'S LIKE I AM HEARING MY CD'S FOR THE VERY FIRST TIME!**

## FOR A DEMONSTRATION, VISIT NEAREST DEALER LISTED BELOW

However, many additional Dealers—too numerous to list here—are located throughout the U.S. with many models on display. If no dealer is shown near you, or you encounter any difficulty, please phone us at 714-556-6191, ask for our "Dealer Locator Operator!"

- ARKANSAS** Jonesboro THE SOUND CENTER Monticello THOMASSON'S SOUND **NO. CALIFORNIA** Berkeley UNCLE RALPH'S AUDIO Chico G&G STEREO Concord SOUND DISTINCTION Goleta HOUSE OF AUDIO San Francisco AUDIO VIDEO CENTER San Jose AMERICAN VIDEO CENTER **SO. CALIFORNIA** Cathedral City SOUND COMPANY Cerritos FEDCO Costa Mesa ATLANTIC MUSIC FEDCO Goleta HOUSE OF AUDIO Hollywood AMETRON, AUDIO-VIDEO SOLUTIONS Los Angeles FEDCO Montebello AUDIO-VIDEO SOLUTIONS, SML, INC. Newport Beach ATLANTIC MUSIC Ontario FEDCO Orange FIDELITY SOUND Pasadena FEDCO San Bernardino FEDCO Santa Ana FIDELITY SOUND Torrance STEREO HI FI CENTER Van Nuys FEDCO Whittier HI FI HAVEN **CONNECTICUT** Norwalk CRAZY EDDIE **FLORIDA** Belle Glade JAMROCK ELECTRONICS Fort Lauderdale SPEAKER WAREHOUSE Hialeah SPEAKER WAREHOUSE Hollywood SPEAKER WAREHOUSE Jacksonville FRONT ROW RECORDS Miami LAS FABRICAS Miami South AUDIO PLUS, ELECTRO SOUND, PARS ELECTRONICS Orlando SOUND EFFECTS West Palm Beach SOUND SHACK **GEORGIA** Atlanta ATLANTA STEREO, STEREO VIDEO WAREHOUSE **HAWAII** Hilo YAFUO T.V. APPLIANCE Honolulu BOSE ENTERTAINMENT CENTER, VIDEO LIFE **IDAHO** Idaho Falls PHASE 4 STEREO **ILLINOIS** Burbank POLK BROS. Chicago MARTRDY ELECTRONICS, MIDWEST STEREO, MUSICRAFT, POLK BROTHERS Cottage Grove, POLK BROS Elgin, POLK BROS. Evergreen Park MUSICRAFT Gurnee OPUS EQUIPMENT Homewood MUSICRAFT Meirose Park, POLK BROS. Jacksonville FRONT ROW RECORDS Morton Grove MUSICRAFT Naperville, POLK BROS. Oak Park MUSICRAFT Palatine MUSICRAFT Springfield REEL TO REAL DESIGNS Villa Park MUSICRAFT **INDIANA** Michigan City AUDIO CONNECTION New Haven HJS SOUND West Lafayette VON'S ELECTRONICS **KANSAS** Overland Park AUDIO ELECTRONICS **KENTUCKY** Louisville HI-FIDELITY, INC **LOUISIANA** New Orleans TULANE STEREO **MAINE** Ellsworth Falls ELLSWORTH AUDIO **MARYLAND** Frederick THE ELECTRONIC SHOP **MASSACHUSETTS** Boston ENCORE AUDIO **MICHIGAN** Drayton Plains TUNE SALOON Holland INTERFACE AUDIO Livonia CARTEL DISTRIBUTING, VIDEO STUDIO Marquette AMERICAN TV **NEW HAMPSHIRE** Nashua TECH HI FI **NEW JERSEY** Boundbrook PRANZATELLI'S STEREO Hawthorne THE SPEAKERMEN Kinnelon SOUND CITY Lakewood RAINBOW TRONICS Newark MEG RADIO CORP. New Brunswick BARRACKS TRADING POST Paramus CRAZY EDDIE Paterson CONSUMER'S DISCOUNT CENTER Totowa CRAZY EDDIE Trenton BARRACK'S TRADING POST Union CRAZY EDDIE **NEW MEXICO** Santa Fe OVATION AUDIO **NEW YORK** Bronx VICMARR STEREO, BRONEN ENTERPRISES, D&J ELECTRONICS Brooklyn CENTRAL AUDIO, MAGNA ELECTRONICS Jamaica THE FOX ELECTRONICS Long Island City IVY ELECTRONICS New York City STEREO PLAZA, VICMARR STEREO, CANAL HI FI, LEONARD RADIO, 14TH STREET AUDIO, CRAZY EDDIE Glen Cove ISLAND AUDIO Woodside LEONARD RADIO **NORTH CAROLINA** Fayetteville QUALITY SOUND Raleigh CREATIVE ACOUSTICS Shelby SOUND ADVICE Wilmington JUST CD'S **OHIO** Akron OHIO SOUND Cleveland OHIO SOUND Columbus AUDIO EXCHANGE Deland ZELLER'S SOUND STORE Lima HART AUDIO Parma DESIRO ENT. Wooster S&W TELEVISION **OKLAHOMA** Oklahoma City JOHNSON TV & SOUND **PENNSYLVANIA** McKeesport HI FI CENTER Philadelphia SOUND OF MARKET Pittsburgh AUDIO JUNCTION Reading, Shillington PHOENIX HI FI Willow Grove SOUNDEX **PUERTO RICO** Santurce R. F. ELECTRONICS **SOUTH CAROLINA** Columbia NORTON'S STEREO Greenville DON JONES STEREO **TEXAS** Arlington SOUND IDEA Dallas/Carrollton VERY SERIOUS TOYS El Paso CASA SONIDO Houston A & B VIDEO Laredo JETT SALES Mesquite VIDEO ACCESSORIES PLUS Midland FOLGERS San Antonio THE SOUND IDEA **UTAH** Bountiful TRAX AUDIO **VIRGINIA** Falls Church AUDIO BUY'S **VIRGIN ISLANDS** St. Thomas, U.S. and British Virgin Islands ELECTRONICS UNLIMITED **WEST VIRGINIA** Morgantown THE SOUND POST Princeton THE SOUND POST **WISCONSIN** Appleton AMERICAN TV Glendale SOUNDSTAGE Madison AMERICAN TV Waukesha AMERICAN TV

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# Soundcraftsmen

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\$19.95 EQ-EVALUATION KIT, includes 1-12" LP Frequency Spectrum Analysis Test Record, 2-sets of Computone Charts, 1-Connector Cable for comparison test, 1-instruction folder. **WRITE TO US FOR FAST ACTION, OR CIRCLE READER SERVICE CARD #30**, and we'll send you **FREE SPECIAL OFFER DETAILS**.



## Philips CD-Video Player

The CDV488 plays six different video and audio disc formats: 3- and 4.7-inch CDs, 4.7-inch CD-V singles, and 8- and 12-inch laser videodiscs, including the new, thinner, 8-inch LV singles. The 16-bit D/A, with four-times oversampling, uses the same premium select-grade chips as Philips' audio-only CD players, and



has both optical and electrical digital outputs. Favorite Track Selection (FTS) is also featured. The video circuitry includes separate chrominance and luminance processing, with both conventional and "S"

video outputs, plus capabilities for many video special effects. The unit comes with a remote that can learn codes for 10 different audio or video components. Price: \$1,300. For literature, circle No. 106

## Mitsubishi Car DAT

The DT 10 can be used either as the sole program source in a car stereo system, or in conjunction with a radio/cassette or radio/CD unit, thanks to having both its own volume and tone controls and a switchable AUX input. The DAT transport has a dustproof shutter, four repeat modes, and a fast-forward/rewind speed

approximately 150 times normal playback speed. When ambient temperature drops below 68° F (20° C), a built-in sensor activates a heater to prevent condensation buildup on the head wheel. Specifications include frequency response from 20 Hz to 20 kHz, THD of 0.01% and S/N of 90 dB. Price: \$1,650. For literature, circle No. 107



## Denon AM/FM Tuner

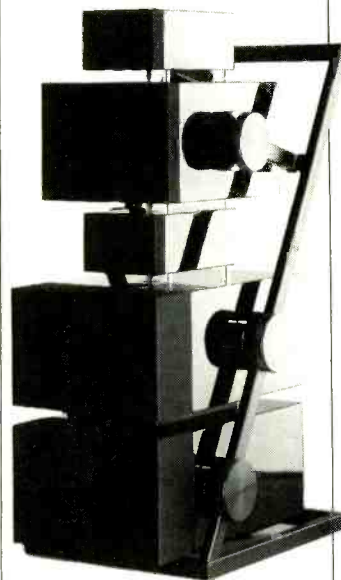
When strong local stations intrude, maximum sensitivity is exactly what you don't need. So the TU-460 has a switched r.f. attenuator circuit that reduces incoming signal strength of FM stations to ensure against front-end overload. Sensitivity for 50-dB quieting is normally 15.3 dBf in mono and 38.5 dBf in stereo. The



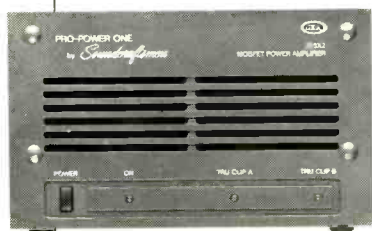
preset memories, which can hold 30 AM and FM stations in any combination, store attenuator settings along with the FM station frequencies. There is also auto-scan tuning. The digital comparator circuit operates

## Goldmund Loudspeaker

Each of the five drivers of the Apologue speaker system has its own black lacquer enclosure. A frame holds the five enclosures in rigid alignment, for correct time and phase relationships. The crossover



networks use more than 700 elements. Efficiency is a high 100 dB at 1 meter for 1 watt input. The striking visual design is by Claudio Rotta-Loria, an Italian designer and painter. He will also sign each of the 300 units in the first production run. Price: \$49,900 per pair. For literature, circle No. 108



## Soundcraftsmen Power Amp

The Pro-Power One is an ultra-high-current design using MOS-FET amplification stages. Power is rated at 205 watts per channel into 8 ohms and 300 watts per channel into 4 ohms, from 20 Hz to 20 kHz, with less than 0.05% THD. Due to its high-current design, the amplifier can also deliver up to 1,500 watts into a 1-ohm load. To achieve this current capacity, power MOS-FETs and filter capacitors with very high storage capacity are used. True clipping indicators for each channel light when actual waveform distortion is detected. Price: \$579. For literature, circle No. 105

above the audio band, at 25 kHz, so as not to generate audible noise. S/N is 78 dB in stereo, 82 dB in mono. The AM stage uses ceramic i.f. filters for lower noise. Price: \$240. For literature, circle No. 109





*The Monitor Series*



Monitor 10B

*"The best high performance speaker value on the market today."* Off The Record



# “Polk’s Remarkable Monitors Redefine Incredible Sound/Affordable Price”

*“At their price, they’re simply a steal”* Audiogram Magazine

## Monitor 10B — \$349.95 ea.

Considered one of the worlds’ best sounding loudspeakers and, in the words of Audiogram magazine, “At the price they are simply a steal.” The Polk 10B utilizes dual trilaminate polymer drivers coupled to a built-in subwoofer for accurate bass response and superior dynamic range. A 1” dome tweeter perfectly complements the other drivers to insure outstanding reproduction of every type of music.

## Monitor 7C — \$274.95 ea.

Basically a smaller, less expensive version of the Monitor 10B. By offering superlative performance whether mounted on a shelf or a speaker stand, the 7C is a highly versatile addition to any audio system. How good does it sound? Audio Alternative magazine said, “It is amazing.”

## Monitor 5B — \$214.95 ea.

Similar in design and performance to the Monitor 7C, however it utilizes an 8” subwoofer (rather than 10”) and is more compact. The 5B represents one of the best values of the entire Monitor Series.

## Monitor 5Jr. + — \$169.95 ea.

Called the best sounding speaker of its price in the world regardless of size. It achieves life-like three-dimensional imaging which 10 years ago was not available in any bookshelf speaker at any price.

## Monitor 4.5 — \$122.45 ea.

Shares most of the high technology components and rewarding musical performance of the larger Polk speakers at a surprisingly low price. A critically tuned bass duct insures high efficiency and great bass performance despite its convenient compact design.

## Monitor 4A — \$99.95 ea.

Identical to the 4.5 in a smaller cabinet. Audio critic Lawrence Johnson called it, “an all around star of great magnitude.” The 4A’s affordable price means that no matter how small your budget, you can afford the incredible sound of Polk!

## Matthew Polk’s Vision: Superior Sound for Everyone

Polk Audio is an American company that was founded in 1972 by three Johns Hopkins University graduates who were fanatical audiophiles with a common vision. They believed that it was possible to make speakers that performed as well as the most exotic and expensive systems at a fraction of the price. Starting with only \$200, they began by designing and manufacturing the Monitor Series loudspeakers. The Monitor Series combined the advantages of American high technology and durability with European styling and refinement. Over the years an unending stream of rave reviews, industry awards, and thousands of enthusiastic Polk customers have established the Monitor Series as the choice for those looking for both incredible sound and an affordable price. There is no better value in audio equipment today than a Polk Monitor series loudspeaker.

## Uncompromising Standards at Every Price

A limited budget does not mean a limited ability to appreciate fantastic sounding music. That’s why we put our best engineering efforts and only the finest materials into every Polk product regardless of price.

Every Polk Monitor Series speaker uses the same trilaminate polymer cone technology as the flagship SDA-SRS 1.2. Every Polk Monitor utilizes a 1” polymer dome tweeter, and most use exactly the same tweeter found in the SRS 1.2. All Polk Monitors employ costly multi-component crossover networks and ¾” thick high density, non-resonant cabinets. Pick up a Polk Monitor 4A, then pick up a comparably priced but larger speaker from a different manufacturer. You’ll notice that the Polk is heavier, more solidly built, and sports a superior fit and finish. Now compare the sound. We are sure you’ll agree with Musician magazine, which said Polk Monitors are: “Vastly superior to the competition.”



Matthew Polk with his incredible sounding/affordably priced Monitor Series loudspeakers.

Front row (L to R) Monitor 5Jr. +, Monitor 4A, Monitor 4.5 Back row (L to R) Monitor 10B, Monitor 7C, Monitor 5B

## The Thrilling Sound of Polk Monitors

Polk Monitors achieve open, boxless, three-dimensional imaging surpassed only by the SDA’s. Their silky smooth frequency response assures natural, non-fatiguing, easy to listen to sound, while their fast transient response results in music that is reproduced with life-like clarity and detail. In addition, dynamic bass performance, ultra-wide dispersion, high efficiency and high power handling are all hallmarks of Monitor Series performance.

## There is a Polk Monitor Perfect for You

Each time you advance through the six Monitor Series models, you’ll immediately hear a remarkable improvement in efficiency, bass response, and output volume. They are designed so that a smaller Polk played in a small room will sound nearly identical to a larger Polk played in a large room. A larger Polk in a small room will, of course, play that much louder with even better bass. No matter what price range fits your budget, there is a spectacular Polk Monitor Series speaker waiting to fulfill your sonic dreams.

**polkaudio**  
The speaker specialists

**Where to buy Polk Speakers?  
For your nearest dealer, see page 52.**

## STAY TUNED



**E**ver heard of the Sharper Image? Some years ago, we in audio were dithering about a thing we knew had to happen, the "marriage" of hi-fi and TV. Thinking on this, I borrowed the name of an estimable mail-order house because it hit precisely what I had in mind: A sharper image. We were rightly concerned, at that point, for our own high-tech reputation. TV sound was dismal. Would our marriage partner ever accept a sharper, better audio for its millions of products? We did not like TV audio. And the TV image itself was only a little better.

There and then, before this doubtful marriage got started, I discovered another of my Canby Principles that immediately applied to this situation. Today, it is a supernova of a Principle, at the heart of immense change that may upset the whole American TV setup. The Japanese are going to push us right into it—the sharper image!

The Canby Laws, I admit, do not emerge out of long and painstaking research. They come to me straight from the blue. I just look around and see what's what, and out pops a Principle. The more research, the duller, I say. Boyle's Law! All about pressure. Ohm's Law, mere high school algebra, if no less than the truth. May these rest

where they belong: In the textbooks. I like my Principles more colorful, if less precise—like Murphy's Law, or the Peter Principle, or the resounding proclamations of Marshall McLuhan ("The medium is the message"). These exalted laws are the very stuff of my own lesser ones, exclusively published in this magazine. Oddly enough, they sometimes turn out to be quite significant in the long reach of time.

Let's put the Sharper Image in perspective among these Canby efforts. My first-ever Law, as far as I can remember, was the Canby Constant, promulgated for *Audio's* 25th anniversary issue (May 1972) and reformulated, a month later, for our 40th (June 1987). It was all in the mind, this principle, though it might account for an audio generation gap: *The apparent time from your earliest childhood memories to the present—any present—remains unchanged in length.* This has nice mathematical complications (see the above back issues).

Then came a curious principle I stumbled on way back, while looking around me at what was what. This one is much more outward and very economic. It seems to have intrigued quite a few professional economists who hadn't looked at things this way, in-

cluding a student at the Harvard Business School who wrote asking where I did my research and if it was in print. *Research?* Just common sense, as I saw it. The principle was this: In the U.S. economy—including, of course, audio—*there is room for 2½ directly competing major systems in each area, but no more.* In our wars of competition, the others just fade away or bide their time. It is a kind of pairing, like two charioteers in ancient Greece. But very American.

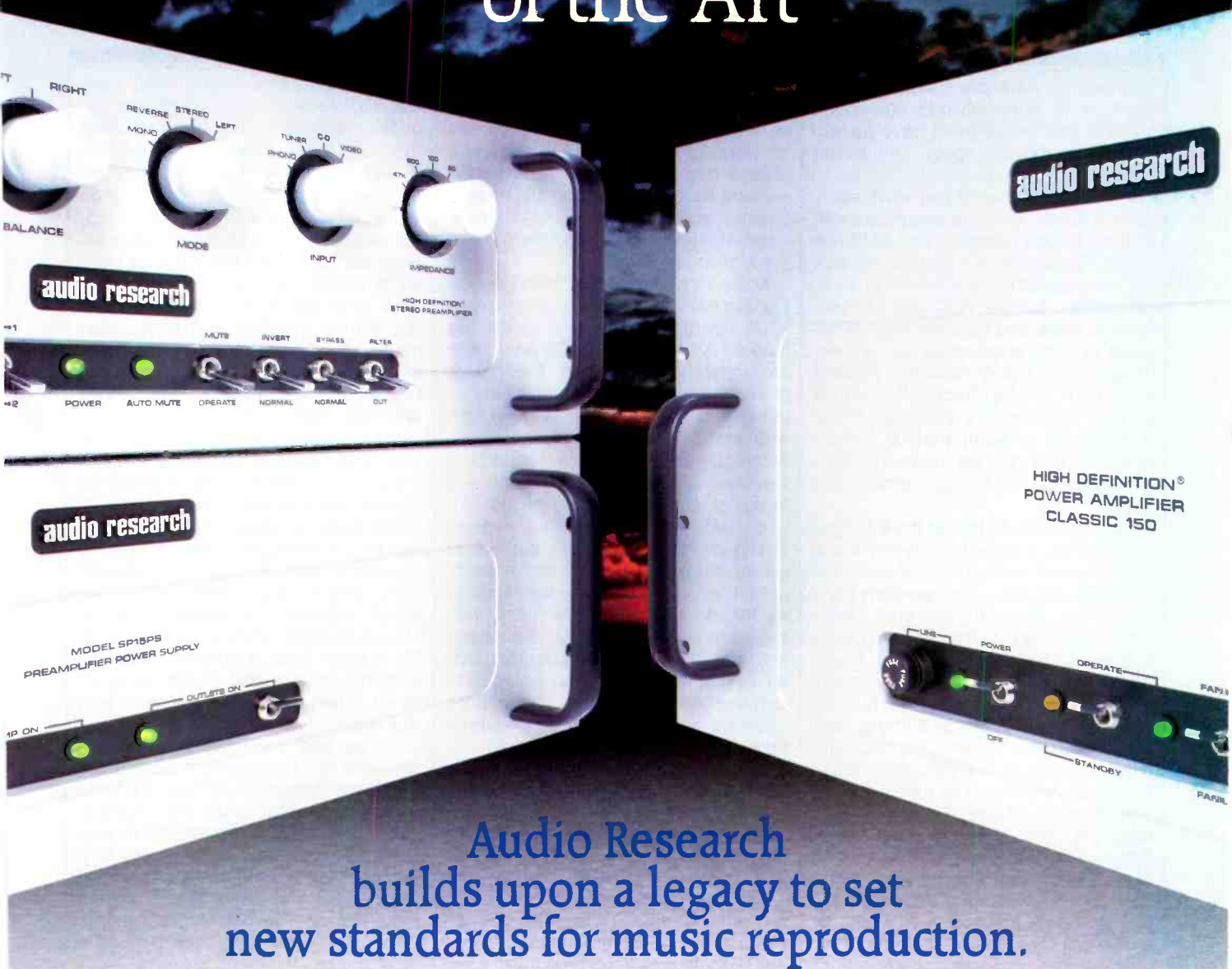
Heavens no—never just one system! That would be *monopoly*. We do not like monopoly hereabouts. But two is okay, especially among economic giants. I call it *biopoly*. Today, we move rapidly toward a polyopoly, edged along by the rest of the big world. But for long years, long before I came along, we did practice this biopoly all over the place, according to the Second Canby Principle. I now revise this for greater accuracy: The Principle of Two-Plus, two competing systems with a few lesser ones around the edges (that's the "Plus"). This unique pattern has been everywhere in our American life. It has dominated us for centuries and has shaped our audio business from the very beginning. Astonishing when you begin to think about it.

The LP and the 45, for instance. Beta and VHS, with the videodisc hovering hopefully on the outskirts. The two great networks, NBC and CBS, with Mutual (and later ABC) hanging in there—"Plus." How about Victor and Columbia, those early rivals from 78 days, with labels such as American Decca or Capitol strongly to one side? Victor and Columbia went right on, decade after decade, evolving into RCA Victor and CBS Records.

You understand that all this was fluid and changeable, being business in action. Like the swirls of oil and water stirred together, like the highs and lows that make our weather, nothing in this pattern is permanent. But somehow, with new forces coming in, the pattern always reemerges. When the early NBC network got too big, it was split—ABC and NBC, right there together in the old Radio City precincts. (Unfortunately, at that time, the NBC anchor station was called WABC! It had to be changed: WNBC. So we had the usual—National and American, opposite



# A Classic Restatement of the Art



**Audio Research**  
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new standards for music reproduction.

Audio Research has been in the business of establishing audio benchmarks for nearly two decades. Some audiophiles and critics might even take Audio Research a little for granted. But when they listen to our new SP15 hybrid preamplifier and Classic 150 hybrid monaural power amplifiers, some ears are going to perk up and some eyes are going to widen.

Because the SP15 and the Classic 150 redefine the audio art, yet remain especially user-friendly.

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paint one wall and you'll  
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numbers in American fashion. There seem to be more networks now, but if you ask me, two of them have usually dominated the top spots. The others are in my "Plus" area.

The rest of the world has never really gone this way. Briefly, perhaps, as with English Decca (London) and EMI, two giants. More often it is straight monopoly, benevolent of course—Air France, British Rail. But the BBC has its commercial rivals and so does French national TV. This is not really our system, though; it is rivalry between government and "private" forces. We merely edge in that new direction, as with the P.O. This is a world pattern, not an American one, and we are borrowing it as we now borrow so much else in One World.

Biopoly! Look further at the Principle of Two-Plus. It goes far beyond audio and beyond economics: Democrats and Republicans—the two-party system, "Plus." For every "National," there is an "American" to match, from banks to baseball leagues to airlines. Do you remember when American Express was an express company, hauling heavy stuff in wagons and trucks, and competing with Railway Express and smaller outfits on the side, like Adams Express? Two-Plus. You may not know that Western Union, Emperor of the telegram, had its major rival, too—Postal Telegraph. It's the American Way. When I went home for college vacations, I would send a telegram (by phone), telling the folks in 10 words, or a 50-word Night Letter, the time of my arrival. I got so expert at writing 10-word masterpieces that often my family couldn't figure out what I was saying. I alternated between Western Union and Postal. You can probably think of a dozen more examples of this curious American habit of pairing. My Second Principle turned it into Law. Of a sort.

As a P.S., I remind you of a presently quaint leftover of the traditional American Two-Plus habit, now in an unlikely place: Japan. Those current giants in audio, JVC and Denon, were both founded far back in the early days of American influence in that country. To this moment, JVC is still the Japanese *Victor*, and Denon is officially Nippon *Columbia*. Need I say more?

Back to the Sharper Image. The Third Canby Principle, governing the

oncoming wedding between hi-fi and TV, stated (out of the blue) that in a two-element reproduced system, such as video or TV, one of the elements always dominates and *this dominant element must have the sharper image*. Greater accuracy, more detail, more information—more bits. Where did this put high-quality audio?

At the time I brought forth this principle, our conventional TV was still largely unchallenged—supreme as the big market, even with early VCR and cable and maybe proto satellite. The impact of improved quality, whether sound or sight, had not hit the general public with more than a tiny dent. People were still satisfied—more important, they were basically right. TV audio was marginal, but with the aid of the picture (real people, lips moving, expressive gestures, smiles), the audio was plenty intelligible and mostly speech, at that, which is minimally demanding. As for the picture, it was fuzzy, with problems of many sorts in the reception, but it still was considerably better—when it worked—than the accompanying audio. Indeed, the picture could be beautiful, as it still is—even if fuzzy and lacking in detailed information. And so we had a good balance according to the Canby Principle. The picture obviously dominated. (Do we *listen* to television? No, we *watch* TV.) It did have the better quality, the greater information. The sound was vital for sense, but it went along for the ride. It was understandable. That was enough.

But in the industries, both video and audio, there was a lot more awareness of what *could* be done—already had been done, behind the scenes. As with the LP and the CD, we knew only too well how much was lacking in TV audio, but what if we improved it? Not good! The balance would be destroyed, the picture would be noticeably less sharp than the sound. That would disrupt.

Like painting one wall in your long-unpainted home. Age can quietly lend a patina of harmony to fading paint, if there is no competition, no obvious contrast. But paint one little segment in a bright new color, and you'll have to do the whole house. Rebuild the whole TV system to higher fi? No less will do.

So we were up against it, both in audio and video. This "marriage" was

going to be complicated. And here was TV, stuck with an enormously expensive broadcast system implacably fixed to those inevitable broadcast "lines" that defined the ultimate possible sharpness for the airborne signal.

Well, you know what has happened. We still have that broadcast system—as of this fleeting moment. But we have undermined it right and left. Yes, marginal and useful improvements were abundantly possible and have been made, to everybody's pleasure. But in the end, *the system itself* has to go. Like the LP, which was so wonderfully improved over the late years.

Meanwhile, non-broadcast video has forged right ahead, TV or no, and the public is ever more familiar with its superior picture and improved sound. Good balance, again. The broadcast system, reaching its limits, is toppling on elderly legs. A new, much sharper TV is almost visibly getting closer. Indeed, it exists! On Japanese air, of course. But the pressure for a new U.S. TV system (and a sharper audio, in balance) is just that much more intense. Sharper, *sharper!* Now it is a real need.

So you see, the Third Canby Principle—that in a dual-medium system, the dominant element must have the higher fi (the greater detail and information)—is absolutely entangled in present developments. Audio must follow video. Video must lead in sharpness. Now, at last, we will be able to strike a new balance without compromise. When the perfect television picture finally arrives.

Don't forget that European TV has, for years, been a great deal closer to that perfect picture. On continental TV, you can already see not only the whites of their eyes but their individual eyelashes. And strands of hair. Leaves on distant trees instead of green smudges. Tiny people at a distance instead of blobs. Our own ultimate TV, when and if, will be even better. It will match any color transparency, and size. *Sharp!* Really sharp. And with good audio, right in balance.

That's it for now. We have to wait a bit for a few gigantic commercial upheavals costing billions before we see that picture. It might take years. But, barring national disaster, we'll have it. And the audio to go with it. 



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History shows that in 1973 the Nakamichi 1000 forever changed the destiny of the audio cassette. Against all odds the world's first true three-head cassette deck had transformed a medium designed for convenience into a serious audio recorder's dream-come-true.

And over the years the Nakamichi 1000 has come to represent a product philosophy—an example of what can be accomplished when a group of single-minded people throw out the rules and eliminate the word "compromise" from their vocabulary.

If, therefore, you're inclined to expect achievements of historical proportions in the new Nakamichi 1000 Digital Audio Recording System, you won't be alone, and you won't be disappointed.

You'll notice a profound difference the very first time you use the Nakamichi 1000 Digital Audio Recorder. Unlike other DAT recorders, the Nakamichi 1000 neither loads nor feels like a VCR. The

smooth, rapid, and quiet operation of the transport will rather remind you of the acclaimed Silent Mechanism found in Nakamichi's analog cassette decks.

That's because the unique F.A.S.T. (Fast Access Stationary Tape Guide Transport) mechanism was designed from the ground up as a digital audio tape transport. Its exclusive, patented stationary tape guides assure more precise and stable tape alignment, so digital error caused by mistracking is dramatically reduced. And articulated link arms gently bring the tape into playing position within 1.9 seconds after a cassette is inserted—two to three times faster than VCR-derived DAT mechanisms.

The four-head drum has separate record and play heads, so you can monitor off the tape while you record. And a unique half-load position fast-winds the tape at 400-times normal play speed—twice that of conventional fast wind—with less wear and tear on tape and heads.

Included with each Nakamichi 1000 recorder is the 1000r infrared wireless remote controller, which gives you full access to the deck's expansive array of advanced operating features.

The Nakamichi 1000p Digital Audio Processor establishes a new reference

standard for sonic accuracy. 8-times oversampling digital filters and fully calibrated 20-bit digital-to-analog converters deliver unprecedented resolution, linearity, and dynamic range.

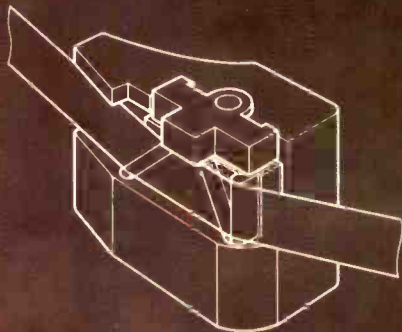


In conventional VCR-derived DAT mechanisms tape alignment guides move with the loading arms. Nakamichi's F.A.S.T. mechanism has exclusive stationary tape guides for faster alignment and superior long-term accuracy.



Nakamichi 1000 Digital Audio Recorder





Each stationary tape guide block actually consists of four separate guide surfaces—two slanted, one vertical, and one horizontal—that work together to more reliably maintain critical tape alignment.

Simply increasing the number of bits is meaningless unless they are implemented with a high degree of precision. So, the Nakamichi 1000p 20-bit D/A converter employs a novel RCM (read-only memory) calibration system. Each D/A converter IC has a corresponding ROM chip programmed at the factory with individual bit error compensation data. Together with a newly developed glitch cancellation circuit, this sophisticated calibration system brings the D/A converter to the theoretical limits of 20-bit performance.

The equally advanced analog-to-digital converter employs an ingenious charge comparison principle that assures accurate encoding without conventional, distortion-causing sample-and-hold circuits. And an extraordinary auto-calibration system precisely trims the quantization increments for all bits within 1.4 seconds every time the 1000p is turned on. That means, unlike typical designs, the 1000p's A/D converter maintains its high level of precision forever.

Finally, to eliminate the adverse effects of any jitter at the digital inputs, the Nakamichi 1000p incorporates a sophisticated two-speed phase-locked-loop interface that more effectively handles a wide range of time-axis fluctuations.

Perhaps most significant is the basic design of the Nakamichi 1000 Digital Audio Recording System. Not content to capture a mere, fleeting moment in audio history, Nakamichi engineers have made the system easily upgradeable. The essential circuitry of both recorder and processor resides on plug-in boards, all readily accessed from the rear panels. The system thus delivers the very best performance available today...whenever "today" happens to be.

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BERT WHYTE

## TREETOP TECHNIQUES

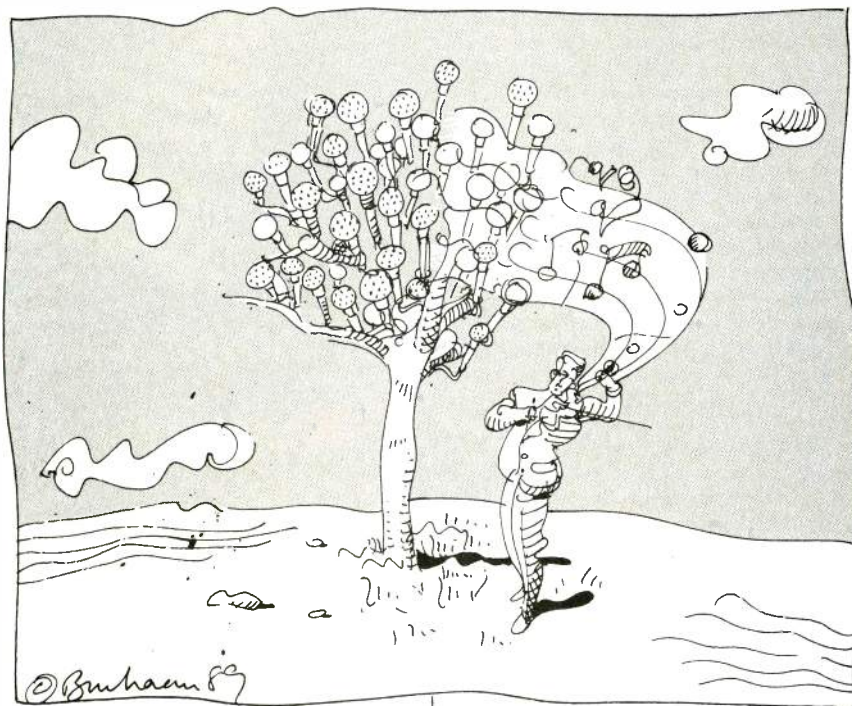


Illustration: Yvonne Buchanan

**Y**ou may recall that in my column in the January issue, I stated that digital recording is "the great leveler." I pointed out that among the generally used digital recorders, none has a significant performance advantage over the others. Since this is the case, the sound qualities of classical music recordings are therefore largely a matter of choice and application of microphones, choice of recording hall, and, of course, the skill of the recording engineer in integrating and controlling these factors to achieve a recording that mirrors the sound of the live performance.

In the old days, there were "sound labels," record companies that emphasized the high-fidelity sound of their recordings as well as their music values. We had Mercury, with Bob Fine's Olympian Series, Westminster, Vanguard, and my own Everest label. Of course, some recordings with good-quality sound were issued by other labels, but the audiophiles of those days knew they could consistently get the best recorded sound from these specialized "sound labels."

Gone now is the relentless striving for technical superiority in the recording medium itself. Digital recording, no matter what brand of recorder may be

used, gives all engineers an equal advantage. In spite of this, we still have "sound labels" today. This certainly must include London/Decca, Telarc, Delos, Chandos, and some smaller specialty labels. EMI is also a frequent source of recordings with high-quality sound, and it must be emphasized that recordings with good sound are becoming more common, even from other major labels. Obviously, with the medium no longer a factor, the "new face" of recording technology resides in the skills of the recording engineer and, to a certain extent, in the philosophies and musical perceptions of the producer.

I think it would be instructive to examine some of the early techniques of classical music recording. Back when the great Arturo Toscanini was conducting the NBC Symphony Orchestra, his performances were broadcast from the notorious Studio 8H in New York City's Rockefeller Center. RCA Victor also made recordings with Toscanini and the orchestra in the same studio, and 8H gained its notoriety because it was an acoustic "sponge." Granted, the recordings were monophonic, but the acoustics of 8H were dry as a bone and completely robbed the sound of any warmth or dimensionality, making

it seem very compressed. Other recordings made during that era were pretty dry acoustically, but not to the extent of those from 8H.

Bob Fine changed all that in 1950, when he first used a Telefunken U-47 omnidirectional condenser microphone in his famous "single-point" mono pickup of the Chicago Symphony. He reasoned quite correctly that when you are attending a concert—in Orchestra Hall in Chicago, for example—you hear not only the direct sound of the orchestra but all of the reflections and reverberation characteristics that reconstitute the hall's acoustic signature. Thus, the omnidirectional pattern of the U-47 was used, with the mike painstakingly adjusted to achieve a "focus" that would capture just the right ratio of direct-to-reflected sound.

Incidentally, Bob Fine also recorded pop music for Mercury, and to him goes the credit for first incorporating reverberant information into pop recordings. If I recall, he used it initially on vocalist Frankie Laine's recordings of "Rawhide" and "The Cry of the Wild Goose." The idea caught on quickly, but you must remember that there were no reverb plates then (like those made now by EMT) and certainly no digital delay or reverb. Consequently, all sorts of means were employed to achieve reverb, including Columbia's (CBS) using the stairwell of their building on Seventh Avenue in New York City!

With the advent of the stereo disc in 1958, both Bob Fine and I began using the spaced-array stereo recording technique. We employed omnidirectional U-47 microphones at the left, center, and right, with the center mike discretely recorded on the center channel of the three-channel, half-inch Ampex. The spacing of the three mikes varied according to the size of the performing group and the acoustics of the hall. On the two-channel stereo disc, mixed from the three-channel tape, the center channel was heard as a phantom image, thus avoiding the hole in the middle which was a common fault of original X/Y two-channel stereo recordings.

Currently, the chief proponent of the three-mike spaced-array technique is Jack Renner, chief engineer of Telarc.



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Julian Hirsch—Stereo Review, Sept. '88

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## What Henry Kloss tells his friends:

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In the old days, "sound labels" emphasized the high-quality sound as well as the musical values of their recordings.

Since this label was founded some 10 years ago, it has achieved a well-deserved reputation for recordings with consistently high-quality sound. However, Renner is not dogmatic. He generally favors the use of Schoeps omnidirectional mikes in his spaced array, but he has used Sennheiser and Brüel

& Kjaer mikes, again depending on the recording hall and the performers. In large-scale works such as oratorios, Renner is not above employing some discreetly used accent mikes. His main considerations are the reverberant characteristics and ambient qualities of the recording hall. Like most engi-

neers, he is on a never-ending quest for good recording venues.

What is the rationale for using a spaced array of three omnidirectional mikes? After all, the British are always damning this technique as being "too phasey" and lacking in instrumental localization and stereo focus. There is a certain amount of truth in this, but there is also no denying that, from a subjective standpoint, many listeners like the feeling of stereo width, depth, and ambient spaciousness which this technique conveys. Another major plus is that the best omnidirectional mikes—from the likes of Schoeps, Neumann, Sennheiser, and AKG—have the most extended low-frequency response. Some B & K mikes respond as low as 2 Hz! Most reach below 20 Hz with ease. In contrast, most cardioid mikes have a low-frequency response that rolls off rather steeply below 40 Hz. So to capture the essence of a big bass drum or 32-foot organ pipes, the omni mike is first choice.

Needless to say, one does not use a three-omni spaced array in a hall that has too short a reverberation period. Conversely, it is equally difficult to use this type of array in a hall with an excessively long reverberation period. In 1950, when Bob Fine first recorded in Chicago's Orchestra Hall, it had a reverberation period of about 1.9 seconds. It made for a lush, wonderful sound, with great dynamics, ultra-solid bass, and brass you could taste. When I was music director of RCA Victor classical recordings in 1965, I found out that a well-meaning patroness had given the Chicago Symphony Society some \$3 million for a "general restoration and rehabilitation of Orchestra Hall." As you may recall, after Mercury ended its contract to record the Chicago Symphony, RCA took over and made all those fine recordings with Chicago conductor Fritz Reiner. In those recordings, they also used the three-mike spaced-array technique. When I heard about the nature of some of the remodelling being done in Orchestra Hall, I had considerable misgivings about how this would affect its acoustics. Imagine my horror when we sent young Peter Serkin to record Bartók's Piano Concerto No. 1, with Seiji Ozawa conducting, and the engineer reported that the famous Orchestra

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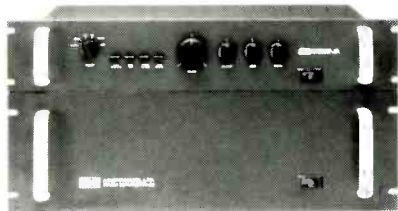
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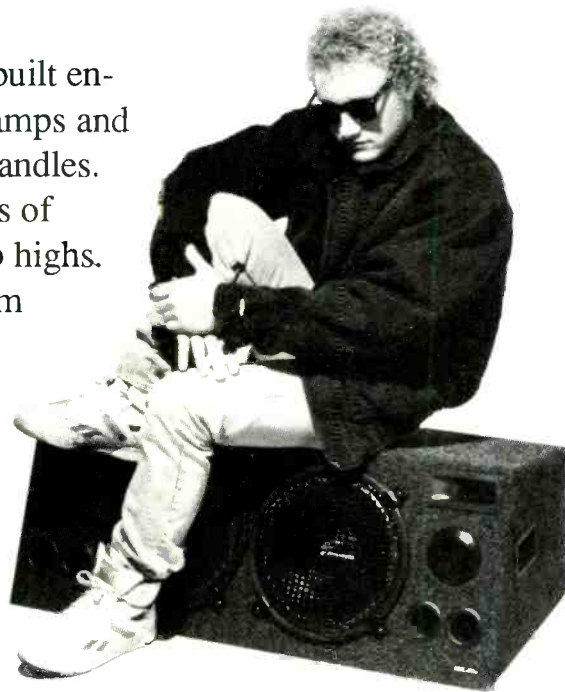
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With the current recording technology, the skills of the engineer and, to some extent, the perceptions of the producer, are crucial.

Hall now had a reverb period of 0.4 second! That's when the Chicago Symphony Orchestra began to record in nearby Medinah Temple.

Since the 78-rpm days of *ffrr* recordings, London/Decca has been justly famed for the generally high-quality sound of their releases. It is safe to say

that no other major label produces recordings with such consistently high sound quality.

Decca uses a complicated technique that generally affords good sound, but it allows for flexibility to cope with a wide variety of recording environments. Like most of the "sound

labels," one of the cornerstones of the Decca technique is in the use of halls with outstandingly good acoustic qualities. At a typical Decca recording session, you will see the famous Decca "Christmas tree" mike array, mounted approximately 12 to 15 feet above and a couple of feet behind the conductor.

This tree is an equilateral triangle of 1 meter per side. Facing forward toward the orchestra, at the apex, is a Neumann M-50 mike. At the base of the tree are M-50 mikes angled to the left and right of the orchestra. These Neumann mikes are of a rather unusual design. At low frequencies, the M-50 acts like an omnidirectional mike, with the typically extended bass response. As the frequency rises to about 2 kHz, the M-50 starts to gradually assume cardioid-like directional characteristics. At 3 kHz, there is also a rise in output level. Such a mike provides good low-frequency response, and the quasi-cardioid pattern affords more high-frequency definition. The directional effects give more localization to orchestral sections. Flanking the tree at various distances, depending on the acoustics of the hall, are a left and right omnidirectional microphone. Stereo pairs of cardioid mikes are used sparingly as accent mikes—again in accordance with the hall acoustics. This Decca tree mike setup works wonderfully well in most halls, but it is easy to perceive the sonic differences between halls. For example, Decca recorded the Shostakovich Fifth Symphony in the great Concertgebouw Hall in Amsterdam. Just recently, they made a great recording of the same work in Walthamstow Assembly Hall in London, the scene of so many splendid Decca recordings. Spaciousness, ambience, depth, directionality, and instrumental localization are equally well delineated in both recordings. However, the Concertgebouw has a somewhat longer reverb period, and bass response is fuller; the Walthamstow sound, on the other hand, is wonderfully detailed and more refined. Some will prefer the massive sonorities of the Concertgebouw, while others will revel in the sparkling definition of Walthamstow.

Chandos is another "sound label" which has been steadily gaining respect for their well-engineered record-

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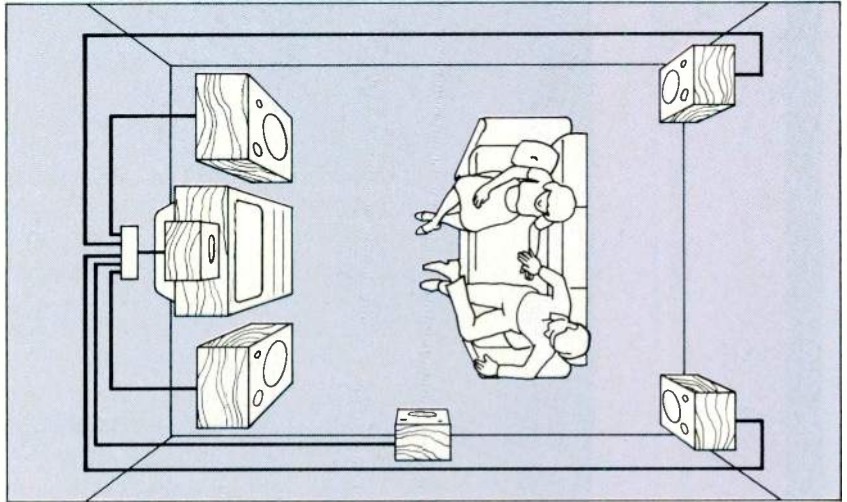
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# Announcing!

## TECHNOLOGY UPDATE #4

# EVERYTHING YOU SHOULD KNOW ABOUT SURROUND SOUND

You're missing some great opportunities if you haven't yet seen the audio technology updates called Audio Information Magazine (AIM).



A typical Dolby Surround Sound System with front and surround speakers. Pro Logic surround sound systems may also have a separate center channel and subwoofer for added realism and dynamics.

The latest educational update (fourth in the AIM Series), is all about Dolby Surround™ Sound and its ability to mimic the soundfield we encounter in real life.

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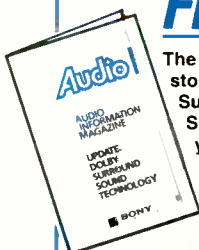
## UPDATE: DOLBY SURROUND SOUND

How Dolby Surround Sound Works  
Dolby Surround and Pro Logic  
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# Audio

# SONY

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The best omnidirectional microphones have a very extended low-frequency response. Some B & K mikes respond as low as 2 Hz!

ings, using a somewhat modified version of the Decca tree: Here is the same 1-meter, forward-facing equilateral triangle but with Neumann M-83 straightforward cardioid mikes at the apex and each base. Flanking the tree, left and right, are omnidirectional mikes, usually Brüel & Kjaer. Stereo

pairs of accent mikes complete the setup.

Chandos makes some spectacular, vital, and very musical recordings. They have a tendency to live dangerously with hall reverb. When they are successful, the sound is splendidly musical, although some recordings

seem a bit overly reverberant and become a bit diffuse.

Finally, we come to the Delos recordings engineered by friend and colleague John Eargle. As you would expect from the man who wrote *The Microphone Handbook*, Eargle's approach to high-quality recording is well reasoned and uniquely successful because of his engineering and musical savvy. His approach is different from most other techniques in that he uses a

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quasi-coincident pair of Sanken cardioid mikes in a modification of the French ORTF technique. This calls for a separation of 17 cm between the mikes, with an included angle of 110°. Eargle uses flanking, omnidirectional mikes, left and right of the coincident pair. To round out the setup, he uses cardioid stereo pairs as very discreet accent mikes. In some halls, he uses a so-called house mike—a cardioid never more than 35 feet from the stage—in order to preserve the Haas effect by not exceeding the 33- to 35-mS limit of ear/brain fusion. Eargle's recordings are models of the art—wide dynamics, subterranean bass, and great orchestral definition, depth, and ambience.

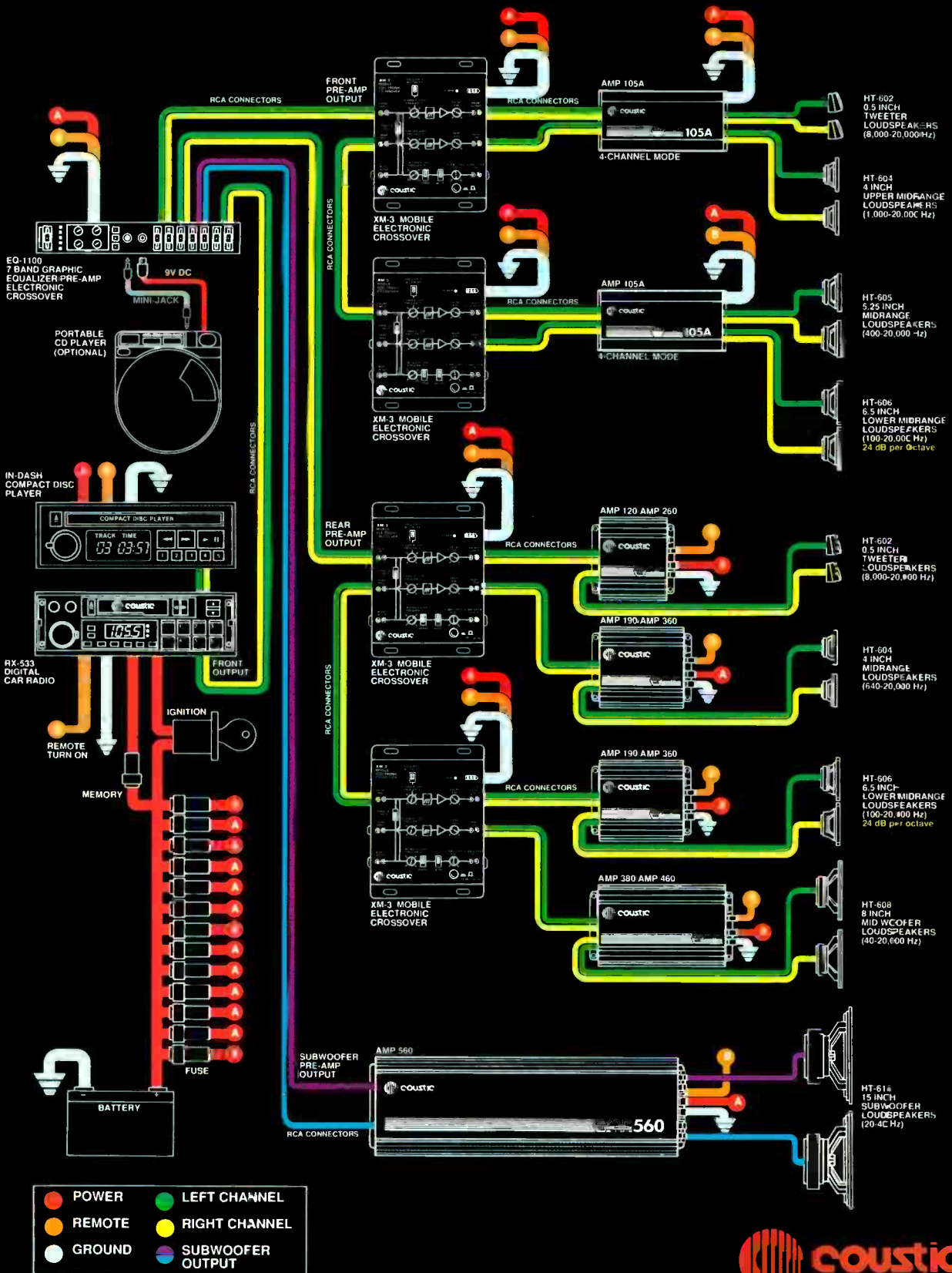
There are, of course, a few other recording setups—including the overt, heavy-handed, multi-mike, multi-track situations—which, in general, do a disservice to the music. Next time you listen to some of the "sound label" recordings, try to visualize the mike setups and the hard work the engineers have put into bringing you such great sound.





# Double Scoop

When one is plainly not enough ...indulge!



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## DESERT BLOOMS



The Fosgate/Barco CES exhibit (right) featured high-definition video images like the one above.

The Winter Consumer Electronics Show was, as usual, held in Las Vegas in the beginning of January. Although some genuinely high-end exhibits of superb sounding and expensive products are found in the Riviera Hotel, for the most part this is the site for smaller companies looking for a larger share of an already crowded specialty market. From time to time, a company makes it into the "big time" and "graduates" from the Riviera to the East Wing of the main convention center. In recent years, Polk Audio and the Carver Corporation have done just that, joining the ranks of a number of larger, broadly distributed manufacturers. On the convention center's main floor, audio companies are represented but still seem to be pushed aside by video and video accessories. No matter where you roam, however, you can be sure you'll be exposed to the absurd (\$4,000 headphones), the visionary (a glimpse of a future car navigational system), and everything in between.

For many reasons, I find the Riviera exhibits more fun to poke around in, and there are old friends at every turn. Not many long-established audio companies bear the name, as well as the continuing presence and philosophical imprint, of their founders. Thus, I was delighted to encounter Richard Shahinian, founder



of Shahinian Acoustics. His company manufactures the noted Obelisk loudspeaker, which radiates sound spherically into the listening space. Dick is an indefatigable music lover who comes to CES with several cases of CDs (and often more than one CD player to boot). Whatever your taste in classical music, he is sure to have superb recorded examples at hand. It was also a pleasure to spend time with Roy Allison of Allison Acoustics. He still pursues the philosophy which he first espoused many years ago: Loudspeaker/room boundary conditions can be optimized in the speaker itself, thus providing the user with better speaker interface in the listening room. His new AL series is, however, a standard, free-standing group of speakers. David Hafler is another pioneer, known primarily for electronics. (Who hasn't built a Dynakit?) The Hafler Co. and Acoustat (the well-known brand of electrostatic loudspeakers built in Florida) are now part of Rockford-Fosgate in Tempe, Arizona. Finally, I had a good chat with Irving M. Fried.

Readers may know of him from his former affiliation with IMF Loudspeakers. His present organization, Fried Products, manufactures quality loudspeakers, some of which use transmission-line loading of the woofers. What distinguishes these "grand old men" is their devotion to music and to honest value for the consumer's dollar. There are doubtless many like them among today's audio entrepreneurs, but that number may not be as large as it once was.

If there was a real show stopper, it was the joint Fosgate/Barco exhibit at the Riviera. Barco is a Belgian manufacturer of video projectors, and Fosgate (in Heber City, Utah) is well known for surround sound decoding of Dolby Stereo soundtracks and other stereo program material. At this impressive exhibit, film clips were shown in normal NTSC color TV with excellent surround sound. Good, but limited by the NTSC 525-line raster. Then came the *pièce de résistance*. The large Barco projector had been modified to handle the NHK (Japanese Broadcasting Organization) high-definition television standard (HDTV), and we then saw a program presented on the 1.85-to-1, 7 x 12-foot screen. The image was absolutely gorgeous. There was no sign of video artifacts or misconvergence, and color saturation was excellent. Only the absolute luminance seemed to be a little less than what you would see in a movie theater, but this would likely not be as noticeable on a home screen. The pity is that we cannot get HDTV. It has hurdles to overcome in this country, including an FCC requirement for "backward compatibility," i.e., that the new signal must work, at least in part, on standard NTSC TV sets. Another problem is software. What we saw was reproduced from a 1-inch videotape system operating at about three times the normal video bandwidth. Laser videodiscs are capable of carrying such a signal but with only about 20 minutes of playing time. I understand that future developments, using a shorter laser wavelength for recording and playback of laser videodiscs, could



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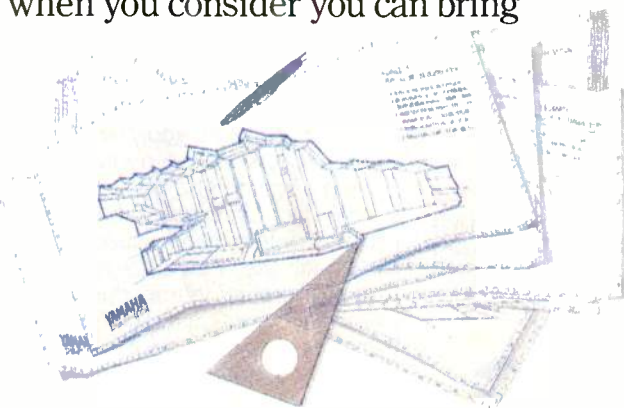
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## The three-piece concept, two small satellites and a common bass module, is coming on strong as a loudspeaker trend

increase playing time proportionally, but this will be far in the future.

It is rare to come across a basic new loudspeaker transducer that is relatively free of problems. Sumo Products of Chatsworth, California presented the Aria, a loudspeaker system designed and built by

Highwood Audio of Calgary, Ontario. Sumo refers to it as a planar loudspeaker; however, that term might be a little misleading, inasmuch as the large diaphragm does not move as a plane. Rather, the highly damped surface is driven at its midpoint by a traditional voice-coil

mechanism. Travelling waves are set up in the diaphragm, but they are effectively attenuated by the damping well before they reach the diaphragm boundaries and reflect to cause interference. For high frequencies (short wavelengths), the signal is attenuated early in its path outward; the highs are radiated only from a small portion of the diaphragm, in the vicinity of the voice-coil. For progressively longer wavelengths (lower frequencies), more of the diaphragm is engaged as a radiating surface. In essence, the voice-coil operates virtually as a point source, with all of the advantages in imaging that this implies. Furthermore, since the voice-coil effectively decouples itself from the diaphragm at high frequencies, a single driving mechanism can accommodate the entire frequency band.

At low frequencies, the large expanse of radiating diaphragm does have dipole properties, and, like an electrostatic, it will benefit from a subwoofer (which Sumo offers). Nominal sensitivity is 86 dB SPL with an input of 2.83 V measured at 1 meter. This is a nominal power input of 2 watts, and with the recommended maximum amplifier rating of 200 watts, levels of 106 dB SPL could be generated at a distance of 1 meter from each loudspeaker. This is not rock-and-roll level, but for most classical and jazz listening in typical living rooms, it will be more than enough—especially with a subwoofer. Congratulations to all involved.

Pioneer has probably made the most auspicious loudspeaker introduction by a Japanese company since Yamaha introduced the immensely successful NS-1000 some 15 or more years ago. Yamaha was not able to keep the particular "magic" going at a high pitch for more than a few years, but Pioneer seems determined to succeed here. Although their new Elite series breaks no new ground in transducer design or system configuration, Pioneer's engineers basically optimized each element of the system. (Much of the design was done by the TAD division, their professional loudspeaker products group, whose work is highly regarded by specialists in high-level



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# Meridian of England showed a very interesting concept of electronics/loudspeaker interface which makes the speaker a system's center.

audio.) They took a no-compromise approach in minimizing enclosure resonances and cone-diaphragm breakup. New materials, such as ceramic graphite and ceramic carbon, were used for optimum stiffness and mass in the mid- and high-frequency transducers. All in all,

great care was taken in system configuration and in the design of dividing networks. The high-end models seem capable of superior performance, but these speakers deserve to be presented better than they were at the Show. The demos took place in a small, prefabricated

space in a ballroom, with concomitant loss of low-frequency response and interference due to the noisy environment.

In the way of trends in loudspeakers, the three-piece concept is coming on strong. These systems—in powered or passive versions—comprise small satellites (getting even smaller) and a common bass module (also getting smaller). Obviously, we don't think of such bass units as subwoofers, since they don't really extend the low end much below about 40 Hz. However, they do enable a modest to mid-sized system to fit into almost any space, and they generally offer good performance. Tower configurations are becoming more prevalent, especially at the high end. This is a trend from Germany and Northern Europe which first surfaced about three years ago. Broad expanses of oak and walnut finishes with brown grille cloths are on the wane, and in their place we see more glossy piano finishes in a variety of colors. Sounds are getting leaner, with bass more understated than a few years ago.

Each year, the poor acoustic environments prompt several manufacturers to schedule product introductions well away from the din of the main CES centers. Madrigal Audio Laboratories, manufacturers of Mark Levinson electronics products, set up in a quiet hotel meeting room downtown. Here, you could engage engineers in detailed conversation as well as enjoy music under near-ideal conditions. For CD demos, an Accuphase player was teamed with Canadian Mirage loudspeakers, and various Levinson amplifiers were showcased. Gorgeous sound overall.

In a neighboring room, Meridian of England demonstrated a very interesting concept of electronics/loudspeaker interface which, in effect, makes the loudspeaker the center of a system. Imagine sitting in front of loudspeakers with a remote control in your hands. The control communicates with a unit atop one loudspeaker, and commands are sent back to a CD player or other source. Volume and equalization settings are made via the remote, so one never needs to leave the listening spot,

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**PA Allentown:** Bryn Mawr Stereo •  **Blakely:** Hart Electronics •  **Bryn Mawr:** Bryn Mawr Stereo •  **Camp Hill:** Bryn Mawr Stereo •  **Chambersburg:** Sunrise Electronics •  **Erie:** Studio One •  **Johnstown:** Gary's Entertainment •  **Kingston:** Hart Electronics •  **Lancaster:** G'n'T Stereo •  **Longhome:** Bryn Mawr Stereo •  **Montgomeryville:** Bryn Mawr Stereo •  **Natrona Heights:** Stereo Land •  **Philadelphia & Suburbs:** Bryn Mawr Stereo •  **Pittsburgh:** Audio Junction •  **Quakertown:** Bryn Mawr Stereo •  **Reading:** G'n'T Stereo •  **Selinsgrove:** Stereo Shop •  **State College:** Paul & Tony's Stereo •  **Stroudsburg:** Main St. Audio Video •  **Wexford:** Audio Insight •  **Williamsport:** Robert M. Sides  
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**RI N. Providence:** Eastern Audio  
**SC Anderson:** Music Machine •  **Charleston:** Audio Warehouse •  **Columbia:** Music Machine •  **Greenville:** Mitchell's Stereo •  **Myrtle Beach:** Greenwood •  **Stereo Shop** •  **Spartanburg:** Stereo Shop  
**SD Aberdeen:** Engel Music •  **Rapid City:** Team Electronics •  **Sioux Falls:** Audio King  
**TN Chattanooga:** R&R TV •  **Cookeville:** Lindsey Ward •  **Jackson:** New Wave Electronics •  **Kingsport:** Addition •  **Knoxville:** Lindsey Ward •  **McMinnville:** Lindsey Ward •  **Memphis:** New Wave Electronics •  **Nashville:** Hi Fi Buys  
**TX Amarillo:** Sound Systems Ltd. •  **Arlington:** Sound Idea •  **Austin:** Marcum Electronics •  **College Station:** Audio Video •  **Corpus Christi:** Tape Town •  **Dallas:** Hillcrest Hi Fidelity •  **El Paso:** Soundquest •  **Ft. Worth:** Sound Idea •  **Houston:** Sheffield Audio •  **Hurst:** Sound Idea •  **Laredo:** Melex International •  **Longview:** Audio Techniques •  **Lubbock:** Electronics Supercenter •  **San Antonio:** Bill Case Sound •  **San Marcos:** Discovery Audio Video •  **Sherman:** Worldwide Stereo •  **Temple:** Audio Tech •  **Texarkana:** Sound Towne •  **Waco:** Audio Tech  
**UT Logan:** Stokes Brothers •  **Ogden:** Stokes Brothers •  **Salt Lake City:** Broadway Music •  **St. George:** Boulevard Home Furnishings  
**VA Bristol:** Audition •  **Charlottesville:** Holdens •  **Sound Machine** •  **Falls Church/Manassas:** Audio Buys •  **Richmond:** Gary's Stereo •  **Roanoke:** Holdens •  **Virginia Beach:** Digital Sound  
**VT Brattleboro:** Scientific Stereo •  **Essex Junction:** Creative Sound •  **Rutland:** Mountain Music  
**WA Bellingham:** QC Stereo •  **Chelan:** Music Store •  **Oak Harbor:** QC Stereo Center •  **Richland:** Tim Ear Stereo •  **Spokane:** Electracraft (Hals)  
**WI Appleton:** Sound World •  **Eau Claire:** EME Audio Systems •  **Green Bay:** Sound World •  **Lacrosse:** Sound World •  **Madison:** Happy Medium •  **Milwaukee:** Audio Emporium •  **Wausau:** Sound World  
**WV Barboursville:** Beckley, Charleston: Pied Piper •  **Clarksburg:** Audio Visual Concepts •  **Huntington:** Pied Piper •  **Piedmont:** Sound Gallery •  **Wheeling:** Stereo Lab  
**WY Cheyenne:** Electronics Unlimited

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Nakamichi predicts huge success for its 1000 DAT. They're probably right, but everyone wonders how the RIAA will react to it.

save to change a disc. The loudspeakers are triamplified, and for the sake of simplicity, the entire digital-to-analog conversion (for CD and DAT) is carried out in the receiving unit on top of the loudspeaker. The concept may seem odd at first, but a little thought will convince you that it makes sense. Excellent sound.

Another off-site demo was held by Nakamichi. The main attraction here was their new Model 1000 DAT recorder. You may recall the original Model 1000, a superlative cassette machine which redefined standards for that product class. It sold, I believe, for around \$1,500 and was immensely successful, once professionals and audiophile consumers found out how good it was. Nakamichi is forecasting a similar future for the new Model 1000, and they are probably right!

The unit will permit recording at the 44.1-kHz sampling rate, and multiple heads on the helical-scan drum will permit direct read after write, a feature many professional digital recorders do not have. The three-piece system (recorder, digital processor, and controller) costs \$10,000 and will accommodate modular sub-sections to upgrade performance from time to time, as the company develops improvements.

The question everyone is asking is how the sale of the 1000 recorder will be viewed by the RIAA, long the holdout against DAT because of its presumed economic consequences on consumer copying of CDs, cassettes, and LPs. Nakamichi is taking a bold step, but someone must do it. I suspect that there will be no problems at all.

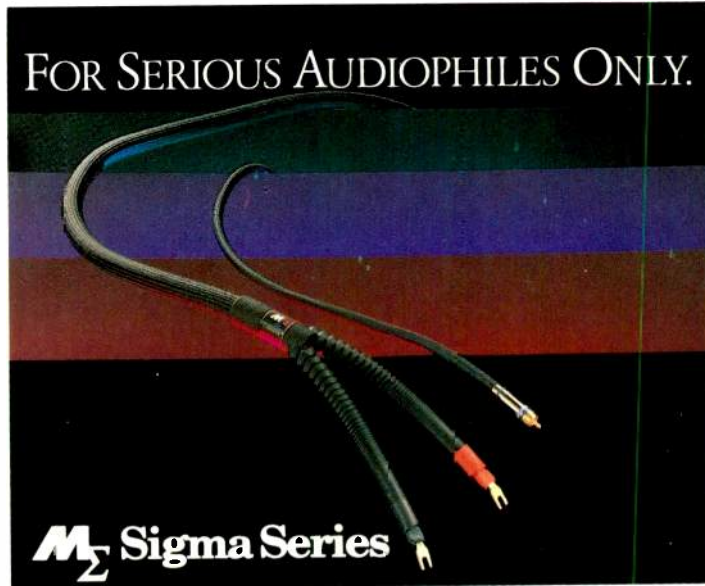
While Nakamichi attempts to break the DAT logjam, Wadia is on hand with an external processor which can be used to enhance the performance of any digital source. At the Riviera, the Wisconsin-based manufacturer compared their existing Model 2000 (at \$6,500) to their new Model 1000 (at \$3,900). For all intents and purposes, there was no substantial difference between the two—and we were listening over a pair of Duntech Marquis loudspeakers driven by Classé Audio amplifiers, easily some

of the best sound at the Show. The new unit uses 16-times oversampling, as opposed to 64-times in the Model 2000.

Finally, let us welcome several new organizations to the digital software business. Wilson Audio, long a maker of very high-end loudspeakers and

audiophile LPs, introduced its first CDs. Dorian Records debuted some superb organ discs, and Chesky Records, the company which brought us new transfers of 1960s RCA masters long after RCA had given up on them, also introduced Compact Discs.

John Eargle



**Good things come to those who wait.**

These days, serious audiophiles searching for the right high-performance cable face a long, difficult road. Each manufacturer has their own story. And it takes time to sort out all the different designs before deciding which cable to buy.

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The M2Sigma Series is Monster's latest musical revelation. Representing the ultimate extension of Monster's *Bandwidth Balanced*® technology, the M2Sigma Series delivers the highest level of audio interconnect and speaker cable performance.

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**New Monster "Balanced Impedance" technology.**

Both the M22000 Audio Interconnect and the M22 Speaker Cable incorporate several innovative new technologies.

Consisting of separate multi-gauge wire networks featuring Monster's advanced "time-compensated" windings,

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**The World's Reference Standard Cable Termination.**

M2Sigma's sonic improvements require a new approach to termination technology. Using a massive ground contact crimped with over 20 tons of pressure, we feature a special copper-to-copper, cold-welding process using no solder or other extraneous metal that can cause sonic degradation.

With a more direct hook-up of M2Sigma's conductors, all the subtle nuances and power of your music are transferred to the speakers through an uncompromising connection that ensures absolute accuracy and signal integrity.

**Sonic rewards worth the price of admission.**

With signal phase integrity now maintained, all the depth, range, and power of your music are reproduced with unequal-d accuracy. You'll hear singers and soloists projected to a pinpoint spot in front of your speakers. Instruments and vocals that seem to "float" space. With a realism that breathtakingly captures the essence of the original performance.

Although not inexpensive, the M2Sigma Series represents the highest level of sonic performance money can buy. We invite you to audition these extraordinary cables at a Monster M•Series™ dealer. And prepare yourself for a thoroughly enjoyable musical experience.

- Absolute Audio Orange, CA GNP Pasadena, CA Paris Audio Woodland Hills, CA, West Los Angeles, CA Upscale Audio Canoga Park, CA Wilson Audio Video Entertainment Woodland Hills, CA Audio-Visions W. Babylon, NY Hal's Stereo Trenton, NJ Lyric HiFi New York, NY, White Plains, NY Sight and Sound Morristown, NJ, Flemington, NJ Sound by Singer New York, NY Soundex Willow Grove, PA, Berwyn, PA Sounds of Distinction Atlanta, GA Woodbridge Stereo Woodbridge, NJ, West Long Branch, NJ, Princeton, NJ Listening Room Scarsdale, NY HiFi Heaven Green Bay, WI Sound II No. Dartmouth, MA Tweak Shop Santa Rosa, CA Absolutely Sound! Rockville, MD Jamieson Stereo Toledo, OH Paul Heath Audio Chicago, IL Quintessence Audio Naperville, IL Audio Visions Tampa, FL World of Sound San Francisco, CA Natural Sound Framingham, MA Sound Concept Rochester, NY Sound Gallery Melbourne, FL Don's Hi Fidelity Amarillo, TX 20/20 Inc., Honolulu, HI Cooper Ior Stereo St. Petersburg, FL Harmony Audio Video San Francisco, CA Audio Excellence San Francisco, CA Longplayer Stereo Goshen, NY Sound Components Coral Gables, FL Sound Scape Baltimore, MD

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Technology You Can Hear.







# END OF CONVERSATION.

Close your eyes, put on your favorite CD and listen. That's the best way to appreciate the natural, accurate musical reproduction of the new Elite TZ Series reference loudspeakers from Pioneer.

Designed by the same engineering team that developed Pioneer's renowned TAD studio monitors, the TZ Series speakers are designed to accommodate the extended dynamic range, superb clarity and depth of digital source materials.

Pioneer began by developing two entirely new diaphragm materials—ceramic graphite and ceramic carbon. These unique low-mass materials are used to construct midrange and high-frequency dome-type diaphragms that virtually eliminate spurious resonance while providing lightness, stiffness and excellent signal propagation speed. Now critical midrange frequencies and delicate highs will sound clearer and more natural than ever before.

To reproduce the extended low frequencies found on digital recordings, Pioneer developed a twin woofer system that packs a punch you'll feel as well as hear. Opposite-mounted bar-jointed

woofers placed in the center of the TZ's cabinet minimize standing waves while providing accurate low-frequency response to 20 Hz.

The cabinet of the 143-lb. TZ-9

is specially constructed, using 1" thick high-density board and a separate inner baffle that isolates the negative influence of low-frequency



Unique bar-jointed twin-woofer system.

vibration. Corners are specially rounded to eliminate diffraction and drivers are arranged for optimum sound-field intensity. The result is imaging and clarity that bring performances alive with smooth, true-to-life sound.

But enough conversation. If you're interested in hearing more about Pioneer's new TZ Series speakers, call 1-800-421-1404 for a technical white paper and the Elite dealer nearest you.

And let the speakers do the talking.



© 1989 Pioneer Electronics (USA) Inc., Long Beach, CA  
Model shown: TZ-9. Also available: TZ-7.

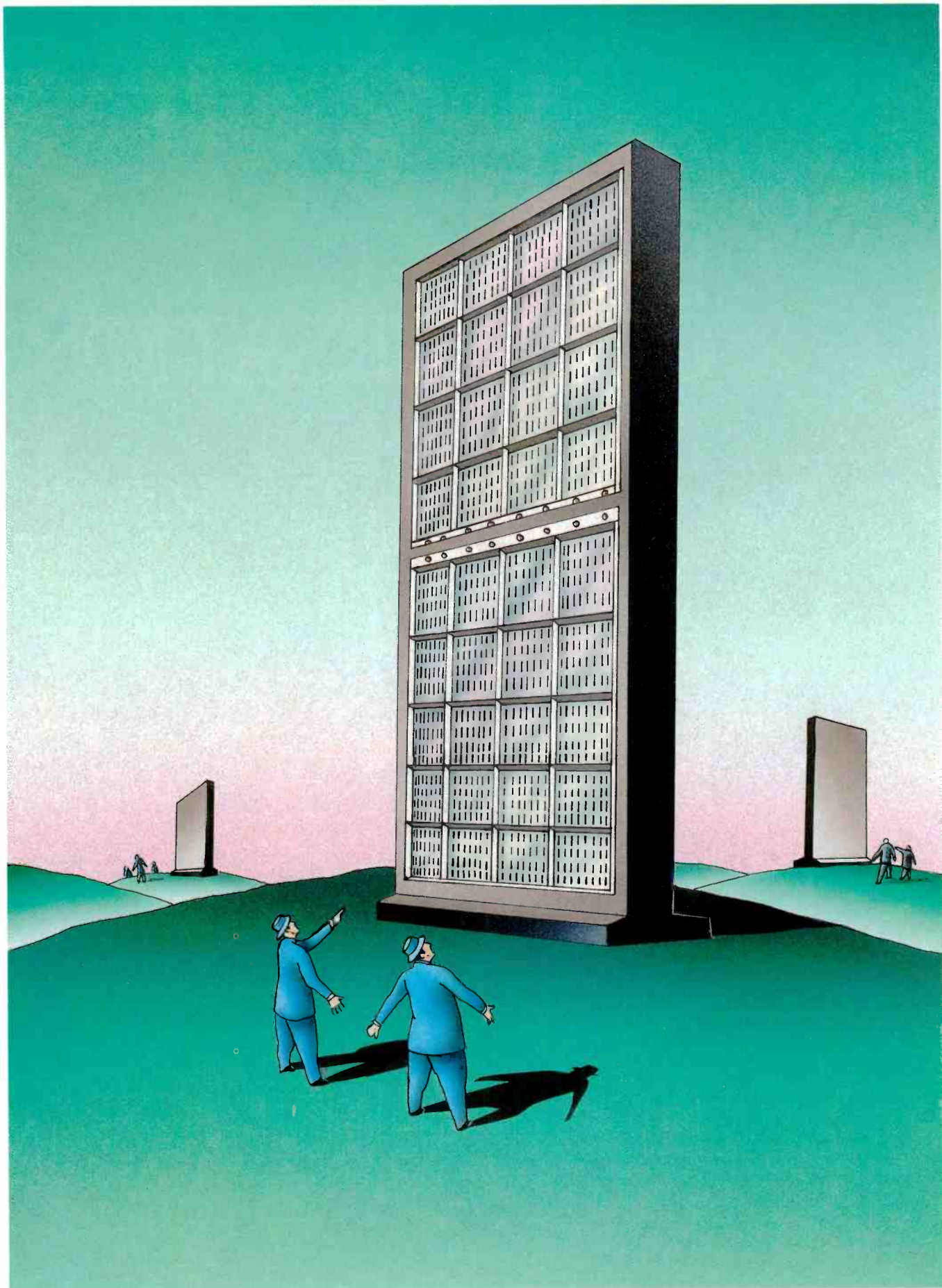


Illustration: Michael McGurl



# ELECTROSTATIC SPEAKERS

## Theory & Practice

RONALD WAGNER

Last time, we covered the history and principles of the electrostatic loudspeaker (ESL) and the forces that move its diaphragm. Now it's time to discuss the ways signals are coupled to that diaphragm, its acoustic parameters, and ways to improve ESL performance.

One of the most critical items in an electrostatic speaker is the audio transformer that is connected between the plates and the source of the audio volt-

age. This device has two interrelated functions. First, it increases the amplifier's output voltage to a value that can produce the required diaphragm movement. Second, it reflects the speaker's capacitance, and its associated impedance, back to the output of the amplifier.

### URNS RATIO

One of the key factors in the performance of a transformer is its turns ratio, which relates the number of turns in one winding to the number of turns in another winding. Although this ratio is not specifically stated in transformer data sheets, it is usually provided in some other form. For an existing transformer, the number can be determined by measuring the voltages on each

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*Ronald Wagner is the author of Electrostatic Loudspeaker Design and Construction, published by Tab Books. Since 1968, he has been experimenting with the design of electrostatic speakers.*

**T**he true efficiency of an ESL can be higher than expected, but its apparent efficiency is considerably lower.

winding and then computing the ratio between these voltages. That is:

$$N = \frac{V_2}{V_1} \quad (10)$$

where N is the turns ratio between the two windings; V<sub>2</sub> is the a.c. voltage across one transformer winding, and V<sub>1</sub> is the a.c. voltage across another winding.

Besides increasing the secondary voltages, the turns ratio also increases the speaker capacitance that is reflected back to the audio amplifier. As an example, suppose a speaker is to be driven by a 100-watt amplifier. If the amp's full rated power is delivered into a 4-ohm load, then its peak-to-peak output is 56.56 V. When the amp is connected to the 24-inch ESL described last month, this voltage must be increased until the plate-to-plate voltage is 6,250 V. The ratio of these two voltages will establish the transformer turns ratio; in this example, it is 110.5.

Once this value is defined, it can also be used to calculate the speaker's reflected capacitance. Thus:

$$C_{pri} = C_{spkr} \times N^2 \quad (11)$$

where C<sub>pri</sub> is the speaker capacitance reflected back to the primary winding of the transformer, and C<sub>spkr</sub> is the speaker's plate-to-plate capacitance. For a plate-to-diaphragm capacitance of 2,074 pF, as discussed last month, C<sub>spkr</sub> is 1,037 pF, or 1.037 × 10<sup>-9</sup> farad. Therefore, the reflected capacitance of the indicated loudspeaker is equal to:

$$\begin{aligned} C_{pri} &= (1.037 \times 10^{-9})110.5^2 \\ &= 12.7 \times 10^{-6} \text{ farad.} \end{aligned}$$

Power amplifiers used for driving loudspeakers are usually designed for load impedances between 4 and 16 ohms. A 12.7-μF capacitor will have an associated impedance, at 100 Hz, of 125 ohms. Because this calculated impedance value is very large, it will affect the speaker's ability to produce the required amount of acoustic power. In addition to this, a capacitor's impedance is not constant. At 10 kHz, for instance, the value will have decreased to 1.25 ohms. Not only can this cause the amplifier to limit its output power, but the capacitive load can also produce oscillation in the amp.

One way to overcome these difficulties is to use several speakers. If each speaker is operated over a reduced

frequency range and connected to the amplifier by a suitable crossover network, the impedance variation at the amp's output will be less. Another solution is to break a large diaphragm area up into smaller sections. Using this technique, each section is again connected to the amplifier by a crossover network. For higher frequencies, speakers or speaker sections of smaller area are used. More information on this method will be presented in the section on "Segmentation."

### TRANSFORMER FREQUENCY RESPONSE

All transformers have frequency response limits. Some, such as power transformers, have very narrow bandwidths that only occupy a few hundred hertz. Others, used in communication systems, can have a frequency response that spans many megahertz.

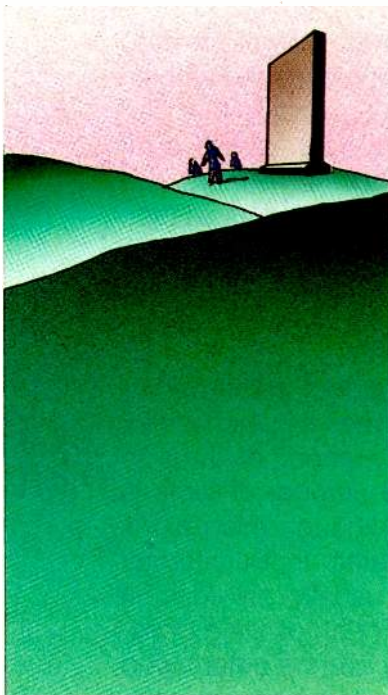
A transformer for a single-diaphragm ESL should reach frequency limits of 20 Hz and 20 kHz. For any transformer, the exact location of these limits can be determined by dividing its frequency response into three regions. Each region is then analyzed by using an equivalent model that predicts how the transformer and its associated load will perform.

The best place to start analyzing a transformer's response is in its mid-frequency range. Within this region, the transformer is considered ideal, and its performance is determined by its turns ratio. To create an equivalent model, the output winding resistance, as well as the load, must be reflected back to the input terminals.

Consider, for example, the transformer circuit shown in Fig. 8A. The resistance (r<sub>g</sub>) is the internal resistance of the voltage source (e<sub>s</sub>). The resistance of the input or primary winding is shown as r<sub>p</sub>. On the speaker, output, or secondary side of the transformer, the winding resistance is designated as r<sub>s</sub>. The speaker capacitance is shown as C<sub>spkr</sub>.

An equivalent model is shown in Fig. 8B. In this diagram, the two resistances (r<sub>g</sub> and r<sub>p</sub>) are unchanged. As indicated, the secondary resistance (r<sub>s</sub>) is referred to the input or primary winding by dividing its value by the square of the turns ratio (N). The speaker capacitance is also reflected to the input, but its value is multiplied by the square of the turns ratio, as shown in equation 11 above.

Although this circuit does not look very complicated, it can be simplified still further. For instance, most solid-state amplifiers have an r<sub>g</sub> of less than





1 ohm. The primary winding resistance is about the same value, and the two resistances can be combined. The output or secondary winding resistance is dependent on the wire size and the number of turns. For a transformer used in an electrostatic speaker, this value can vary from 50 to 100 ohms. When it is referred to the input, it becomes so small that it can be dropped from the circuit, yielding the new circuit shown in Fig. 8C.

Electrically, this circuit is called a low-pass filter. The output voltage across the speaker's capacitance will decrease by 3 dB when the reflected impedance of the capacitance is equal to the combined values of  $r_g$  and  $r_p$ . If, for instance, the winding resistance ( $r_p$ ) plus the source resistance ( $r_s$ ) is equal to 1 ohm, then the speaker's upper frequency response would be limited to 12.5 kHz. On the other hand, if this resistance were only 0.5 ohm, the upper limit would be extended to 25 kHz. Unfortunately, transformers are not ideal, and their high-end response will be determined by a number of other factors. One of these factors, inductance, affects low-frequency performance, too.

A transformer's low-frequency response is determined by the inductance ( $L_{pri}$ ) of the primary winding. When the impedance of this winding is equal to  $r_g$  plus  $r_p$ , the voltage across the speaker will decrease by 3 dB. Although  $C_{spkr}$  is in parallel with  $L_{pri}$  its impedance is much greater and does not become a factor in the low-frequency limit. The low-frequency transformer model is shown in Fig. 8D, and the location of the -3 dB point can be calculated by:

$$f = \frac{X_L}{2\pi(L_{pri})} \quad (12)$$

where  $f$  is the -3 dB frequency in Hz;  $X_L$  is the impedance value, in ohms, that is equal to the sum of  $r_p$  and  $r_g$ , and  $L_{pri}$  is the inductance of the primary winding, in henries.

As an example, suppose a transformer has a primary inductance of 1.5 mH (0.0015 H). If the total resistance of  $r_g$  plus  $r_p$  in the circuit of Fig. 8D is equal to 1 ohm, the transformer's low-frequency limit would be:

$$f = \frac{1}{6.28(1.5 \times 10^{-3})} \\ = 106 \text{ Hz.}$$

As already stated, a number of factors must be considered in establish-

ing the transformer's upper frequency limit. The circuit in Fig. 8E shows the majority of these elements. In this type of circuit, the unknown components are the leakage inductance, the interwinding capacitance ( $C_{iw}$ ), the secondary-winding capacitance ( $C_s$ ), and the primary-winding capacitance ( $C_p$ ).

The model shown in Fig. 8F is an equivalent circuit, with all of the secondary elements reflected to the primary winding. This circuit can also be reduced in complexity. For instance, the secondary-winding capacitance ( $C_s$ ) is very small when compared to the speaker's capacitance, and it can be removed from the circuit. The value of the interwinding capacitance ( $C_{iw}$ ), the capacitance between the two windings, is not multiplied by the turns ratio. However, it can be moved to the input side of the transformer and added to  $C_p$ ; the combination is shown as  $C_1$ . As long as the source and the primary-winding resistance are very low,  $C_1$  will not seriously affect the transformer's upper frequency limit, and it can be removed from the circuit.

In the transformer's mid-frequency range, the analysis assumes that all of the magnetic lines from the primary winding are linked to the secondary. In actual practice, this is not always true. The difference between the number of magnetic lines produced in the primary and the number coupled to the secondary yields an additional parameter called the leakage inductance. This inductance can be calculated by:

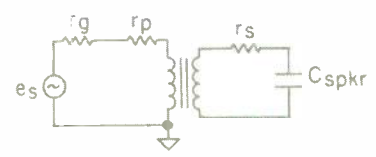
$$L_l = 2(1 - k)L_{pri} \quad (13)$$

where  $L_l$  is the leakage inductance, referred to the primary winding;  $k$  is the coefficient of coupling between the two windings, and  $L_{pri}$  is the inductance of the primary winding.

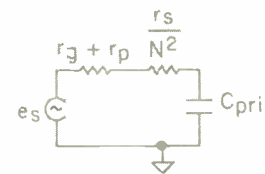
In the mid-frequency range, the value of the coupling coefficient ( $k$ ) is equal to unity, which makes  $L_l$  equal to zero. As the frequency is increased, the value of  $k$  decreases. If  $k$  is reduced to 95%, the leakage inductance is equal to:

$$L_l = 2(1 - 0.95)(1.5 \times 10^{-3}) \\ = 2(0.05)(1.5 \times 10^{-3}) \\ = 1.5 \times 10^{-4} \text{ H.}$$

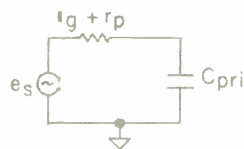
As shown in Fig. 8F, this leakage inductance is in series with the reflected load impedance. The voltage across the speaker will be down 3 dB when the impedance of  $C_{pri}$  is equal to



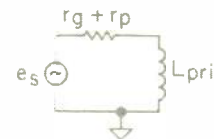
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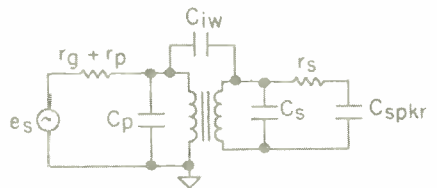
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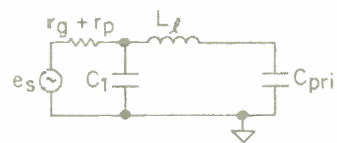
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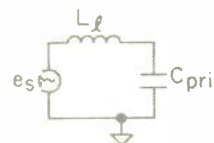
D



E



F



G

Fig. 8—Transformer circuits and equivalent electric circuits.

**E**lectrostatic speakers do not actually require much power, but they do demand lots of current from the amplifier.



the impedance of the leakage inductance. The modified circuit, shown in Fig. 8G, is also a low-pass filter. Its -3 dB point can be calculated by:

$$f = \frac{1}{6.28 \sqrt{L_l \times C_{pn}}} \quad (14)$$

$$= \frac{1}{6.28 \sqrt{(1.5 \times 10^{-4})(12.7 \times 10^{-6})}}$$

$$= 3,648 \text{ Hz.}$$

Because the previous calculations have indicated that this transformer has a very poor bandwidth for high-fidelity reproduction, it can only be used for midrange speakers. To reproduce the bass and high-frequency portions would require substituting a different transformer. If the full audio spectrum is to be reproduced by a single transformer, that transformer's primary inductance must be greater than the previous value.

Similarly, high-frequency response can be extended by selecting a transformer with a lower leakage inductance. In some instances, this can be achieved by careful transformer design. However, this may be very difficult if the transformer has a high step-up ratio. One alternative is to use a separate transformer with a lower turns ratio to cover the high-frequency range. Although there are a number of other interrelated factors, this would decrease the leakage inductance and extend the high-frequency limit.

### ACOUSTIC PERFORMANCE

The major acoustical parameters of a loudspeaker are its volume velocity, radiation resistance, power output, frequency response, directivity, and distortion. This last parameter is not usually a significant factor in ESL performance.

Volume velocity is a measure of how much air the speaker is moving. This is calculated by multiplying the diaphragm area by the rms value of the diaphragm movement, and dividing the result by the required time per cycle. That is:

$$U = A \left( \frac{2\pi \times d_{rms}}{t} \right) \quad (15)$$

where U is the volume velocity, A is the diaphragm area,  $d_{rms}$  is the rms value of the diaphragm movement, and t is time. Using the same diaphragm area and plate-to-diaphragm distance as in Part I of this article, and a frequency of 100 Hz, we get:

$$U = \frac{0.372[6.28(1.5875 \times 10^{-3})0.707]}{0.01}$$

$$= 0.262 \text{ cubic meter per second (m}^3\text{/S).}$$

### RADIATION RESISTANCE

The acoustic power from a speaker is dissipated in the radiation resistance of the air load. Beranek's *Acoustics* (Table 5.3, page 126) defines the radiation resistance (on both sides of a diaphragm, without a baffle) as being equal to:

$$R_a = \frac{(1.9 \times 10^{-2}) \times (a^2 \times \rho_o \times w^4)}{c^3} \quad (16)$$

where  $R_a$  is the radiation resistance, in acoustic ohms; a is the diaphragm radius, in meters;  $\rho_o$  is the density of air (1.19 kg/m<sup>3</sup>); w is  $2\pi f$ , and c is the velocity of sound, in meters.

As the radius (a) indicates, Beranek's equation is for conventional, round speakers. To use this equation for our 24-inch square (0.372 m<sup>2</sup>) speaker, we must first calculate the radius of a circle of equivalent area, which is 0.344 m. Therefore, the value of  $R_a$  for this speaker, at 100 Hz, is:

$$R_a = \frac{(1.9 \times 10^{-2}) \times (0.344^2 \times 1.19 \times 628^4)}{345^3}$$

$$= 10.13 \text{ acoustic ohms.}$$

### ACOUSTIC POWER

The acoustic power ( $P_a$ ) produced by the speaker is equal to the radiation resistance multiplied by the square of the volume velocity. That is:

$$P_a = R_a \times U^2 \quad (17)$$

$$= 10.13 \times 0.263^2$$

$$= 0.700 \text{ watt.}$$

If this number seems high, it is. The previous calculation for the volume velocity assumed that the entire diaphragm moved the total distance which separated the two plates. Due to the mounting system, this is far from true. As an estimate, the average displacement is about 5% to 10% of this distance. To keep things simple, let's assume an rms value of 0.0125 inch, or  $317.5 \times 10^{-6}$  m. The corresponding volume velocity will be:

$$U = 74.2 \times 10^{-3} \text{ m}^3\text{/S, and}$$

$$P_a = 55.8 \times 10^{-3} \text{ watt.}$$



The total power that must be supplied by the source is equal to the power dissipated in the radiation resistance and the power needed to move the diaphragm. That is:

$$P_{in} = P_m + P_a \quad (18)$$

where  $P_{in}$  is the input power to the speaker;  $P_m$  is the power required to move the diaphragm (which we calculated in Part I as 0.468 watt), and  $P_a$  is the power expended in the acoustic resistance. Thus:

$$\begin{aligned} P_{in} &= 0.468 + (55.8 \times 10^{-3}) \\ &= 523.8 \times 10^{-3} \text{ watt.} \end{aligned}$$

### EFFICIENCY

When the input and output power are known, they can be used to determine the speaker's efficiency. The ratio of these two values indicates that our 24-inch square speaker has an efficiency, at 100 Hz, that is equal to:

$$\begin{aligned} \text{eff} &= \frac{P_{out}}{P_{in}} \times 100 \quad (19) \\ &= \frac{55.8 \times 10^{-3}}{523.8 \times 10^{-3}} \times 100 \\ &= 10.65\% \end{aligned}$$

where eff is percentage of efficiency.

At first, this number may also seem high. It has been stated that the efficiency of a conventional dynamic speaker is often less than 10%. Some articles on ESLs have also indicated that an electrostatic speaker's efficiency is about the same as a dynamic speaker's. The apparent discrepancy between this and our figure of 10.65% is a matter of definition.

In his 1955 *Wireless World* article, "A Wide Range Electrostatic Loudspeaker," P. J. Walker stated that "The true efficiency of an electrostatic speaker is very high indeed, but it is difficult to realize because of the large wattless current which has to be provided due to the electrical capacity of the loudspeaker."

To illustrate this point, let us calculate the a.c. current flowing through an ESL's capacitance:

$$I = \frac{v \times C_{pri}}{t} \quad (20)$$

where  $I$  is the peak a.c. current flowing through the speaker's plate-to-plate capacitance;  $v$  is the peak a.c. voltage

Fig. 9—  
Speaker output vs.  
frequency; see text.

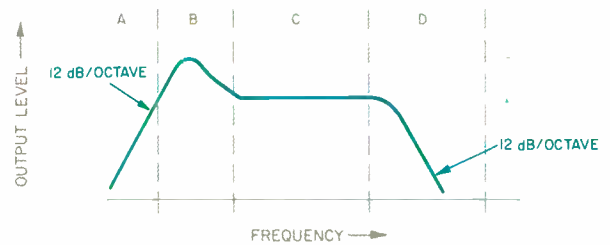
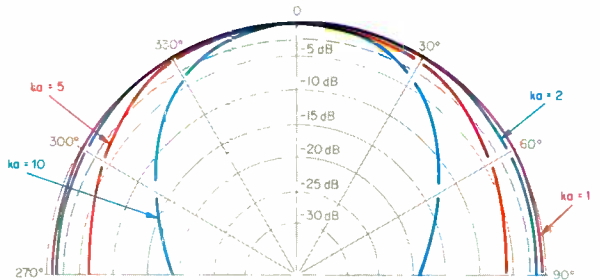


Fig. 10—  
Speaker directivity vs.  
wavelength for four  
values of ka.



across the two plates;  $C_{pri}$  is the speaker's capacitance as reflected back to the transformer primary, and  $t$  is the time required for the voltage to reach its peak value. For our 24-inch square speaker, with its reflected capacitance of 12.7  $\mu\text{F}$ , and an amplifier with a peak-to-peak output voltage of 56.56 V, the peak current flow is:

$$\begin{aligned} I &= \frac{28.3(1.27 \times 10^{-5})}{2.5 \times 10^{-3}} \\ &= 144 \times 10^{-3} \text{ ampere.} \end{aligned}$$

If the rms value of the input voltage is multiplied by a similar value for the current, the result is the apparent power being supplied by the source ( $P_{app}$ ):

$$\begin{aligned} P_{app} &= V_{rms} \times I_{rms} \quad (21) \\ &= (28.3 \times 0.707)(144 \times 10^{-3} \times 0.707) \\ &= 2.04 \text{ watts.} \end{aligned}$$

When this value is used to calculate the speaker's efficiency, the result is closer to a conventional speaker's:

$$\begin{aligned} \text{eff} &= \frac{55.8 \times 10^{-3}}{2.04} \times 100 \\ &= 2.74\%. \end{aligned}$$

This calculation reinforces P. J. Walker's statement about the loudspeaker's efficiency.

Note that this efficiency figure is frequency dependent, as the current value used in equation 21 was derived from equation 20, whose time factor is a function of the signal frequency.

### SPEAKER FREQUENCY RESPONSE

The frequency spectrum that a loudspeaker must cover can be divided into four areas. The cone or diaphragm movement is controlled, in each of these areas, by one or more speaker parameters. In Fig. 9, the peak in region B is the speaker's resonant frequency. This point is a function of the diaphragm's mass and the compliance of the mounting system. The height of the peak is controlled by both the electrical resistance (such as  $r_g$ ,  $r_p$ , and  $r_s$ ) and the opposition produced by the diaphragm's air load ( $R_a$ ).

Below the resonant frequency, in region A, the diaphragm motion is controlled by the compliance of the mounting system. In this region, the acoustic output falls at a rate of 12 dB/octave, and the speaker's output is generally not usable.

In the C region, the output is determined by the mass of the air load. Most textbooks indicate that the speaker's performance is related to a factor called  $ka$ . The "k" value is frequency dependent and is equal to  $(1.83 \times 10^{-2})f$ . The "a" is the speaker's radius, in meters. For our square speaker, using one-half the width provides a reasonable approximation (304.8 mm), which will be used in some of the calculations to follow.

Over most of the C region, the reactance of the air mass ( $X_m$ ) rises in direct proportion to the increasing frequency, reaching a maximum value when  $ka$  is between 1 and 2. Because of this reactance rise, the diaphragm's movement will decrease and the speaker's output will remain constant.

**A**dding an extra diaphragm behind the first one will increase an ESL's output without making the speaker too wide to fit most rooms.



When the frequency exceeds the point where  $ka$  equals 2, the reactance of the air mass decreases and the speaker's performance enters region D.

The radiation resistance ( $R_a$ ) is also increasing in region C, but its value goes up by the square of the increasing frequency. Except for the region where  $ka$  is between 1 and 2, the radiation resistance is always less than the reactance. It is the radiation resistance that determines the radiated acoustic power.

In the last region, D, above the point where  $ka$  equals 2, the amplitude falls because the response is controlled by the radiation resistance. In this region, the reactance of the air mass is considerably less than the value of the radiation resistance.

As indicated, diaphragm resonance determines the lower limit of the C region. For our 24-inch square speaker, this is approximately 30 Hz. The boundary between regions C and D can be determined by calculating the frequency that will produce a  $ka$  factor equal to 1:

$$ka = [(1.83 \times 10^{-2})f]a \quad (22)$$

$$f = \frac{1}{(1.83 \times 10^{-2})a}$$

$$= \frac{1}{(1.83 \times 10^{-2})(304.8 \times 10^{-3})}$$

$$= 179 \text{ Hz.}$$

This frequency is a long way from the upper limits of the audio spectrum, and some method must be found to extend its value.

In a conventional speaker system, the solution is to use several drivers of different sizes to cover the entire audio range. While this same technique has been used in some ESLs, there is an alternative method.

Instead of using separate drivers, the plate or diaphragm area can be divided into a number of smaller sections. Because the speaker's width determines where  $ka$  equals 1, only this factor needs to be made smaller. In equation 17, it was stated that the speaker's power output is a function of its volume velocity and its radiation resistance. If its width is made smaller, its length should be increased so that the area remains about the same.

#### SEGMENTATION

Segmentation is the division of the plate or diaphragm area into smaller sections. As an example of this tech-

nique, suppose the speaker's 24-inch width is divided into six sections, so that the widest part is 12 inches, and the rest of the speaker is divided into sections of 4, 2, 1, 0.5, and 0.25 inches. (The total will not equal 24 inches. Some space is used to separate each of the sections, and the remainder is needed for the diaphragm-to-plate spacers.) For the above sizes, the corresponding upper frequency limits are 360, 1075, 2150, 4300, 8600, and 17,200 Hz.

If these sections are combined through a suitable crossover network, then the entire diaphragm will radiate as one piece below 360 Hz. Above this frequency, the output from the 12-inch section will decrease, and the remaining part of the diaphragm will continue to provide the speaker's acoustic output. When the frequency exceeds 1,075 Hz, the speaker's effective size will again decrease, and the four remaining sections will continue to supply the acoustic output. As the frequency continues to rise, the output from each of these sections will decrease, and at 17.2 kHz, only the 0.25-inch section will be acting as a speaker. This segmentation is very useful in maintaining the system's frequency response.

A speaker driver's dimensions affect not only its high-frequency cutoff but also its directivity at higher frequencies. As the frequency increases and the reproduced wavelength begins to approach the diaphragm's diameter, the speaker's radiation angle narrows. Some electrostatic speakers use curved diaphragms to increase their radiation angle, but flat or planar speakers must change their effective width with frequency (such as by segmentation) to eliminate the beaming effect. The polar plot of Fig. 10 indicates a speaker's radiation pattern as a function of  $ka$ . Because a hemispherical pattern only occurs when  $ka$  is less than 1, the diameter of a speaker must be reduced as the frequency is increased.

For instance, suppose it is desired to radiate a 20-kHz signal over an angle of  $\pm 90^\circ$ . The wavelength is equal to:

$$\text{wavelength} = \frac{\text{speed of sound}}{\text{frequency}} \quad (23)$$

$$= \frac{13,440 \text{ inches}}{20,000}$$

$$= 0.672 \text{ inch.}$$

To obtain the required radiation angle, the speaker's radius must not exceed one-third of the wavelength. Al-



though this would make the speaker's diameter equal to 0.224 inch, the 0.250-inch segment of our ESL causes only a slight modification of the desired frequency response and directivity pattern.

### IMPROVING ESL PERFORMANCE

Some audiophiles feel that an ESL does not produce enough bass, and they have tried to modify the low end by adding a conventional cone woofer. This type of modification can produce a number of undesirable effects. First, the bass can easily be overemphasized, destroying the sonic balance that is inherent in the design of a wide-range electrostatic speaker.

Another problem with adding a conventional speaker is increased distortion. Most ESLs have a distortion value that is less than 0.1%; a conventional speaker's distortion is 10 to 100 times greater.

### INCREASING ACOUSTIC OUTPUT

From a manufacturing standpoint, the acoustic output of a speaker can be increased by altering its diameter, its cone or diaphragm displacement, the number of drivers, or all three.

In an ESL system, some of these factors are difficult to change. For instance, when the plates are moved farther apart to obtain greater diaphragm movement, the reflected capacitance will decrease and the speaker's impedance will rise. To compensate, the transformer's turns ratio must also be increased. Although this will restore both the impedance and the a.c. field strength, it will also increase the transformer's leakage inductance. In addition, the charging voltage for the diaphragm must then be increased in order to maintain the same field strength.

If the diameter is made larger, some other design changes must be made. One critical factor is to keep the diaphragm uniformly suspended between the plates. The increased size will also require additional segmentation.

### MULTIPLE DIAPHRAGMS

The simplest way to produce more output is to add additional panels. When two or more panels, radiating the same frequency, are placed next to each other, the amount of air being moved increases.

Volume velocity, which is the measure of this air movement, is similar to the current in an electrical circuit. If the current is doubled by connecting two

current generators in parallel, then the resulting voltage across the load will also double.

Placing two or more speakers next to each other creates, in effect, a parallel configuration. The volume velocity will increase, and this will develop a greater acoustic pressure across the radiation resistance. The result will be an increase in acoustic power.

The biggest problem with increasing output by paralleling additional diaphragms is the effect on the speaker's size. It might at first seem reasonable to parallel two of the speakers shown last month in Fig. 3. This system uses two 24-inch square diaphragms, one above the other. However, paralleling would make the speaker 4 feet wide, in which case a stereo pair would occupy a space of 8 feet. Proper placement could then be obtained only in a very large listening area.

In addition to the side-by-side parallel configuration just described, it is also possible to increase a speaker's output by creating a serial configuration, with one speaker placed behind the other. This increases the speaker's bass response but does not change its width.

In this configuration, the pressure produced by the front diaphragm is increased by the pressure from the rear diaphragm. The electrical equivalent of this would be connecting two voltage generators in series, which would increase the output voltage and produce a corresponding increase in current. Acoustically, the increased pressure from the serial diaphragm arrangement will also increase the volume velocity. The radiated power for either the parallel or serial configuration will go up by a factor of 4.

It may seem relatively easy to add an entire second panel or speaker behind the first, but commercial implementations actually use two diaphragms sharing one common plate (Fig. 11). If the two diaphragms are very close—less than 0.1 inch—then the speaker will work as indicated.

Should the design prevent such close spacing, then the rear diaphragm must operate over a reduced frequency range. The reason for this is sound cancellation. When the two diaphragms are in series, their outputs will add, as long as they are in phase. When the frequency rises to the point where its half wavelength is equal to the distance separating the diaphragms, the sound from the second diaphragm will arrive at the first diaphragm in opposite phase. When this happens, the two waves cancel and

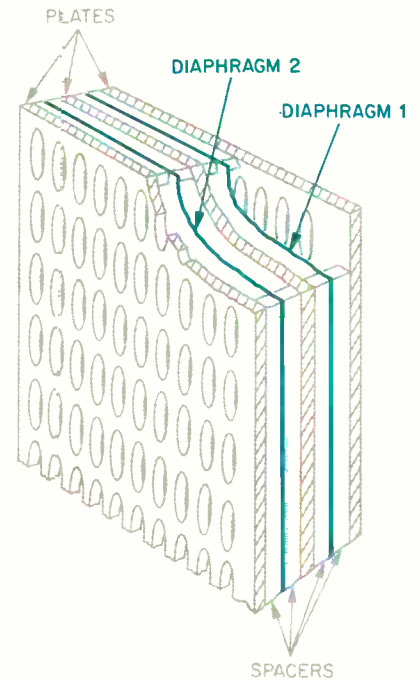


Fig. 11—An electrostatic speaker using dual diaphragms in a serial configuration.

the speaker produces no output. But even at lower frequencies, whose half wavelengths only approach the inter-diaphragm distance, partial cancellations occur and cause a roll-off.

The Harold Beveridge patent mentioned in Part I describes a speaker that uses this minimum-separation serial construction, although I have been unable to find out if any speakers were ever produced under this patent. The Sound-Lab Co., of Park City, Utah does produce a serial-diaphragm speaker (Fig. 1 in Part I). Its frequency response is limited to the range below 350 Hz, but the company does not say if this is a minimum-separation design.

The use of multiple diaphragms in an electrostatic speaker should overcome any listener's objection to the speaker's lack of bass, without altering the ESL's advantages of correct tonal balance and extremely low distortion. The result is a loudspeaker whose sound quality can only be duplicated by a live source. **A**

### SUGGESTED READING

Beranek, L. L., *Acoustics*, McGraw-Hill, 1954.  
Walker, P. J., "A Wide Range Electrostatic Loudspeaker," *Wireless World*, May, June, and August 1955.

# DESIGN DIG

## The QUAD Manchester Competitions

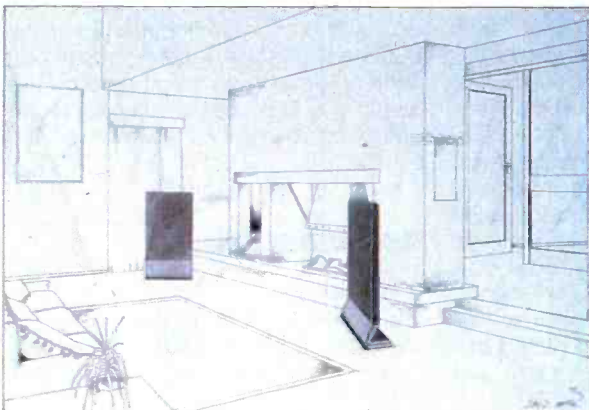
**David Lander**

1985  
QUAD

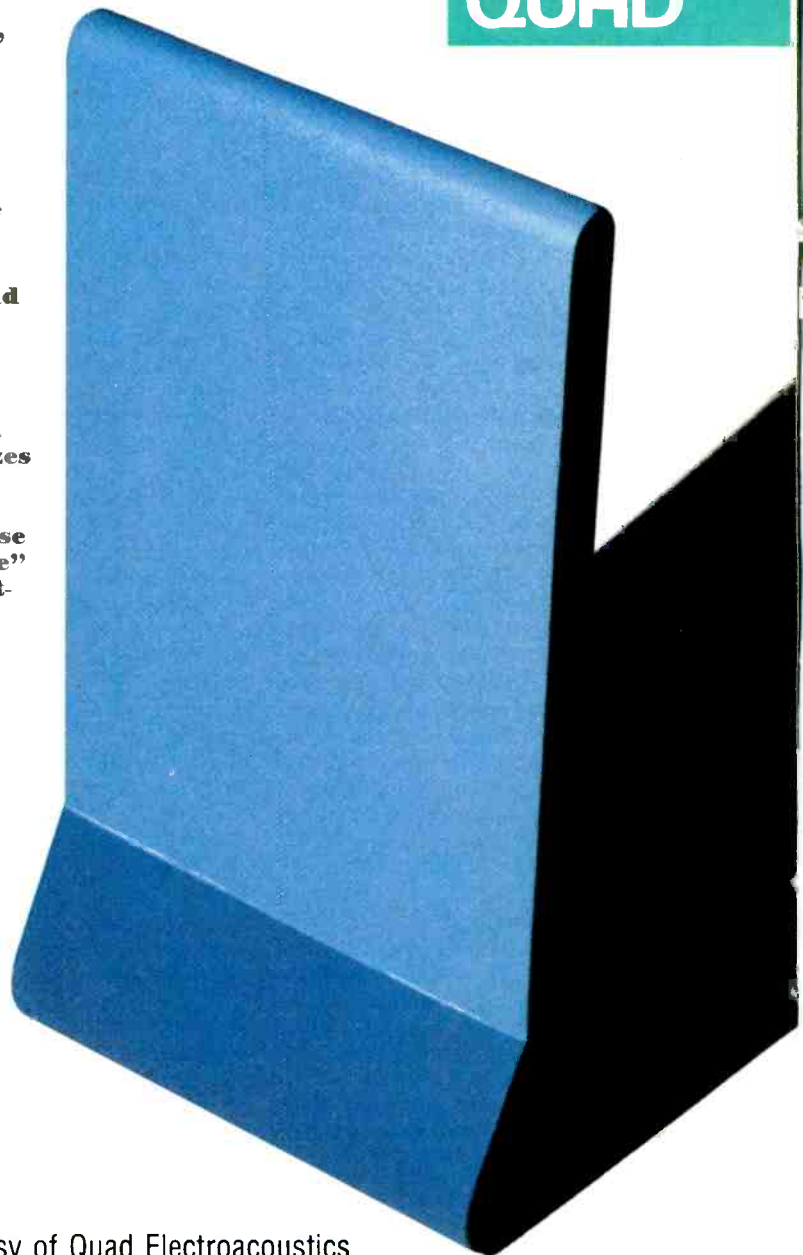
When asked to pinpoint the world's industrial design capitals, a connoisseur might single out Helsinki, Milan, or Frankfurt. Few, if any, would place an English city on the list. At least one British hi-fi manufacturer is acutely aware of that fact, and in their own quiet way, is working to change it.

Ross Walker, a director of Quad Electroacoustics, understands that great design doesn't just happen. So in 1985, he instituted a competition for pupils at Manchester Polytechnic. Walker chose the institution, situated in what is often called the western world's first industrial city, because of grass-roots interest in his industry. He had received numerous letters from students there who were interested in working on high-fidelity products.

**Coincidentally, the winner of the first Quad-Manchester Polytechnic competition bears the same name as one of our century's truly great sculptors. David Smith took a minimalist approach to a boxless loud-speaker design that "emphasizes the light membrane interior and enables ease of manufacture" and is also suitable for "any domestic interior."**



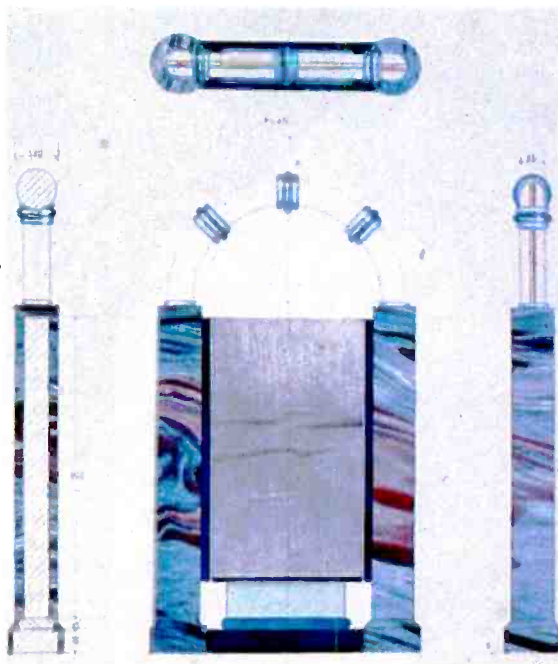
Photographs: Courtesy of Quad Electroacoustics





# EST

**Timothy Greenhalgh, the 1985 runner-up, framed his transducer with marble columns of Greco-Roman derivation and crowned it with a distinctly contemporary arch. The materials were meant to project "both quality and high fashion," according to the young designer, who specified a level of illumination "acceptable for general room lighting when listening to music."**



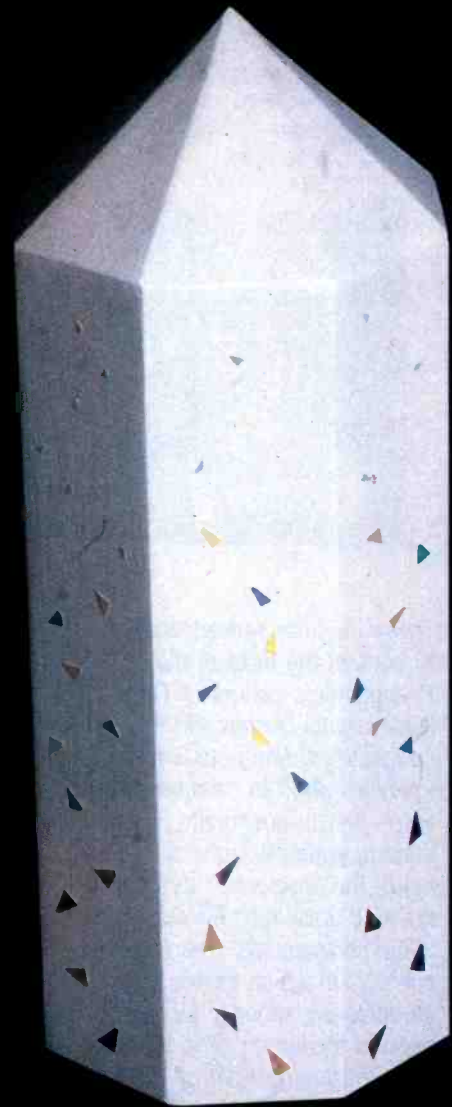
These inquiries moved Walker to contact the head of the Polytechnic's School of Three Dimensional Design and to suggest furthering student interest in hi-fi in "a more formal way—just to encourage up-and-coming young designers to think about the problems" involved in creating envelopes for real-world audio components. The resulting contest, in which scores of students vie annually for 500 pounds sterling in prize money, is now a regular part of the school's second-year curriculum.

The goal is more than mere flights of fancy on the part of young competitors. When industrial designers work with manufacturing companies on a project, Walker points out, it is the manufacturer's responsibility to set a very clear brief. And the industrial designer's obligation is to follow it.

It is Ross Walker who determines the product to be designed and its specifications. This, he explains, gives the students "a chance to actually work to a brief set by a real capitalist rather than a teacher." After being presented with his brief, competitors have a

# 1985 QUAD

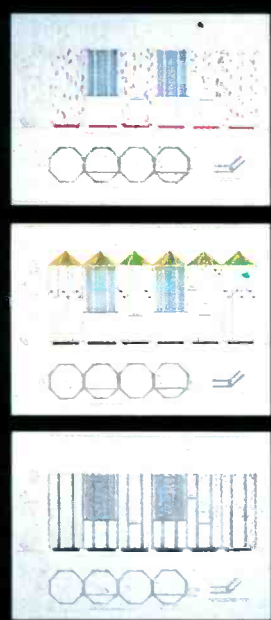
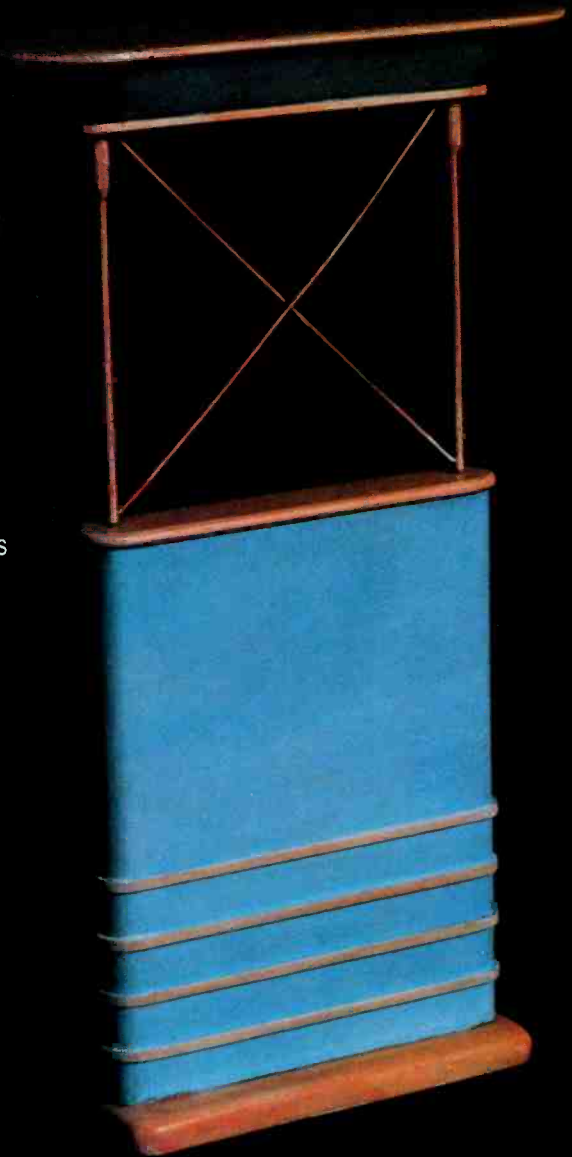
**Nicholas Haynes felt that the sculptural qualities of his latter-day Art Deco loudspeaker, when coupled with its framework's capacity for physically supporting accessory lighting fixtures, presented design-conscious listeners with an unusual degree of flexibility.**



day to develop their ideas. Then, finalists are selected and given ample time to produce more detailed drawings and models from which the winning entries are chosen.

While Ross Walker, capitalist and design *provocateur*, ultimately ranks competitors, he is quick to note that the successful ones are those he feels best meet his specified criteria, not the ones whose sense of contour or color he personally prefers.

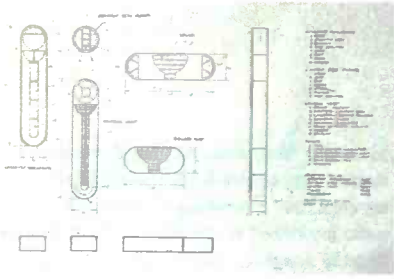
Other than in the competition's first year, when his challenge was to repackage the vaunted Quad ESL-63 loudspeaker, Walker has



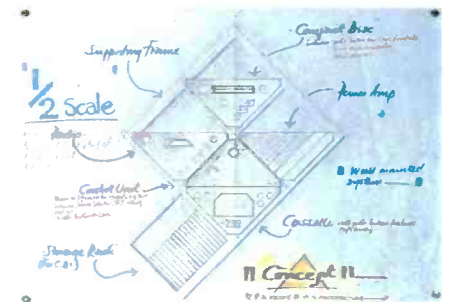
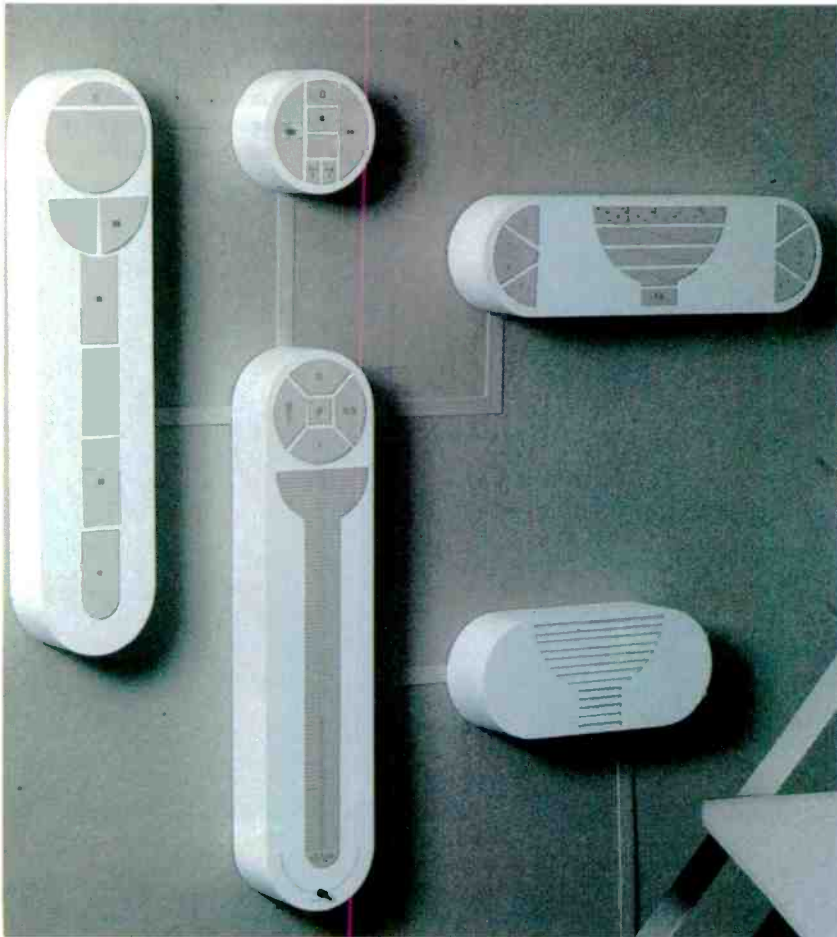
**Whether or not John Cook was punning when he described his 1985 entry as "a starting point," the graphic treatment of its multi-sided surface clearly reveals whimsy. "I wanted to design a free-standing piece of furniture that was multi-variable in its application and not redesign an existing speaker," Cook noted. "The fact that a Quad speaker could be fitted into the module was purely coincidental."**



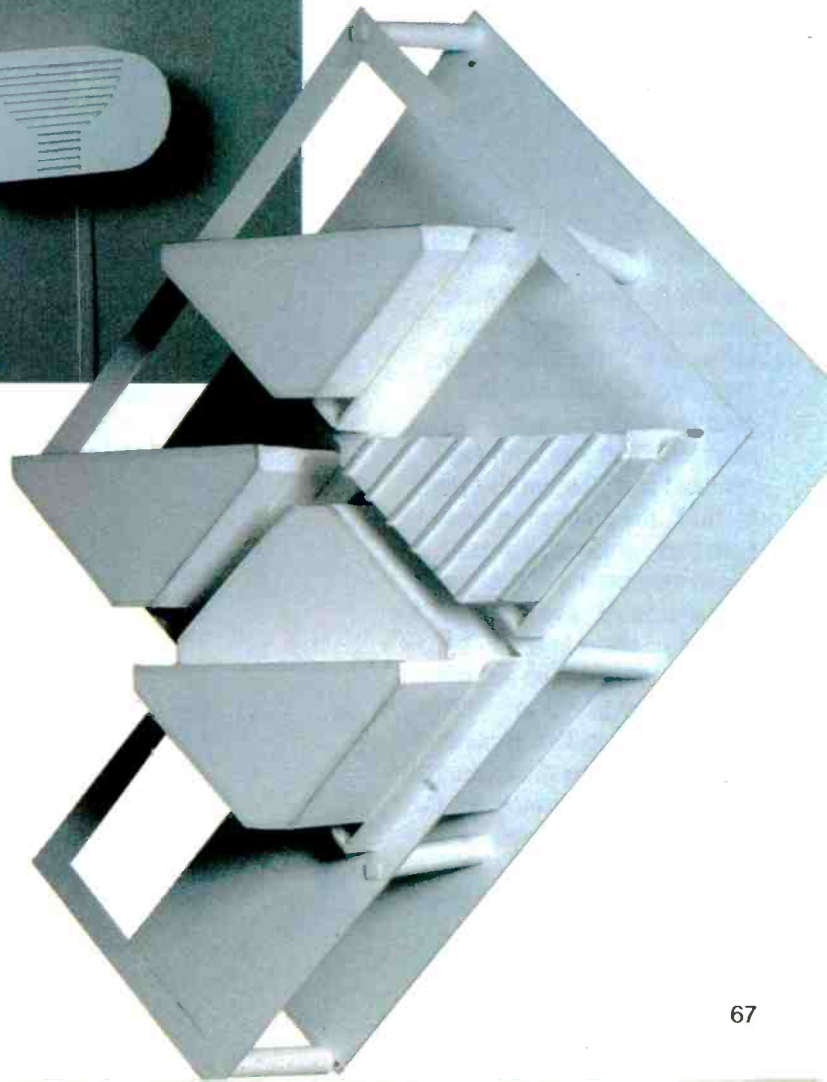
# 1986 QUAD



Like the work of master architect I. M. Pei, Peter H. Moore's design reveals an affinity for the triangle. "The controls have been kept to a functional minimum," he said of his plan for a wall-mounted system, "and the gridded framework is designed to a basic modular form [for] visual unity." Moore's design would even allow buyers to participate in creating his ensemble's appearance, since modules can be rotated 90° or 180° within the grid "to create a preferred composition."



In Quad's 1986 competition, Manchester Polytechnic students were asked to submit designs that combined three program sources—tuner, CD, and cassette—with necessary amplification and system controls. For Martin Hasenstrauch, that year's winner, ergonomics took precedence. He wanted his component system to be "immediately understandable and usable by anyone," with or without the ability to read the language in which front-panel control designations appeared.

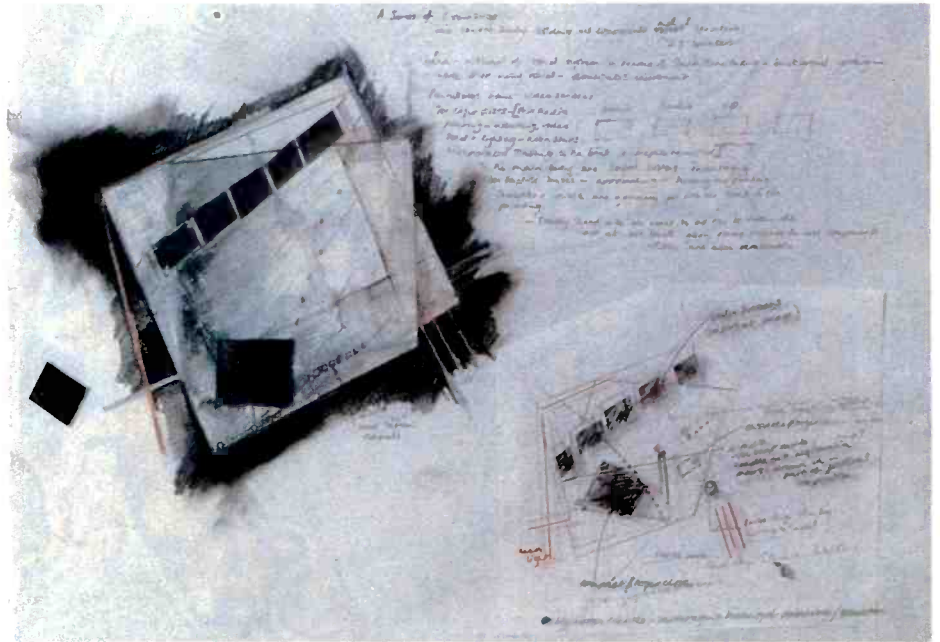


deliberately devised design projects unrelated to his own company's business. This, he says, is to foster creativity rather than encourage fawning. If asked to design an improved Quad product, the hi-fi maker feels, many students would do no more than seek approval.

Since Walker is convinced that "people hate loudspeakers" because of their looks, it was a logical starting point for him to ask that competitors design a

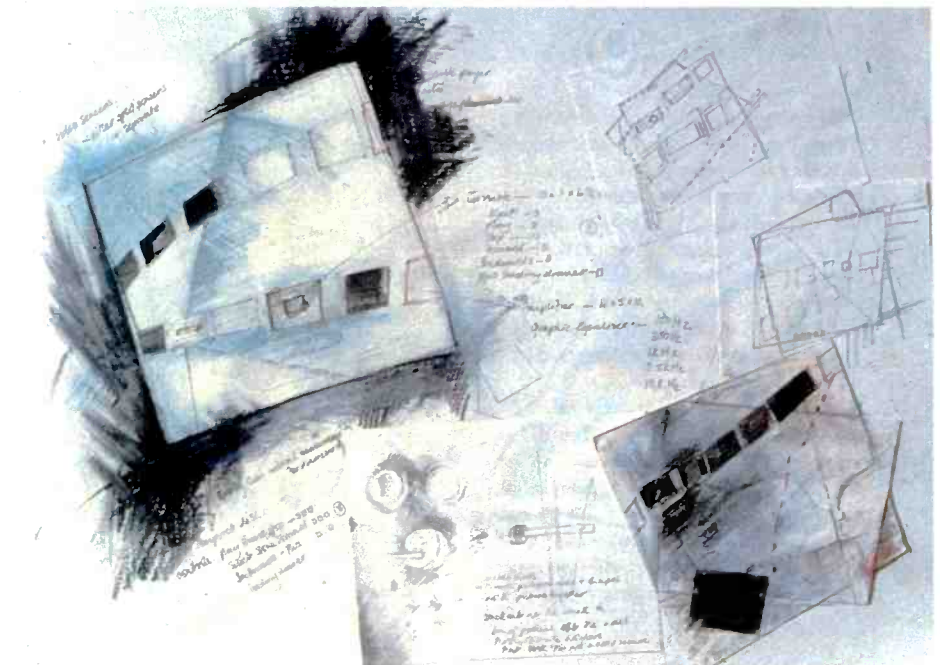
# 1986 QUAD

**Emma Beech, a 1986 entrant, won an accolade for her creative concept. Beech conceived a system in which both audio and visual functions would be contained within three "structural painted images." She intended for these to "dominate the environment" when in use, and at other times, to serve as decor.**



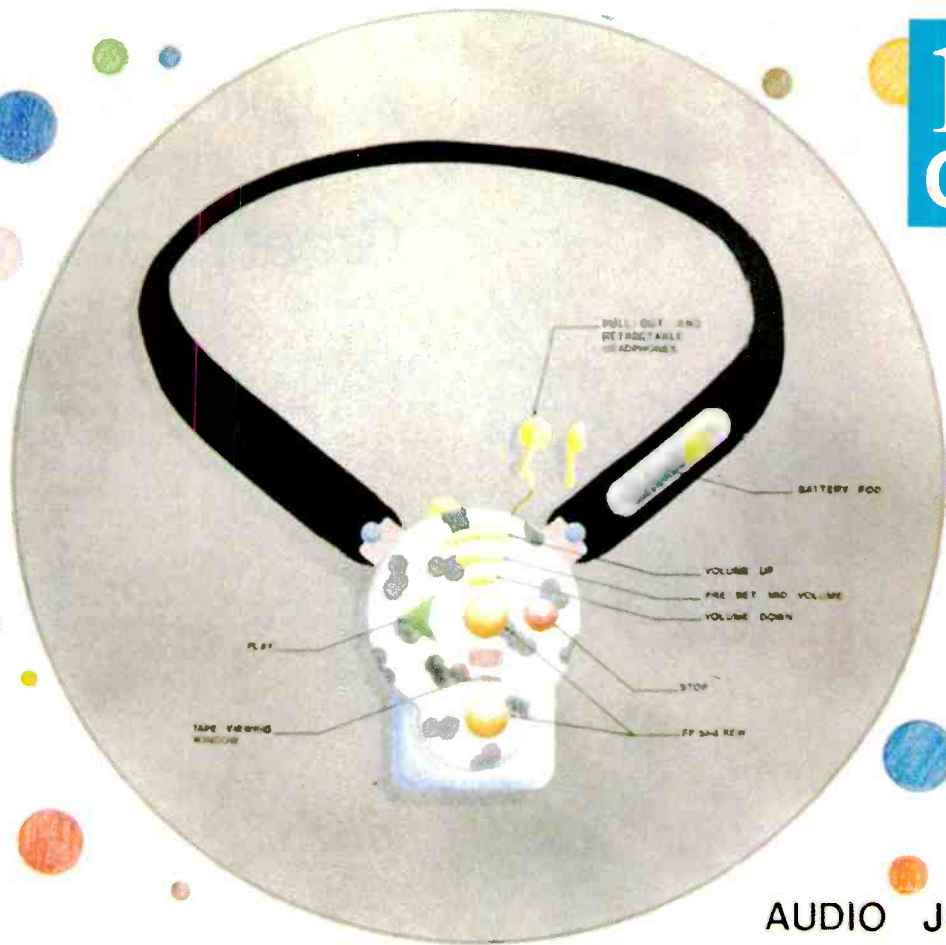
speaker that would be "more than just a rectilinear, walnut-veneer box." The following year, 1986, his mandate was the creation of a rack-system alternative that was both easily operated and pleasant to behold. In 1987, the problem of personal portables, which Walker contends "have only been half designed," was addressed. And last year, the students worked in teams to conceive an attractive audio showroom available to independent retailers at minimal cost. The winning group drafted designs for interior modules that could be variously combined.

At this writing, Walker continues to ponder projects for the competition's fifth year. Though

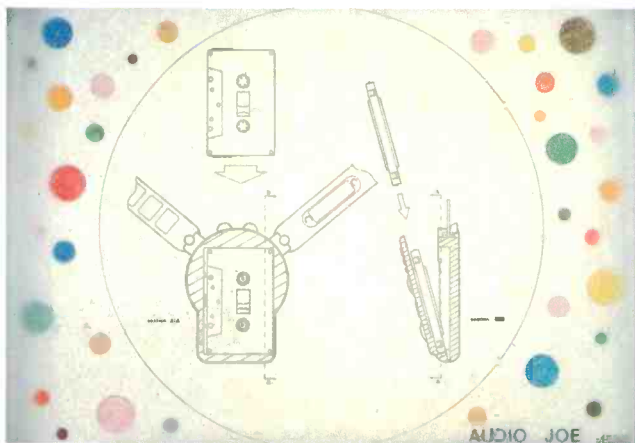




# 1987 QUAD



**AUDIO JOE** QUAD



**In his 1987 brief, Quad's Ross Walker mandated a personal portable designed "so that whether one is walking, sitting, cycling, skiing, running for the train, or whatever, it does not have to be held or put in a bag or a pocket." Winner Charles Cann's neckpiece met these specifications by employing retractable headphones and a strap more common to cameras.**

no star designers have yet been produced, either for England or for audio, the self-described capitalist from Quad is optimistic about the contest's long-term impact. "It's not as philanthropic as it may seem," he remarked during a recent visit to this country. "For far too long, the industry has basically designed boxes with knobs on them—and not very well done at that. As a consequence, we are missing out on an enormous section of the marketplace."



# 中國之音響

## AUDIO IN CHINA Hi-Fi Takes a Great Leap Forward

Xinjiekou Square is one of the busiest in Nanjing, particularly on a Sunday, when most Chinese have the time to shop. Just off it, within a few hundred yards of one another, stand three large, new consumer electronics shops, all owned by the state and locked in fierce competition with each other. At almost any time during the business day, you'll find audiophiles shuttling back and forth among these shops in search of the right loudspeaker or the best price on a power amplifier.

That's right. Audiophiles. In China.

Nobody's sure just how many of China's one billion people are dyed-in-the-wool sound perfectionists, but there are enough to make consumer electronics, in general, and audio, in particular, a growth industry





and for state-owned industries like Panda, Peony, and Feida to pay attention. Just ask Cu Shaolin, Li Jun, Yang He Ming, or Yao Hong. Du manages the Nanjing Electrical Home Appliances store just off Xinjiekou Square, a sort of Oriental "Circuit City." This shop caters to electronics hobbyists and experimenters as well as offering a more prosaic selection of stereo music centers, color TV sets, VCRs, refrigerators, and electric ranges. Mme. Li edits *Radio*, China's largest (900,000 circulation) monthly magazine for electronics enthusiasts, while Yang is vice president of the China Audio Industry Association and director of the Shanghai Tape Recording Equipment Factory. Yao is typical of China's fast-growing yuppie class—a young professional fiercely proud of the component A/V system he assembled himself.

Yao, who has a relative living in Hong Kong, received his first stereo system five years ago, when he

## ROBERT ANGUS



*Nanjing's newest consumer electronics specialty shop is this modern, two-story showroom on Xinjiekou Square.*



*Du Shaolin (right) chats with the author in front of some of the shop's offerings.*



*At the Feica factory in Beijing, workers assemble VCRs from parts supplied by Goldstar in Korea.*





Yang He Ming, director of the Shanghai Tape Recording Equipment Factory, poses with China's first wire recorder, made by the factory in 1951 (far left). Next to it are three open-reel machines produced by the factory from 1953 to 1973. The second and third machines from the left were designed to use paper-based tape.



Yang with his factory's current, more up-to-date product line.

got married. It was, in fact, the centerpiece among the wedding gifts, replacing more traditional presents such as furniture and bedding. The system cost about \$1,000—roughly 20 months' income for a typical Chinese worker. It consisted of two giant three-way loudspeaker systems (brought up, one at a time, on the Saturday train from Hong Kong to Guangzhou), a Chinese-made Feida AM receiver (10 watts per channel, he recalls proudly), a domestic Panda dual-well cassette deck, and a turntable made for professional use in Shanghai. FM simply isn't available in China, but Yao claims that the quality of mono-only AM broadcasting is quite good.

**M**anufacturer Yang says that to understand the Chinese audiophile, it helps to have a background in 20th-century Chinese history. As recently as 1928, China was still ruled by feudal warlords. Six years later, while Europe and the Americas struggled to climb out of the Great Depression, China's Civil War started with Mao Zedong's Long March to the North, which was interrupted by the Japanese invasion of Manchuria. The

Civil War resumed with a vengeance at the conclusion of World War II in 1945, culminating in the expulsion of the forces of Chiang Kai-shek in 1949. At just about this time, hi-fi was developing as a hobby for music lovers and do-it-yourselfers in the United States.

In 1951, Yang's factory made China's first wire recorder—for broadcast use—after reading about them in Western magazines like *Audio*. "You must remember that we were completely cut off from technical information from the West at the time, and we had to rely on information in the popular press," he recalled recently. Beginning in 1952, the government not only forcibly collectivized China's struggling radio and television factories but took over the distribution and sale of all consumer products, replacing privately owned shops with ones owned by the state. Although it was government policy, at the time, to provide the people with radios and television sets, these were supplied first to community centers and trade unions rather than consumers. Viewed as part of the state communications network, basic radios were considered essential products—

niceties like music-reproduction systems for the home were not.

During the Great Leap Forward, which lasted from 1958 to 1960, professionals (including engineers) were repatriated to the countryside in an attempt to force the pace of development by substituting manual labor for technological progress. Although in 1953 Yang's factory began making tape recorders—designed for paper-backed, quarter-inch tape—it continued to produce wire recorders for the government until 1958. It wasn't until 1960 that acetate and polyester replaced paper—a bare three years before the introduction of the Compact Cassette in the West.

Yang and his factory are proud of these early products, maintaining a museum where they are displayed. Interestingly, my photo of Yang with the collection was the only one I shot on my entire Chinese tour which caused any controversy. I simply asked Yang if he would pose with the wire recorder. Following the translation, there was a feverish and heated discussion among his colleagues. As I tried to take the picture, I had camera trouble. Another heated discussion. Yang then volunteered the services of one of his colleagues—the most vociferous one—to see what was wrong with the camera. Nothing was, as it happened, and I took the picture. Then the translator asked me to take another, showing Yang and his current line of boomboxes and personal portables, which I did. Outside, the translator explained that while Yang had no objection to the picture, his colleagues were concerned that he and the factory might be subject to ridicule because of the primitive equipment. I assured her that I had no intention of embarrassing either Yang or the factory and that the story of how the recorder came into being was of immense interest in the West, as was historic equipment of this type. (In fact, since I'm a collector, these historical gems made my mouth water!)

The Great Proletarian Cultural Revolution, a period which saw political turbulence at home and attempts to spread revolution abroad, lasted from 1965 to 1968. Beginning with the death of Mao in 1976, a power struggle for leadership was followed by a purge of Maoist elements. Toward the end of the decade, China was actively seeking better trade and cultural relations with the West, and in 1980, the government encouraged factories to begin producing more consumer goods. In mid-1987, restrictions on so-called private and individual businesses were



# 中國之音響

relaxed, permitting citizens to open their own shops, provide services, and even employ others. Since then, according to the official newspaper, *China Daily*, the economy has created a large new class of millionaires (in yuan; translated, that's \$275,000-aire).

Nobody really knows how audiophilia got started in China, or exactly when. Mme. Li says that her magazine has been publishing do-it-yourself projects, including the construction of loudspeaker systems and amplifiers, since the late 1950s. Retailer Du recalls that kids and experimenters have been scouring electronics shops for parts ever since he can remember. "In the early days," Yang recalls, "being an audiophile required a great deal of time—not so much to construct a project as to find the parts for it. You might have visited every electronics shop, department store, and repair shop in your city to find what you needed. Even then, it might have taken trips to two or three different cities to find everything." People did build amplifiers, tuners, and speaker systems from the circuit diagrams published in *Radio* or copied from equipment brought into China from abroad.

**A**fter the easing of tensions with the Crown Colony of Hong Kong in the early 1980s, hi-fi took its own Great Leap Forward, particularly in the southern city of Guangzhou. During the height of the Cultural Revolution, hundreds of thousands of Chinese poured across the border to find work or sanctuary. By Chinese standards, they became well-to-do within a few years and began returning home on the Saturday afternoon train. As is the Chinese custom, they returned with gifts—the kind of items not available in the People's Republic. The more elaborate the gift, the more prosperous the donor was deemed to be. By the mid-'80s, that led to train travelers bent under the weight of gigantic loudspeaker systems, big-screen color TV receivers, VCRs, and just about every audio component and package available in Hong Kong. The trade became so lucrative that some Japanese manufacturers and Hong Kong retailers found it worthwhile to advertise in China to convince shoppers that only *their* brand or the products available in *their* shop were worth having.

Most of these gifts have become the centerpieces of households which usually embrace three generations, in homes which have no central heating and where warmth is provided by many layers of clothing. Some have turned up in flea markets and black markets and have found their way to

cities farther north. As the products have spread northward, so has the prestige of owning a first-rate music system, particularly if one or more of the elements is imported.

One of the problems facing Chinese audiophiles is the shortage of software. There's no such thing as FM radio or broadcast stereo, and Compact Discs have yet to make any impact, for two reasons. There is no domestic supplier, although CD players are being manufactured for export. Further, the few titles available from Hong Kong or Japan are of limited interest and are unreasonably expensive. (If CDs were available, it's been estimated that they would cost the equivalent of one month's salary!) Vinyl records have all but disappeared from shops, replaced by audio cassettes, which generally are inexpensive and of acceptable quality—no Dolby noise reduction and no high-bias tape, but at least some very presentable recordings in terms of dynamic range, background noise levels, and frequency response. Actually, there are dozens, if not hundreds,

of tape duplicators in China. These include the likes of back-street pirate operations (which survive on scrap tape and parts imported from Hong Kong), the current Chinese pop hits taped from Hong Kong radio, tapes from the Crown Colony, and tapes provided by the large state-owned plants which produce a bewildering array of programs. These programs include folk and Chinese classical music, talking books for the blind, and instruction-

*Shanghai TV Store is one of the city's largest electronics specialty shops.*



*Clerks at Shanghai TV Store's audio counter cope with midmorning crowds. Items on sale are listed and priced on the blackboard behind the counter.*



# 中國之音響

al tapes for students from preschool to postgraduate level.

Shops in the major cities are well stocked with blank audio and video-cassettes. Locally made C-60 tapes sell for as little as 54¢, while Japanese-made TDK D60 and Maxell UR 60 cassettes cost \$1.33 and serve as the country's premium audio tapes. It is said that in some southern cities, counterfeit and look-alike Japanese-brand cassettes (made in China and/or Hong

Kong) are on sale for somewhat less, but I saw no evidence of them or of any cassette lengths other than C-60. Yang He Ming hopes, however, that China soon will be producing its own premium recording tape, either as part of a joint venture with a U.S. or Japanese company, or on its own.

According to Yang, some 280 factories are members of the China Audio Industry Association, competing with one another for retail outlets and customers. This helps to explain why Du Shaolin's shop offers different brands, products, and prices from its nearby competitors, although they are all owned and operated by the government. "All other things being equal," Du observes, "Chinese like to buy from local factories," which helps to explain the prominence of the local Panda brand in his showroom.

However, things are not always equal. Some brands have a reputation for offering better value, greater reliability, or better workmanship, just as in the West. Du says that if he has bad experiences with a brand or a particu-

lar product, he stops carrying it—usually after drawing the factory's attention to the problem. "Many times, they are able to correct it and we have no more trouble. But I can't afford to have customers complaining. If the factory can't or won't solve the problem, we'll turn to someone else to get what we need." Du has more clout with the factories than some of his competitors; he's also a wholesaler who supplies smaller shops with equipment.

**T**he Yaos agree that, among domestic brands and products, they prefer to buy things made locally. But when it comes to serious purchases like audio and video equipment, there's a distinct preference for imports, even though they may cost twice as much as the domestic equivalent. According to Mme. Yao, there is a perception that imports are made better and will last longer, thus making them worth the extra money.

Du's shop has a parts department which caters to hobbyists and experimenters, but he believes that the great days of do-it-yourself audio are over, at least in Nanjing. "The quality of the factory-produced systems is very much better than it was a few years ago and represents much better value than any do-it-yourself project," Du claims. For enthusiasts who want separate preamps, power amps, and low-boy two- and three-way loudspeaker systems, Du sells them but admits that packaged systems outsell components handily. One exception is the audio cassette deck, which upgrades older turntable-only systems. The most popular decks, he explains, are dual-well units which permit their owners to make copies of favorite recordings. Mme. Li agrees, saying that her readers these days are more interested in new audio and video technology than in circuit diagrams. "Nobody has the time, anymore, to chase around from shop to shop to get the parts and then sit down and build an amplifier or loudspeaker system—particularly when they can buy something that's just as good in a shop for less money."

Although Du is free to choose the products he sells, there are strict government guidelines on how he conducts his business. Every retail shop provides its customers with a three-way guarantee on their purchases. The buyer is entitled to his money back within five days if he changes his mind or finds something wrong with the item—provided, of course, he hasn't damaged it. There is a factory guarantee that, for a reasonable period of time, the unit will be repaired or, if



Workers at Nanjing's Panda factory assemble Sharp TV sets on one side of the assembly line and Philips TV sets on the other.



Equipment from all over the world was on view at Beijing's Second Annual International Audio-Visual Show last December.





A scene at the Peony factory in Beijing, where VCRs, TV sets, tape decks, and boomboxes are made.

repair is not possible, exchanged. Finally, the shop itself guarantees that parts will be available for the life of the product. While Du's store maintains its own service department, a much larger state-run repair shop is just down the street. "We do the simple repairs here, but we don't have the parts or the manpower for more elaborate repairs," he adds. In addition to the state shop, there are also private repair shops. These came into existence some years ago, as moonlighting operations run by technicians employed in the government-owned shops. The private repair shops charged more, but customers usually got their equipment back in a fraction of the time the state-owned shops took. There was some official criticism that the moonlighters were using tools and parts which belonged to their daytime employers, although the practice was allowed to continue because of the popularity of private repair. When the government officially welcomed private enterprise in 1987, electronic technicians were among the first to begin hiring help—often their former colleagues. It's said that they are now among the nation's new "millionaire" class.

Also said to be bucking for such status are the peddlers—entrepreneurs who buy goods in the city where they're made (and consequently are inexpensive) and transport them to another (where they're either unavailable or very expensive). Factories in the southern cities of Guangzhou and Shenzhen are grinding out everything from cheap transistor radios and personal portables to semiprofessional audio gear. But in the cities of Kunming and Guiyang, less than 1,500 miles away, state-run stores can't keep

the hottest audio items on their shelves. Enter the entrepreneurs, who aren't bound by the 15% markup government-owned shops are allowed. In alleys, the front rooms of homes, and increasingly in small shops, the peddlers offer a dazzling array of items at equally dazzling prices. There, a hobbyist can find a printed circuit board for an amp or VCR, as well as woofers, tweeters, crossovers, cassette decks, portable players, and the other accoutrements of Chinese audio. All this is in addition to articles of clothing, foodstuffs not found in the state stores, and more. Acknowledging the importance to the economy of this growing class, *China Daily* recently reported that these private and individual business people "come mainly from those previously unemployed: Retired or resigned workers or technicians, farmers, and ex-criminals." The private shops have another edge over their state competitors: They are often open an hour earlier and stay open several hours later than their 9-to-5 competitors, to catch potential shoppers on the way to and from work.

Du notes that while he's allowed a maximum 15% to 18% markup on the products he buys from state-owned factories, he can charge what the traffic will bear when it comes to imported items, such as Sherwood car stereo and home components. He is also free to charge less than the authorized markup, to stimulate sales. "I love imports," Du says, claiming that by handling them, he performs an important market-research function for the factories. "We tried Compact Discs a while back, importing players and discs from Hong Kong. But they were too expensive—nobody bought. So I

reported this to the factories. If CD players had proved more successful, one or more of the factories would be making them by now." A current experiment involves VCRs. Du's shop offers two Panasonic models, at \$3,630 and \$3,800. "We haven't sold any yet," Du says, "but we've had a lot of people looking at them." He remains hopeful that someone may yet purchase one of the VCRs. Du's status as a wholesaler allows him to import directly for his own shop, provided he has the hard currency to pay for the products he wants.

**D**u seemed genuinely surprised to learn that the Sherwood components he sells were not made in the United States—he has been marketing Sherwood as "the American brand." "We have also handled Ampex tape recorders from time to time," he added, "but we're not carrying them now because the price is too high."

Some genuinely American equipment—as well as a great deal of European and Japanese gear—was on view in Beijing during my visit, at the Second Annual International Audio-Visual Show held last December. According to organizers for the six-day event, some 75,000 electronics hobbyists and consumers came to see a full range of do-it-yourself parts, audio and video components, and professional broadcast and video equipment, shown by 51 exhibitors. The Show even included the latest in high tech, such as Super-VHS VCRs and high-definition TV.

By far the biggest attention-getter was NHK's 20-foot HDTV screen. "I'd love to own it," taxi driver Feng Zhao-heng said, "but I don't have a room that large." Yao Yunzheng, wife of a

Beijing University lecturer, marvelled at the fine detail in the picture. "You could see individual strands of hair and the model's complexion," she reported.

Immediately behind the jammed NHK exhibit were booths for Panasonic and JVC, demonstrating Super VHS—also to thick crowds. A JVC spokesman explained that while none of his company's Super-VHS products are available to Chinese consumers, the company exhibited in order to demonstrate the components' abilities to professional and semiprofessional users "and perhaps to encourage some shops to import Super-VHS camcorders and VCRs directly, when they see the reception these products are getting here." Not to be outdone, Sony showed Betacam SP, 8 mm, and U-Matic. The latter is widely available in Chinese department stores and specialty shops.

Packing them in among the audio exhibitors was Sansui, which featured the 130-watt/channel Vintage Series AU-X901 power amplifier with matching preamp. Bose's Acoustic Wave Cannon and Acoustimass professional speakers and JBL's pro speaker systems were prominent, along with Revox's B285 90-watt receiver, B252 preamp, B242 200-watt power amp,

and \$1,800 B226-S CD player. Chinese-made products included rack-stereo systems from Panda, a dual-well cassette deck and 25-watt AM/FM receiver from Feida, and speakers from the Shanghai Broadcast Equipment Factory.

What can the determined audiophile buy? In theory, almost anything I saw at the Show. In practice, the neighborhood store probably won't have most of it, but it will have such items as a two-way acoustic-suspension mini speaker from Feida, with a 5-inch woofer/midrange driver and a 1½-inch dome tweeter in a natural teak enclosure. The speaker costs \$19.30 (71.50 yuan at the official exchange rate), and its sound is not bad. Or, for about \$100 (370 yuan), the same company supplies a waist-high bass-reflex model with 12-inch woofer, 8-inch midrange, and two 1½-inch dome tweeters. To go with it, how about a JSGF 250-watt power amp in black, with a profile which would remind McIntosh owners of the vintage models of 20 years ago? It costs \$580 (2,150 yuan). A companion Fidek preamp at \$230 (850 yuan) provides inputs for tape, phono, tuner, and auxiliary; outputs for two pairs of loudspeakers, and full stereo and switching controls. To complete the ensemble, you could choose a Peony



*China hopes to export its consumer electronics equipment. This rack system was part of a trade exhibit in New York City a few months ago.*

Photograph: Ray Curleitt

or Panda dual-well cassette deck for about \$120 (450 yuan) or a more expensive, more professional single-well recorder from Mr. Yang's Shanghai Tape Recording Equipment Factory. These and other audio components—microphones, keyboard synthesizers, mixers, stereo headphones, equalizers, tuners, etc—are readily available not only in the specialty shops but also in the larger department stores in cities like Beijing, Nanjing, and Shanghai.



**T**he search for the ultimate sound system inevitably leads to speaker systems employing electronic crossovers ahead of the amplifiers, since this places the individual drivers under much more direct control than is otherwise possible.

The only difficulty, in the past, has been the task of obtaining a crossover unit with sufficient flexibility to control these speakers correctly.

Bryston's Model 10B Electronic Crossover com-

bines ideal signal-handling with an enormously flexible control function. Simple, direct front-panel switches allow any crossover curve to be set instantly, and listening quality is vastly improved over passive, in-speaker networks.

The Model 10B features independently selectable crossover points for high-pass and low-pass. You can also independently select crossover slope, from 6, 12, or 18 dB/Oct., where one driver requires a different cutoff from another in the same system.



Asked why such products are on sale in department stores at prices which seem too high for the average consumer, the manager of the audio department in the cavernous Shanghai No. 1 Department Store says that his customers include institutions, professionals, musicians, and theaters as well as audiophiles who, he admits, are a small percentage of the total. However, the audio department has noticed an increase in demand for professional-quality components during the past year, and its manager attributes this to China's fast-improving standard of living.

While the Shanghai No. 1 Department Store stocks an ample supply of music recorded on cassettes, there are no black vinyl discs to be seen, and the audio department seems equally devoid of turntables and phono pickups. "There's no demand for them," says the manager, a view Du Shaolin seconds. His shop sells packaged systems which contain inexpensive turntables, but there are no component-quality turntables or pickups. "The audio cassette is the medium of choice today," he argues. "There is no demand for turntables."

Although apparently there is demand, at least in the Guangzhou area, it's being met by personal imports from

Hong Kong of moderately priced Sony, Kenwood, Sansui, and Pioneer models. It is with one of these that Yao replaced the aging broadcast turntable which formed part of his original stereo system. His moving-coil pickup, likewise, is a product made in Japan. By Western standards, Yao's library of several dozen long-playing albums, mostly of Chinese popular and folk music, is small indeed. By Chinese standards, it's enormous. "Very few people have the need for a turntable. Young people have cassettes. Older people, who grew up during the Cultural Revolution, don't have much interest in having music reproduced electronically in the home," he believes. For those who can afford turntables, some occasionally "fall off the back of a truck"—an expression my translator had trouble understanding and explaining, although it turns out that the phenomenon occurs in China, too. Some can be bought second-hand from radio stations or from public halls where they form part of the P/A system.

Casual observers of the audio scene in China who are old enough to remember audio's early days in the U.S. will notice many similarities—in the kinds of products that are available, the appearance of many of the shops, and the enthusiasm among active hob-

byists. But there are differences, too—such as in buying power, which, at least for the moment, outstrips the goods to spend it on. Another difference from the America of 30 years ago is a well-educated, prosperous yuppie class which wants the very best and has a pretty good idea of how to get it. But the most significant difference may be an electronics industry determined to do, in 10 years or less, what it took the West a third of a century to do. It's an exciting, vibrant scene—one we'll all be hearing a lot more about. **A**

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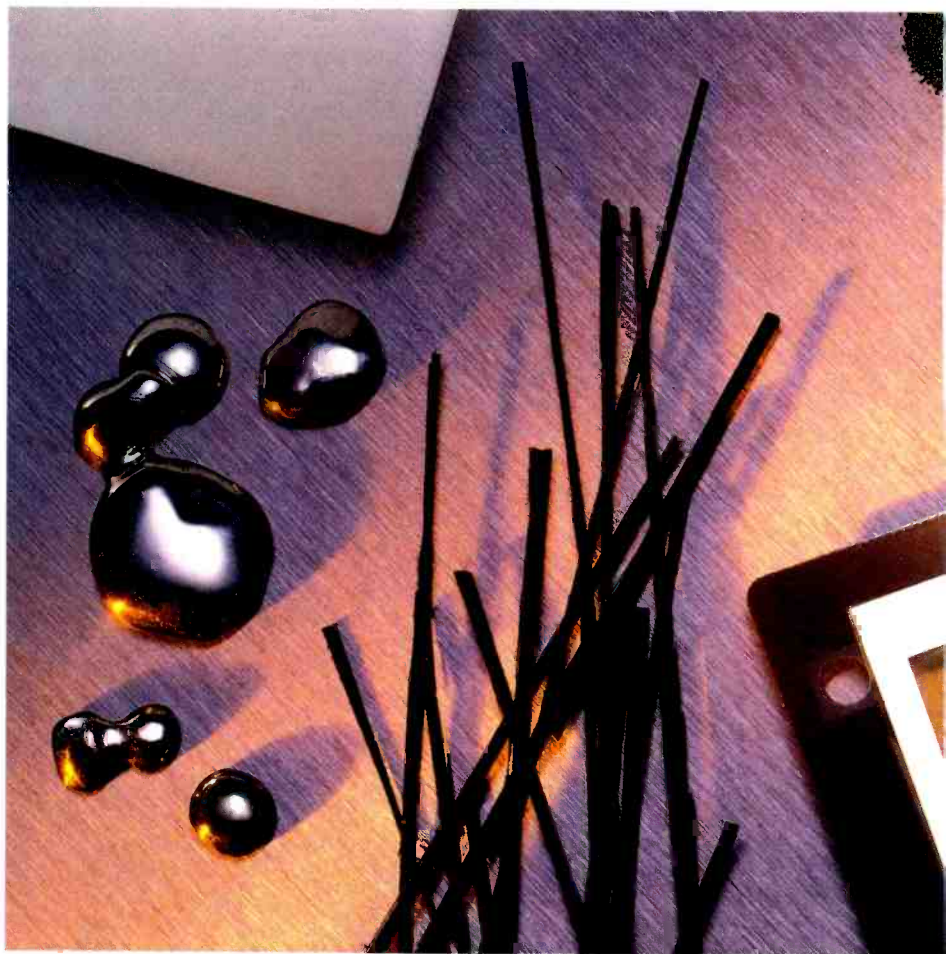
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# 1

## ACCUPHASE G-18 THIRD-OCTAVE EQUALIZER

### Manufacturer's Specifications

**Frequency Response:** 0.3 Hz to 160 kHz, +0, -3 dB; 1 Hz to 40 kHz, +0, -0.2 dB.

**THD:** 0.002%.

**Rated Input/Output:** 2.0 V.

**S/N Ratio:** 110 dB.

**Third-Octave Filters:** 33 in each channel, at standard ISO frequencies from 16 Hz to 25 kHz.

**Q Factor:** Constant 4.3.

**Boost/Cut Range:** ±12 dB.

**Input Impedance:** Unbalanced, 20 kilohms; balanced, 600 ohms or 40 kilohms.

**Output Impedance:** Unbalanced, 10 ohms; balanced, 50 ohms.

**Maximum In/Out Level:** 8 V.

**Dimensions:** 17½ in. W × 6<sup>5</sup>/<sub>16</sub> in. H

× 14<sup>11</sup>/<sub>16</sub> in. D (44.5 cm × 16 cm × 37.3 cm).

**Weight:** 26.4 lbs. (12 kg).

**Price:** \$5,450.

**Company Address:** c/o Madrigal Audio Laboratories, P.O. Box 781, Middletown, Conn. 06457.

For literature, circle No. 90





The Accuphase G-18 is an uncommon product for audiophiles in that it is a third-octave equalizer, something more likely to be found in sound-reinforcement systems. It has 33 filters on ISO frequencies for each channel—a very useful three more than the typical third-octave unit. The two extra filters at the low-frequency end are at 16 and 20 Hz, and the added high-frequency filter is at 25 kHz. For the best control of music now available on CD, equalization adjustment may be quite necessary below and/or above the normal range of 20 Hz to 20 kHz.

Accuphase states that the filters have a constant third-octave bandwidth with a Q of 4.3. A claimed advantage is that interference between filters does not increase with changes in the level-control settings. The manufacturer uses discrete components to gain substantial improvement in sound quality. There are a total of 706 transistors, eight FETs, and just 10 ICs. The buffer and the bandpass-filter amplifiers are configured as differential, complementary, push-pull circuits.

The G-18 is one of the relatively few units that have balanced inputs and outputs; these can keep noise pickup to a minimum and eliminate troublesome ground loops. The impedance of the balanced inputs can be switched either to 600 ohms to match some professional-type equipment or to 40 kilohms for minimum loading on the source. There are also phono-jack inputs and outputs for unbalanced connections to typical systems. The G-18 does not have connections for a tape recorder, something which almost all other audiophile equalizers include. Accuphase states that not having these additional external connections ensures the purity of the signal path.

The G-18 uses a proprietary filter circuit with separate power-transformer coils for the left and right channels. This greatly reduces the possibility of interaction between channels when adjustments are made. An acrylic protective panel is provided; it is easily installed or removed, and protects the equalizer from inadvertent shifting of the filter settings.

### Control Layout

The Accuphase G-18 is immediately impressive because of its physical size and weight. The 6-inch-high front panel, with its 66 filter sliders, is not easily ignored. The left-channel sliders are on the top half of the panel, and the right-channel ones are below. Each slider adjusts smoothly and has a soft but definite center detent. The total travel is 1¾ inches, which makes for easy, accurate adjustment. The



panel is marked with horizontal lines for every dB of boost or cut; these are located between all sliders and at the scale ends. There are numbers every 2 dB, with the "dB" designation at the bottom of each scale. Filter frequencies are shown on a horizontal gray band across the center of the front panel, between the two filter sections. The labels for "100," "1k," and "10k" glow in a gentle red that helps to guide the user to particular filters.

A small pushbutton to the left of the upper filter section selects "Off" or "Equalizer." The button is black, and there is no LED status indicator, so on the black version of the G-18, which I had, it is difficult to be certain of the switch's position from a distance. With the optional champagne-gold front panel, the button would stand out better. The power switch and its red LED indicator are at the lower left of the panel. All panel designations are white and are easy to read even in fairly dim light; markings on the gold version, which I have not seen, are black. The steel top and bottom panels are perforated to ensure good ventilation.

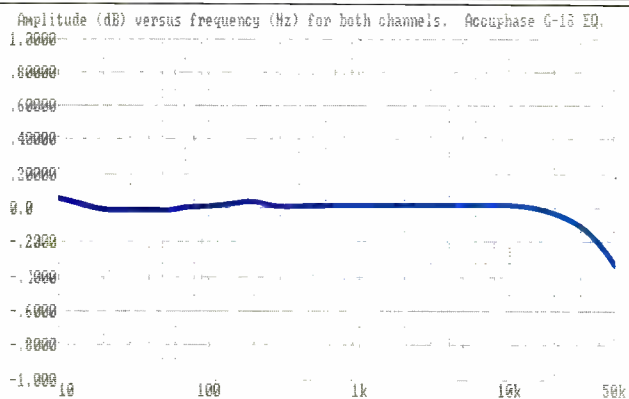
The inputs are on the left of the rear panel. The two "Unbalanced" inputs use unusually rugged phono jacks. The "Balanced" inputs use three-pin, XLR-type, female sockets. To their right, slide switches select "Unbalanced" or "Balanced," and "600 Ohms" or "40k Ohms" impedance for the balanced inputs. The unbalanced input impedance is 20 kilohms.

The outputs are on the right center of the panel, and the XLR-type connectors for the balanced outputs are male in this case. The output impedances are labelled "10 Ohms" for unbalanced and "50 Ohms" for balanced. The choices of connectors, configurations, and impedances on the G-18 are outstanding. Two unswitched a.c. outlets, with a total capacity of 200 watts, are at the right end of the rear panel.

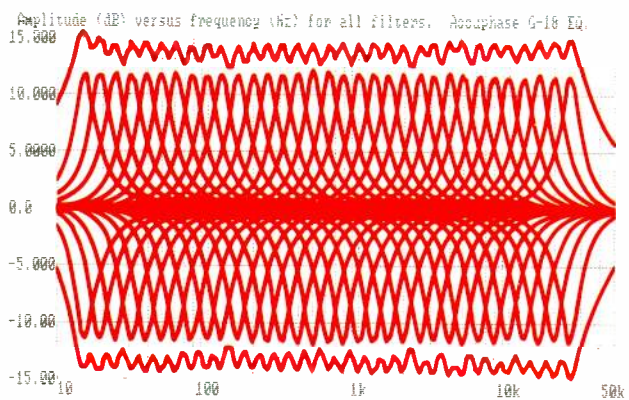
I removed the top cover to get a better view of the p.c. board which covers most of the chassis area. As I was looking at the layout, I realized that this board was for the left channel only and that another board was below a separating, isolating metal plate. The good-sized, fully enclosed power transformer on one side of the top board was quite warm to the touch after several hours of operation, but it was not hot enough to burn the fingers. The boards and the components on them are of excellent quality, and all parts



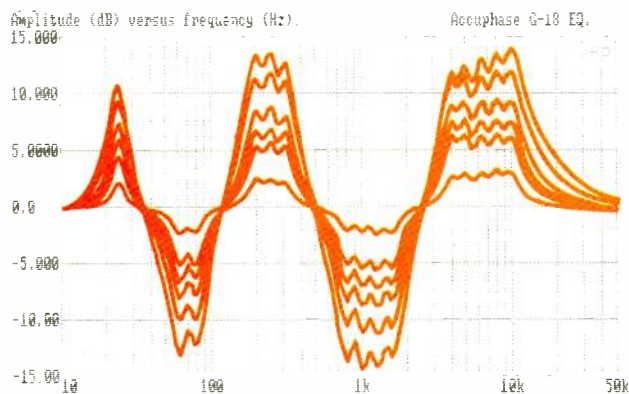
Internal construction was of the highest quality I have seen to date in audiophile equipment.



**Fig. 1—Frequency response with EQ in and filter sliders at their center detents. Note the expanded vertical scale of 0.2 dB/div.**



**Fig. 2—Frequency response of each filter section at maximum boost and maximum cut and of all sections combined at maximum boost and cut.**



**Fig. 3—Frequency response of various filter combinations, set in 2-dB steps from zero to maximum (12-dB) boost or cut. From left to right: 25-Hz boost; 63- and 80-Hz cut; 200-, 250-, and 315-Hz boost; 800-, 1000-, 1250-, and 1600-Hz cut, and 4-, 5-, 6.3-, 8-, and 10-kHz boost.**

are neatly labelled. Boards at the back of the front panel are for the sliders; a connection board is at the back.

Soldering was excellent, and there was basically no flux anywhere, even on the hand-soldered points. Interboard connections were made with multi-conductor cabling, with sockets and plugs for the most part. Ground wiring was heavy gauge, something I had never noticed in equipment examined previously. The chassis was rigid and rugged. Overall, I judged this Accuphase equalizer's construction to be of the highest quality I have seen to date in audiophile components.

### Measurements

Because the G-18 has filters above and below the normal audio band, I set my Audio Precision System One test gear to check frequency responses all the way from 10 Hz up to 50 kHz. Figure 1 shows the very flat response when EQ was switched in but all filters were at their center detents. Specific results were  $-0.01$  dB at 20 Hz and  $-0.04$  dB at 20 kHz; the  $-3$  dB points were at 2.6 Hz and 160 kHz. Figure 2 shows the responses for each of the 33 filters at maximum boost and maximum cut as well as the results with all filters set at their extremes. A close examination of Fig. 2 confirms that the maxima are very consistent and that the center frequencies are accurate. The frequency of the 1-kHz filter's response peak was 1,015 Hz, which is just 1.5% high. Figure 3 presents the responses that resulted from boosting and cutting combinations of adjacent filters (listed in the caption). The 2-dB steps were set by eye, but there does generally appear to be a bigger change between +2 and +4 dB than for the other steps. The filters have relatively little effect on the response outside their immediate areas, which is good; however, the ripple in the frequency response with the multiple filters is higher than desired at settings of +4 dB and above.

I first checked for THD + N from 20 Hz to 20 kHz to 2 V, and the plot was a straight line just above 0.001%. I concluded that distortion was down under the noise. Figure 4 is the result of repeating this test but with the level increased to 5 V. Over a good part of the band, the results are less than 0.0007%. You can see a little jump in the left channel at around 60 Hz and two jumps in the right channel at around 5 and 16 kHz. I'm not certain if these high points were caused by filters slightly out of exact zero, but even if they were, the results are marvelous. Figure 5 shows THD + N at 1 kHz for increasing voltage. Below 2 V, the measured THD + N is controlled by noise. The actual distortion does not exceed 0.001% until both channels are driven to almost 9.5 V. Clipping did not appear anywhere from 20 Hz to 20 kHz, until 11.8 V.

To get a good look at filter shape with increasing amounts of boost, I took an expanded look (Fig. 6) at the response of the 1-kHz filter while increasing boost in 2-dB steps. The peak-reference mode of the Audio Precision System One plotted the six sweeps with all peaks at the 0-dB reference, which helps in finding the bandwidths ( $-3$  dB points) and in comparing filter shapes. A Q of 1.0 (with a bandwidth of 1.4 octaves) is the maximum possible for good assurance that there will be no ringing. A one-octave bandwidth has a Q of 1.4, which usually is quite acceptable even in critical listen-



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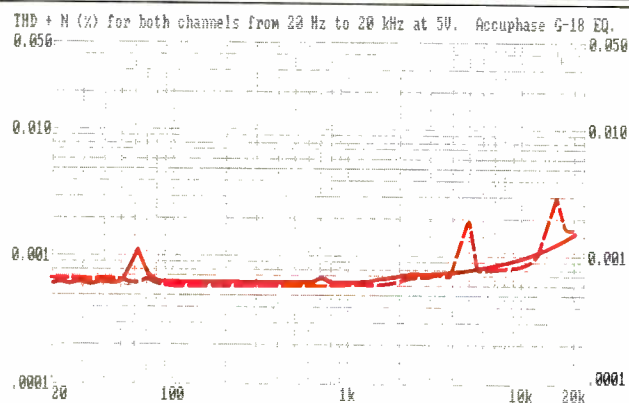
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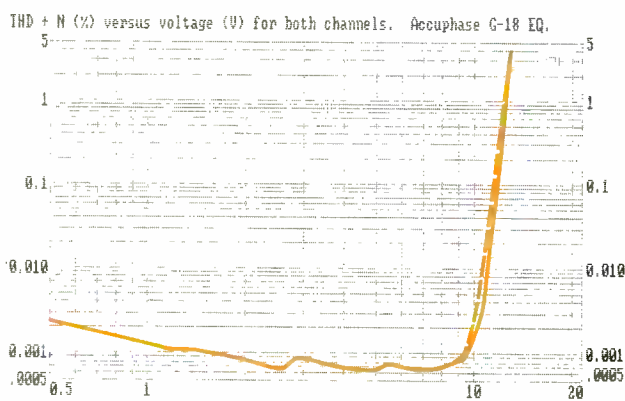
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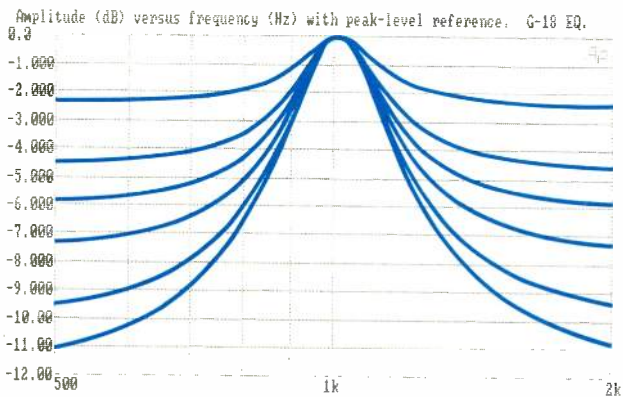
At the rated 2 V output, distortion was unmeasurable; even at 5 V out, it was marvelously low.



**Fig. 4—THD + N at 5 V out, well above the rated output voltage, is still quite low. Note slight distortion peaks at around 63 Hz in the left channel (solid curve) and at about 5 and 16 kHz in the right (dashed curve); see text.**



**Fig. 5—THD + N vs. output voltage at 1 kHz for left channel (solid curve) and right (dashed curve). Elevation of curves at low voltages is due to noise.**



**Fig. 6—Bandwidth of 1-kHz filter for boost settings from 0 to +10 dB, in 2-dB steps. Curves have been normalized to peak at 0 dB; see text.**

ing. A filter with a third-octave bandwidth has a Q of 4.3, which is much more likely to ring when hit with a transient. Frankly, I am not a fan of constant-Q equalizers, particularly when they are relatively narrow band, such as third-octave. I was glad to see that the G-18's filters are not that constant in Q, even though the manufacturer states that such a design is a virtue. Figure 6 shows that a Q of 1.4 (–3 dB at 720 Hz) would be reached with a boost of about 3 dB. The Q gets close to 4.3 (–3 dB at 904 Hz) at a boost of 7.5 dB or so. An operational caution, therefore, would be to avoid boosts approaching 7.5 dB, if at all possible.

The S/N ratios, referred to 1 V, were 103.4 dB with a bandwidth of 22 Hz to 22 kHz, 102.9 dB with CCIR/ARM weighting, and 105.8 dB with A-weighting. Using Accuphase's 2 V rated output as the reference would increase all of these results by 6 dB. The output polarity is the same as the input.

#### Use and Listening Tests

The owner's manual has good instructions on connecting the G-18 to other equipment. The options are more limited than with most equalizers because the unit does not have tape in/out connections. Occasionally the language is a bit clumsy, which obscures some of the valid points being made. It is true that all of the filters are at ISO standard frequencies, but it is also true that the frequencies are standard for acoustical analysis, not for musical reasons.

The G-18 does cover the entire band, plus a little extra, with its 33 filters per channel. This calls for a third-octave RTA for guidance in making response connections. Adjusting a third-octave equalizer from start to finish by ear can lead to many bad choices and can waste a lot of time. I assume that, considering the G-18's price, Accuphase dealers will help buyers adjust this equalizer for the best overall response. However, the manual should say much more on this subject than what is contained in a couple lines of general reference.

Figure 7 shows the before and after responses of a JBL 4411 loudspeaker. Response adjustments were made with the help of an Ivie IE-30A third-octave RTA. The before-EQ response was rough, and there was an erratic roll-off of the higher frequencies. I started by pulling down the 63-, 125-, and 250-Hz peaks. After that, I worked on making the display the way I wanted it, boosting and cutting for a flat response out to almost 2 kHz, with a roll-off above that point. The scale settings for the filters used were: +6 dB at 16 Hz, +5 dB at 20 Hz, +4 dB at 25 Hz, +3 dB at 31.5 Hz, 0 dB at 40 and 50 Hz, –4 dB at 63 Hz, +0.7 dB at 80 Hz, +1 dB at 100 Hz, –4.5 dB at 125 Hz, +3 dB at 160 Hz, –0.8 dB at 200 Hz, –3 dB at 250 Hz, –0.3 dB at 315 Hz, –3 dB at 400 Hz, +2.2 dB at 500 Hz, +3.4 dB at 630 Hz, +2 dB at 800 Hz, +4 dB at 1 kHz, 0 dB at 1.25 kHz, +0.7 dB at 1.6 kHz, +3.2 dB at 2 kHz, –3 dB at 2.5 kHz, +3.5 dB at 3.15 kHz, –1.3 dB at 4 kHz, 0 dB at 5 kHz, +4.4 dB at 6.3 kHz, +4 dB at 8 kHz, +1.2 dB at 10 kHz, +2.1 dB at 12.5 kHz, +0.4 dB at 16 kHz, –0.3 dB at 20 kHz, and 0 dB at 25 kHz.

There was no doubt about the great improvement in the low-frequency/high-frequency balance and the smoothness of the sound with pink noise. I wondered what the actual response of the equalizer was after all these adjustments





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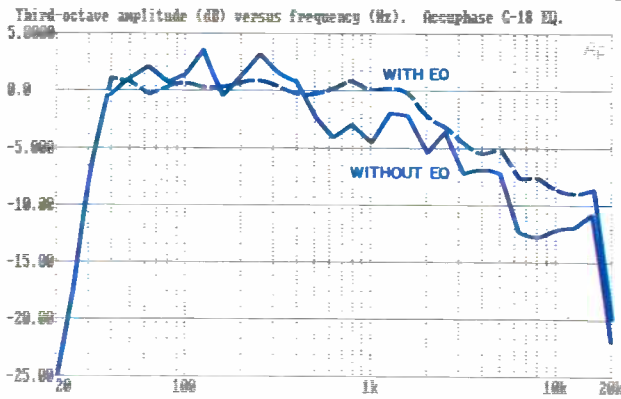
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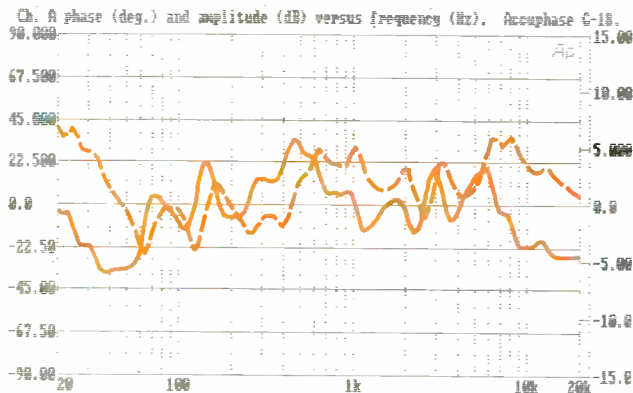
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Used properly, the G-18 can deliver superb performance, with virtually no noise or distortion. Its response with EQ out is ruler-flat.



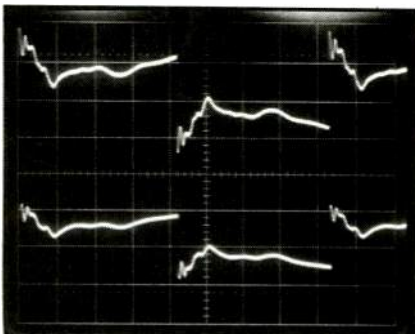
**Fig. 7—Third-octave response of a loudspeaker before and after equalization. Note that frequency balance**

**and smoothness have improved, but equalization cannot extend the low bass.**



**Fig. 8—Relative phase (solid curve) and frequency response (dashed curve) of G-18**

**with equalization used in Fig. 7. Phase, in degrees, can be read from left-hand scale.**



**Fig. 9—Equalizer output with 119-Hz, 0.8-V square-wave signal. Top waveform shows the results of using the equalization in Fig. 8; note the ringing. Bottom waveform shows results**

**of shifting all 33 sliders down about 2 dB in order to reduce ringing without changing relative frequency response; see text. Horizontal scale: 1 mS/div.**

and how phase varied with frequency. Figure 8 shows the response was generally boosted rather than cut below 50 Hz and above 400 Hz. Phase deviations remained within  $\pm 35^\circ$ . Reexamination of Fig. 7 convinced me that the boost in the lowest frequencies had been ineffective in extending the speaker's low-bass response. (To do this, a subwoofer would be in order.) Listening to a variety of CDs led me to believe there was a little unwanted ringing.

Because I was only using one channel for this testing and listening, it was easy to set up an alternate equalization, which would cause less ringing on the other channel. A given boost setting causes more ringing than the same degree of cut, so I followed the same curve but with all sliders set 2 dB lower. This caused a 2-dB drop in the signal level with EQ in, but it maintained all of the response corrections and reduced the ringing. Long-term listening satisfaction was then possible with all types of music. This result emphasizes that there is more to equalization than making the response flat. The top waveform in Fig. 9, made through the channel that was set for the first-try EQ, shows obvious ringing at several of the boosted frequencies. The bottom waveform shows the reduction in ringing and overshoot after all slider settings were lowered by 2 dB.

At this point, let me put in a caveat about equalizers in general and third-octave units in particular. Be careful about trying to do too much with an equalizer. A common failing among users of third-octave equalizers is in trying to get the "perfect" flat display on an RTA, ignoring the other effects of the filter settings. This approach can lead to excessive boost and cut settings in an attempt to get the desired amplitude display, such as pumping in 10 dB of boost in order to fill an indicated 2-dB dip at the crossover frequency. Such excesses can actually cause great response deviations within a filter band and large phase shifts in the equalizer, as well as excessive ringing.

As far as possible, improve the sound with acoustical treatment of the room and with speaker location and aiming, to say nothing about the initial choice of loudspeakers. I have seen quite a few cases where users have boosted equalizers across the whole band as a form of gain control. Do *not* do this; even octave-band equalizers will ring with excessive boost. With any equalizer, bring down the peaks instead of boosting the valleys. Be especially wary of trying to boost a deep dip such as that from a crossover. To correct broad response deviations, make most of your corrections, if possible, with the tone controls or the speaker's midrange and tweeter adjustments (which have low Q). Use EQ only to finish the smoothing. These constraints apply to the use of any equalizer but particularly to third-octave models.

When used properly, the Accuphase G-18 delivers superb performance, with substantially no distortion or noise and a ruler-flat response when EQ is out. The 33 filters will all find their uses in quality installations, and the filters at the low end can smooth subwoofer response, a task at which most equalizers are not effective. The G-18's balanced inputs and outputs may be of great benefit, and perhaps essential, both for high-end audiophile systems and for professional uses. The price is very high, but the quality is impeccable.

*Howard A. Roberson*





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## 2

LINN LK1  
PREAMP**Manufacturer's Specifications**

**Nominal Output Level:** 0.5 V rms  
at 1 kHz, 1-kilohm load.

**Input Levels:** MM phono, 5.0 mV;  
MC phono, 150  $\mu$ V; high-level, 0.5 V  
rms.

**Tape Output Level:** 0.4 V rms, 2-  
kilohm load.

**Dimensions:** 10.24 in. W x 2.95 in.  
H x 10.43 in. D (26 cm x 7.5 cm x  
26.5 cm).

**Weight:** 9.9 lbs. (4.5 kg).

**Price:** \$1,050; remote control, \$100;  
adaptor cables, \$40 each.

**Company Address:** c/o Audiophile  
Systems, 8709 Castle Park Dr., Indi-  
anapolis, Ind. 46256.

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Although most of us tend to think of Linn primarily as a manufacturer of high-quality turntables, the company, based in Glasgow, Scotland, has an equally high reputation in the field of audio electronics. I had an opportunity to evaluate both their LK1 microprocessor-controlled preamplifier and companion power amplifier, the Model LK280. Although my experiences with these two components appear here as separate reports, I would stress that the LK1 and LK280 are very definitely meant for each other, as shown by their method of interconnection (which I'll get to shortly). In fact, you would find it difficult, if not impossible, to use either of these products singly without special adaptor cables. Think of these two units, then, as an exceptionally fine integrated amplifier delivered on two chassis.

The LK1 preamplifier is of dual-monophonic construction and has inputs for tuner, auxiliary, MM or MC phono car-

*Continued on page 92*





# LINN LK280 POWER AMPLIFIER

## Manufacturer's Specifications

**Power Output:** 80 watts per channel  
into 8 ohms, 160 watts per channel  
into 4 ohms.

**Voltage Gain:** 26 dB.

**Input Impedance:** 3 kilohms.

**Dimensions:** 12.6 in. W x 2.95 in. H  
x 10.4 in. D (32 cm x 7.5 cm x  
26.5 cm).

**Weight:** 19.8 lbs. (9 kg).

**Price:** \$1,495.

**Company Address:** c/o Audiophile  
Systems, 8709 Castle Park Dr., Indi-  
anapolis, Ind. 46256.

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The Linn LK280 power amplifier, intended to be used with that company's LK1 preamp, is the successor to Linn's earlier LK2. It features higher power output than the earlier model (80 watts per channel into 8 ohms, as opposed to 60 watts) and a host of other improvements and refinements. In passing, I must point out that, although I appreciate and understand Linn's reluctance to include in the owner's manual or publish any more revealing specifications than those shown, here in the U.S., we do have to contend with the FTC power rule, for better or worse. This rule requires that for amplifiers intended for consumer use, the manufacturer must list not only the unit's rated power and the impedance at which it can be achieved, but also the frequency bandwidth over which the rated power can be delivered and the maximum harmonic distortion likely to occur at any frequency up to the rated power level. Clearly, those last two

*Continued on page 98*



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Think of this Linn amp and preamp as an exceptionally fine integrated amplifier delivered on two chassis.

Continued from page 88



tridge, and two tape decks. Outputs are provided for two power amps and two tape decks. Dubbing from either connected tape deck to the other is possible, and volume adjustment is performed in 256 steps using a precision resistor network. A protection system silences output during any power-supply or line-voltage transient.

Physically, the LK1 is divided into three sections: The audio board, the power supplies, and the control board. The audio board takes up most of the space inside the preamp. All amplification, switching, and level adjustment are performed on this board, which also contains much of the power-supply circuitry. The audio signal, from input to output, is routed only through this board. The control board, located just behind the front panel, handles only digital control signals, as does the ribbon cable connecting it to the audio board.

The toroidal power transformer used in the LK1 is shielded in a steel case. All switching is done electronically; there are no moving parts in the preamp. Operation of the preamp can be controlled from the front panel or from an optional remote control. When a key is pressed—either on the front panel or on the remote control—a microprocessor generates the correct output commands to the audio board. Product literature, provided by Audiophile Systems, goes into great detail concerning the circuit specifics of this product as well as of its companion LK280 amplifier. To attempt to trace the signal from input to output would require far more space than this report can occupy, so I will summarize key features and design objectives, as stated by the product's designers.

Microprocessor control provides not only remote-control capability but volume level presets for each input, the ability to listen to one source while recording another, and even keyboard lockout to prevent unauthorized use by children or, as the Linn brochure puts it, "during drunken orgies." (Editor's Note: Whilst I cannot publicly attest to the actual occurrence of orgies in any part of Glasgow, or even that I have personally witnessed any member of the Linn Products team take part in orgies outside of 'twixt-ear environs, I must take cognizance of certain ill-founded rumors.—E.P.) The LK1 features modular construction, extremely high r.f. rejection, a high level of immunity to external mechanical feedback, high-quality connectors, and compact dimensions.

Key design objectives, according to the designers, were the preservation of signal integrity from a moving-coil cartridge and optimization of low-noise performance (including thermal noise, digital noise, and r.f. breakthrough). Solid-state switching was used to avoid long signal runs and distortion from mechanical contacts due to contact rectification, microphony, or wear. Finally, the designers sought to develop power supplies and voltage-regulation circuitry that would provide very high isolation from the a.c. line and between stages. For the most part, I would say that these objectives were achieved.

### Control Layout

All user controls for the LK1 are located at the left end of the front panel, except the power switch, which is at the panel's lower right corner. There are individual buttons for "MM" and "MC" phono, "Tun," "AUX," and "Tp 1" and "Tp 2." If the nearby "Rec" button is pressed prior to pressing one of these primary-function buttons, the designated input will be routed to the tape outputs. Pressing the button labelled "Mute" after pressing "Rec" will disconnect the input from the tape outputs. Two "Bal" buttons adjust channel balance, while buttons labelled "+" and "-" are used to change volume. After selecting any input and adjusting volume and balance, the volume settings for that particular input can be stored by pressing "Rec" and then "Mute." The stored volume settings can be recalled by selecting the appropriate input and then pressing the "Mem" button. Stored volume settings are retained by the microprocessor, which is powered by a rechargeable battery. Settings will be retained for several months, even if the power cord is disconnected. Several other combinations of buttons provide additional, if rarely used, functions such as causing balance to shift completely to one channel or the other, restoring center balance settings, and, perhaps most inter-





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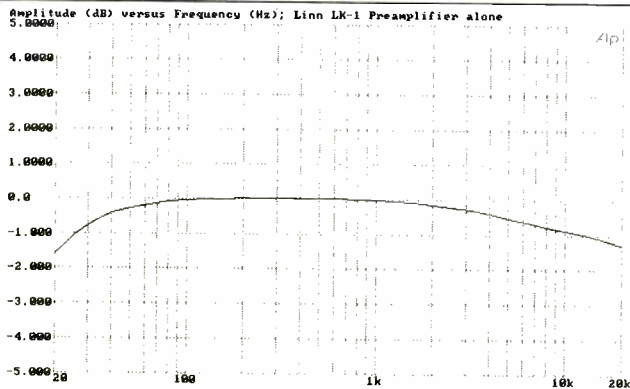


Fig. 1—Frequency response, LK1 preamp alone.

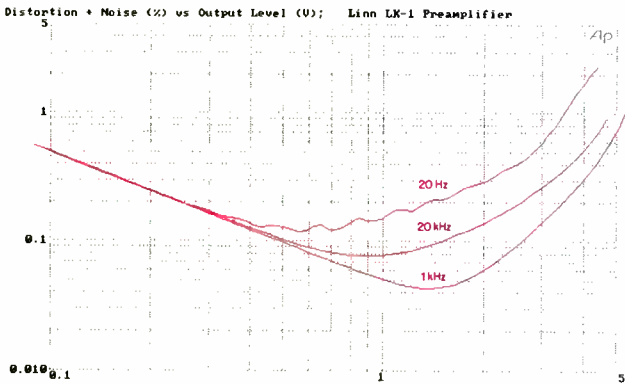


Fig. 2—THD + N vs. output voltage.

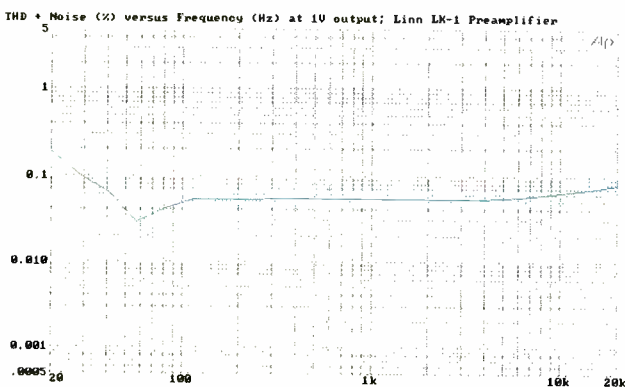


Fig. 3—THD + N vs. frequency at 1 V output.

esting of all, completely disabling all panel controls. This last trick is accomplished by touching "Rec" and then the volume "-" button. To cancel this lockout feature, the same buttons are touched in the same order a second time. The remote control has functions identical to those on the front panel; it is activated by pressing a button on the remote labelled "Pre." The only difference is that pressing "Rec" and then the volume "-" on the remote disables the remote without disabling the front-panel controls themselves. Several unmarked buttons on the remote, I am told, are for future use with other Linn components.

The rear panel of the LK1 has one of the most unusual layouts I have ever encountered in a preamplifier. Although the phono inputs are gold-plated phono jacks, all other inputs and outputs use three- or five-pin Cannon-type connectors. The inputs for "AUX" and "Tun" and the two outputs use three-pin connectors, while the "Tp 1" and "Tp 2" input/output receptacles use five-pin connectors. Initially, I thought that the high-level inputs and outputs might be balanced, or "floating." Such was not the case at all. For the three-pin connectors, pin 1 is used as a signal ground, pin 2 is a left input (or output), and pin 3 is a right input (or output). For this reason, you will not be able to use "standard" XLR three-pin cables but must either acquire special cables from Audiophile Systems (as I did) or wire up your own. I was loaned cables for connecting to the high-level inputs, as well as a pair of cables that enabled me to connect from the LK1 to the LK280 power amp, which has the same sort of unusual connector arrangement. As for measuring the performance of the preamp alone, I was able to do that because my Audio Precision System One test panel is equipped with XLR as well as unbalanced banana-plug connectors. Since at least one of the channel outputs is wired in standard XLR fashion, I was able to check out the LK1's performance without having to tear into the supplied cables. Both channels of the LK1 are identical and completely separate, so it didn't matter at all that by connecting this "nonstandard" cable to the standard three-pin receptacle on the test equipment, the opposite channel output was being "shorted out" completely! A separate line cord is supplied with the preamp and must be connected to the appropriate socket on the rear panel. There's also an IEC Standard, auxiliary, unswitched, unfused power receptacle that can be used to connect the power cord for the LK280 or any other equipment.

### Measurements

As you can see by examining the published specifications at the beginning of this report, Linn does not put too much stock in lab measurements. I, on the other hand, have always maintained that only an intelligent combination of lab and listening tests will reveal the true merits, or demerits, of an audio component. Therefore, I hope the folks at Linn—and those readers who rely solely upon subjective judgment—will bear with me as I discuss first how the unit measured.

Overall frequency response of the preamplifier, using the high-level inputs, is shown in Fig. 1. Response was down by just over 1.5 dB at 20 Hz and by 1.2 dB at 20 kHz. This deviation from perfectly flat response is also reflected in my



S/N for the MM and even the MC phono inputs was almost as good as it was for the high-level inputs. Amazing!

tests of phono frequency response and of the LK280 power amp's performance. This latter measurement had to be made using the LK1 preamp as an interface between my test equipment and the amp because of the amp's unusual input jacks.

Input sensitivity for 0.5 V output, using the AUX or tuner inputs, was 255 mV. The MM phono inputs required 2.4 mV, at 1 kHz, to produce the same output level, and the MC inputs required only 215  $\mu$ V for 0.5 V at the main outputs.

Figure 2 shows THD + N versus output level at three test frequencies. At 1 V output, THD + N was 0.05% for a 1-kHz test signal, 0.16% for a 20-Hz signal, and 0.08% for a 20-kHz signal. Maximum output level for the preamp, before reaching gross levels of distortion, was about 5 V. A continuous plot of distortion versus frequency for a fixed output of 1 V (Fig. 3) pretty well confirmed the results of Fig. 2.

S/N ratio for the high-level inputs measured 77.5 dBA, using a standard input of 0.5 V and with the volume control adjusted to deliver the standard reference output of 0.5 V. S/N for the MM phono inputs, referred to the same output level and to an input of 5 mV, was 76.7 dBA—almost as good as for the high-level inputs. Even more amazing was the S/N for the MC phono inputs, which was 76 dBA using an input reference level of 500  $\mu$ V.

I was quite satisfied with all of these results, but some time later, for confirmation, I decided to run a spectrum analysis of the residual noise to see at what frequencies most of the noise was occurring. By the time I got around to doing this, the LK280 power amp, which was sitting beneath the LK1 on my test bench, had been left on following some listening tests of the two units. Much to my surprise, in running the spectrum analysis, I was shocked to discover a noise peak at the power-line frequency of 60 Hz that was barely 60 dB below reference level. I realized that this analysis was made without A-weighting, but it still seemed too great a difference between my overall reading of 77.5 dB and the "hum" peak seen in Fig. 4.

Referring to the owner's manual, I came across the following note: "The power amp should be at least 15 cm (6 inches) from the preamp to avoid hum." Sure enough, when I turned off the power amplifier and repeated the spectrum-analysis sweep, the previous peak receded by nearly 25 dB! This second plot, also shown in Fig. 4, should remind prospective owners of this Linn combination how important that note in the manual is. The new plot made more sense in light of the overall S/N results obtained earlier.

I was a bit disappointed with the results I obtained for phono overload. If you are going to use this combination to play records, I would recommend that you use a high-quality cartridge which delivers relatively low output voltage (whether you use an MM or MC cartridge). MM phono overload measured 65 mV, and overload for the MC inputs occurred at a level of 6 mV. In both cases, a 1-kHz signal was used. Incidentally, although it is possible to connect and use both an MM and an MC cartridge with the LK1, the two inputs share a common equalization stage. It will therefore not be possible to listen to the MC cartridge output while recording from the MM cartridge, or vice versa.

Figure 5 shows how much the overall phono frequency response, via either the MM or MC inputs, deviates from the

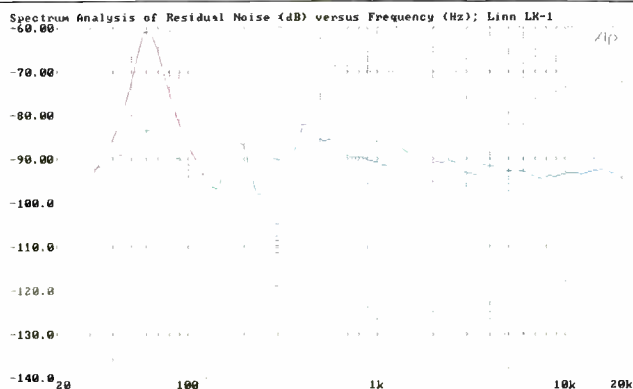


Fig. 4—Spectrum analysis of residual noise, with no input applied. Main curve shows residual noise with LK1 preamp 2 feet from LK280 amp. The 60-Hz noise peak was obtained when the preamp was just above the amp; see text.

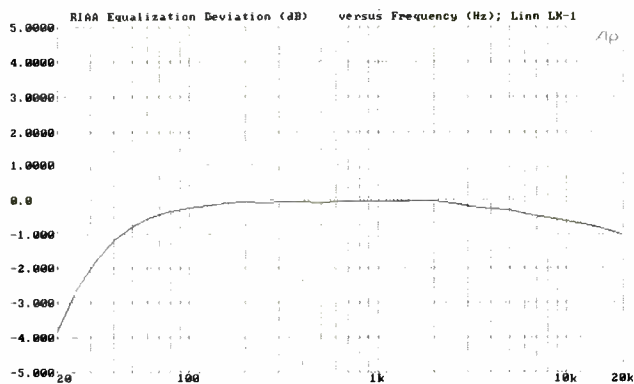
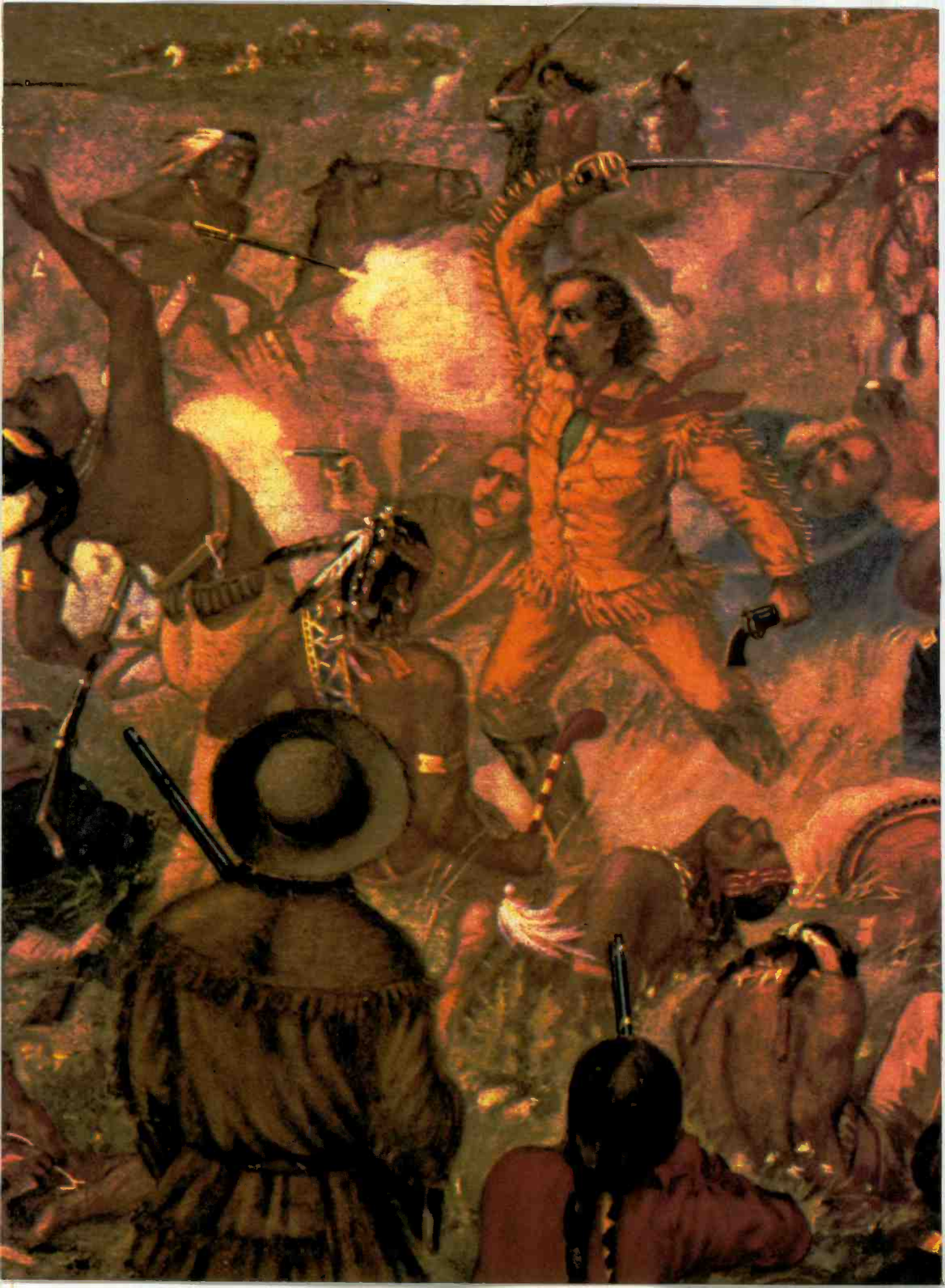
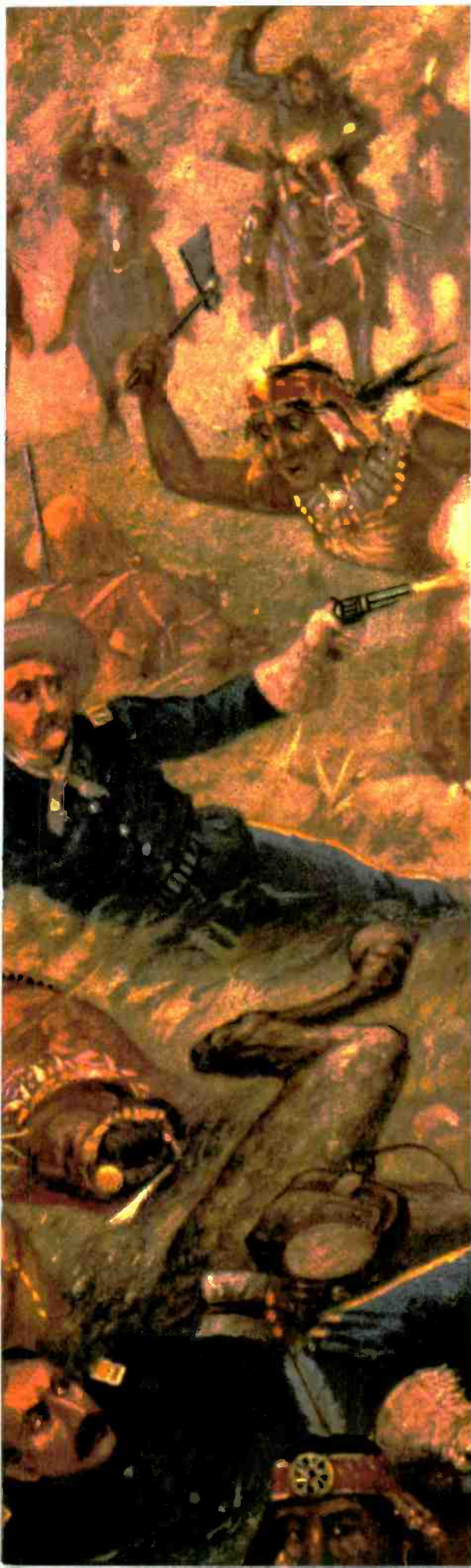


Fig. 5—Deviation from RIAA equalization, including effects of overall frequency errors shown in Fig. 1; see text.

RIAA equalization curve. I should point out that the error at the treble end of the plot is almost entirely due to the high-frequency roll-off previously measured for the high-level inputs (see Fig. 1). At the base end, subtracting the low-frequency roll-off previously obtained would leave an equalization error of only about 2 dB—and this is not really an error. European manufacturers subscribe to the IEC version of low-frequency equalization—a gentle roll-off below 30 Hz—that the U.S.-based RIAA stubbornly refuses to adopt. Had I used the IEC version of the reciprocal curve, the deviation at the low end would have been off, but only by the same 1.5 dB measured earlier for the high-level inputs.







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Linn's engineers listed such key design objectives as low noise and very high isolation. I'd say those objectives were achieved.

Of course, since this preamp has no tone controls, there is no way to correct the errors in frequency response for any of the inputs without hooking in a high-quality equalizer via one of the tape-monitor loops. For most listeners, I suspect that the minimal error in response is not serious enough to worry about. After all, it is less than 0.5 dB at 40 Hz, and very few speaker systems are "flat" below this to begin with.

#### Use and Listening Tests

It took me no time at all to become accustomed to the simple, but elegant, microprocessor-controlled switching

facilities of the front panel of the LK1. I detected absolutely no spikes or noise when switching from one program source to another, nor could I detect any audible crosstalk when directing one program source to the LK280 amplifier while another was being fed to the tape outputs. All in all, the LK1 is an unencumbered preamplifier that should gladden the hearts of purists—especially those who elect to couple it to the LK280, as I did for my serious listening tests. Accordingly, I'll discuss my reactions to the sound quality at the end of the report dealing with this companion component.

Leonard Feldman

Continued from page 89

specification requirements are not being met by Linn, and I would urge the American importer, Audiophile Systems, to revise their literature to correct that omission. This amplifier is just too good a product to be troubled by such a small thing.

As is true of the LK1 preamp, the LK280 features modular construction, immunity to r.f. and mechanical feedback, high-quality connectors, and compact size. The LK280 is actually a dual-mono amplifier, although both channels are powered by a single, toroidally wound transformer. Separate secondary windings are used for each channel, and the main filter capacitors in each channel have a value of 10,000  $\mu$ F. The massive shielded transformer takes up a good deal of the amp's interior volume, while two identical, modular, audio amplifier channels are mounted vertically on either side of the centrally located transformer housing, close to the heat-sinks.

A detailed circuit description supplied by Audiophile Systems revealed some of the design philosophy embodied in this amplifier. The LK280 has no circuitry for sensing the temperature of the output transistors; its design eliminates the need for adjusting the quiescent current in the output stages as device temperatures change. Further, it has no current-limiting circuits; instead, it is protected against failure by a line fuse. In addition, a sensing circuit responds to any potentially damaging conditions—such as an excessive static current drain or a high-level transient—by shutting down after only a few milliseconds. When such a shutdown occurs (it never did during my preconditioning and other bench tests), the only way to restore operation is to turn the amplifier off for at least five minutes and then turn it back on. Unlike the earlier LK2, all protection and regulator control circuitry is now contained on a custom-made, thick-film hybrid microcircuit.

#### Control Layout

The LK280 has no controls other than a power switch and a nearby green power indicator light which is visible only if you are at eye-level with the front panel. The rear panel, on the other hand, is unlike that of any power amp I have ever tested. Instead of using ordinary phono input jacks, signals from the companion LK1 preamplifier are applied to the LK280 via three-pin connectors. Special interconnect cables, supplied with the LK1, link the amplifier with the XLR connectors on the preamplifier. For the left channel, pin 2 is

the "hot" signal pin, pin 3 has no connection, and ground return is via pin 1. For the right channel, pin 3 carries the audio signal, with no connection at pin 2. For this reason, standard XLR cables cannot be used, though adaptor cables with RCA plugs at one end are available from Audiophile Systems. Not having these, I fed signals via the LK1 preamp in order to measure the amp's performance. A more direct approach would have involved either destroying the obviously expensive cables supplied with the preamp or stopping to buy XLR plugs and then fabricating new cables.

The speaker output terminals resemble banana-plug sockets, but they are not spaced to accommodate standard double-banana plugs and are too small for normal bananas to fit. (Audiophile Systems says they're deliberately undersized to provide a very tight fit, but I couldn't get regular bananas into them.) Linn provides four color-coded banana plugs, each having a spring-loaded wire along one side, instead of the usual four spring leaves. These plugs must be soldered to your speaker-cable conductors. Audiophile Systems says they would hope that the dealer would take care of this. However, I've noted that European manufacturers, especially those from the U.K., seem to thrive on making their customers buy and use soldering irons. I suppose it gives the user a sense of involvement in the installation process that is not possible if all you have to do is feed a stripped wire neatly into a hole that is exposed when a binding post is loosened! I will admit that once the soldering task was completed, the friction fit of Linn's special plugs made far better contact than would be obtained with most banana plugs.

The separately supplied power cord must be plugged into a corresponding three-terminal receptacle on the rear of the amplifier. There is an additional a.c. convenience





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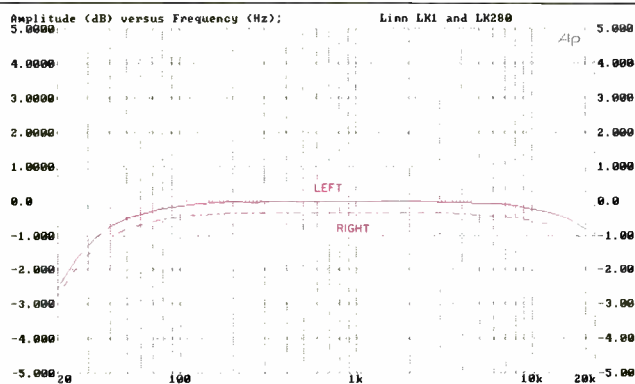
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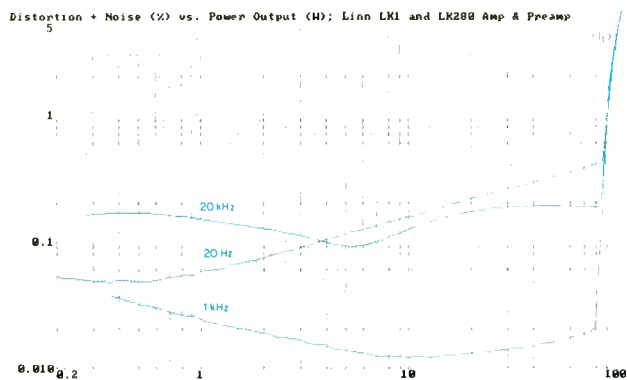
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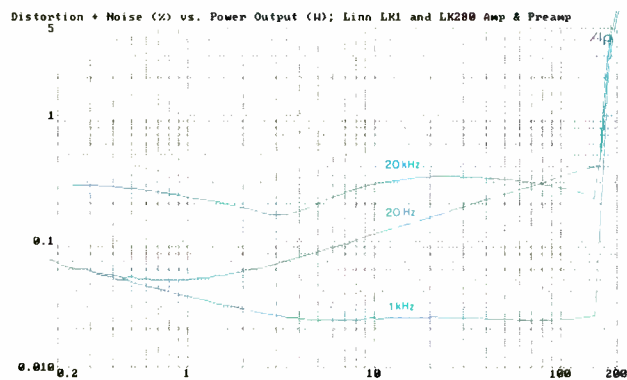
The LK280's output stage is designed to be stable as device temperatures change; it is protected by a fuse, not a current-limiting circuit.



**Fig. 1—Frequency response, Linn LK280 amplifier and LK1 preamp; (see text). Right channel has been displaced for clarity.**



**A**



**Fig. 2—THD + N vs. power output per channel for 8-ohm loads (A) and 4-ohm loads (B).**

receptacle configured in accordance with IEC Standards, as well as a fuse-holder. Since the fuse contained in this holder is an important amplifier protection device, care must be taken to assure that its value is correct. When the amp is used in Europe (at 220 or 240 V), the proper fuse value is 3.15 amperes, slow-blow—or anti-surge, as the "mother country" calls it—while for U.S. use (at 120 V), the value should be doubled to 6.3 amps, slow-blow.

### Measurements

Figure 1 shows the frequency response of the LK1 and LK280 combination, not that of the amp alone. You can derive the amp's response by comparing Fig. 1 with the response curve for the preamp alone (see accompanying test report). It is possible to conclude that, if anything, the amp's response at 20 kHz is up a fraction of a dB, since the response of the LK1 at this frequency was down a bit more than 1 dB. At 20 Hz, however, the response of the amp alone is actually down about 1 dB, since the preamp's response was down some 2.5 dB at this frequency. The dashed curve of Fig. 1 is the response of the right channel; this curve has been deliberately displaced for clarity.

Figure 2A shows how THD + N varied as a function of output power when the amp was connected to 8-ohm loads. For a 1-kHz test signal, THD + N for the preamp/amp combination was only 0.03% at the rated output of 80 watts per channel. For a 20-kHz signal, THD + N was just under 0.2%, and for a 20-Hz signal, it was just over 0.4%—both at rated output. So, to conform to FTC regulations, Linn would have to elaborate on their 80-watt rating by additionally specifying a THD rating of 0.4% and a bandwidth from 20 Hz to 20 kHz.

The same measurements were repeated using 4-ohm loads, and the results are shown in Fig. 2B. This time, for the rated power of 160 watts per channel, THD + N was 0.03% at 1 kHz, while it increased at the frequency extremes to approximately 0.3% at 20 Hz and 20 kHz. Frequency sweeps were then made at full rated power, with output regulated to produce 80 watts per channel into 8-ohm loads and 160 watts into 4 ohms. The results, shown in Fig. 3, agree fairly well with those shown in Figs. 2A and 2B. The slight disparities in THD + N values may well be due to very slight variations in line voltage or slight differences in output-device temperatures (which affect the devices' operating points).

Plots of SMPTE-IM distortion versus power output, for both 8- and 4-ohm loads, were made; the results are shown in Fig. 4. SMPTE IM was 0.4% at 80 watts per channel for 8-ohm loads and just under 1% at 160 watts per channel for 4-ohm loads. Similar plots were made to determine CCIF-IM, or twin-tone, distortion, using 18- and 19-kHz test tones of equal amplitude. Results are shown as a function of power output for 8-ohm loads in Fig. 5A and for 4-ohm loads in Fig. 5B. At rated output, CCIF IM measured just under 0.04% with 8-ohm loads and just over 0.03% with 4 ohms.

Dynamic headroom, using 8-ohm loads, was exactly 1.0 dB. I tested the amplifier briefly with 2-ohm loads and found that it could deliver as much as 345 watts per channel before observable clipping occurred. To avoid having to replace fuse after fuse, however, this test was limited to no



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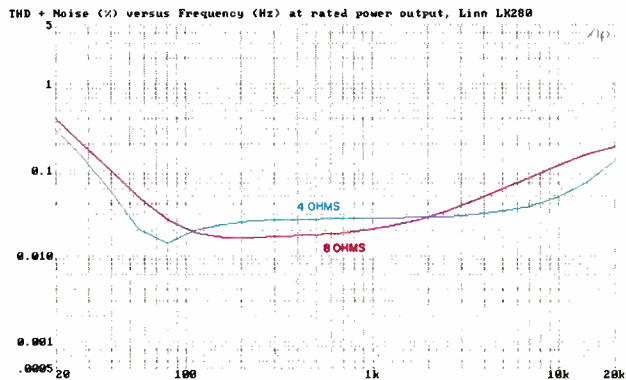


Fig. 3—THD + N vs. frequency at rated output.

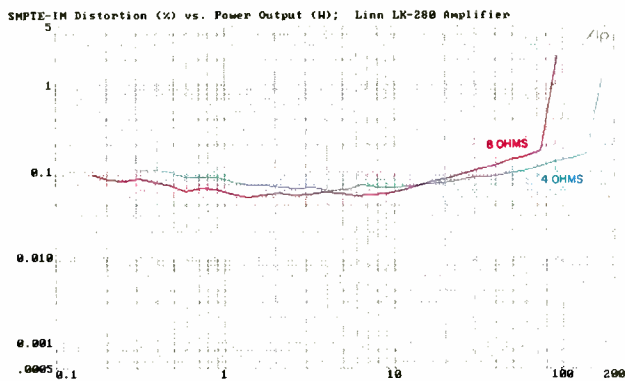


Fig. 4—SMPTE IM vs. power output.

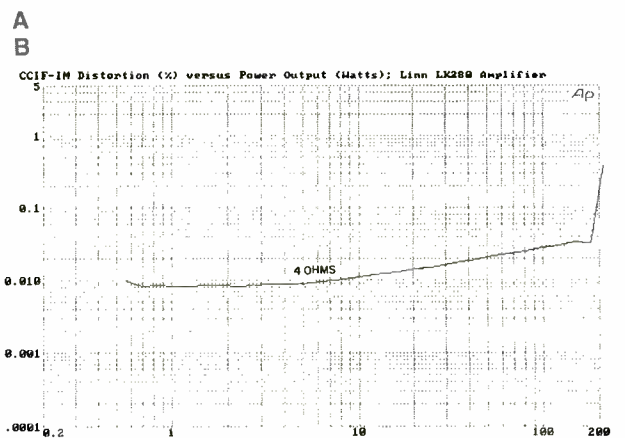
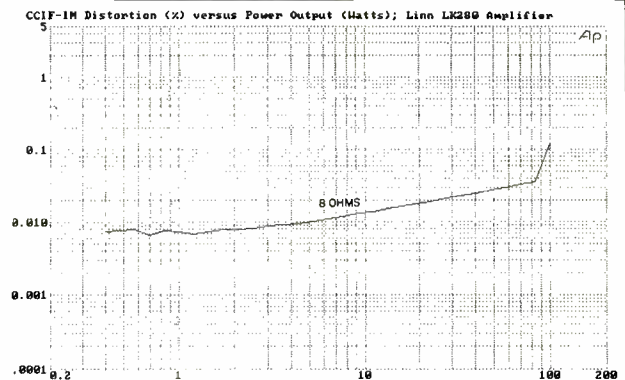


Fig. 5—CCIF-IM (twin-tone) distortion vs. power output for 8-ohm loads (A) and 4-ohm loads (B).

more than a second or two—just long enough to read the voltage across this load, from which I was able to calculate the power level.

Damping factor, referred to 8-ohm loads and using a 50-Hz test tone, was in excess of 125. In view of the fact that all tests were made with the LK1/LK280 combination, it was not possible to measure S/N ratio of the power amp alone. Subsequent listening tests using the two components convinced me that Linn had achieved an extremely low level of residual noise, one that did not intrude at any realizable listening level.

#### Use and Listening Tests

I am always looking for CDs that will serve well in evaluating new equipment. It was my good fortune to recently acquire a complete set of 16 discs containing all of Gustav Mahler's symphonic works plus his monumental "Das Lied von der Erde" ("The Song of the Earth"). These definitive recordings, issued by Denon (CO-72589 to CO-72604), feature the Frankfurt Radio Symphony Orchestra conducted by Elisha Inbal, and they have been praised by many critics. As a recent convert to Mahler (whose music I neither liked nor understood in my younger years), I have been sitting here, almost as if in a trance, listening to disc after

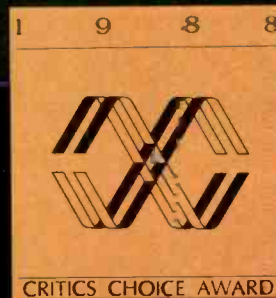
disc played through this wonderful pair of components. Both the First and Fifth Symphonies—my two favorites—sounded so completely open and devoid of electronic artifacts that when I closed my eyes, I almost felt as though I had been transported to the sight of the live performance. This doesn't happen to me very often, and I must confess that I did not get the same sensation when these recordings were played through what I had previously regarded as a pretty good integrated amplifier which I often use as a reference in my listening room.

The more I do this sort of listening, the more convinced I become that differences in relatively good audio components are most easily perceived when the source material is well recorded and well performed. Play a pedestrian CD through a variety of equipment, and it will sound pretty much the same each time. Play a superb recording like the Denon Mahler releases on a superior component combination such as this Linn system, and you know at once that you are dealing with audio components which are far above the ordinary. Are they worth their price—which is, to say the least, not inexpensive? Are a Rolls-Royce or top-of-the-line Mercedes worth what one has to pay for them? For those few who seek the best in any product category, the answer is a resounding "yes!"

Leonard Feldman



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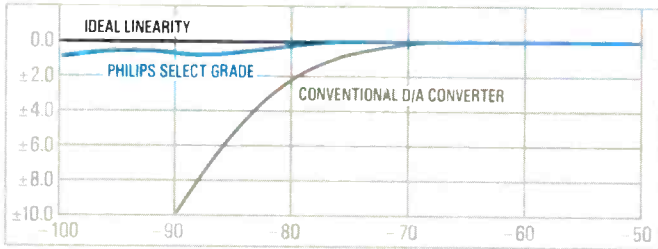
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## PHILIPS

3

## REVOLVER TURNTABLE, STANDARD ARM, AND BULLET CARTRIDGE

### Manufacturer's Specifications

#### Turntable

**Speeds:** 33 $\frac{1}{3}$  and 45 rpm, with manual speed change.

**Drive System:** Round-section peripheral belt and a.c. synchronous motor.

**Power Requirements:** 110 V a.c., 60 Hz or 240 V a.c., 50 Hz (factory preset); less than 4 watts.

**Dimensions:** 16 $\frac{1}{2}$  in. W x 14 $\frac{3}{16}$  in. D x 5 $\frac{5}{16}$  in. H (42 cm x 36 cm x 13.5 cm).

**Weight:** 14.3 lbs. (6.5 kg).

**Price:** \$400 in red beechwood or \$350 in black ash; with factory-installed Revolver Standard tonearm, \$175 additional.

#### Tonearm

**Effective Length:** 9 in. (228 mm).

**Recommended Cartridge Compliance Range:** 4 to 50 c.u. (1 c.u. equals 10<sup>-6</sup> cm/dyne).

**Adjustments:** Tracking and anti-skating force, arm and cueing height, and overhang.

**Cables:** 47 $\frac{1}{4}$  in. (120 cm), color-coded, gold-plated connectors.

**Price:** \$200.

#### Cartridge

**Type:** Moving magnet.

**Frequency Response:** 20 Hz to 20 kHz.

**Channel Separation:** Greater than 20 dB at 1 kHz.

**Channel Balance:** Within 2.0 dB at 1 kHz.

**Output:** 3.5 mV for 5-cm/S rms lateral velocity at 1 kHz.

**Recommended Load Capacitance:** 100 to 200 pF.

**Stylus Shape:** Elliptical, 0.4 x 0.7 mil.

**Optimum Tracking Force:** 1.7 grams.

**Mounting Type:** Standard  $\frac{1}{2}$ -inch spacing.

**Weight:** 5.8 grams.

**Price:** \$125.

**Company Address:** c/o Music Hall, 108 Station Rd., Great Neck, N.Y. 11023.

For literature, circle No. 93





There are many people who have collections of LP and 45-rpm records who are still interested in the possibility of upgrading their systems. I imagine that you are probably one of them, since you are reading this report on the Revolver turntable. Someone who was interested in buying a completely new music system recently told me something very interesting. He said that he was in a music store to find out what was available and a salesman demonstrated a \$2,000 system complete with receiver, cassette deck, CD player, turntable, and loudspeakers. The salesman was really enthusiastic about the CD player, but when asked for more information about the turntable, he gave it short shrift. When *pressed* for more information, he shrugged his shoulders and said he didn't have any details—it was just a record player. So the prospective buyer told me that although he thought the system was really great sounding, he left the store. He said that he had hundreds of records and if he got a new system, he certainly wanted it to include a really good turntable, especially if the system cost \$2,000!

I think that this experience is probably typical of many people's today. It is the good fortune of such people that there are many fine, moderately priced turntables still available. Even more interesting to me is the fact that new turntables continue to be introduced when you might think that the Compact Disc revolution would discourage companies from doing so.

The Revolver turntable has been available for a few years in England, but now it is being imported to the U.S. by Music Hall. It is a complete record player, since it can be bought as a system which includes the Revolver Standard tonearm and the Bullet cartridge. Buying a complete record-playing system from the same manufacturer should have some advantages, since it can be assumed that all the parts have been made to work well together. At least the problems of mounting a separate tonearm to the turntable have been eliminated, although the Revolver turntable can be purchased as a separate item, for those who would like the option of using a different arm.

### First Impressions

The Revolver turntable that I tested was finished in red and is certainly very eye-catching. It might not appeal to everyone, though, so it is available in a black ash finish as well. The Revolver is built using two separate platforms, one slightly smaller than the other. This is what the manufacturer calls their "split plinth construction," in which the motor, turntable bearing, tonearm, and a.c. power switch are mounted on the smaller, upper platform. The power circuitry and cover hinges are mounted on the lower platform. These two platforms, or "plinths," are connected together by two 1-inch-wide × 12-inch-long strips of neoprene rubber, which provide what I think is a very stiff mounting. The rubber mounting feet, attached to the bottom of the larger platform, are a little more compliant, but they are still stiff by comparison to those on many other turntables. The tonearm is made in Japan by Jelco and has no features which could be called radical.

I performed my usual test for bearing integrity by holding the main pillar in one hand while I tried to gently pull, push, and twist the armtube with my other hand. There was no

## MEASURED DATA

### Revolver Turntable

Parameter	Measured	Comment
Speed (at 33 $\frac{1}{3}$ rpm)	+ 1%	Fast
Speed Stability	± 0.69%	Moderate
Long-Term Drift	± 0.29%	Good
Wow, DIN Unwtd. Peak	0.60%	Moderate
Wow, DIN Wtd. Peak	0.42%	Moderate
Flutter, DIN Unwtd. Peak	0.46%	Moderate
Flutter, DIN Wtd. Peak	0.08%	Good
W & F, DIN Unwtd. Peak	0.68%	Moderate
W & F, DIN Wtd. Peak	0.44%	Moderate
Rumble, Unwtd.	-71 dB	Good
Rumble, Wtd.	-87 dB	Excellent

Suspension resonance was too damped to measure.

### Revolver Tonearm

Pivot-to-Stylus Distance: 8.8125 in. (224 mm).

Pivot-to-Rear-of-Arm Distance: 2.375 in. (60 mm).

Overall Height Adjustment: 0.75 in. (19 mm).

Tracking Force Adjustment: Sliding counterweight on armtube.

Tracking Force Calibration: 0 to 3.0 grams, within 0.1 gram.

Cartridge Weight Range: 2 to 10 grams.

Counterweights: One. 97 grams.

Counterweight Mounting: Direct to armtube.

Sidethrust Correction: Calibrated knob on base of main pillar.

Pivot Damping: None.

Lifting Device: Fingerlift on headshell and damped cueing lever.

Headshell Offset: 23°.

Overhang Adjustment: Slots in headshell.

Bearing Alignment: Good.

Bearing Friction: Very low.

Bearing Type: Horizontal, ball race; vertical, jewel point.

Lead Torque: Very low.

Arm-Lead Capacitance: 135 pF with external phono cable.

Arm-Lead Resistance: 1.0 ohm with external phono cable.

External Lead Length: 48 inches.

Structural Resonances: 450, 950, 1350, 1750, 2600, 4400, 4600, and 7950 Hz.

Base Mounting: 1 $\frac{1}{8}$ -inch-diameter hole for main pillar and 2 $\frac{3}{8}$ -inch-diameter clearance for tonearm base.

### Revolver Bullet Cartridge

Coil Inductance: 390 mH, both channels.

Coil Resistance: 408 ohms, both channels.

Output Voltage: Left, 0.71 mV/cm/S; right, 0.64 mV/cm/S.

Cartridge Mass: 5.6 grams.

Microphony: Very good.

Hum Rejection: Very good.

Rise-Time: 20  $\mu$ S.

High-Frequency Resonance: 25.1 kHz.

Low-Frequency Resonance: 11 to 12 Hz.

Low-Frequency Q: 1.5 to 4.4.

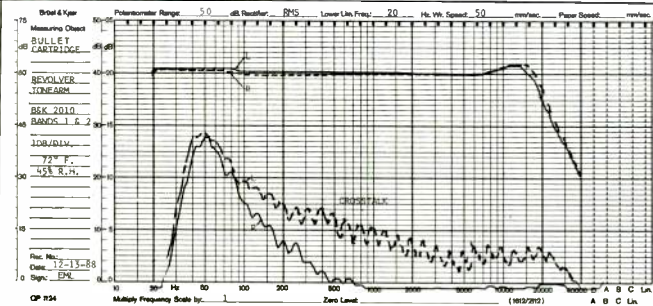
Recommended Load Resistance: 47 kilohms.

Recommended Load Capacitance: 250 pF.

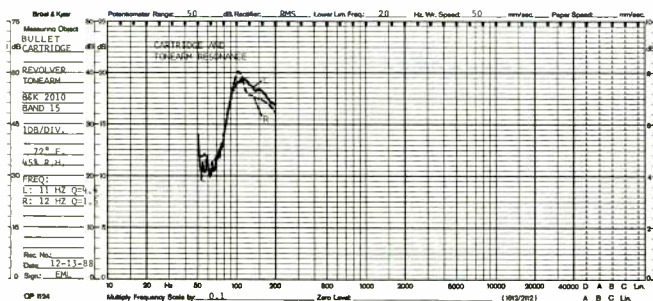
Recommended Tracking Force: 2.0 grams.

Polarity: Positive.

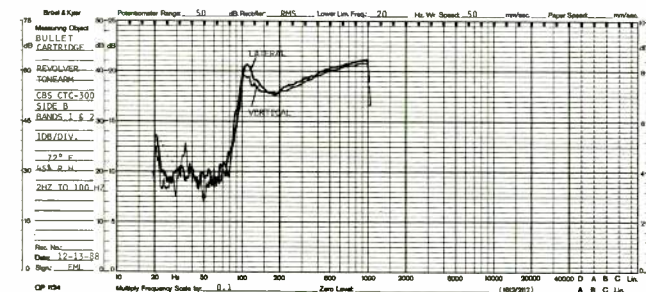
We're fortunate that there are still fine, moderately priced turntables around and that new ones continue to be introduced.



**Fig. 1—Frequency response and crosstalk of Revolver Bullet cartridge and Standard tonearm.**



**Fig. 2—Low-frequency tonearm/cartridge resonance for right channel is at 11.0 Hz with a Q of 4.4 and for left channel is at 12.0 Hz with a Q of 1.5.**



**Fig. 3—Slow sweep from 2 to 100 Hz to check for lateral and vertical arm/cartridge resonances. The Bullet's stylus compliance and the arm's mass are well matched, but Q is higher than desirable; see text.**

discernible play in the bearings, and the tonearm exhibited very low friction in the normal horizontal and vertical planes of motion.

I also performed the tap test on the armtube to listen for any audible resonances. If any resonances can be heard during this test, it is quite likely that they will cause coloration in the reproduced sound. If the armtube is well damped, these resonances are harder to distinguish and therefore less likely to cause serious degradation of the reproduced sound. When an armtube has many resonances which are not harmonically related, the sound is more like a noise and it is harder to hear a definite pitch. The sound emitted by the Revolver tonearm varied from one end of the armtube to the other. Near the cartridge, the sound was a "tank"; in the middle, it was a "tack," and near the pillar, it was a "tock." This indicated to me that no damping is used inside the armtube and that vibrations are damped only by the main bearings.

### Features

The Revolver is a belt-drive turntable which offers both 33 $\frac{1}{3}$ - and 45-rpm speeds. The motor has a two-step pulley, and the speed change is accomplished by moving the belt from one pulley to the other. The belt is seamless, round, 0.080 inch in diameter, and made of rubber. The motor is a 12-pole synchronous type made by Landis & Gyr of Switzerland. A synchronous a.c. motor is of the type which locks to the frequency of the a.c. power line. While a variation of the a.c. line voltage can affect the torque of the motor, the speed will remain constant as long as the frequency of the a.c. power line remains constant. While everyone is probably aware that the a.c. power-line voltage can vary up and down quite dramatically, the frequency of the power line is very precisely regulated here in the U.S. to be exactly 60 Hz. This is necessary because the power system is generally locked together across the country, and when generators are running together, they must be at the same frequency or chaos would ensue. Also, if a generator running at the wrong speed were accidentally put on the system, it could be destroyed. Since the frequency of the a.c. power line is so closely controlled, an a.c. motor of the synchronous type can be counted on to run at exactly the correct speed. It is fairly easy to determine the diameter of the platter and the motor pulleys necessary to achieve any desired turntable speed. The Revolver is one of the few turntables I have tested which works directly from the a.c. power line. Because there are no step-down transformers, a.c.-to-d.c. converters, or electronic speed-control circuits, the motor has to be of excellent quality to achieve high-quality music reproduction.

Another important factor in turntable performance is the quality of the main platter bearing and the precision of the 0.375-inch-diameter shaft; computer-controlled machining is used to ensure an accuracy of  $\pm 0.0001$  inch. The typical clearance for the shaft and bearing, 0.0004 inch, is born out by the fact that when the shaft has a thin coating of oil, it takes up to 30 minutes for it to slide down into the bearing well. The contact point for the flat end of the main shaft is a captive ball bearing at the bottom of the bearing well; it also appears to be of high quality.



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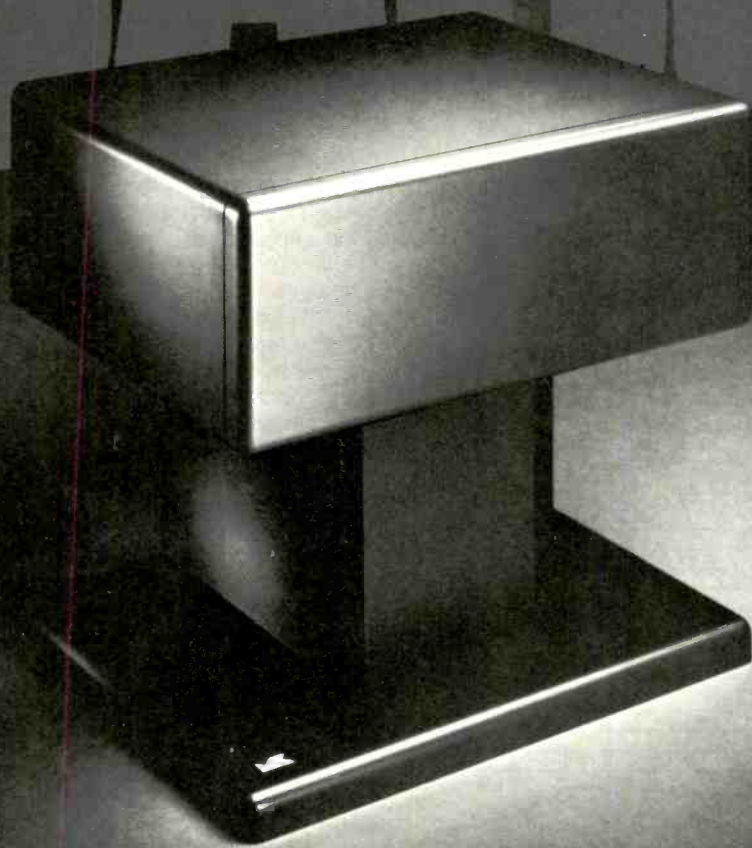
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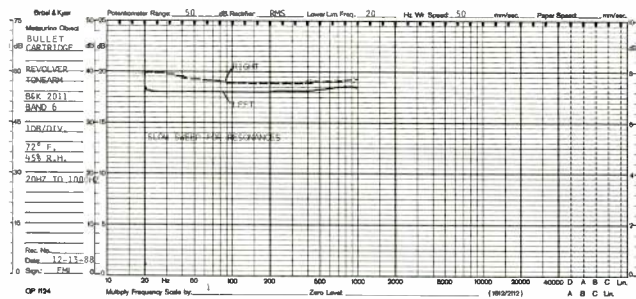
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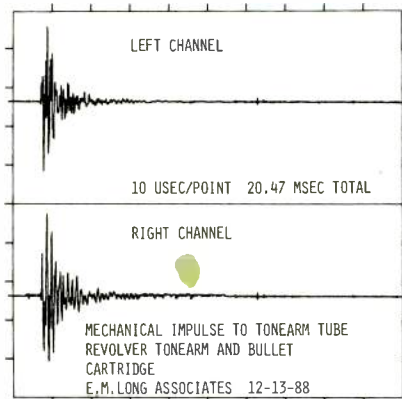
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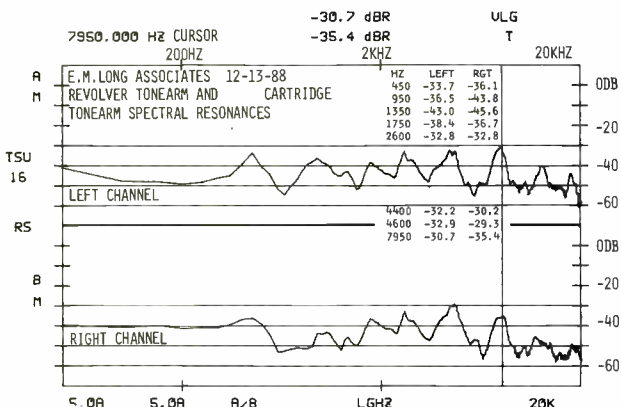
As I tapped my way down the tonearm to assess its resonances, I heard it go "tank," "tack," and then "tock" near its pillar.



**Fig. 4—**Slow sweep from 20 Hz to 1 kHz to check for mechanical resonances in arm.



**Fig. 5—**Output vs. time of arm/cartridge when mechanical impulse was applied to armtube near headshell, with arm on rest.



**Fig. 6—**Spectral output (averaged) of arm/cartridge for 16 mechanical impulses applied to armtube. Several resonances, which could add coloration, are visible.

The main platter is injection-molded of glass-filled polyphenylene and has three concentric reinforcing rings on the underside; these are at diameters of 3¾, 6¼, and 8¾ inches. The platter mat, which is made of a felt material, is about 1/16-inch thick and is treated so that it will conduct static charges away from the record. It is not intended to absorb energy from the record, as most of the mats found on other turntables are.

The Revolver Standard tonearm is a statically balanced type. This means that the tracking force is set by moving the counterweight, located on the rear of the armtube, toward the main pillar. There is a scale, calibrated from 1 to 3 grams, which rotates with the counterweight, making the tracking-force adjustment easy. After the counterweight is set to balance the cartridge weight, the calibrated scale is rotated so the zero is next to the white cursor line on the armtube. Then the counterweight is rotated toward the tonearm pillar until the desired tracking-force figure is lined up with the cursor. The sidethrust or anti-skating force is set by rotating a calibrated knob on a platform which sticks out from the tonearm's main pillar. It is also calibrated from 1 to 3 grams, to match the tracking force. The height of the tonearm can be adjusted to allow for different cartridges or to change the vertical tracking angle. The stylus overhang can be adjusted by sliding the cartridge and then tightening the mounting bolts in the slots provided in the headshell. A template is supplied with the Revolver tonearm to set the proper overhang. (The overhang is the amount that the stylus overhangs the center post of the turntable platter when it is on a straight line from a lateral arm's pivot through the center post.) This adjustment is necessary in order to overcome the tracking error inherent in all pivoted tonearm designs.

This tonearm is supplied with 48-inch-long phono cables. These have gold phono plugs at one end and a five-pin DIN connector at the other end which fits into a mating plug at the bottom of the tonearm pillar. The clips which connect to the cartridge pins are also gold-plated.

The Revolver turntable is 55/16 inches high with the lid closed, while the base is 16½ inches wide and 14¼ inches deep. The lid is injection-molded of clear acrylic plastic. It is easily removed by sliding it out of the hinges fastened to the rear of the bottom platform; it fits over the upper platform and rests in front on two compliant bumpers.

The Revolver Bullet is a modified Audio-Technica AT95E moving-magnet cartridge which has been filled with silicone to lock all the internal parts together and to damp any potential vibration. It has an elliptical diamond stylus, and the stylus assembly has been bonded to the cartridge body with something like Crazy Glue to prevent vibration. This means that the stylus assembly is not user-replaceable; the cartridge must be returned to the factory for replacement. This is the case with most high-quality cartridges, and it should not be a cause for concern since it ensures that the original quality is maintained.

### Measurements and Listening Tests

The listening panel found little difficulty in hearing the differences in sound produced by the Revolver and the reference system. Considering the relatively low cost of the



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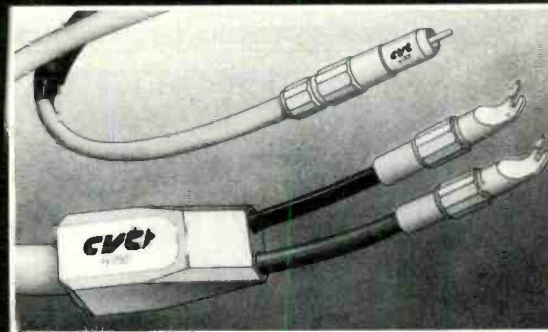
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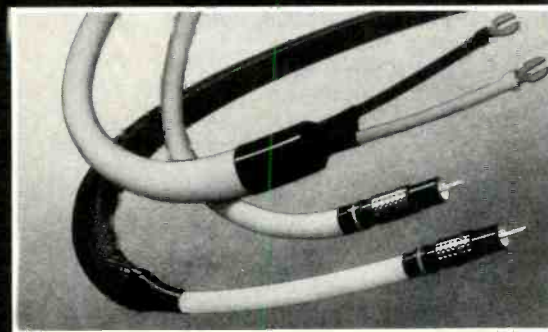
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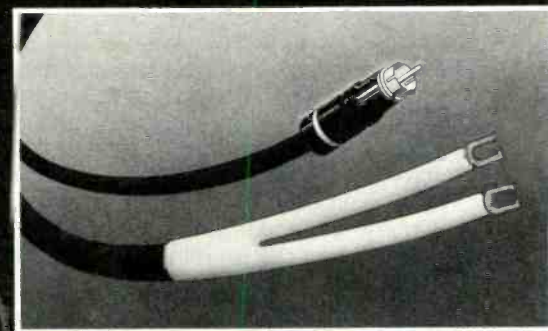
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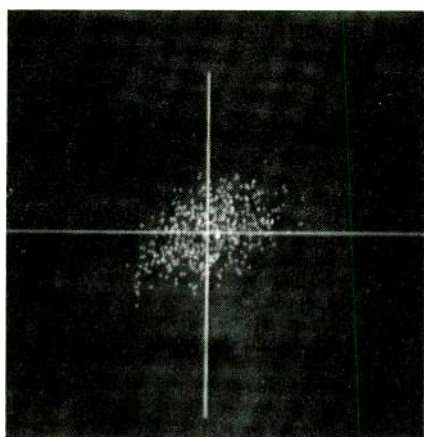


Fig. 7—Interchannel phase difference, using pink noise from B & K 2011, band 7.

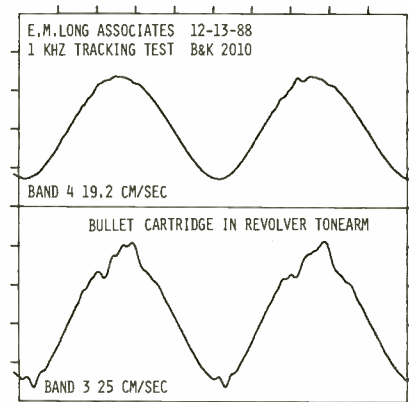


Fig. 9—Tracking of arm/cartridge with 1-kHz test tones at 19.2 cm/S (top) and 25 cm/S (highest level on B & K 2010). There is some jitter in the 25-cm/S waveform.

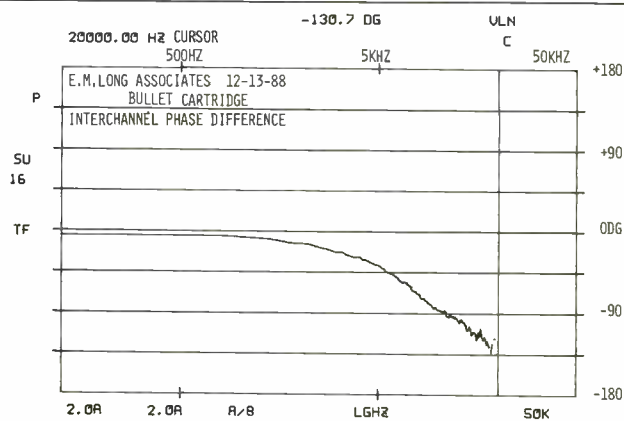


Fig. 8—Interchannel phase difference vs. frequency. At 20 kHz, the phase difference is 130.7° (18.2 μS).

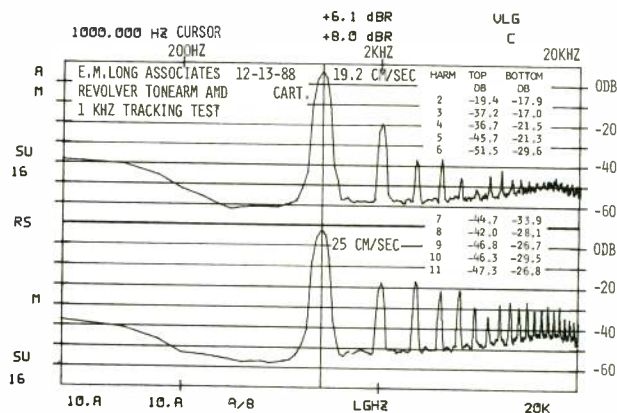


Fig. 10—Spectral analysis of the cartridge output when reproducing the signals of Fig. 9. The increase in odd-order harmonics at the 25-cm/S level could increase perceived brightness.

Revolver system, which consisted of the Revolver turntable and tonearm and the Bullet cartridge, this was not surprising. During these listening evaluations, the listening panel members had no idea of the cost of the Revolver system, because I wanted to eliminate any preconceptions that might be based on price.

Figure 1 shows the amplitude versus frequency response of the Revolver system with the Bullet cartridge. The smooth response indicates the care that has been taken to eliminate structural problems in the system which could cause vibrations or reflected energy. The peak in energy at 13 to 15 kHz is very well controlled, and the crosstalk is very low. The slight rise in the lower frequency range is apparently an artifact of the B & K 2010 test record, since it is evident for every cartridge I have tested.

The low-frequency resonance, due to the interaction of the cartridge compliance and the tonearm effective mass, is shown in Fig. 2. The frequency is slightly above 10 Hz but with a moderate Q, at least for the left channel. The listening panel's comments regarding the deep bass indicate that

the quality of the reproduced sound was good but not as well defined as with the reference system. Figure 3, a slow sweep from 2 to 100 Hz with lateral and vertical groove modulation, shows that the compliance of the Bullet cartridge and the effective mass of the Revolver tonearm are well matched in both the lateral and vertical planes of motion, which is good. However, when the Q is this high, there is an effect on the sound in the lower bass range. The comments of listening panel members were that the Revolver system's bass sound was more "boomy" and "less defined" than that of the reference system. There were also remarks about the rumble from certain records being more pronounced with the Revolver system.

Figure 4 shows the results of a slow sweep from 20 Hz to 1 kHz, to check for mechanical resonances in the Revolver system. The results are quite good, and there is little indication that there might be problems associated with reflected energy in the tonearm and cartridge system. Such problems can be caused by less than perfect junctions between parts of the system, such as between the cartridge and the



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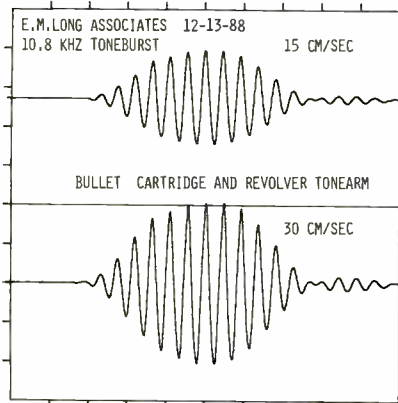
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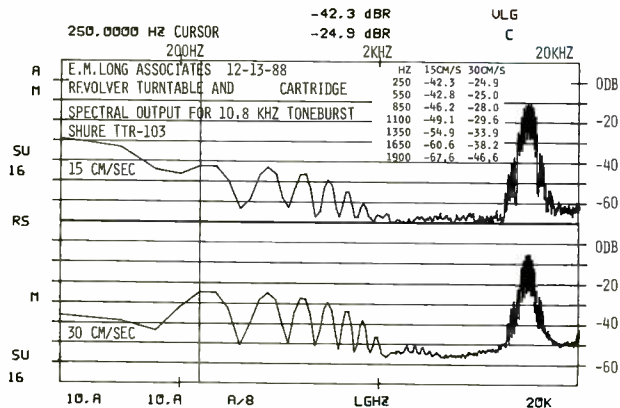


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Frequency response of the Revolver/Bullet system is smooth, showing the careful elimination of vibration problems.

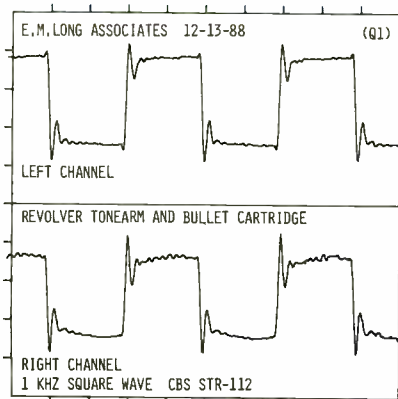


**Fig. 11—** Output from 15- and 30-cm/S, 10.8-kHz pulse test, using Shure TTR-103 test record. The asymmetry in the 30-cm/S signal could produce audible output in the lower frequencies but is still reasonably good performance.



**Fig. 12—**Spectral analysis of distortion products from signals shown in Fig. 11 (average of 16 samples at each level).

Note the rise in low-frequency content at the 30-cm/S level, the result of the slight flattening shown in Fig. 11.



**Fig. 13—** Output from 1-kHz square wave, using CBS STR-112 test record.

headshell, the headshell and armtube, the armtube and pivot bearings, or the main pillar and turntable base.

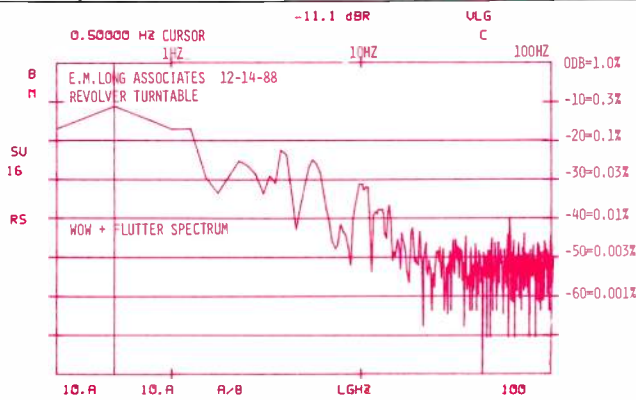
Figure 5 shows the output versus time for a mechanical impulse applied to the armtube near the headshell. This is the position on the armtube where the sound of the tap test was described as a "tank." The damping is reasonably good, compared to other similar tonearms, despite apparent lack of damping material inside the armtube. Figure 6 shows the output spectrum from a series of 16 mechanical impulses applied to the tonearm tube. There are a number of prominent peaks in the range from 450 to 7,950 Hz; the peaks above this are at a lower level and probably have less effect on the sound. Some of the peaks are harmonically related to each other, being spaced about 400 to 500 Hz (or a multiple thereof) apart. This might account for the comments made by some panel members that the sound of brass seemed to be "enhanced" but "with changes in timbre." In fact, I think many of the other remarks regarding the sound of various instruments could be correlated to the colorations introduced by the tonearm. For instance, the sound of the piano was heard as "wooden" and "uneven"; the sound of strings as "harsh," and the sound of full orchestra as "muddy." I realize that these comments might seem to put the Revolver tonearm and Bullet cartridge in a bad light, but it must be remembered that the remarks were made when the panel members were comparing the tested combination to a very expensive, state-of-the-art turntable, tonearm, and cartridge combination.

Figure 7 shows the interchannel phase difference of the Bullet cartridge mounted in the Revolver tonearm; the source was the pink-noise test signal of the B & K 2011 test record, band 7. If there were no phase differences between the channels, the display would be a straight line, at 45°, from the lower-left to the upper-right quadrant. This display does not show the frequency range where the difference in phase occurs, but Fig. 8, a graph of interchannel phase difference versus frequency, does show this information. The difference increases as the frequency increases. Since image localization is less affected by extreme high frequencies, the effect on the ability of panel members to localize sounds should not be very great. One panel member commented that cymbal sounds seemed to be "splattered" and that the reference system seemed "closer to the microphone" during the playing of the *Sheffield Drum Record*. These remarks could be related to the information in Fig. 8, but they might also be correlated, to some extent, with the lower waveform in Fig. 9.

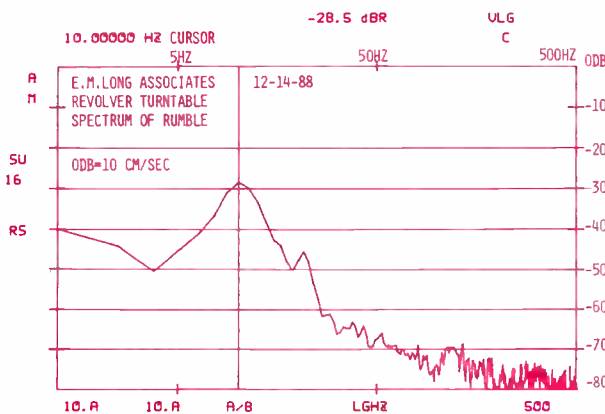
Figure 9 shows the output versus time for two different levels of the 1-kHz signal on the B & K 2010 test record. The upper trace shows the output for a level of 19.2 cm/S. A slight amount of distortion can be seen on the top of the waveform. This is a very high level and one at which many cartridges have difficulty tracking without distortion. The lower trace shows much higher distortion and was made using the 25-cm/S band, which is the highest level cut on the B & K 2010 record. Some cartridge/arm combinations cannot track this level. The spectrum of the output for these two test levels is shown in Fig. 10. The increase in odd-order harmonics, which tends to cause the sound for some types of program material to be noted "bright" and even "harsh"



The deep bass response of the Revolver/Bullet is good, as the cartridge and arm are well matched to each other.

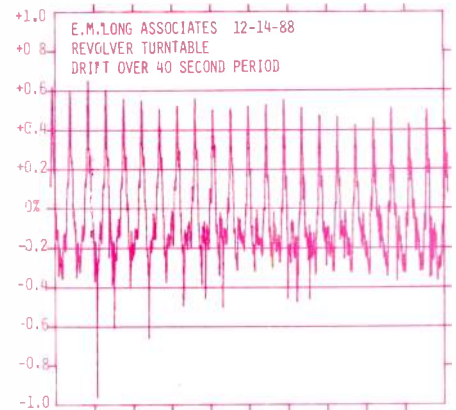


**Fig. 14—Wow-and-flutter spectrum, from 0.25 to 100 Hz. The output peak at the cursor (0.5 Hz) is related to the 33 1/3-rpm rotational frequency; the small peak from 10 to 12 Hz shows the arm/cartridge resonance.**

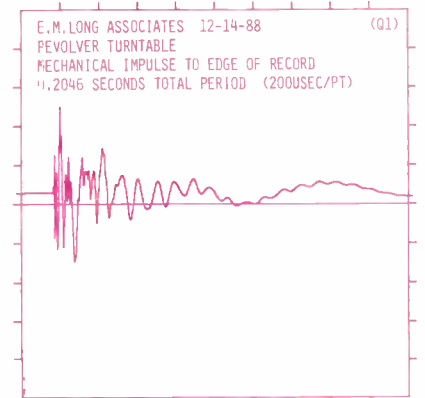


**Fig. 16—Rumble spectrum. The rumble is extremely low, except where emphasized by the arm/cartridge resonance (at cursor position); see text.**

**Fig. 15—Speed drift over 40 S is indicated by the slowly changing heights of the peaks.**



**Fig. 17—Output vs. time for a mechanical impulse applied to the edge of a stationary record with stylus resting in a groove. The turntable mat is clearly not removing much energy from the record.**



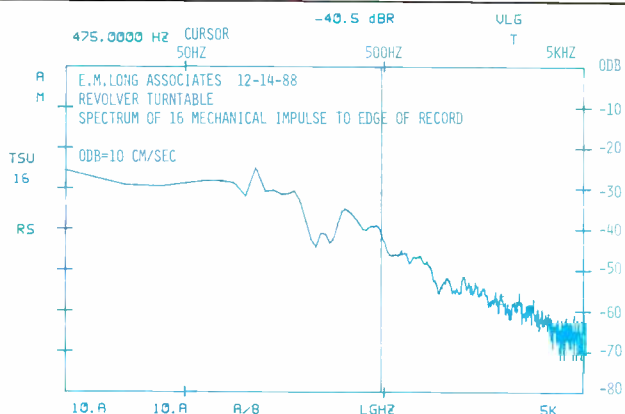
by panel members, can be clearly seen in the lower trace of Fig. 10. I should mention that there was some instability or jitter in the lower trace of Fig. 9 during the test. This could be the reason for the comment about the cymbal "splatter."

Figure 11 shows the output versus time for the 10.8-kHz tone burst of the Shure TTR-103 test record. A small amount of asymmetry or flattening of the top of the lower trace can be seen; this trace is from the highest level (30 cm/S) on the Shure record. This is reasonably good performance by the Revolver tonearm and cartridge combination. The spectrum due to the 10.8-kHz tracking test is shown in Fig. 12. The output at lower frequencies is the result of the fact that the Revolver combination cannot completely cope with the higher 30-cm/S level. Compare the dB levels for the frequencies shown in Fig. 12, and you will see that the 10.8-kHz tone burst at 30 cm/S produces quite a bit more output at lower frequencies. This can be correlated with comments about the brass, which sounded "muted" and "lackluster" to at least one panel member, compared to the reference system.

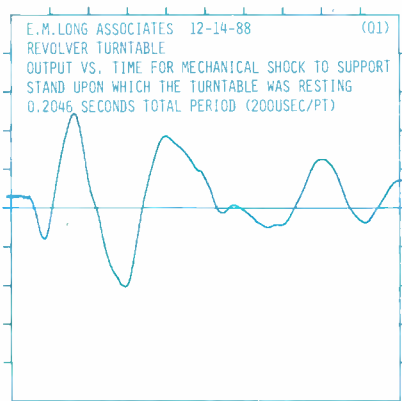
The overshoot and notch at the beginning of the 1-kHz square wave in Fig. 13 are the result of the phase shift with frequency which increases at higher frequencies. This is related to the fall in output above 15 kHz shown in Fig. 1; this is still a respectable result. While the Bullet cartridge may not have the transparent quality associated with the finest cartridges, it is still capable of producing very good sound.

Figure 14 shows the wow and flutter spectrum of the Revolver turntable. Most of the output is at 0.5 Hz, which is the closest spectral line to the 0.56-Hz turntable rotational frequency at 33 1/3 rpm (33 1/3 divided by 60 equals 0.56). The output at the tonearm and cartridge resonance can also be seen at about 10 to 12 Hz. The comments about the sound of the piano being "more blurred" can be related directly to the wow and flutter performance of the Revolver turntable. The variation in speed can be seen as the cyclical variations shown in Fig. 15. The drift, over this period of about 40 S, can be seen in the slowly changing heights of the peaks.

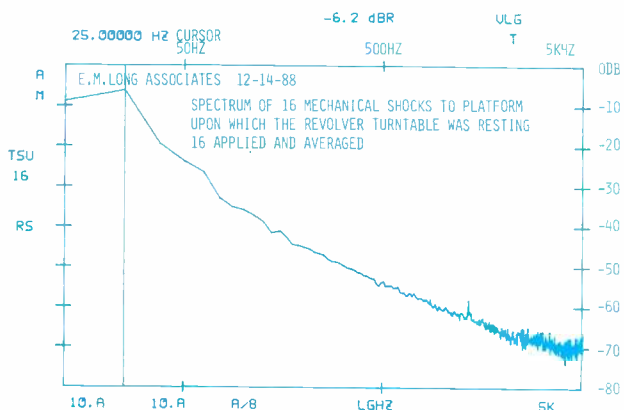
If a friend asked whether the Revolver and Bullet were a good choice for moderately priced systems, I'd definitely say yes.



**Fig. 18—Spectral output (averaged) from 16 mechanical impulses applied as in Fig. 17. Note the considerable output below 475 Hz; see text.**



**Fig. 19—Output vs. time for a mechanical impulse applied to the platform on which the turntable was resting. Isolation from mechanical shock is poor.**



**Fig. 20—Spectral output (averaged) from 16 mechanical impulses applied as in Fig. 19. The energy is concentrated at the lower frequencies and is well controlled; see text.**

Figure 16 shows that the rumble is extremely low, except at the tonearm and cartridge resonance. It is mainly this resonance that accounts for the perceived increase in rumble, noted by all the panel members, when playing records with lots of rumble, rather than the turntable itself. This is the main reason why I prefer to show the spectrum of the rumble rather than give numbers alone. The numbers, by themselves, can be very misleading.

Figure 17 shows the output versus time for a mechanical impulse applied to the edge of a stationary record and with the phono stylus resting in the groove near the center of the record. This test is made to determine the effectiveness of the turntable mat in removing delayed mechanical energy from the record. The main purpose of the Revolver Starmat is to remove static electricity from a record and not necessarily to remove mechanical energy. This is clearly evident from the fact that there is quite a large output from the cartridge. This delayed energy can cause the sound to be perceived as being "blurred" for some types of program material.

The spectrum produced by a series of 16 mechanical impulses applied to the edge of a record and averaged is shown in Fig. 18. The spectral output below 475 Hz is considerable and can contribute to the impression that complex sounds, such as that of full orchestra, are less detailed than they might be if this delayed energy were absorbed by the record mat.

Figure 19 shows the output versus time for a mechanical impulse applied to the platform on which the Revolver turntable was resting. The two strips of neoprene rubber between the upper and lower turntable platforms are aligned in such a way as to be in parallel with the stylus when it is somewhere near the middle of a 12-inch record. The idea is to cause the energy to be in the same plane as the length of the stylus cantilever, a direction in which it is not free to move. Although the cartridge is in this optimum position, it is apparent that the mechanical energy does cause considerable output from the cartridge. The spectrum of energy from a series of 16 mechanical shocks, applied to the platform and averaged, is shown in Fig. 20. The energy is concentrated at the lower frequencies and is well controlled. I recommend that the Revolver turntable system be placed on a wall-mounted shelf if you discover that mechanical shocks, induced by dancing or even by ordinary footsteps, are a problem.

### Conclusions

For those in the market for a turntable, tonearm, and cartridge with a total cost of several hundred dollars, it will probably be worth their while to read my reviews of the Dual CS 5000 (November 1988) and the Ariston Forte turntable and Enigma tonearm (December 1988). Aside from questions of final delivered price, it is also interesting to consider if the Ortofon X3-MC cartridge would be worth the additional \$75 it would cost to add it to the Revolver system.

In any case, if the fellow I discussed at the outset of this report had asked me whether the Revolver system, including the Bullet cartridge, was a good choice for use in a moderately priced record-playing system, I would definitely have said, "yes."

*Edward M. Long*



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## WHEN HE WAS GOODE



**The Chess Box:** Chuck Berry  
MCA CHD3-80001, three CDs; AAD;  
65:39, 64:44, and 71:33.

Sound: B+

Performance: What, you kidding?

After time enough for perspective, some things are beyond a critic's judgment. What can you say about The Sphinx? That its paws are too big? And what can you say about "Maybellene," "Johnny B. Goode," "Roll Over Beethoven," "School Day," "Memphis," "Living in the U.S.A." . . . ? You get the idea. The worthiness of this new Chuck Berry anthology has much less to do with Berry himself than with those things that make it different from all the other collections by this seminal rocker. Immense attention to detail and authenticity, audio spiff-ups without musical touch-ups, Berry's blessing, and, at 71 songs, sheer size.

From 1955 to 1966, and then again from 1970 to 1975, Berry's home was the Chicago blues label Chess (since absorbed by MCA). The story goes that Berry auditioned for co-founder Leonard Chess with the sensuous blues tune "Wee Wee Hours." Chess preferred another song on the tape—a rollicking number called "Ida Red" that, with a title change, became "Maybellene." Disc-jockey Alan Freed took the song under his wing and helped Berry, with his acceptable-to-whites diction, cross over to mainstream success. The legend also says that Freed took a co-writing credit on "Maybellene" for his trouble, yet fascinatingly, the 32-page booklet that accompanies *The Chess Box* has a photo of the original 78 with only Berry listed as writer.

Whatever its origins, "Maybellene" appropriately and vigorously begins the parade. All the Berry hits are here, as are the expected handful of alternate, unreleased, and new-to-the-U.S. tracks. Only a couple of the latter—1957's slow and sensual "tell mah woman what it is" number, "I've Changed" and 1960's instrumental "Crying Steel"—are anything exceptional. And with all the glorious Berry legacy at his disposal, one has to wonder why the obviously diligent and loving project coordinator, Andy McKaie, included "Anthony Boy," surely the most embarrassingly awful song this

side of, well, "My Ding-a-Ling" (which is at least historically important, being, inexplicably, the only Berry song ever to hit No. 1).

By far, however, the blues scale tips to the good. The AAD CDs keep Berry's vocals and amazingly inventive lyrics upfront as always, but Johnnie Johnson's critically important piano rattle and rolls are as clear here as they deserve to be. You can really *hear* Johnson on "Wee Wee Hours," as he successfully fights a slightly spongy keyboard. There are many such newfound moments: Eddie Hardy playing with his drumsticks at the end of "No Money Down" and the unknown background vocalists of "Living in the U.S.A." suddenly developing a personality (albeit ragged). And though Berry never was the most technically adept singer, his guitar playing has a new clarity that shows him off as an incredible mix of Road Runner and Tasmanian devil.

McKaie, going back to the original masters, wisely left in mono what was recorded that way. Same with the early stabs at real and *faux* stereo. I applaud him: Resisting the urge to go back to the original tapes and fiddle with them is as aesthetically and morally important as leaving silent movies silent and black-and-white movies uncolorized.

The accompanying booklet should likewise please purists. Along with a new interview with Berry, McKaie gives us an illustrated Chess discography, voluminous information about each track here, *Billboard* listings, and some terrific photos—not only of Berry and the band, but of records, posters, and other paraphernalia.

All that information, along with the clarity of the sound and the largely intelligent choice of songs—virtually all of them the first versions released, which is another historical plus—make *The Chess Box* standard equipment in any home or office. The verdict? Berry good. *Frank Lovece*

**Toots in Memphis:** Toots Hibbert  
Mango MLPS 9818, LP; CCD 9818,  
CD.

Sound: B

Performance: A-

One of the earliest reggae groups to get an American release was Toots and The Maytals. But of late, they have





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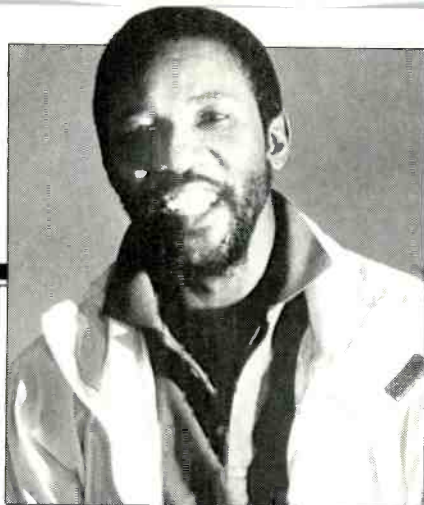
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Toots Hibbert's new album is a solid blend of R&B and Jamaican reggae that is even better than one could have hoped for.



been extremely low-profile. This inactivity has been unfortunate because Toots Hibbert is an exceptional singer and an exciting performer. Why his appeal was never properly exploited always seemed a mystery to us.

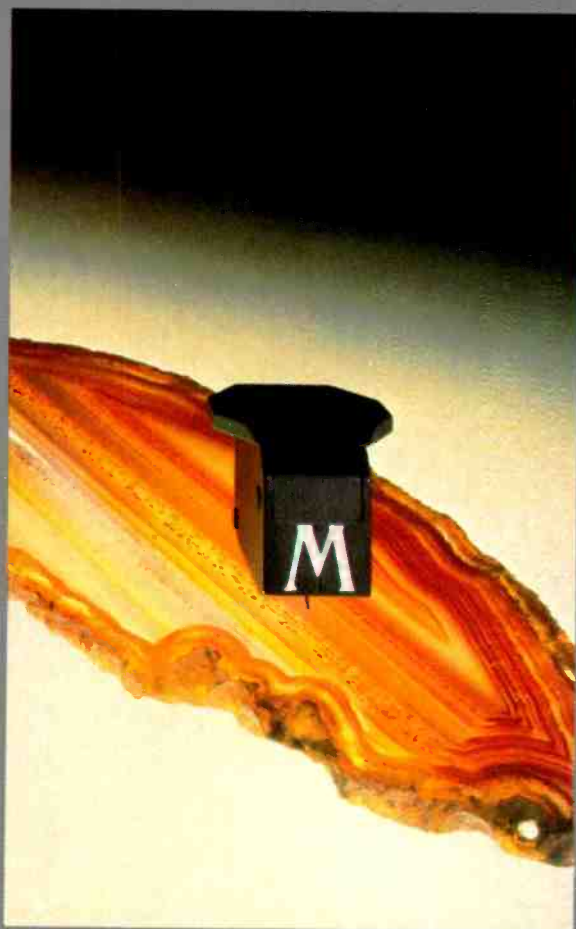
Finally, a new album has emerged from Toots. Here, he has recorded a

collection of soul classics from the late '60s and early '70s with a consortium of Kingston and Memphis studio musicians of the highest caliber. The result is even better than one could have hoped for: Not just a pastiche of players and songs, but a truly solid blend of American rhythm and blues and Jamaican reggae.

The outstanding tracks are "I Can't Stand the Rain" (here titled "Love the Rain"), "Love and Happiness," and "Knock on Wood," but the whole album is very strong. Some of the grooves are straight-ahead reggae, some are closer to American dance music, and a couple straddle the line.

Toots is in superb voice, giving his original interpretation to songs which are not the easiest in the world to cover. Let's hope that he can make this more than just a shot in the dark, and that he can continue his career in a positive direction. *Jon & Sally Tiven*

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**No Rest for the Wicked:** Ozzy Osbourne

CBS Associated OZ 44245, LP; ZK 44245, CD.

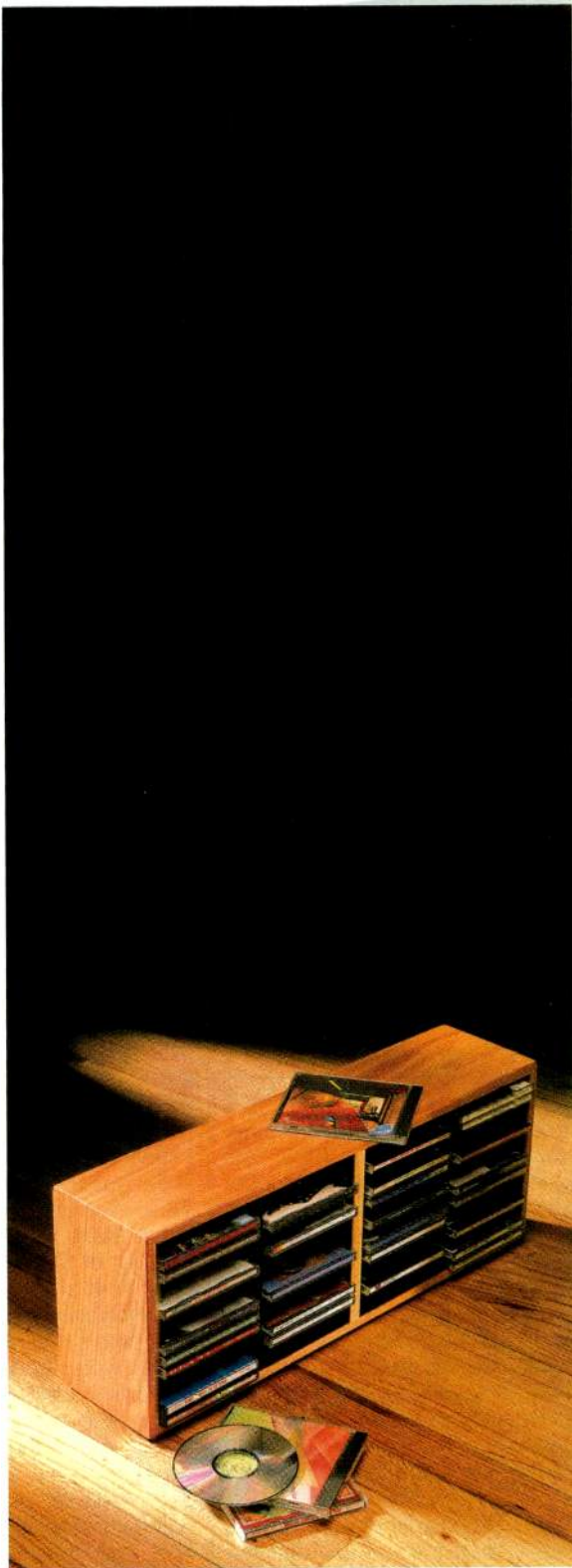
Sound: A-/B+ Performance: C

Haunted by a ghost, Ozzy Osbourne is driven in search of another guitar superstar. And whether it's fair or not, at least half of spinning any new Ozzy record is listening to hear if he's found another Randy Rhoads. With *No Rest for the Wicked*, he hasn't. But then, legends don't come along every day.

Not that Ozzy's newest guitar hopeful, Zakk Wylde, has no chops. But there's really nothing particularly innovative in this set. A few fast scales ("Breaking All the Rules") and some respectable rhythm playing ("Tattooed Dancer"), and you have it all. Maybe next time Wylde will cut loose a little bit more.

What Ozzy has here is a parcel of brain-crunchers, a little light on his gift for mildly clever lyrics, and heavy on metal that skews closer to nonmelodic thrash than ever before. The gothic style predominates, as usual, but what's the point of these songs? "Miracle Man," another *de rigueur* satire of TV evangelism, is entertaining enough. "Demon Alcohol" airs some dirty laundry and is probably designed to head off any lawsuits accusing him of driving





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kids to drink. But the rest are impenetrably obscure—even as abstractions. There's a passable, unidentified bonus cut tacked onto the end of the CD, but you won't really miss it unless you're a hard-core Ozzy collector.

The sonics here are great. This is the way metal should sound: Clear, clean, big. It's just too bad there's not more substance—musical or lyrical—to make it more enjoyable.

Michael Wright

### Lips Against the Steel: David Knopfler Cypress YD 0120, CD.

Sound: B+ Performance: B

His best work since leaving brother Mark's band, Dire Straits, in 1980, *Lips Against the Steel* finds David Knopfler mining territory not far from the Straits. Indeed, as similar as David's gruff voice is to Mark's, and as atmospheric as the music is, it's not impossible to mistake *Lips* for a lost Dire Straits album. And I don't mean that as a slight. In fact, I like this album a lot. The cuts I especially enjoyed are the driving opener "Heat Come Down," the moody and cinematic "Angie and Johnny," and the aching "To Feel That Way Again."

Intelligent songwriting—spare, yet evocative—smart production, and the extra presence that digital recording allows make *Lips Against the Steel* a very effective and satisfying album with some keen tales to tell. Though nowhere near as ambitious as *Brothers in Arms*, David Knopfler's new album succeeds beautifully because it doesn't try to overreach itself, nor does it flounder in the shoals of self-importance. In scope, it is more along the lines of a well-made art film.

Michael Tearson

David Knopfler's best work since Dire Straits, *Lips Against the Steel* is like an art film, with some keen tales to tell.

### Live at The Ritz: Ronnie Wood & Bo Diddley

Victor Musical Industries VDPZ-1329, CD; DDD. (Available from Victor Musical Industries, 6363 Sunset Blvd., Suite 500, Los Angeles, Cal. 90028.)

Sound: A- Performance: A-/C-

Two musical icons like Ronnie Wood and Bo Diddley ought to add up to something smashing, but instead, *Live at The Ritz* simply illustrates a sad fact of the music business: The real talent doesn't always get top billing—just compare the packaging to the music.

This is billed as Ronnie Wood and Bo Diddley. Cover art is by Wood, and with him in front of Diddley. Back cover photos give Wood two-thirds of the space. Inside color photos: There are 13 of Wood, two of Diddley, and five of them together.

Now listen to the music. Bo Diddley's deep, rich vocals and tremolo-laden square guitar propel "Road Runner," "I'm a Man," "Hey Bo Diddley," "Money to Ronnie," and the CD bonus cut "Who Do You Love." They also remind you of his great contributions to the genre (A-). Then comes the Wood set (C-), with embarrassing, emphysematic vocal renditions of The Faces ("Ooh La La," saved only by some deft slide guitar) and Stones hits ("Honky Tonk Women") and a dreadful "They Don't Make Outlaws Like They Used To." All of this interspersed with easy New York patter to get the crowd going. However, two hot jams—"Crackin' Up," with some nice call-and-response guitar work, and "Plynth/Water Down the Drain"—are worth the price.

The set is not badly recorded, although it sounds a little cramped—as if you're sitting in a small, crowded venue, which is probably realistic. The editing is very uneven, with rapid fades and fast cuts (except when Wood speaks) that are mildly distracting. The accompanying booklet is mostly in Japanese and not that informative.

Ronnie Wood and Bo Diddley *Live at The Ritz* isn't a total bust, and if you like either artist, you probably ought to check it out. Maybe I'm just being oversensitive to the marketing hype here and maybe focusing on Ron Wood will move more units. But if you get this CD, get it to hear Bo Diddley.

Michael Wright



Roy Orbison's music was praised by singers from Presley to Springsteen, and these two new all-hit compilations show why.

**For the Lonely—18 Greatest Hits:**

Roy Orbison  
Rhino R21S 71493, CD.

Sound: A Performance: A

**The All-Time Greatest Hits, Vols. I & II:** Roy Orbison

CBS AGK 45116 and AK 44349, two CDs.

Sound: A Performance: A

Roy Orbison records have long been prized among collectors, but until very recently, Orbison admirers looking for the original hits on CD were out of luck. An imposing presence on the pop music scene throughout much of the '60s, Orbison's credentials were impressive: Elvis Presley referred to him as "the greatest singer I have ever heard"; in Europe, his popularity was such that The Beatles, no less, were the opening act to Orbison's headliner on a 1963 tour; moreover, Bruce Springsteen has cited the singer's influence as affecting his own recording aspirations.

Originally, Roy Orbison was more successful writing songs for other people. He integrated his musical roots into each song, helping to create first-generation rock 'n' roll and the nascent rockabilly sound of Memphis in the '50s. His first hit, "Ooby Dooby," was recorded for Sam Phillips' Sun Records around the time Phillips was also cutting Elvis, Carl Perkins, Johnny Cash, and Jerry Lee Lewis—the "Million Dollar Quartet." It was later, however, in Nashville for Monument Records, that Orbison came into his own with a string of hits which established him as an unsurpassed country/pop balladeer. Like the perennial dark glasses and all-black outfits he wore, his range and dynamic falsetto became a trademark. His moody, anxious songs were cloaked in orchestral melodrama, and his singles, some of the most memorable of the era, earned him a number of gold records and eventually sold more than 35 million copies.

Those recordings, under the direction of producer Fred Foster and arranger Bill Justis, are finally available on CD. Surprisingly, these two competing compilations, both of which were actually released before Orbison's sudden and untimely death, use the same source material. This situation

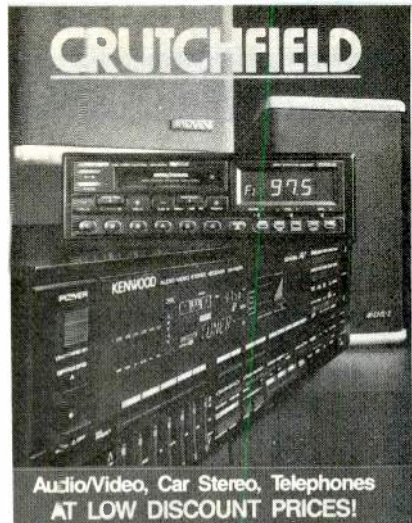
normally does not arise in the domestic market, but is an indication of Orbison's esteem. Rhino Records, with its customary diligence, researched the music included on *For the Lonely—18 Greatest Hits* and attempted a broader perspective by including two early Sun cuts. Rhino also includes a comprehensive booklet. CBS Special Products, which owns the rights to the Monument catalog, offers a similar 20-title, two-disc set. Entitled *The All-Time Greatest Hits, Vols. I & II*, the discs are available separately but, regrettably, CBS provides nothing in the way of detailed information in their insert. Rhino's enterprise extends to mixing down the original three- and four-track recordings onto digital, essentially introducing a new aspect, while CBS, for their transfer, has apparently utilized the authentic, albeit second-generation stereo copy-masters used for the 1972 vinyl release, *All-Time Greatest Hits of Roy Orbison*.

Remixing the original multi-tracks for digital replication is a step not without controversy. Although it may give the sound an extra presence, sometimes it can mean the loss of that indefinable quality that set a record apart the first time around. Rhino's compilation does sound marginally brighter, but the nuances of Bill Inglot's remix are almost indistinguishable when compared to the CBS set. Orbison's voice is slightly more forward in some instances, though, and one may now even hear the singer breathe. The CBS tapes evidence fractionally more tape hiss, without it being a problem, and the echoes and equalization employed during the '60s recording process do yield a warmer feel. However, both are remarkably close in concept.

The choice between these packages is more likely to be one of personal preference for individual songs. Both include the major hits: "Only the Lonely," "Blue Angel," "Running Scared," "Crying," "Dream Baby," "In Dreams," "Blue Bayou," "It's Over," and "Oh Pretty Woman."

Roy Orbison was inducted into the Rock 'n' Roll Hall of Fame in 1987 and is finally being recognized in America for his contribution to popular music culture. Either of these "Greatest Hits" CD compilations will reveal why.

Michael Aldred



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## DIXON PLAYS CHESS



**The Chess Box:** Willie Dixon  
MCA CH3-16500, three LPs.

Sound: B Performance: A—

If you're a fan of the blues, you're a fan of Willie Dixon. You may not recognize his name, but as a songwriter, session musician, arranger, producer, performer, and mainstay of Chess Records, Willie Dixon is one of the dominant figures in post-war Chicago blues.

Boxed tributes to an artist generally consist of an anthology of his performances, but such a collection isn't feasible in Dixon's case. As a bandleader/performer, Dixon wasn't in the same league as the Chess bluesmen whose careers he advanced: Muddy Waters, Howlin' Wolf, Little Walter, and other legends. His reputation now primarily rests on his classic songs, which combined contemporary catch phrases, Southern black folklore, and savvy rhythmic hooks.

*The Chess Box* is devoted to 36 of Dixon's hundreds of songs, which have provided a mother lode of material for countless rock and blues bands. This three-record set illustrates Dixon's range as a writer. It is a collection of his material, performed by a wide stylistic variety of Chess artists. At the same

time, *The Chess Box* is a shrewd combination of intelligent packaging and commercial compromises that is designed to attract a broad spectrum of blues fans.

Little Walter's jump-band influenced "My Babe" demonstrates Dixon's gift for modernizing the familiar—in this case, grafting secular lyrics onto the gospel number "This Train." The resulting single, blessed with a typically frenzied Little Walter harp solo, crashed onto the pop charts and gave Dixon his first No. 1 R&B hit. Walter is also represented by "Mellow Down Easy" (superb!) and the dismal "Dead Presidents," a deservedly obscure track from his last session. Blues-belter Koko Taylor's greatest hit, "Wang Dang Doodle," with its colorful description of a wild party, is a sanitized version of a popular "toast," a form of narrative poem. Taylor also does a duet with Dixon on the overblown "Insane Asylum."

The Howlin' Wolf tracks are all familiar and justifiably classics: "I Ain't Superstitious" (covered by Jeff Beck), "Back Door Man" (a Doors' standard), "Evil," and "Little Red Rooster." Also included are two songs written specifically for the massive Wolf: "300 Pounds of Joy" and "Built for Comfort."

Several of Muddy Waters' powerful signature numbers are included: "Hoochie Coochie Man," "I Just Want to Make Love to You," and "I'm Ready," as well as less successful but solid singles such as "You Shook Me" (an early hit for Led Zeppelin), the spirited "Young Fashioned Ways," and the overlooked "You Need Love."

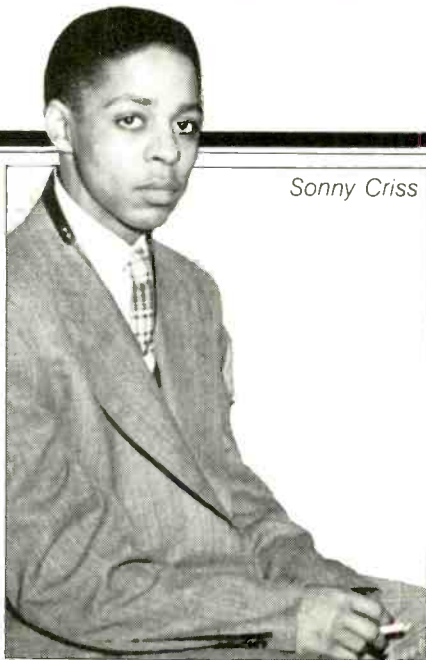
Otis Rush, a towering second-generation singer/guitarist who was ill-used by Chess, contributes the ballad "You Know My Love," which he had previously recorded for Cobra under Dixon's guidance. Rush's greatest hit, "I Can't Quit You" (later a smash for Led Zeppelin), is represented by an inferior cover by Little Milton Campbell. Primal rocker Bo Diddley offers "Pretty Thing" (built on classic call-and-response patterns in black music) and the clever "You Can't Judge a Book by Looking at Its Cover." West Coast guitar player Lowell Fulson gives a strong reading of the foreboding "Tollin' Bells" and "Do Me Right." Sonny Boy Williamson, Chess' other great singer/harp blower, whose own songs rivalled Dixon's wit and originality, contributes "Bring It On Home," one of the handful of Dixon numbers he recorded. Also included are tracks by Jimmy Witherspoon ("When the Lights Go Out"), Willie Mabon ("Seventh Son"), and Eddie Boyd ("Third Degree").

The least memorable tracks are the six featuring Dixon as vocalist. The songs, "29 Ways" and "Crazy for My Baby," are up to his usual standards, but the tracks inevitably pale in comparison to the other performances, which include some of the finest Chicago blues ever recorded.

*The Chess Box* is a fine tribute to a major musical figure who hasn't received the recognition he deserves. The enclosed 12-page booklet by Don Snowden, Dixon's collaborator on his forthcoming autobiography, gives an intelligent sketch of the performer's career and is illustrated by some wonderful photos. *The Chess Box* was digitally remastered from original Chess masters, and has more presence—and certainly fewer scratches—than the well-played albums on most blues fans' shelves. As Dixon's most prolific years were inextricably entwined with Chess Records, newcomers to the blues will find this package a good

Photograph: Fran Byrne, 1946, Frank Driggs Collection





Sonny Criss

is aptly called the Swamp Boogie Queen, and her Alligator debut is simply a gas. *Michael Tearson*

**Sonny Criss—Intermission Riff Pablo 2310-929, LP.**

Sound: B Performance: B+/C

The liner notes on this album would make the buyer think that he has just discovered the Holy Grail or the Rosetta Stone. In reality, they are just good promotion for what I would call a fairly ordinary run-through of material.

These previously unissued 1951 "Jazz at the Philharmonic" concert tapes feature—along with alto saxist Sonny Criss—trumpeter Joe Newman, trombonist Bennie Green, tenorman Eddie "Lockjaw" Davis, and a rhythm section of Bobby Tucker on piano, Tommy Potter on bass, and Kenny Clarke on drums. Their performances are no better or worse than any other JATP concerts. (I happen to think jazz concerts are not a very viable way to present music, but this puts me in the minority.) Norman Granz, to his credit, kept a goodly number of talented players employed when they might otherwise have had difficulty finding work. The dark side of this situation is that the atmosphere of these concerts was frenetic. At times, the audiences seem to inhibit the production of some really outstanding music.

Since Sonny Criss has few LPs or CDs in circulation, this record would be welcome, although there are others which show off his talents far better than this set does. I find Newman and Davis to be below average here. Their styles seem to be somewhat blurred. Several years later, their sound came together more effectively in Count Basie's band. For all his skills as a drummer, I find Kenny Clarke's playing far more intrusive than I do supportive—but perhaps it is the mike placement which is at fault. There's too much rumpity bump.

The album has been released under Sonny Criss' name, but he actually has no more solos than the other horn players. I believe he and Bennie Green offer the most lucid solos throughout. Get this LP only for Criss and Green, neither of whom is currently well represented on records—regardless of the format. *Frank Driggs*

introduction to Chicago's best. Long-time collectors, however, will speculate why Chess undertook this particular project instead of releasing unissued material by the blues giants on this set. *Roy Greenberg*

**The Swamp Boogie Queen: Katie Webster Alligator AL 4766, LP.**

Sound: B Performance: A-

Katie Webster opened for Otis Redding and played keyboards with his band from 1964 until his death in 1967. Not surprisingly, he remains one of her key influences, as her reverent versions of the Redding classics "Try a Little Tenderness" and "Fa-Fa-Fa-Fa-Fa (Sad Song)" attest. Other soul chestnuts include Johnnie Taylor's "Who's Making Love," Paul Phillips' 1959 hit "Sea of Love," and Joe Tex's "Hold on to What You Got"; four more are Webster originals.

Katie's got a whale of a voice, and she loves to use it for all it's worth. A more joyous noise will be hard to find. Backing Katie is a crack blues trio, Silent Partners; they are reportedly working on their own album. Guests include the great Memphis Horns (Wayne Jackson and Andrew Love), Robert Cray, The Fabulous Thunderbirds' Kim Wilson, and Bonnie Raitt.

You can hear the fun that Katie and her friends had while they were making this album. It sports a lively sound that lets you sit in on the informality of the sessions and see the interplay of the participants. Louisiana's Katie Webster

**De La Nuit ... Le Jour: Tamia and Pierre Favre ECM 1364, CD.**

Sound: A Performance: A

Tamia and Pierre Favre occupy a nether region of sound, a deep psychic well where whispers, distant drums, and faint rustles tug at the borders of consciousness. *De La Nuit ... Le Jour* introduces U.S. audiences to

Katie Webster



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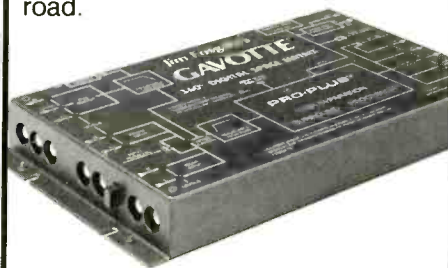
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**Tamia is a sensuous  
singer whose four-octave  
voice hovers between the  
lyric and the earthy,  
with an angel's caress.**

two remarkable musicians that Europeans have been hearing for years.

Of the two, Pierre Favre is the better known. He's a veteran jazz drummer who's recorded or played with Freddie Hubbard, Steve Lacy, Mal Waldron, Don Cherry, John Surman, and Jack DeJohnette. Favre's always been a melodic drummer, but on his own recordings (*Singing Drums* and *Mountain Wind*) he plays percussion like a pan-ethnic chamber ensemble, extracting unusual sounds from his kit and playing tuned percussion, bowed cymbals, and water-filled gourds.

Tamia is an astounding wordless vocalist whose two solo albums, *Tamia* and *Senza Tempo*, explore a haunting world of whispers, screams, and celestial choirs, often multi-tracking her voice into contrapuntal, call-and-response arrangements. She's a sensuous singer whose four-octave voice hovers between lyrical grace and earthy growls.

Together, they conjure a journey of primal immediacy and intuitive interplay. The music evokes African rhythms and chants, nursery rhymes, and torturous wails—and that's just on "Wood Song." Tamia sings the child-like melody, doubled by Favre on tuned percussion, but somewhere in the song a change occurs. The rhythms become more intense, and the little child becomes a grown woman, sensuously chanting against Favre's now-muscular rhythmic drive.

Like singers Meredith Monk and Joan LaBarbara, Tamia always seems on the border of comprehension, speaking in a foreign tongue whose words are unknown but whose meaning is clear.

Needless to say, this all-digital recording is well served by the quiet and dynamic range of CD, with every whispered breath and percussive beat decaying into the silence.

*De La Nuit . . . Le Jour* is an album of spaces—those echoing moments in your mind as well as the literal spaces of sound. Favre's unusual percussion

is sparse, taking its rhythms from the silences, while Tamia's voice caresses like that of a word-weary angel. They end on a celebratory note with "Ye-manja," somehow combining celestial choirs with a percussive rhythm dance, gradually leaving you to the haunting spaces of silence as bowed cymbals and ethereal voice fade to black.

*John Diliberto*

**Spice of Life Too:** Kazumi Watanabe  
**Gramavision 8810-1, LP; 8810-2, CD.**

Sound: A- /B+ Performance: A-

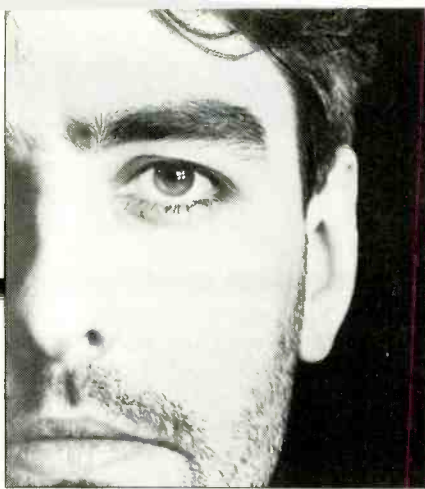
From funky to quasi-Latin grooves, Kazumi Watanabe's back with his latest all-star fusion combo's second installment on *Spice of Life Too*. Actually, it seems Watanabe's gotten his sea legs with his new outfit and has backed off somewhat from the generic "rock" fusion of his first album (with Jeff Berlin and Bill Bruford) to a more characteristic world-beat perspective. On "We the Planet," for example, a salsa rhythm segues into Oriental-sounding muted arpeggios and then into Peter Vettese's ubiquitous Andean-pipe keyboard chords (which show up again on "Rain" and "Small Wonder"). "Fu Bu Ki" and "Kaimon" feature Watanabe's trademark headless Steinberger guitar lines slinking over sinuous syncopation. Not that the straight-ahead fusion blowing is gone, it's just modified with delightfully odd time signatures and rhythm shifts ("Andre" and "Concrete Cow"). These make the songs more distinctive than your basic 4/4 groove. For tasteful acoustic guitar work, check out "Men and Angels."

With production by Akira Yada, this hot quartet achieves a thick, full sound that pushes aggressively forward around Watanabe's varied guitar tones. Most of the spaces are filled in by the keyboards, although the fairly dense textures do not seem to be the result of extensive multi-tracking, and each of the instruments manages to keep its definition. Both LP and CD sound excellent, so pick your poison.

It's good to hear Kazumi Watanabe recapturing a little more of the individuality which made his early work so unique. *Spice of Life Too* is still mainstream, but now you won't mistake it for the rest of the faceless fusion pack.

*Michael Wright*





**Ancient Evenings:** Garry Hughes  
Audion SYNCD 314, CD.

British musician Garry Hughes has made a significant reputation as a studio player for groups such as Depeche Mode. Lately, he has been striking off on his own with his own style. *Ancient Evenings* is his second solo album (following *Sacred Cities*), and it's a tour de force of synthesizer technique. Hughes uses all the latest hardware and software, giving him a wide-ranging and flexible palette of sounds. These include the typical world-music assortment of New Age plus the fascinating category of "found sounds." Composers have been including sounds from sources outside the bounds of traditional musical instruments for most of the 20th century, but the sampling synthesizer has made the technique practical and immediately accessible. Now, a composer can record a short sample of a sound and create an entirely new musical instrument out of that sample.

*Ancient Evenings* begins with some extraordinarily beautiful bell-like sounds that are probably derived from auto brake drums! And I'm sure I detected the sounds of piano strings being hit with tympani sticks. Hughes has sharp ears for interesting colors, and uses them quite expressively.

At the beginning of "Breakfast in the Ruins," Hughes goes quite far afield with what used to be a daringly avant-garde device—music without meter or pulse, sounds suspended in time. The technique creates exactly the right effect before the "real music" begins. Later on, he uses a Vocoder (voice modifier) to suggest a rather unearthly ambience for these ruins. "Dead Sea" features a harp on both channels, with many subtle modifications of their timbres as the track progresses. *Ancient Evenings* points the way toward integrating the newest electronic technology into musical styles—with musical imagination and expressiveness.

Steve Birchall



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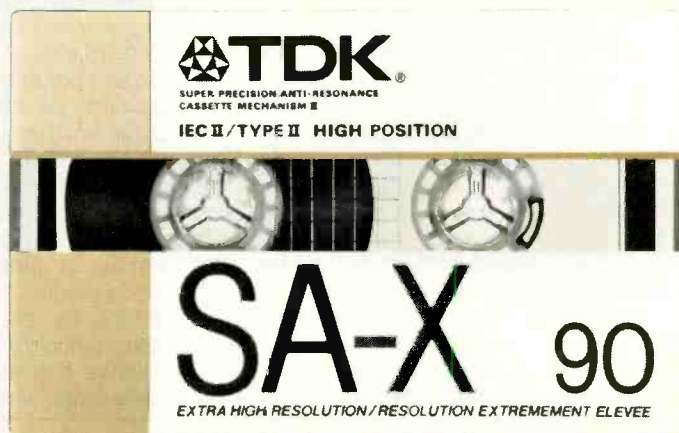
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## GRAND PIANO



**Louis Moreau Gottschalk: Selected Piano Music.** Lambert Orkis, 1865 Chickering concert grand.

**Smithsonian Collection of Recordings ND-033, CD; AAD.** (Available from Smithsonian Collection of Recordings, 955 L'Enfant Plaza, Washington, D.C. 20560.)

Such an unprepossessing title, and an unprepossessing pianist, too—getting on to middle age, receding hair, big grin—yet wow, what a CD! It's the greatest entertainment piano show of the year.

Not only is the recorded sound fascinating, the 1865 piano is an astonishment, out of a period very little explored so far in "original instruments." The music is light but beautifully written, mixing the most polished European technique with New Orleans, Latin American, U.S. of A., Star Spangled Banner, banjo—our very first American genius, at a time when "classical" music barely existed in most of the New World. And the pianist! This man speaks music. He is marvelous, one of the greats—at least in this show-off entertainment music. Effortlessly fluent, completely communicative—if the pi-

ano itself weren't so extraordinary, you would forget it and just hear the music in all its fervor, straight from Gottschalk.

This piano is huge—talk about Bösendorfers. It is 10 feet long and 3 feet wide at its distant tail end, the strings not crossed but all straight parallel from one end to the other. The bass is thunderous: In the final set piece on the disc, a reading of 113 dB was hit at one point, with everything going. No longer a fortepiano! But more remarkable, this monster has the brilliantly changeable tones of the earlier piano—gossamer high notes at low volume, piercingly metallic when loud. Each register has three or four distinct ways of sounding, from piercingly bright to somber and muffled. So *much* is explained, for this surely was the sound that such as Liszt played upon. You will not believe it at first, but very soon it begins to make sense. It *has* to be right for the period. Lambert Orkis writes an amusing account of his own discoveries in getting to know the Chickering piano. (It was shipped from the factory, by the way, during the week after Lincoln's assassination.)

I suppose that some pianists and especially those who are career-mind-

ed and contest-oriented, will shy away from this sound. A tinny piece of junk? (It does indeed have some of the sound of the old beat-up uprights of the honky-tonk school!) Not if the Smithsonian has anything to say about it. I find it a revelation as to the sound that still persisted far into the Romantic era—so different from the modern piano of this century. Now if this performer, please, would just do us some of the biggest Liszt, even the music of the many Liszt followers up beyond the end of the century, we might know how *that* music really sounded when it was new. On the big Chickering, and *not* on the big Bösendorfer, it should blow out the roof—not to mention the mikes.

Postscript: Gottschalk himself toured the world in the '50s and '60s, accompanied by two of these very same Chickering—this in the days of the horse, the sail, maybe the ox! He called them "mastodons." They went by train in the U.S.A., those quaint early steam trains you see in the movies, and he took along a piano technician to keep them operating.

Edward Tatnall Canby

**The Baroque Guitar: The Segovia Collection, Vol. 4** Andrés Segovia.

**MCA Classics MCAD-42070, CD; ADD; 66:48.**

Sound: B— Performance: A—

**Agustin Barrios Mangore (1885-1944), Vols. 1 & 2, and Vol. 3.**

**El Maestro EM 8002, two-LP set; EM 8002V3, LP.** (Available from El Maestro, P.O. Box 5505, Mill Valley, Cal. 94942.)

Sound: C+ Performance: A

From the Old and New Worlds come curious collections by two of the most important early 20th-century classical guitar pioneers, Andrés Segovia and Agustin Barrios.

*The Baroque Guitar: The Segovia Collection, Vol. 4* continues MCA's Compact Disc tribute to the late Spanish maestro Andrés Segovia (1893 to 1987). In recordings made in 1952, 1960, 1962, 1967, and 1969, Segovia offers interpretations of works by Purcell, Domenico Scarlatti, Handel, Frescobaldi, Weiss, and Bach (all but one



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in his own transcriptions). These performances vary from somewhat stiff, occasionally sloppy readings to highly colored romanticizations full of rubato and sweet *dolce* tone quality which the contemporary ear usually does not associate with baroque. That these recordings are not contemporary is beside the point, however, because they antedate modern scholarship and, in fact, provide an insightful glimpse into the evolution of the modern repertoire.

While *The Segovia Collection, Vol. 4* was digitally remixed and remastered—as were previous releases in this series—the sound quality is extremely inconsistent, ranging from acceptable to horribly noisy (in the earliest recordings). That this is an anthology makes things worse. The problem is further exacerbated by the delicate presence of the classical guitar, which simply cannot overpower the tape hiss. Much of this material is no longer available, so if you want to hear it and aren't inclined to patiently comb through used record bins, you'll have to live with the noise.

However, unless you own some very rare 78s, *Agustin Barrios Mangore (1885-1944)* is the only place you'll be able to hear one of the great guitar virtuosos and composers of the early 20th century. Born in provincial Paraguay, Barrios rose quickly from child prodigy to perhaps the best-known performer throughout Latin America. He counted the likes of Segovia and Villa-Lobos among his champions and influenced many others, including the young Antonio Lauro.

The material presented in this three-record set is typical of Barrios' concert repertoire. There are selections by Sor and Tárrega; transcriptions of Bach, Beethoven, and Schumann; Barrios' own "classical" compositions, such as "La Catedral" and "Madrigal Gavota" (very advanced pieces which are now standards); many folk-inspired compositions, and renditions of popular music of the day.

Segovia's highly colored romanticizations, full of rubato and sweet *dolce* tone, are not what we now associate with baroque.

Barrios' technique and polish were quite amazing, and while he, like Segovia, approached his instrument with a romantic flair, the florid style always fit the music. The sources here are 78s, so the sound is compact and full of surface noise, but Barrios' vitality comes through loud and clear. Frequently, one is inclined to think that modern technical standards only began with John Williams. *Agustin Barrios Mangore (1885-1944)* and a superb digitally remastered companion collection by turn-of-the-century master Miguel Lobet (EM 8003), produced from the original masters, demonstrate that true guitar virtuosity has a much longer history.

Michael Wright

**Ravel: Bolero; Rapsodie espagnole; Alborada del gracioso; La Valse; Valses nobles et sentimentales.** Cincinnati Symphony, Jesús López-Cobos.

**Telarc CD-80171, CD.**

On this digital disc, the overly well-known "Bolero," listed first (above), is actually last, and is by far the best interpretation in this hour-plus of Spanish music from the Frenchman Ravel. To my real surprise, it is quite extraordinary. For one thing, the tempo is both slow and relentless, allowing the wonderful combination of solo instruments, each time around, to make a maximum impact. The relentlessness brings out precisely what Ravel meant—a horrible, fascinating, hideous, glassy sweet, almost poisonous buildup, to the final hair-raising change of key as the music suddenly collapses.

In my school days, I heard the original performance of this work, the Boston Symphony on tour, and I will never forget it. Utterly unprepared, I was reduced, literally, to terror and frenzy—my hair *did* stand on end (I had it, back then). This playing, just 60 years later, brings back the memory. A very powerful tour de force when played the right way, which is seldom.

The rest of the orchestral Ravel here is okay but not really outstanding. The conductor with the very Spanish name (compared to Maurice Ravel!) knows the tradition and shape but tends to rush and pound things in the faster parts, which is *not* Ravel, the ever-polished, intense but suave perfection-



## NEW RECORDING ARTISTS

## The Passion And Related Mysteries According To Violinist Evan Johnson

When Heinrich von Biber wrote what have come to be known as his "Mystery Sonatas" just over 300 years ago, the composer and violin virtuoso notably enhanced their color with a technique known as *scordatura*. While the term literally means out of tune, it actually refers to any unusual tuning of a stringed instrument. It was used most often in German Baroque music, and Biber was its principal proponent.

In addition to making a number of violinistic effects much simpler to achieve (polyphonic passages otherwise nearly impossible to articulate can often be played with relative ease), variations in tuning lend the violin unusual tonal qualities. Strings can be tightened for a tense, strident effect while loosening them will produce a more mellow sound.

Biber and the *scordatura* technique have found an able champion in 35-year-old violinist Evan Johnson, a member of that increasingly-visible troupe of musicians who play Baroque and Classical instruments in a style they feel is authentic. For his recording debut, Johnson chose to combine these 15 pieces, which were probably played one per evening during a series of Catholic services in October, the first Sunday of which marked the Feast of the Rosary. With them on a pair of Newport Classic CDs is the "Passacaglia for Solo Violin", included with the set in Biber's manuscript.

In that manuscript, an illustrated scene preceding each sonata suggests that it depicts a corresponding mystery of the Rosary. The sequence is divided into groups of five joyful, five sorrowful and finally five glorious compositions, most of which relate to the life of Jesus as described in the Gospels. Biber invests a broad range of emotions in these pieces, which in Johnson's rendition run from four and a half to just under 10 minutes in length. They begin with the excite-

ment of the Annunciation, progress through the profound anguish of Christ's passion and finally terminate in a mood of formal serenity as the Virgin is crowned.

This sort of story telling music is prone to a wide gamut of interpretation, and Johnson makes the most of its possibilities. A master of contrasts, he sharply attacks and speeds adeptly through some passages while allowing others to step slowly along.



*Evan Johnson*

The *scordatura* tunings are emphasized by sustained notes played with an almost complete absence of vibrato. And while Johnson is perfectly capable of producing beautiful tone, his playing is often stark. Some passages, such as those depicting flagellation, are rendered raw as torn flesh.

Two continuo players endow the recording with added depth. These include Eric Milnes, who employs harpsichord on the joyful and glorious sonatas and organ on the sorrowful group, and cellist Loretta O'Sullivan. The recording engineer, Timothy Martyn, a man with considerable ex-

perience capturing the sound of Baroque strings, keeps the violin right out front for maximum drama.

Johnson points out that playing a violin tuned in this manner, even though open strings are employed extensively, is not without its difficulties. For one thing, *scordatura* deprives performers of familiar cues; the tones a violinist normally hears when stopping strings at specific points on the fingerboard are not the ones that result.

Moreover, because it takes a few hours, sometimes even a day or two, for strings to settle into new tunings, playing these sonatas as a set requires the use of multiple instruments. Since switching from one violin to another, even when both are normally tuned, can be disconcerting for a performer, this kind of round dance must prove particularly dizzying. For his two CDs, Johnson used a total of five instruments in recording sessions that comprised eight working days. Since the retuned violins needed time to adjust, workdays were not always consecutive.

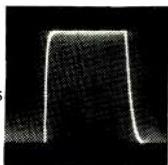
Ironically, Johnson fears these remarkable musical mysteries will be ignored by listeners who mistakenly think "religious music is sombre, serious and that its intent is to put you in an elevated mood." The violinist prefers to view them as "religious in the sense of being very, very connected to life and to intense feeling, connected to what's genuinely important. It's very startling, music to shake you up, really. And I think that's what religion in its ideal form should do. It shouldn't lull you to sleep. It should stimulate you."

If this is indeed the case, both Biber and his disciple are right on the mark. These mysteries according to Evan Johnson—sometimes meditative, sometimes lilting, sometimes formal, sometimes aching—emerge as highly visceral and entirely memorable musical experiences.

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ist. The orchestra, like so many in America, plays with utter competence, and yet one senses a competent routine and too many microscopic ragged edges. Music costs too much here for real depth and polish—unless a conductor somehow gets through. That, luckily, often happens! Not particularly here, *except* in the "Bolero." Odd.

I'll have to make one minor objection to Telarc's recording. I am getting annoyed by the constant Telarc sonic boom—that big drum that always goes off like a cannon when the first chance comes along. Hi-fi, oh yes, but a trademark. Do we need it?

Edward Tatnall Canby

**Irving Fine.** New York Chamber Symphony, New York Woodwind Quintet, Lydian String Quartet, Cantata Singers.

**Nonesuch 79175-2, CD.**

Irving Fine is a member of an increasingly respected group of American composers who were active in the '50s. A stylistic contemporary of Harold Shapero, with an inclination toward Stravinsky and neoclassicism, Fine died in the early '60s at the age of 47. His catalog is relatively small, and most of it was written for the voice.

All but one of the five works on this CD (there are four on the LP) are instrumental. It is a well-recorded, well-paced collection with some very fine performances.

"Notturmo for Strings and Harp" receives an elegant, precise, yet full-bodied interpretation from the New York Chamber Symphony under Gerard Schwarz. The high strings sound particularly sweet, while the lower timbres are practically transparent in their clarity.

Of the "Notturmo," Fine wrote that it "aims at a certain romantic effect," and its two outer movements have a melancholic beauty; the gorgeous chordal sonorities of the last lend an almost "in memoriam" quality. The heavy breathing (Schwarz's, I assume), though initially distracting, ultimately fits with the focused passion of the performance. Violist Jean Dane and harpist Susan Jolles are both adept, insightful interpreters, though Dane's viola is occasionally wrapped in an overabundance of room (one hopes) echo.

Fine's only string quartet, played here by the Lydian String Quartet, was written in 1952, just a year later than the "Notturmo." It marked the composer's first use of 12-tone technique. Though Fine's quartet occasionally shares the human-pulse quality of the "Notturmo's" Third Movement, its harmonic language is as if from a different muse: Dissonance replaces consonance. While its rhythms are more regular, its textures are more complex, and the faster-paced sections have a nattering intensity.

The "Partita for Wind Quintet," spunkily and colorfully interpreted by the New York Woodwind Quintet, has much surface cheer in its up-tempo passages. The Gigue, for instance, flows, darts, and bounces along with a feathery excitement. By contrast, the Coda's slowing pulse again calls to mind the sweet melancholy of the "Notturmo."

The Cantata Singers do a crisp, commendable job on "The Hourglass," an a cappella setting of six poems by Ben Jonson. Fine's music is highly reflective of its texts, some of which are set in a choppy, recitative style. "Against Jealousy," with its angry sputterings, is a particularly pointed example of music that illustrates its subject.

Vacillating back and forth between tonal and atonal, these pieces are not easy to sing, but the group approaches them with a clean, unnumbered straight tone and a tight sense of ensemble. Diction is not as clear as it might be; fortunately, words are contained in the liner information.

The CD also includes "Serious Song" (not on the LP), recorded in 1980 by the Los Angeles Chamber Orchestra under Schwarz and previously available on Nonesuch's *American Music for Strings* (79002-2).

Susan Elliott

**Wim Mertens: Whisper Me.**  
**Windham Hill WD-1079, CD; AAD.**

Sound: B Performance: A-

Wim Mertens' *Whisper Me* is a stunning, serene album that sounds like it was composed by a medieval court musician time-warped into a contemporary minimalist. A Belgian composer, Mertens has written four pieces for

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Wim Mertens is truly graced, a prolific and gifted composer who has a lovely voice to sing his own refrains.

which closes out "No Plan, No Projects" becomes a triumphal march.

The title piece is a sidelong track with a simple theme stated on viola and cello as a piano wanders in and out like a half-forgotten memory. On top, Wim Mertens sings a sad, tragically beautiful melody in a countertenor voice. "Whisper Me" recalls Pachelbel's Canon, with its insinuating melodic elegance. Its lovely theme, sung by the composer in a gorgeous melismatic countertenor, is a serene meditation which lays most meditation records to waste in its transcendent beauty. Mertens is truly graced to be such a gifted composer and to have such a lovely voice to sing his own refrains.

Mertens is actually a very prolific composer, with several recordings out in Belgium. This is his second Windham Hill collection; the first, *Close Cover*, focused on his instrumental material. Mertens' music stands well apart from the Windham Hill oeuvre.

John Diliberto

chamber group and voices that dovetail sublime melismatic lines and counterpoint over stately accompaniments. His cyclical themes are so compelling that they could go on forever on their own, thus making every small change

an important one. Another voice fading in with a counterline can be an ecstatic experience in this gentle sound world. The soprano saxophone that weaves into "A Visiting Card" is like a passionate cry, and the synthesizer refrain

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James Johnson's compelling recital is one of the best offerings of Bach's music in a while, and yes, it is a sonic thriller.

**James Johnson Plays Bach.** Flentrop organ, Harvard University. **Titanic T1-162**, CD; 58:59. (Available from Titanic Records, P.O. Box 204, Somerville, Mass. 02144.)

Bach scholar Peter Williams has wondered why music studies usually

make the incomprehensible mistake of omitting Bach's masterful organ works from discussions of the innovations that shaped Western music. Is this because the works come from recognizable antecedents but appear not to have been followed in scope or form until Mendelssohn and after? James

Johnson's compelling recital is one of the best offerings of this music in a while, so it gives one pause to think just why Bach is the only 18th-century author of a large body of organ masterpieces.

A case in point is the opening Prelude and Fugue in D, with its gripping pedal scales and fanfare-like chords at the outset. Helped by an articulate briskness that's just fast enough without verging on being rushed, it holds the listener's attention from the start to the double bar. The B-minor Prelude and Fugue, D-minor Vivaldi Concerto transcription, E-flat Trio Sonata, and five well-chosen chorale preludes continue on to delight the ear. The brief, jewel-like "Vom Himmel hoch" and two settings of "In Dulci Jubilo" further display Johnson's impeccable taste and stylishness.

The CD booklet's cover photo shows the instrument in perspective with the part of the Busch-Reisinger Museum where it has stood for three decades and some. Its surprisingly diminutive proportions remind us that the most important mechanical-action instruments are rather tiny compared to the electro-pneumatic giants unconsciously associated with cathedrals, that wretched D-minor Toccata, and "the king of instruments" on many a flashy album cover. This is the beautiful three-manual organ Harvard had built by the Dutch master, Dirk Flentrop. It is only a little bit more than a decade since E. Power Biggs, who urged and prodded until the instrument was commissioned, last sat at the console in that balcony. From there, his recordings and last few broadcasts introduced to the organ and its literature many who had never bothered with the instrument. Bach was always at the very core of these explorations.

This is technically the finest recording of this organ to date. Engineers Brad Meyer, Peter Mitchell, and William Busiek used a high-speed analog half-track deck to tape the signal from an ORTF main pair of mikes and ambient omnis, all Nakamichi CM-700s. The sound is fuller, sweeter, and more potent than one hears the instrument while sitting on the stone floor for noonday concerts. That's miking as an art! And yes, this is a sonic thriller.

*Christopher Greenleaf*

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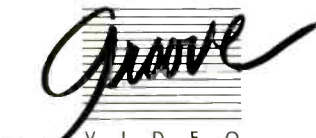
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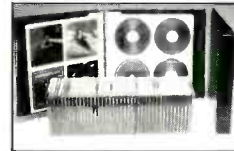
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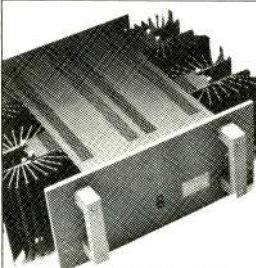
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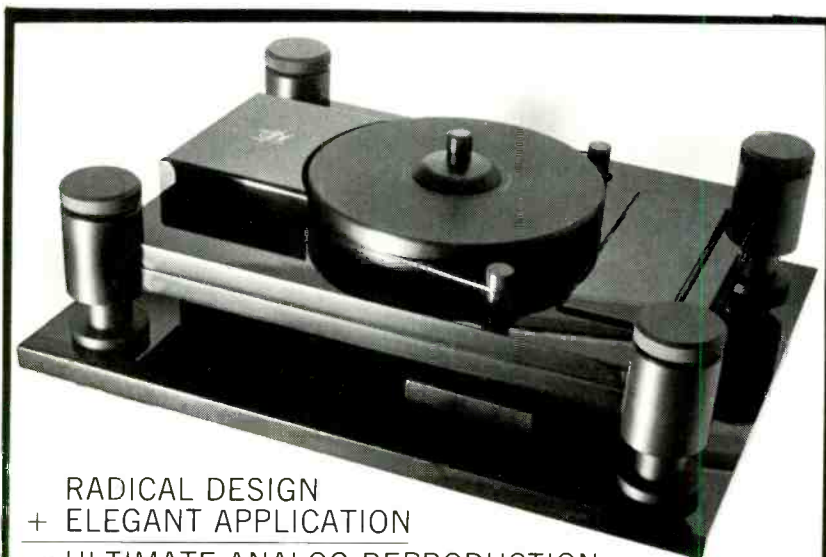
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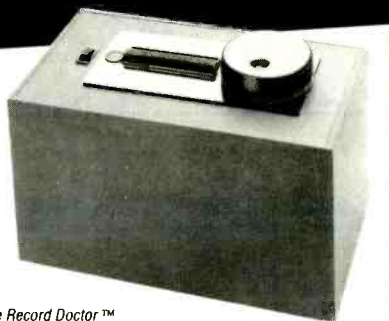
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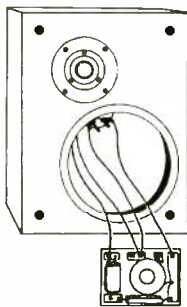
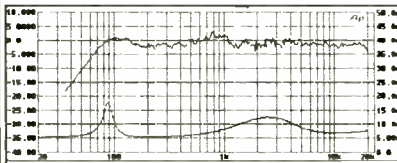
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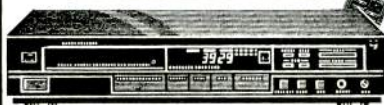
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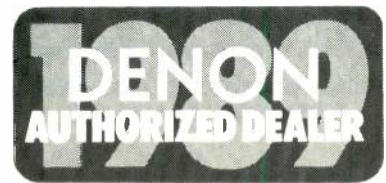
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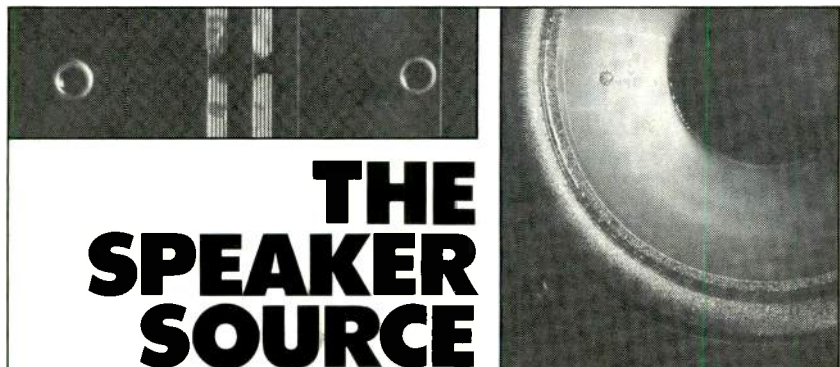
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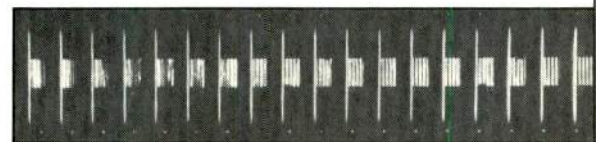
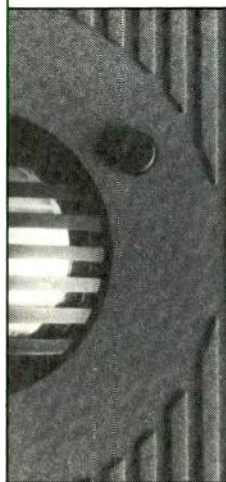
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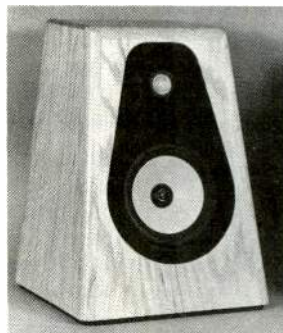
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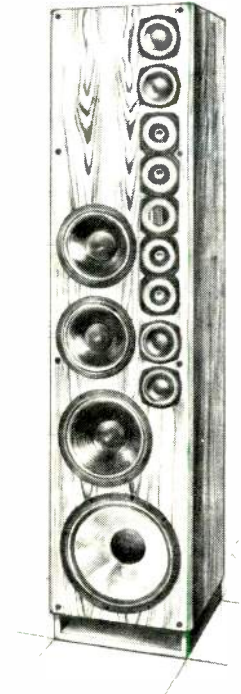


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