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THE PERFECT AMP: ZERO DISTORTION

McINTOSH MC 2002

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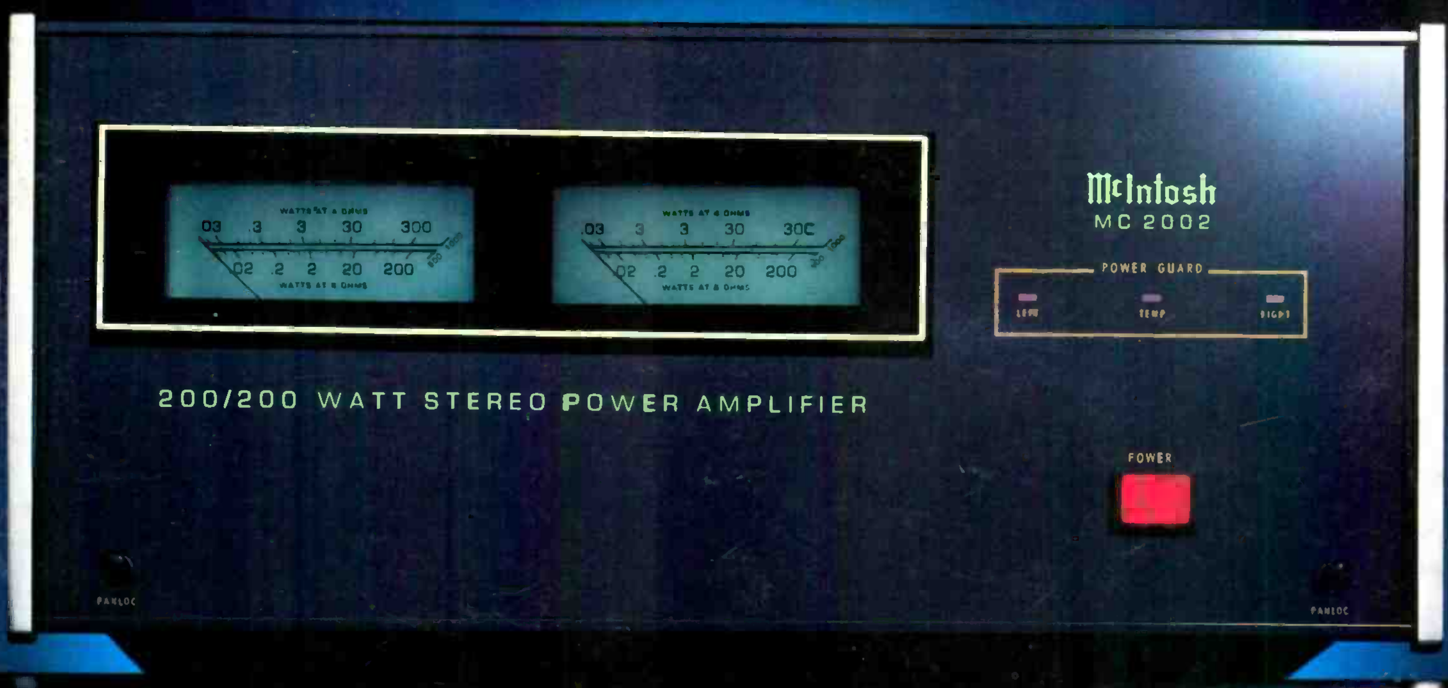
EXCELLENT SOUNDSTAGE



MICROPHONES

START WITH THE BASICS

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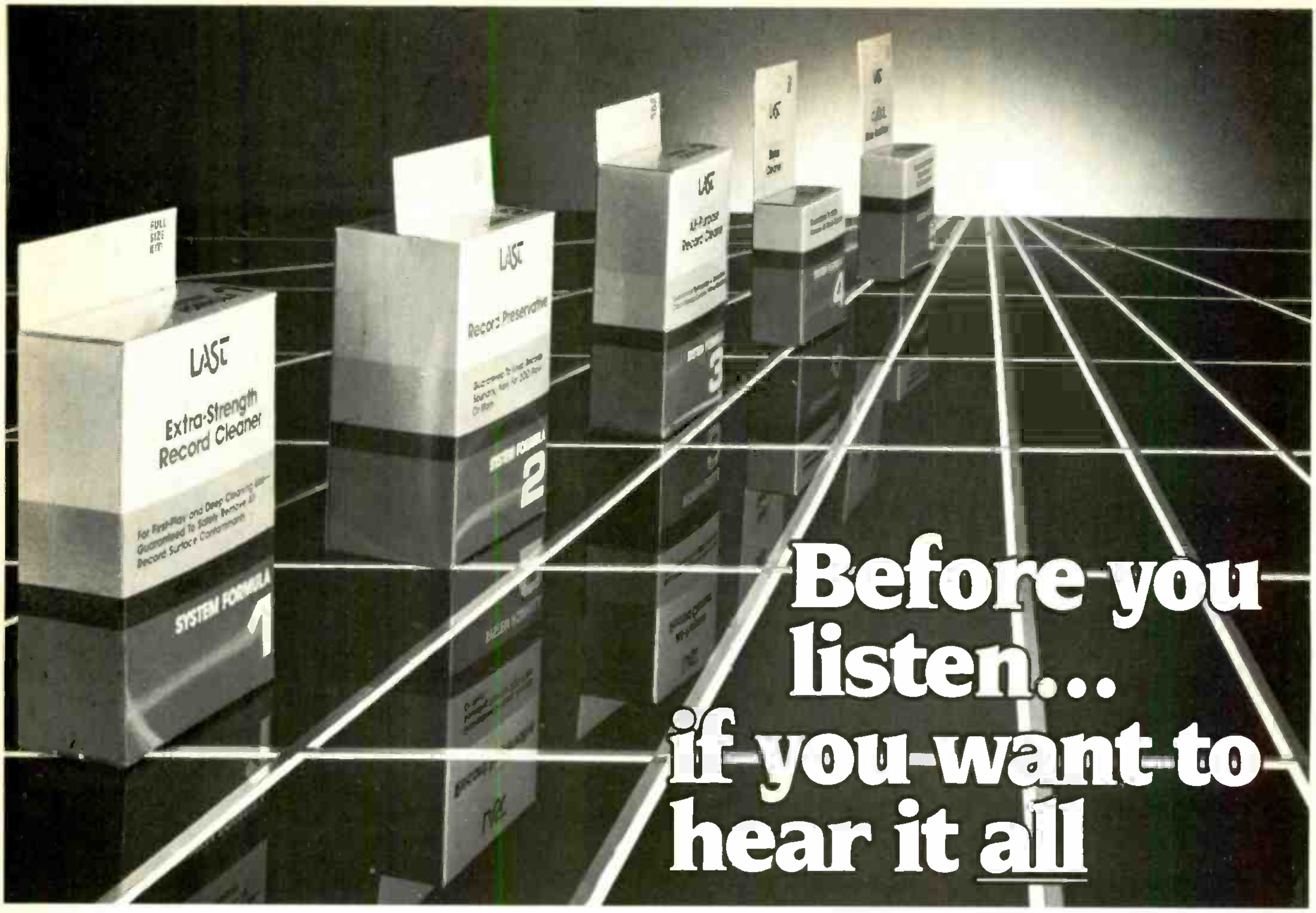

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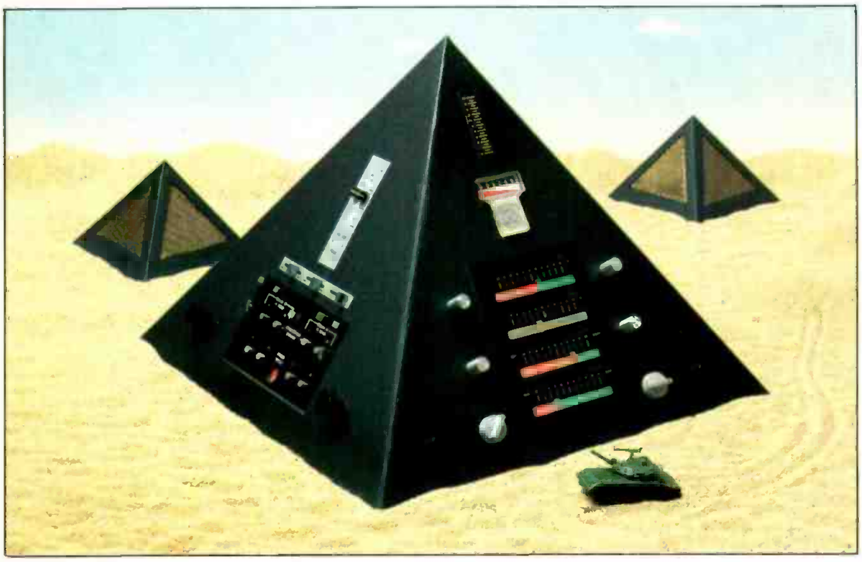

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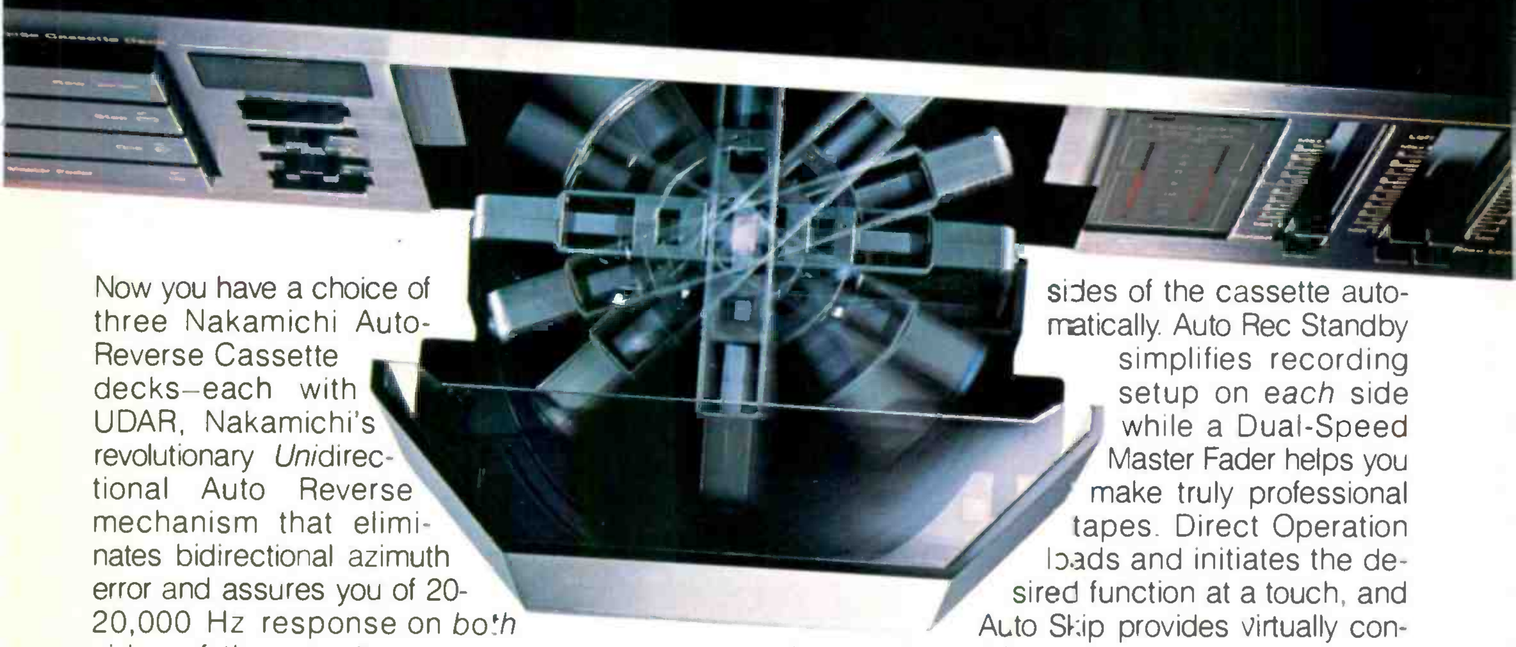
To Nakamichi, Convenience without performance is unthinkable.



Now you have a choice of three Nakamichi Auto-Reverse Cassette decks—each with UDAR, Nakamichi's revolutionary *Uni*directional Auto Reverse mechanism that eliminates bidirectional azimuth error and assures you of 20-20,000 Hz response on *both* sides of the cassette.

UDAR is simple, fast, and reliable. It automates the steps you perform on a conventional one-way deck. At the end of each side, UDAR disengages the cassette, flips it, reloads, and resumes operation *in under 2 seconds*. Tape plays in the *same* direction on Side A *and* on Side B so performance is everything you've come to expect from traditional Nakamichi decks—and more!

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UDAR—the revolutionary auto-reverse recording and playback system—only from Nakamichi. Check out the RX Series now at your local Nakamichi dealer. One audition will convince you there's no longer a reason to sacrifice unidirectional performance for auto-reverse convenience!

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RX-505

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RX-303

The RX-505's only rival. Record/Playback Auto Reverse in a 2-Head Dual-Capstan configuration.

RX-202

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ENTER THE NEW
STONE AGE.

Every great once in a while a new material is discovered of such significance that it changes the way we live. In the same sense that the Iron Age displaced the original Stone Age, new substances recently have been developed of such importance that they already are being described as "21st Century" materials. The materials, called Fine Ceramics, are not to be confused with Ming vases or rare pottery. Rather, they are a bold new set of materials possessing far greater rigidity, durability, thermal stability, and anti-resonance properties than other materials known to man.

Science has barely begun to reap the potential offered by Fine Ceramics. Diesel engines using high-temperature Fine Ceramics for critical components have yielded 30% greater efficiency. The biological compatibility of ceramics within the body have led to their acceptance by the medical community for orthopedic bone replacements and major dental work. The technology of Fine Ceramics has produced gem-quality sapphires, rubies and emeralds which are identical to natural stones in every way, except that they have no flaws.

It should come as no surprise, then, that Fine Ceramics has been predicted to become the major growth industry of the high technology future. But you may be surprised to learn which Company presently is the world leader in Fine Ceramics. That same Company was selected by a leading Japanese business journal as being the Number One Company in all of Japan in terms of technology, growth potential and profitability. Number One. Over every car, TV or other Japanese manufacturer there is. That Company is Kyocera.

Kyocera, a contraction of Kyoto Ceramics, is a Corporation whose combined digital, electronics and materials technology has produced many industry best-sellers in the fields of computers and communications (which they have built for companies you know well).

Kyocera's latest challenge is the application of its exclusive expertise to the field of high fidelity sound reproduction. Embodied in a totally innovative, strikingly different line of no-compromise components proudly bearing the Company's name, Kyocera will show the high fidelity community just how much a brand new way of thinking can accomplish.

Welcome to The New Stone Age.

KYOCERA APPLIES N
TECHNOLOGY TO IMPR
PLAYER PERFORMANC

Begin with the most advanced digital technology.

To demonstrate to the listening world the importance of Fine Ceramics technology, Kyocera first built a Compact Disc player incorporating all of the most advanced CD technology. For example, Kyocera's Compact Disc players feature separate, independent D/A converters for both the right and left channels to preserve phase coherency and for superior channel separation. They also use a 16-bit microprocessor with quadruple over-sampling and digital filters to optimize phase and group delay characteristics. Then, to prevent digital noise from interfering with the musical signal, Kyocera's Compact Disc players employ independent power circuits for both the digital and analog sections.

Incorporate the most advanced audio technology.

The audio sections of Kyocera's Compact Disc players employ DC amplifier systems in which all parts are directly coupled (capacitorless)—from the D/A converter at one end to the output terminals at the other.

Then, LC (Linear-Crystal) OFC (Oxygen Free Copper) material is used (DA-910) for signal circuit wiring with the smoothest electron flow. Naturally, only the most carefully selected, hi-spec parts are used in Kyocera CD players, and, wherever possible, circuit design has been reduced to a bare minimum. For example, a specially designed shorting-type muting relay eliminates "power on" noise, yet remains outside the signal path. And, conventional volume controls have been eliminated in favor of a switchable output to further eliminate possible noise.

Then add Kyocera's Fine Ceramics technology.

In the DA-910, Kyocera's Fine Ceramics engineering has been applied to eliminate a principle impediment to accurate compact disc performance—resonance. With digital tracks spaced only 1.6 microns apart, even the

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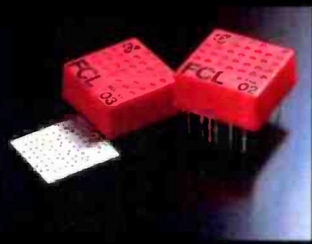
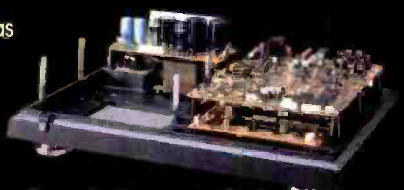


Fine Ceramic Linear (FCL) Module

slightest hint of vibration can create tracking errors, which can significantly degrade sound quality. Thus, Kyocera's Ceramic Compound Resin (CCR) is specified for the chassis base of the DA-910—because of its fast vibration damping characteristics and extremely high rigidity.

The CCR base isolates critical circuitry from harmful external vibrations (mechanical and acoustic feedback) as well as from internal excitations created by the power transformer. Anti-resonance design has become well accepted by the very finest audio manufacturers for sound reasons. Audio circuitry handling very low level signals can actually



Ceramic Compound Resin (CCR) Base Chassis

convert mechanical vibration or shock into electrical signals of their own. The elimination of this phenomena, known as the "Microphonic Effect," is the principle reason for all heavy duty, anti-resonance audio component construction.

The critically important analog circuitry handling the D/A converted signals is directly mounted on the CCR chassis. As an ultimate measure in the DA-910 this circuitry is mounted inside a Fine Ceramic Linear (FCL) module to further isolate it from vibration, to avoid thermal drift and to protect it from pulsive electronic noise created by digital circuitry.

Kyocera's final step in eliminating resonance from Compact Disc players consists of over-sized, adjustable feet to provide further isolation and the firmest support for the players themselves. To minimize vibration the DA-910 employs a diecast zinc pick-up mechanism.

Kyocera advances sound and user performance.

By combining the latest audio and the most advanced digital technologies with proprietary Fine Ceramics expertise, Kyocera was able to produce Compact Disc players widely regarded as the finest-sounding available—with the clarity, smoothness, inner detail and imaging of the finest audiophile components.

Kyocera's vast digital experience also has enabled the company to pay equal attention to sound quality and operational ease. Thus, programming and play functions are extensive, yet perfectly simple.

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DA-810/910 Compact Disc Players.

Kyocera's DA-810 was not designed as a step-down model in any way; rather the DA-910 is a step-up for those seeking the ultimate in anti-resonance construction and the convenience of remote control operation.

The DA-810 features all of Kyocera's advanced digital circuitry, including dual D/A converters with oversampling and digital filtration plus Kyocera's "purist" audio design, including direct coupling, a DC-servo amplifier, "twin mono" construction, separate digital and analog sections, carefully selected high-spec parts and the simplest possible signal path circuit design.

Kyocera's anti-resonance construction for the DA-810 includes a special alloy transport mechanism, heat sink and top cover, plus an anti-resonance coating applied to all delicate analog circuitry.

The DA-810 was designed bearing in mind that anyone buying any Kyocera product is unwilling to compromise.

Finer than the finest.

Those who have followed the development of the Compact Disc will remember that Kyocera's DA-01 was one of the most highly acclaimed of all the first generation Compact Disc players. Rather than simply repackage this initial success more cheaply, Kyocera added the benefits of Fine Ceramics technology to produce what realistically can be described as the finest Compact Disc players available today.

KYOCERA DA-910
Specifications

Frequency response:	5Hz–20kHz (± 0.5dB)
Signal-to-noise ratio:	More than 95dB (1 kHz)
Dynamic range:	More than 95dB (1 kHz)
Phase response:	20kHz 80 degree
Harmonic distortion:	Less than 0.005% (1 kHz, 0dB)
Wow and flutter:	Unmeasurable (dependent on precision of crystal oscillator)
Channel separation:	More than 90dB (1 kHz)
Output level/Impedance:	5V, 2V, 0.77V (3 points)/1 k ohms
AC power requirement:	AC 120V/60Hz
Power consumption:	33W
Dimensions:	430 (W) × 140 (H) × 330 (D)mm (17" × 5-1/2" × 13")
Weight:	9.5 kg (20 lbs. 15 oz.)

KYOCERA DA-810
Specifications

Frequency response:	5Hz–20kHz (± 0.5dB)
Signal-to-noise ratio:	More than 90dB (1 kHz)
Dynamic range:	More than 90dB (1 kHz)
Phase response:	20kHz 80 degree
Harmonic distortion:	Less than 0.005% (1 kHz, 0dB)
Wow and flutter:	Unmeasurable (dependent on precision of crystal oscillator)
Channel separation:	More than 90dB (1 kHz)
Output level/Impedance:	4V, 2V, 0.77V (3 points)/1 k ohms
AC power requirement:	AC 120V/60Hz
Power consumption:	33W
Dimensions:	460 (W) × 115 (H) × 311 (D)mm (18-1/8" × 4-1/2" × 12-5/8")
Weight:	8.5 kg (18 lbs. 12 oz.)

KYOCERA

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NEKNNAML HOP

A GREAT SET OF CHEOPS

I write this on the train from Cairo, having only a few hours ago said farewell to "Biff" Lirpa, son of the famous audio genius and tangled-string consultant, Prof. I. Lirpa. After months of negotiations, I finally arranged a meeting with Biff to check out the incredible rumors concerning his latest audio experiments. At last, he invited me to visit his Think Tank, located in a Cairo suburb behind a hummus stand.

Biff's Think Tank was in reality an old army tank purchased from a surplus bakery in Gaza. From outside, only the famous Lirpa banner flying from the radio antenna suggested anything unusual. But as I greeted Biff and climbed down into the tank, it was clear that the fighting vehicle had been highly modified for other purposes. Glowing electronic displays, rows of switches, a few Ouija boards, and other arcane gear was crammed everywhere in the already crowded space. My eye could just make out Prof. Lirpa's exotic collection of audio equipment, including a subminiature prototype of the Lirpa Compact Dish player (reviewed in the April 1984 issue). In the interests of secrecy, Biff confiscated my camera, as well as my pastrami on white bread with mayo; however, my notebook and pencil remained in my possession.

Diorama: James Nazz

I settled down in the gunner's seat and observed the top of Biff's head as his voice echoed up from the driver's seat below. He explained that the fabulous success of his father's audio products had produced billions in excess cash, and that the family had decided to diversify into areas such as communications, satellites, computers, and the franchising of goldfish-grooming boutiques. Biff had assumed a lot of things, including control of research at his mother's audio-communications corporation, Ma Lirpa. Their familiar slogan, "The louder you talk, the better they'll hear," had already caused the price of their stock on the Baghdad Exchange to catapult tenfold, from 0.01 to 0.1 cents per share.

Biff's department had researched several new products, all aimed at sending messages over incredibly vast distances, using acoustic methods to avoid the high cost of wires or radio transmission. Their prototype power amplifier, Big Bertha Lirpa (named after Biff's sister, Gladys), could deliver an acoustic output of 5 million megawatts (rms), thanks to the surplus Three Mile Island nuclear reactor inside. The unit comes on 28 flatbed trucks and can be operated anywhere, provided there is a large water source nearby (such as Lake Erie) for cooling purposes. NASA is considering using the amplifier to send acoustic messages to the moon, and Biff demonstrated its awesome output power in Los Angeles last year. In a highly publicized demonstration, he played a concert for folks who had recently died.

Following the success of the amplifier, the research team's direction was suddenly altered when Biff began dating Madame Zelda, a palm reader. His psychotherapist, Dr. Lucky (who was coincidentally Zelda's brother), advised Biff to take her advice seriously. Thus a new, crash top-secret project, code-named Crash Top-Secret Project, was initiated.

"How much do you know about the pyramidology theory of digital audio?" Biff asked me as he fired up the Think Tank, put it in gear, and headed out of Cairo into the Sahara. I laughed, thinking it was some kind of joke. Instead, he responded with an explanation which grew more incredible by the minute as we rumbled across the desert. "A couple of years ago, my father researched the monoliths on Easter Island and discovered that they are, in fact, highly sophisticated hot-dog vending machines built by an ancient civilization for outdoor rock concerts. However, he could never uncover the sound system these ancients had used. But one day while watching a *Star Trek* rerun, the one where Spock has a food fight with the guys with inflatable heads, it suddenly occurred to me that any civilization advanced enough to tell the catsup dispenser from the mustard dispenser without making one red and the other yellow, must have designed a *digital* sound system. The rest is obvious!"

My mystified silence caused Biff to explode with exasperation. "Don't you

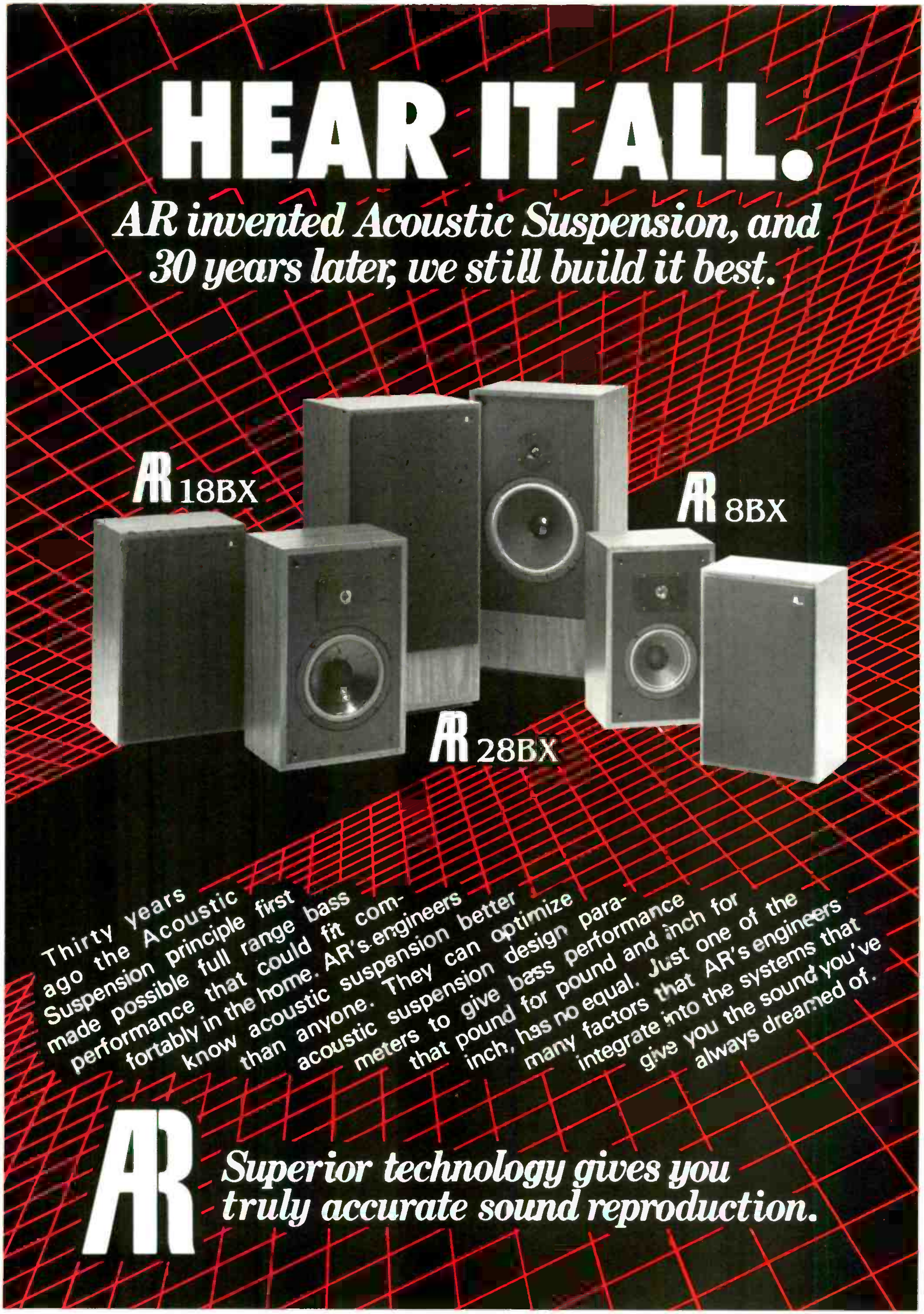
Biff Lirpa wanted to send messages over vast distances acoustically, to avoid the cost of wires or radio transmission.

see? Think about the Great Pyramid of Cheops: It has exactly 2,097,152 building blocks, which is 2^{21}; in other words, 21 bits per data word. And the angle of the sides is exactly 51°, which is their sampling rate in kilohertz. Wow, what a system! There are 201 stepped tiers of limestone blocks, with an average weight of 2½ tons each, all rising 485 feet over the plateau. Its base is 13 acres square—about seven midtown blocks in New York City. If you took it all apart, you could build a wall 3 feet wide and 10 feet high around France! Damn, I bet it's *loud*!"

I looked at him blankly, still wondering how the conversation had gotten from Easter Island to Egypt, never mind New York and France. "Don't you see?" Biff asked again. "It's the world's first, and biggest, digital sound system! He pointed excitedly through the driver's slit. I peered through the gunner's periscope and there, coming up over the desert horizon—a mountain blocking the red sunset—was the Great Pyramid itself. "Don't you see? It's a *stereo*! Each of the 2 million blocks is a quantization interval, and when you resonate it at the sampling frequency, it *plays*, two channels from each of the little pyramids on the sides. Wow, think of the *bass*! Those ancient Egyptians sure loved to dance!" I stared at the man-made mountain towering ever higher before us, my brain frozen with awe and wonder, and then my jaw dropped. Clearly, Biff Lirpa had unlocked the secret of the pyramids.

"Zelda thinks it was probably built by some alien astronauts who couldn't get a permit in their galaxy—I mean, who wants loud music, not to mention all the traffic, in their backyard? So they built it on Earth—got it zoned for recreational use. Easter Island was the concession stand, they probably kept the brewskis cold in Antarctica, and the Middle East here was the stage. Must have been some scene! But anyway, I want to show you just what the Crash Top-Secret Project has developed. My chief engineer Nuke Napoleon and I have replicated all of the electronics necessary to activate the pyramid sound system.

"It's really very simple. We use my Dad's Compact Dish player as a signal source, but we patch the laser beam directly into a special bebop circuit which is powered by a Briggs & Stratton lawn-mower engine modified for fission combustion. Of course, the signal is time-travelled and defrosted before it goes into the spin cycle, and it is filtered through a pair of fuzzy, red dice. The secret of the activation system is the glitter glove which is used to excite the hydraulic angular bremsstrahlung system, provided the time-space continuum isn't ripped apart when the lattice comes unglued. I mean, we are generating the energy equivalent of a head-on collision between two solar systems, which is quite a lot."



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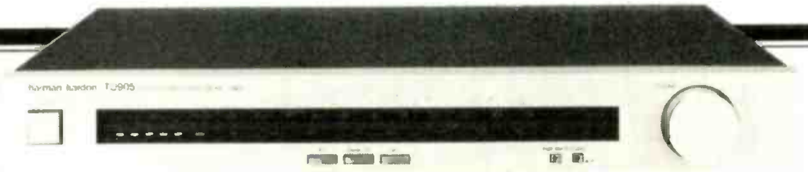
There was a smoking crater where the pyramid had been. "Sorry about that," Biff said. "I guess I miscalculated."

"Okay, let's stop here, about a quarter mile from the site," my guide continued, pulling the Think Tank over. "For demonstration purposes, let's activate that small pyramid over there—the Mycerinus Pyramid, which was the speaker system typically used by the warm-up band. I just look through my viewfinder and rotate this knob on the master control panel until the cross-hairs line up on the apex. Got it! Okay, let's try a 1-kHz test tone through the system—I hope it's all still calibrated—I mean, the last concert they played here was during the fourth dynasty of the Old Kingdom, around 2450 B.C., for Pharaoh Chephren's bar mitzvah."

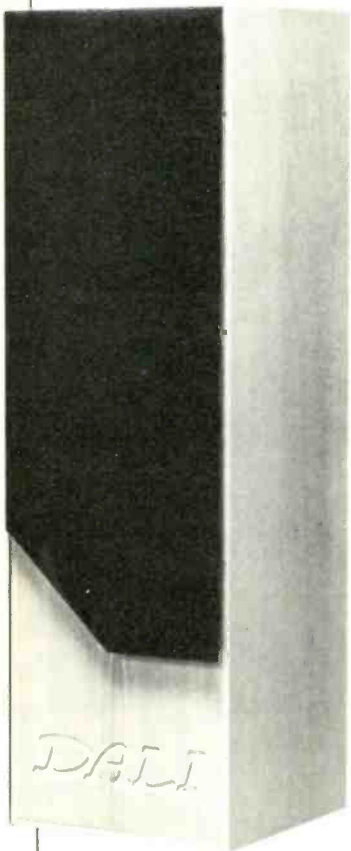
I waited, breathlessly, to hear the ancient, digital sound system come alive after a 4,000-year intermission. Biff made a final systems check, put a quarter in the slot on the master control panel, and pushed the one-play button. A red, beeline laser beam shot through the air and touched the apex of the Mycerinus Pyramid. Instantly the stone monument glowed a resplendent ruby-red against the twilight sky. I heard a deep groan well up from the desert sands, and the 1-kHz test tone sang out into the hot air, growing louder by the second, and then louder and louder still! I clasped my hands to my ears, shaking at the intensity of the sound, my eyes involuntarily blinking against the sonic onslaught, and still it grew *louder*. I screamed at Biff, but my words didn't even reach my own ears, so great was the voice of the ancient sound system, which grew even *louder*! Then suddenly the pyramid turned yellow, then blue, then white—and exploded. The Think Tank rocked under the impact as it was pelted with huge chunks of limestone and camel parts. Then it was over. I cautiously peered through the haze to observe a smoking crater where the Mycerinus Pyramid had once been; now it was history. I slowly drew my hands from my ears, not knowing if the desert was again still, or if I had lost my hearing. Biff's voice broke the silence.

"Gee, I'm sorry about that. I guess I miscalculated the power-handling capacity. You know, I always get squares and roots confused. Well, no matter, it was only a test. But when I try out the Great Pyramid, I'll use the Sphinx as a fuse, just to be safe." ◭



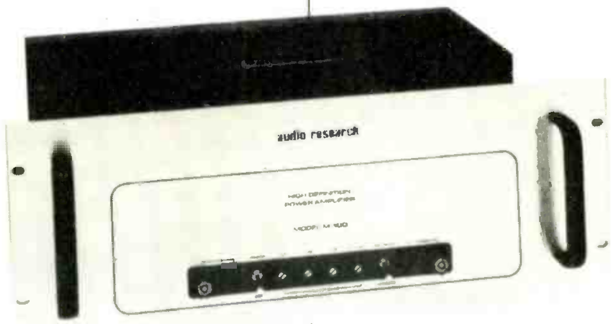
DALI Speaker

Not the artist but Danish American Ltd. offers the DALI 6, a three-way system with 10-inch woofer, 8-inch mid/woofer, and 1⅛-inch dome tweeter, all housed in a walnut-veneer cabinet. It can be driven with just 10 watts of power, or can handle up to 200 watts. Frequency response is rated 40 Hz to 20 kHz, ±3 dB, with distortion 0.3% or less above 100 Hz. Sensitivity is 91 dB. Price: $198 each.
For literature, circle No. 100



Harman/Kardon Tuner

New analog tuners are still appearing. Harman/Kardon's TU905 offers slim-line styling, a few jazzy features (high-blend and muting), and circuitry and layout designed to reduce noise and distortion. Specifications include 50-dB quieting sensitivity of 3.8 μV in mono and 44 μV in stereo, ultimate stereo S/N of 71 dB, and stereo THD of 0.15%. Price: $175.
For literature, circle No. 101



Audio Research Amplifier

The M-100 is a 100-watt, monophonic tube amplifier with several circuit features not found in Audio Research's stereo models: The power supply has 280 joules of energy storage, the highest per watt of output power of all the company's amplifiers. A "cross-coupler" servo circuit automatically maintains d.c. balance, even after tube changes. Output-tube bias can be adjusted from the front panel with the aid of four LED indicators; once set, it is electronically regulated to eliminate drift. Price: $2,495.
For literature, circle No. 102

Technics CD Player

With the Technics SL-P3 Compact Disc player, you can see your CD spinning from any angle. More important than the Disc Prism feature which allows this are several new automatic functions. For radio stations (or the merely impatient), "Auto Cue" finds the first note of a selection and pauses the deck there (not at the track beginning, which may be a few seconds earlier), for instant play at the touch of a button. The automatic music scan system previews the first few seconds of each disc—how many seconds, from 1 to 99, can be programmed by the listener. Both fixed- and variable-level outputs are available, the latter adjustable from the wireless remote control. Up to 15 selections can be programmed, by track or index number, and displayed on a fluorescent bar-graph. The display also shows track and index number, total and remaining play time, and the status of most operating functions. Price: $600.
For literature, circle No. 103

Pioneer CD Player

The P-DX700 features programmable play of 10 tracks, repeat of a track, phrase or side, and audible slow scan in both forward and reverse. Its fluorescent display shows track, index, total play time, total remaining time, and time elapsed since the beginning of a track. Price: $539.95.

For literature, circle No. 104

Uher Cassette Recorder

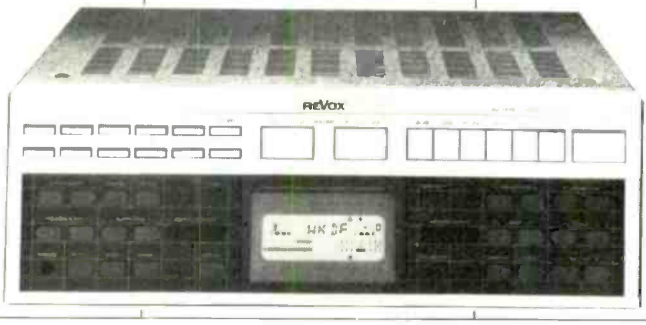
Uher has returned to the U.S. market with the kind of high-fidelity portable cassette recorder they have long been known for. The Uher CR 160 AV features Dolby B and C noise reduction, three built-in speakers for monitoring, separate right and left level controls and meters, and switchable automatic level control with a choice of two time constants. The 160 AV is front-loading and can be powered by dry cells, rechargeable batteries, 12-V car batteries, and 110/220/240-V a.c. Accessories are available for film dubbing, sync sound, and remote control. Price: $998.

For literature, circle No. 105

Revox Receiver

The liquid-crystal display on the Revox B285 shows up to 17 receiver functions, including frequency and call letters of the FM or AM station being heard, the input source, volume and tone settings, tuning accuracy and signal strength, and other control settings. The 29 station presets can be programmed not only for station frequencies but band (AM or FM), stereo/mono/blend setting, and audio signal level. A bidirectional control port permits an optional timer-interface unit to control station and program-source selection; this allows a listening session to be preprogrammed from tape, CD and phono as well as radio, and also permits remote control from other rooms. (The same timer-interface controls other new Revox components.) The B285 delivers 85 watts of power per channel, with power limits separately programmable for each of its two speaker outputs. Price: $1,600.

For literature, circle No. 106



Linn Tonearm

The Linn Basik Plus tonearm incorporates several improvements over the earlier Basik LVX (which remains in production). Its heashell is fixed rather than detachable, for decreased effective mass and increased rigidity. That rigidity, plus better bearings, increase the arm's suitability for use with low-compliance MC cartridges. The arm comes with a Linn Basik III cartridge. Price: $160.

For literature, circle No. 107

Soundcraftsmen presents...

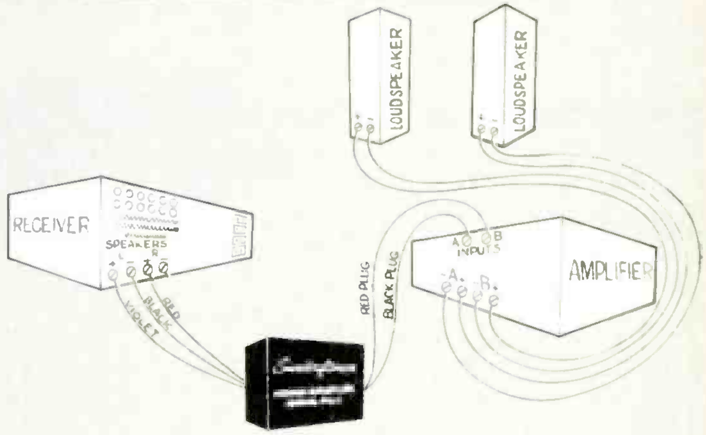
A "DYNAMIC-RANGE-EXPANDER"!

Add the power you need to hear the Full Dynamic Range of the fabulous new digital, dbx, Dolby and Compact Disc recordings—without obsoleting your present stereo system!

Don't sell or trade in your receiver just because you need more power!

The Preamp/Tuner section of your receiver can be instantly coupled to a Soundcraftsmen high-power amplifier with the amazing PC-1 Power Coupler.

The PC-1 connects to receiver (or integrated amplifier) speaker terminals—perfectly matching the inputs of any Soundcraftsmen amplifier!



Add our new Power Coupler, the

PC-1...just $39.00!

Ask your Dealer—(opposite page)—to Demonstrate the PC-1 with the new PCR800 Power Amp...

You must HEAR it, to believe it! The improvement is fantastic! **You'll love it!**

THE SOUNDCRAFTSMEN PCR800 PHASE-CONTROL-REGULATION STEREO AMPLIFIER

410 watts—MOSFET— 205 watts per channel $449.00

@ 8 ohms, 20 Hz–20 KHz, less than 0.05% THD...

Soundcraftsmen's research into **Digital Audio Technology** has resulted in a major advance in amplifier design—**Phase Control Regulation.**® The world's first **PCR** amplifier, the **PCR800**, sets continuous performance and reliability standards never before possible in audiophile equipment.

Soundcraftmen's **PCR technology** makes possible an amplifier that is not only small, lightweight and low in cost, but one which continues to operate normally, in actual **real-world** systems, at any impedance down to zero ohms! Even a **dead short** won't harm the **PCR800**! **Current-limiting**, the most commonly-used form of amplifier protection circuitry, is **totally eliminated** in the **PCR800**, along with the inherent sound degradation commonly associated with current limiting protection circuits.

HERE'S HOW "PCR" WORKS

An **electronic** "**brain**," fed by multiple precision temperature sensors located strategically throughout the amplifier (we call it **Thermo-Coupled Feedback**), constantly monitors the operating temperature of its various sections. It directs the internal cooling fan to supply the required amount of fresh air whenever needed. If the operation of the **PCR800** is **so extreme** that high speed cooling is inadequate, the "brain" constantly **adjusts the voltage** fed to the **POWER MOSFET** output transistors, eliminating any destructive tendencies while permitting continuing operation. **THE RESULT?** Clean, clear, unstrained sound under **any** operating condition, optimum power available into **any** impedance **at all times—not just for "peaks"**... and **total reliability at all times.**

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Take this Market Research Coupon to your dealer, ask for a demonstration of how *ANY* receiver or integrated amp can play FANTASTIC music by adding the Power Coupler and the $449.00 PCR800 (or *ANY* of our other high powered amplifiers).

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Enter No. 30 on Reader Service Card

EDWARD TATNALL CANBY

PHONO SAPIENS

Nature did not envision audio back when ears were developed. Like our eyes, the ears predate all modern technology by millions of years, or thousands of millennia, or tens of thousands of centuries. Quite a long time. This has had curious effects on quite a lot of audio.

Nowhere in our remarkable hearing system is there the slightest trace of physical adaptation to the recent challenges of reproduced sound. We have exactly the same sort of facilities which belonged to Moses and to Methuselah, who lived out his thousand years (it is said) with ears that could be today's.

For that matter, if you follow the latest, we have exactly the same ears as the distant people who left their cave paintings deep in the earth a mere 30,000 or so years back. I've put my eyes within inches of some of that paint and it was an experience just to look at it, as I've noted here before. Unfortunately, we have no audio preserved from those times, but we can be sure that, given a bit of cultural background and some concentrated education, any man from 30,000 years ago could receive our signals exactly as we do—and *substantially* in the same way for a much longer time back.

We've inherited a set of perceptions, then, that are both rigidly fixed, over the short time range, and extremely old, differing among us a bit here and there but essentially the same among all members of the species *homo sapiens sapiens*. What we can do, however, is to develop, exploit, polish these abilities to an astonishing degree. That is man's greatest inheritance, the ability to adapt and perfect what we have built into us. But we cannot ever go beyond the set limits from so far back. Not, at least, for a few million more years.

We will never hear the high sounds bats hear, nor emit them for a personal sonar. (Edward, meet my children—*E.P.*) We can feel the lowest sounds but we cannot train ourselves to hear them. We don't sense earthly magnetic fields, as some birds evidently do to guide their migrations. What an idea—if we only could! We don't digest cellulose, though any old cow or goat does it with nonchalance. (We eat the cow instead, a useful shortcut.) These are the limits.

Illustration: Ben Chase

What happens when a hearing system as rigid and timeless as this runs into a whole new set of sonic stimuli, in the quarter-second of macrotime since audio appeared? Old, familiar sounds are heard in new places—voices on TV, a symphony inside a small automobile. Even more interesting, how about wholly new sound patterns never before heard by any ear?

Will the reaction be bafflement and confusion, as in weightlessness? Or a lethal lack of any response, as in radiation? Or might it be positive in unexpected and surprising new ways? Definitely yes, on that. Otherwise, no audio entertainment.

This line of thought, not new to this department, came to me again out of recent, casual correspondence with a younger colleague out on the West Coast. He is a free-form electronic composer whose work gets immediate practical use in the dance. He puts it together on tape, assembled from bits and pieces, live, recorded, synthesized, in overlays and underdubs; I've done the same for longer than he has, but with very different base material in the "classical" area.

Both of us know that our unchangeable ear systems can be tricked to great advantage—if we know how. But we also know that these same ears are extremely demanding and will not go along with us unless things are *exactly* right. Perfectly reasonable, edited splices that "ought" to work can sound just awful. If you're the composer, don't argue! Just try again. With persistence, you'll find the right place and the ears will allow themselves to be fooled quite beautifully.

It is an exact aural science, and I would rather call it an art. Tiny shavings of tape, maybe as little as a 16th of an inch, can make the difference between failure and credibility. (A search-and-find system on your hi-fi that is, say, accurate to a half-second, is far too crude for any such work.) What has to be learned is not so much the finger dexterity, which is nothing, but rather how to judge the ear's probable reactions. That goes for digital, too, with its costly matching-up of waveforms. The lively ear still may reject what looks to be a perfect match on a CRT.

Take a specific phenomenon, which I mentioned to my West Coast friend: Percussive sound and, in particular, the sound of the piano. What happens if you play piano in reverse?

A few words for those who haven't experienced Sony's new Compact Disc Player.

Listen to it.

Enter No. 40 on Reader Service Card

We developed a specific response to sudden clumps of sound transients, maybe even before we were swinging from tree to tree.

In piano sound, each note has a sharp clump of complex transients, then a slow and smooth decay of the pitch. It is the initial percussion that makes a piano sound like a piano. The sound is only 0.2 millennia old so far, but we all know it well, whether "real" or synthesized. The ear accepts piano sound as a meaningful waveform, straight out of the long mainstream of past hearing experience, back to prototype percussion noises in the dimmest past.

But play that sound backwards, as we can now do via recording, *and you no longer hear a piano*, even though the melodic line is recognizably reversed, note for note. Instead, you are listening to an oddly gasping squeeze box with an accordion sound, each of its rather reedy notes growing spasmodically louder and ending in a sort of stifled gulp, like a nervous singer who swallows involuntarily. A sort of *whup . . . whup*.

That addled and zany sound, my friends, is percussion in reverse, as interpreted by a receptor system that has never encountered such a pattern before and is thus completely unprogrammed. When a computer gets this sort of message it usually throws up an E for error and quits operating.

The reversed signal is no longer percussion! It is someone else's jargon. The ear doesn't recognize the reversal. And so—no piano sound. A squeeze box. Shades of Alice and her looking glass. Remember the "ouch" that came before the needle prick?

Percussive sounds—right way around—are very much a part of our ear's receiving vocabulary, and for good reason. For millions of years our species has been hearing all sorts of bangs, cracks, booms, thwacks, clicks, noises that go "pow," sounds that crackle and rustle, all of them jammed with percussion, which has always conveyed immense sonic intelligence for daily living and, often, for our very survival. So the ears, over the really long haul, developed a specific response to any sudden and loud-seeming clump of sound transients, maybe even before we were swinging from tree to tree like Tarzan. Musical percussion is just a spillover, touching off the same built-in response. You can't describe a percussive sound, as you cannot describe red. But you can hear it, loud and clear. A marvelously exploitable sound.

We have never had to cope with these patterns in reverse, and so we lack any special reaction to them. For the moment, we are helpless. Maybe later, say in another million years, we might come up with something more meaningful than a gulp or *whup*, which is all the ear can now do with backwards percussive sound. Remarkably ineffectual. Try it for yourself.

Even so, the reverse-percussion effect has become familiar, at least to a few of us, and has been put to use. I was playing games with backwards sound in the '50s. The Beatles were into it by the '60s. *Sgt. Pepper?* I think it is there that a reversed piano is neatly mixed into the general zany background. I spotted it long ago and proved the point by playing the LP backwards. There it was, a perfectly ordinary piano playing Chopin or the like, mixed in from a tape loop.

There's an interesting opposite effect. *Any* clump of sudden transients, real or synthesized, will sound out as a "bump" of percussion. Even when it is actually transient distortion generated in the system. Back when I was first experimenting with these things, I got the idea one day that I might create a new kind of smooth melody without percussion if I sliced off the percussive "heads" of a series of piano notes. Sooner thought than done: I laboriously snipped away the beginning of every single piano note in a long melody and then spliced the whole thing back together again. To my astonishment, I still heard a perfectly good piano. Didn't I remove enough? I took it all apart again and removed another slice from every note, indubitably beyond the natural percussion. It was *still* a piano! I was dumbfounded.

Well, as I figure it now, the sudden new "edge" of sound as each note crossed the tape head was too much for the local electronics, and so there was momentary transient distortion until the response settled down—thus a "bump" of false percussion that, for the ear, was just enough to sound like a piano note. You could go on cutting those notes down to nothing and they would still sound like a piano.

The ear itself creates distortions when, so to speak, it finds them convenient. So I suspect that, even with ideally clean electronics (impossible except maybe via digital), the same sort of "bump" could be generated entirely inside your own hearing. You cannot kill normal piano sound. On the other hand, you can never make a reversed piano sound like a piano.

The general lesson of all this applies to everything in audio—percussions of all sorts, but also many another ear-set and waveform. I've often created false consonants to repair vocal music where the real consonant was lacking in strength. Just splice in a little bump and you have your consonant. But beware of vowels! If you don't keep all of the brief vowel buildup, if you cut into the vowel sound itself, you will have a brand-new consonant not intended by the composer. Amen, for example, can become TAH-men.

In another area, for decades we have been enjoying small radios and a billion low-fidelity telephones, because we can synthesize highs and lows that are not there. We understand a man's voice by reconstructing the bass from its higher overtones. The highs, the sibilants, we supply by context. We hear "foap opera" and immediately translate it to "soap opera."

These are the ways in which we manipulate our super-ancient ear responses. The physical rules are implacable, and response cannot be changed. Natural ears cannot hear a literal concert hall inside an automobile, short of a million bucks' worth of digital delay and a trailer behind to carry it. But we can easily trick the ears into thinking we've done it. And we do. Be creative! Use the ears well and they will lead you, as we say, right down to the bank. Presto, you are high-tech, super-fi and state-of-the-art. Assuming, of course, that you've applied a bit of proper audio engineering here and there.

A few words for those who have.

INTRODUCING THE THIRD GENERATION CD PLAYER THAT'S LIGHT YEARS AHEAD OF THE COMPETITION.

After listening to one of Sony's new third generation component CD players, you begin to realize you're hearing something not possible in any first, or even second generation player.

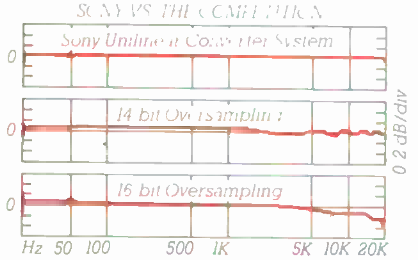
It's a whole new level of technological achievement not merely designed for those who appreciate great specs, but those who appreciate great music, as well.

A RESPONSE CURVE THAT ISN'T A CURVE.

All CD players are endowed with a much flatter response curve than any turntable or tape deck is capable of reproducing. Unfortunately, most are also endowed with a conventional converter/filter system. Which tends to cause high frequency irregularities.

However, take the response curve of Sony's new CDP 302 (the one that's flat as a board).

FREQUENCY RESPONSE
SONY VS THE COMPETITION



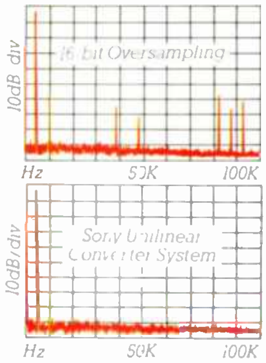
As you can see, it's far more uniform than the one found in conventional models. What this should tell you is that when you listen to even the most intricate piece of music, you'll be hearing precisely what the musicians recorded. Nothing more. And nothing less.

YOU CAN'T BEAT OUR CLOCK.

Perhaps the most interesting "little" feat of engineering is Sony's new Unilinear Converter System. Its high-speed, digital-to-analog converter works by virtue of a "master clock." Using this single clock dramatically reduces intermodulation distortion common to "multiclock" converter systems.

When you combine all this with our new, high-resolution digital filter, it results in something even the most ardent audiophile will find no fault with. Incredibly flat response, remarkable phase linearity and the conspicuous absence of spurious noise caused by conventional oversampling.

NOISE
SPECTRUM COMPARISON



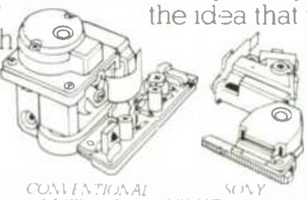
Of course, you'll need a master's degree in engineering to fully understand all the intricacies of our new Unilinear Converter. But you certainly don't need one to appreciate it.

A NEW CHIP OFF THE OLD BLOCK.

The heart of our new CD player is a thing of beauty. This award-winning microchip governs nine different functions usually requiring multiple chips in conventional players. But more importantly, it simplifies the signal path and improves reliability.

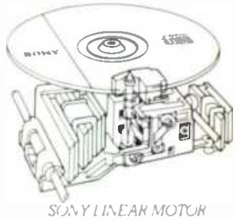
CHANGE TRACKS AT THE SPEED OF LIGHT.

Sony has done away with the lumbering gear-driven tracking mechanism, and instead, created a whole new Linear Motor Tracking System. It uses a compact laser optic assembly that's one-third the size of typical units. And its linear, noncogging motor allows the laser to move faster and more precisely.



CONVENTIONAL LASER OPTIC ASSEMBLY — SONY MINIATURIZED LASER OPTIC ASSEMBLY

If you're wondering what speed has to do with these mechanisms, we'd like to remind you of the fact that it takes some CD players up to 15 seconds to go from the first to the last track on a disc. But with ours, you can go from track 1 to 99 in less than a second.



SONY LINEAR MOTOR TRACKING SYSTEM

FEATURES WORTH HEARING MORE ABOUT.

Not all of these advances are audible to the naked ear.

Both of our new CD players come complete with Sony's Remote Commander® unit which provides direct access to up to 99 tracks or subcoded selections. In addition, both have Automatic Music Sensor,™ high-speed search and three-way repeat. (The CDP 302 shown here also allows for programmability of up to 16 of your favorite songs.)

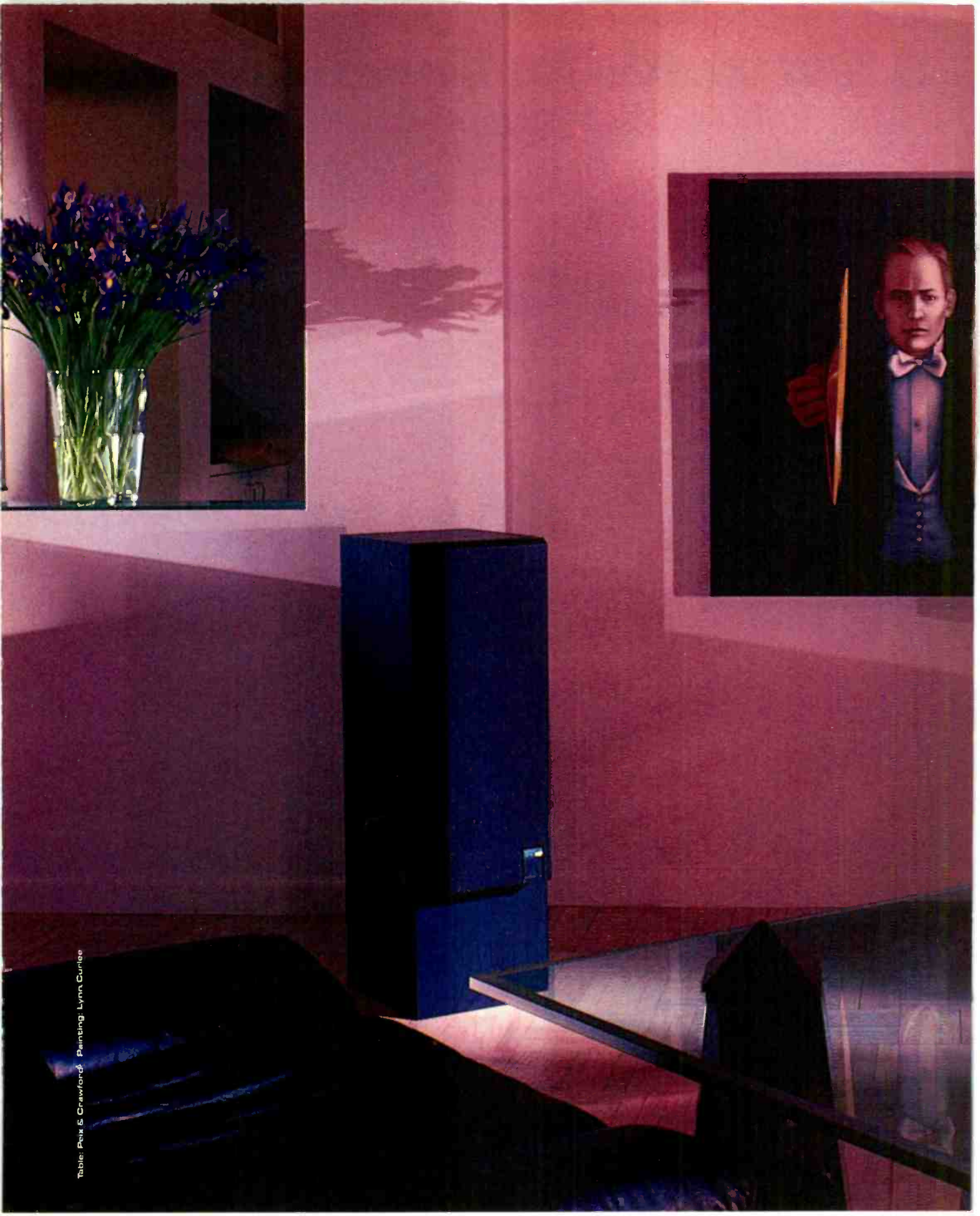
We'd also be remiss in not telling you about our built-in subcode port. Which in the not-too-distant future you can make good use of when CDs are integrated with graphic information.

By now, you're beginning to get the idea that the new line of Sony CD players not only sound remarkable, they are.

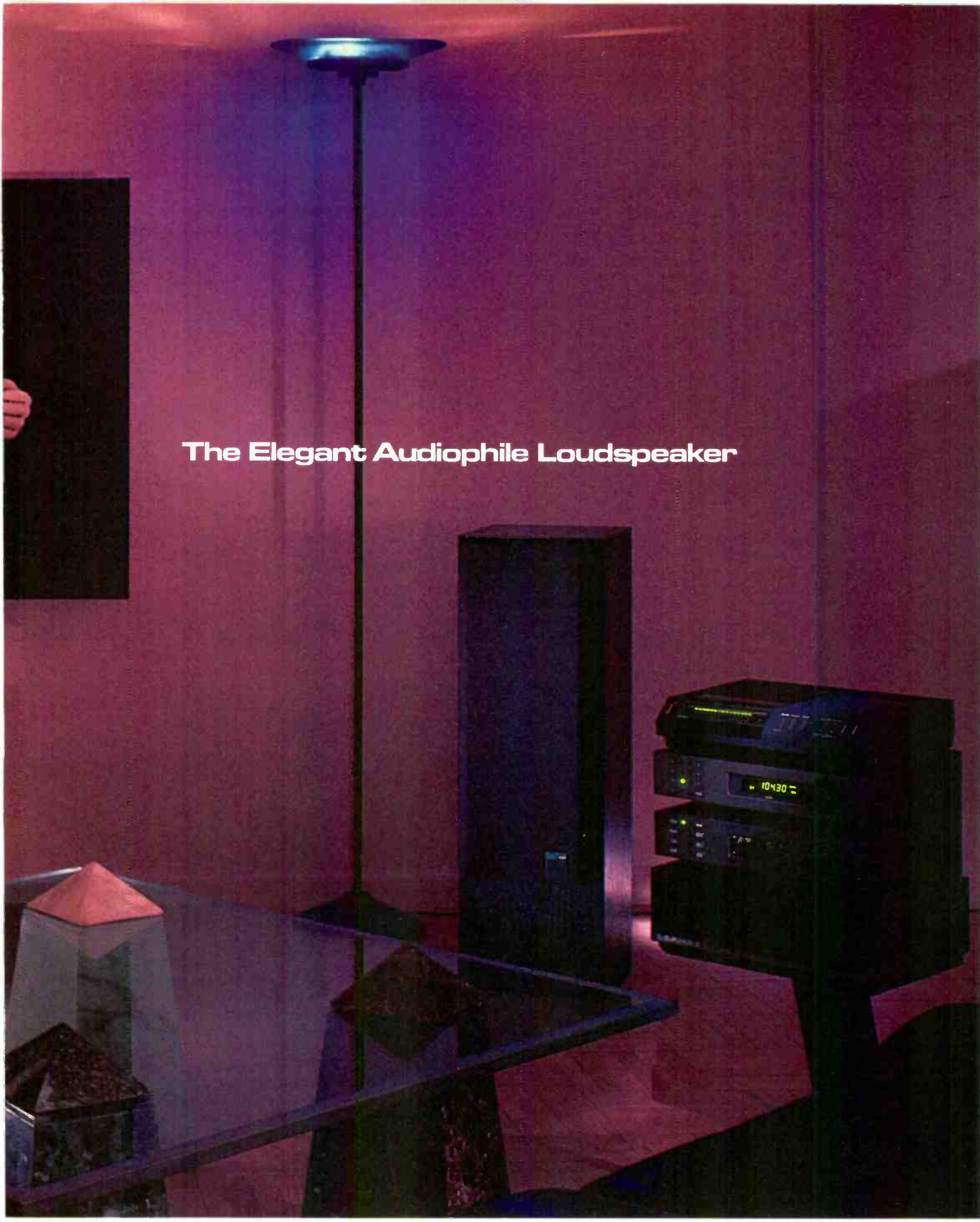
So having heard and read just about all there is to hear and read about them, we suggest there's only one thing left to do. Go to your Sony hi-fi dealer and purchase one.

Of course, there's no rush. It will take our competition at least one or two generations to catch up.

SONY®
THE LEADER IN DIGITAL AUDIO.™



To end the age old dichotomy between sound and style, Great Britain's master loudspeaker builder, KEF, has produced the Reference Series 104/2. Capable of satisfying the design conscious and the sonically critical alike, the 104/2 is predicted to emerge as one of the most significant loudspeakers of the decade. (Previous KEF Reference Series models, including one introduced almost a decade ago, remain to this day at the top of their respective categories.)


The Elegant Audiophile Loudspeaker

IVAN BERGER

LIVE FROM LAS VEGAS

Usually I lead off my CES car stereo reports with in-dash tuner/tape decks, because their lights, buttons and beepers give me more to write about. This time, I'll start off at the speaker end and work my way back, as that's where I found the hottest news.

The speakers which interested me most at the Winter CES in Las Vegas were the new entries from KEF. The basic design for both KEF's GT 100 and GT 200 speakers is a two-way plate with 4½-inch woofer and 1-inch, soft-dome tweeter, designed to sound best when heard off-axis (as most car speakers are). Since the cavity behind the drivers is so unpredictable, the GT 100 has its own vented cavity built in, for controlled rear loading, yielding a rated response of 50 Hz to 20 kHz, ±3 dB. The GT 200 has a closed, damped enclosure, which cuts its response off sooner (−3 dB at 150 Hz)—but this model is designed to cross over at 170 Hz to a matching subwoofer, for response which is only 1 dB down at 50 Hz (but −10 at 30 Hz). The 8-inch subwoofer (I gather there will also be a 6-inch model) has its own enclosure, so it can be mounted below the rear deck or out in the open, in a hatchback or van. The woofer boxes (one per channel) measure only 11¾ × 11¼ × 5¼ inches. The technology is intriguing, and the sound was clear and clean and natural, just what you'd expect from KEF.

I'd expect about the same quality of sound from B & W, of course, but it will be a few months yet before I get to hear how well their car speakers live up to expectations. Still, there was enough of interest in their mock-ups to attract my attention. The B & W MASS (Modular Automobile Sound System) will include similarly styled modules for high frequencies, bass/midrange, subwoofer, and crossover. The HF and bass/mid modules will be shallow speakers in rectangular housings which may be flush-mounted in a hole, mated with a similar-shaped back for mounting on a surface or a bridge (which in turn can be mounted on a shelf or suspended across an open hatchback), or mounted at an angle to the bridge or surface. The subwoofer mounts in the trunk, venting into the passenger compartment through a hose. The hose can open into a "low-bass module" whose function is apparently to make the opening look less like a black hole than a matching speaker. Even the crossover module is styled and mounted like the speakers.

B & W MASS: Modular and then some

The sound of Infinity's new CS-1 component speaker system also impressed me. The system uses separate EMIT tweeters; 4-inch, polypropylene midranges, and woofers measuring 6 × 9 inches, for response rated at 36 Hz to 32 kHz.

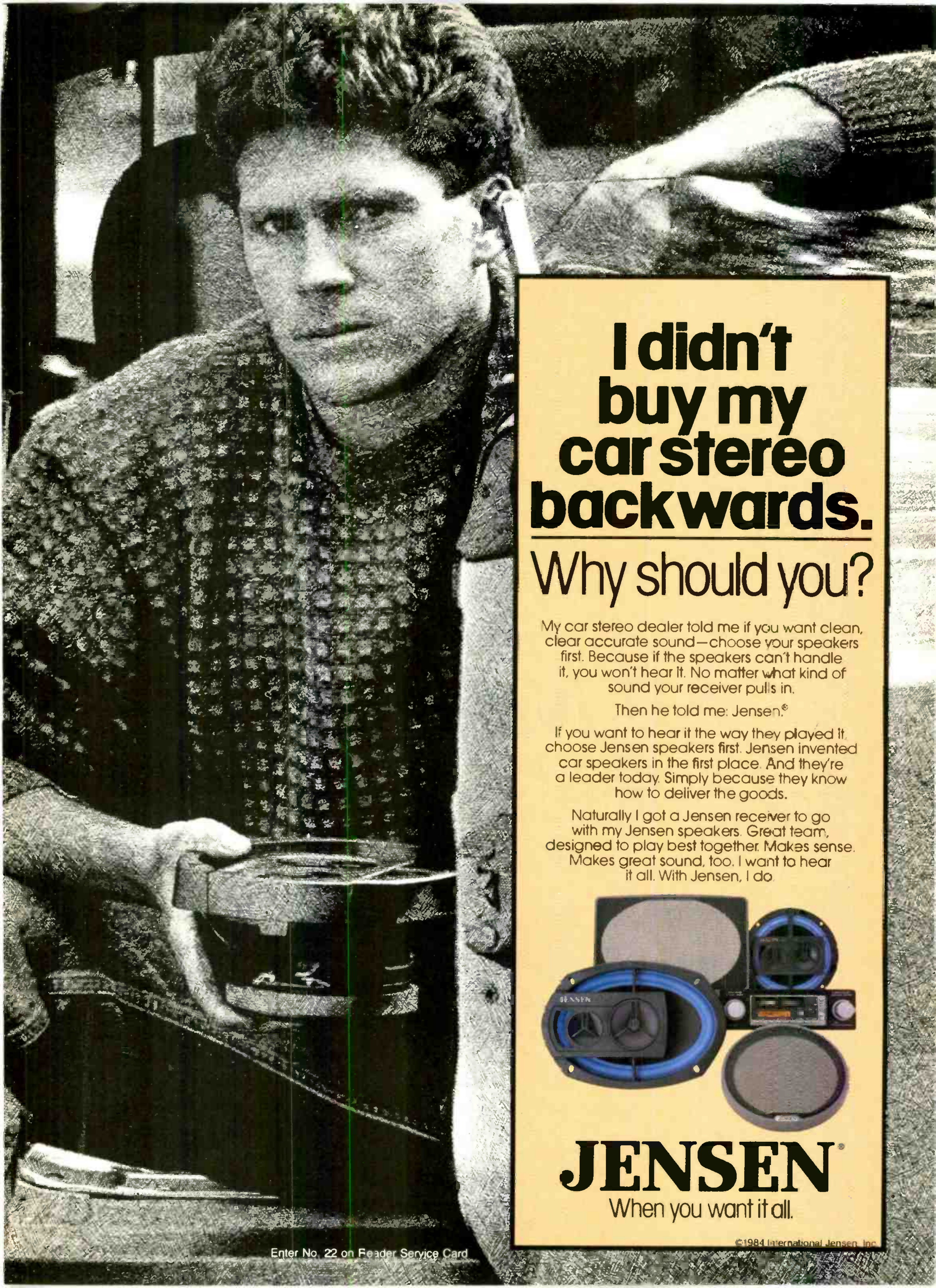
More home-equipment names entered the car speaker market: Jamo, with one surface-mount and four panel-mount systems, and SFI.

The most interesting mounting system belonged to the Challenger Top Sound, a speaker pair designed to mount across the top of a car and equipped with a dome light to supplement or replace your car's present one. The system uses Philips 5-inch woofers and 2-inch cone tweeters. The bass-reflex cabinets, rated down to 70 Hz, are covered in any of six colors of nylon velour. I would not expect great imaging from a system which puts you so much closer to one channel's drivers than to the other's and which sits behind you, but for some installations it may be the only viable solution. The Swedish-built speakers are $249 per system and are imported by World of Sound, West Palm Beach, Fla.

Sparkomatic seems determined to shed its former, humdrum image. Last year, they introduced the Amplidyne ASK 4000 series of biamped speakers in zippy-looking, surface-mount enclosures. This year, they showed the ASK 3000 series, also biamped but primarily designed for flush mounting. The ASK 3000 separates, rated at 70 Hz to 20 kHz, include one 20-watt amplifier per woofer and a 5-watt amp for each tweeter (measured at 5% THD). The ASK 3010 has dual woofers and detachable tweeters, plus the same amplifier power; it mounts in holes measuring 4 × 10 inches, or, with adaptors, 6 × 9 inches. The ASK 3015 is a surface-mount system having more utilitarian styling than the ASK 4000 models and without the latter's periscope tweeters. The ASK 3030 subwoofer has two 4-inch drivers, each with a 25-watt amp, and is rated at 50 to 250 Hz. The systems are $100 to $130 per set; the woofer is $80.

Among Yamaha's three new speakers is one product which is deliberately, and usefully, cheesy: The frame of the new YCS-460, a two-way system with a woofer of 4 × 6 inches, has enough mounting holes to make it look like Swiss cheese—and also enough to make it fit as a replacement for almost any speaker measuring 4 × 6 inches, with no need to drill new holes. I noted that MTX has a similar model.

Magnum Loudspeakers, a sister company of MTX, has produced an impressive-looking Magnum Opus series of drivers, with a lot of attention paid to materials and construction details. For example, they use polypropylene cones for good sound and moisture resistance, barium ferrite


I didn't buy my car stereo backwards.
Why should you?
My car stereo dealer told me if you want clean, clear accurate sound—choose your speakers first. Because if the speakers can't handle it, you won't hear it. No matter what kind of sound your receiver pulls in.
Then he told me: Jensen.®
If you want to hear it the way they played it, choose Jensen speakers first. Jensen invented car speakers in the first place. And they're a leader today. Simply because they know how to deliver the goods.
Naturally I got a Jensen receiver to go with my Jensen speakers. Great team, designed to play best together. Makes sense. Makes great sound, too. I want to hear it all. With Jensen, I do.
JENSEN®
When you want it all.
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The technology of the new KEF speakers may make headlines. The sound is clear, clean and natural.

KEF GT 100: Nice 'n' natural

magnets, baskets die-cast of a nonmagnetic zinc alloy, Kapton voice-coils, and nonlinear resistors for thermal protection.

Philips is going after some specialized markets, with two-way panels designed to fit the dashtop holes of Saab 900s (but not, alas, the hole-less dashboards of Saab 99s like mine); they've also got a seven-driver box (two 6½-inch woofers, a 10-inch passive radiator and two Philips Double Dome drive assemblies, each with 1-inch midrange plus ¾-inch tweeter) to fit behind a pickup truck's seat. The truck system, the Model S-10, includes a carrying handle for use when you're outside the vehicle.

The recent rush of innovation in driver technology seems to have slowed. Ultimate Sound (in City of Industry, Cal.) has honeycomb drivers in sizes from 4½ to 8 inches across, including one 6½-inch-square model. The SFI speakers mentioned earlier use the company's Dynawave flat-driver technology. Sony introduced new APM flat-driver models. The car version of ESS's Heil driver now seems to be in regular production. And that was about it.

Two new subwoofers caught my eye. The SAS Bazooka T62, from Southern Audio Systems in Denham Springs, La., caught my ear as well. The under-$200 system consists of two computer-aligned, ducted-port reflex enclosures. The system is corner-loading, so it's only for vehicles with corners, such as trucks (it fits behind the seats of minis), vans or hatchbacks. Each 6½-inch woofer is coated to lower its resonance, which also makes it more moisture-resistant. The maker's claims that the enclosure is "high-impact" and "moisture-resistant" are, if anything, wild understatements: The basic material is plastic water pipe. And the sound is good.

I didn't get to hear the other subwoofer that caught my eye, Alpine's new 6490, but the technology sounds interesting, incorporating an unusual amalgam of techniques. The 6490 uses an acoustic suspension enclosure, firing through a labyrinth opening into a corner of the vehicle, with that corner serving as a horn. Rated bandwidth is 30 to 500 Hz, and the price is $250 per pair.

Even more fascinating were some hashed technical phrases in the press releases of a company whom I shall leave, mercifully, nameless: "The woofer edge is made of a urethane material with excellent anti-amplitude characteristics . . . . The woofer coil is large and, thus, has a high resistance-to-input." Shows you what can happen to a manufacturer rushing to get ready for a show.

Another amplifier from
McIntosh that

SOUNDS GREAT!

Although 'High Tech' is a new term in our language, 'High Tech' has always been the norm for McIntosh. McIntosh amplifiers have consistently forced new levels for quality performance, new levels for reliability, new demands on quality power that produce near perfect Spectral Fidelity and the greatest sound. McIntosh is the ONLY company that has achieved these superior levels of performance.

'High Tech' is the right description for the NEW McIntosh MC 2002, a powerfully perfect 200 watt per channel (300 watts into 4 ohms) power amplifier. The pleasure you enjoy from music is protected by McIntosh Power Guard (patent #4,048,573), an exclusive McIntosh circuit, McIntosh invented that insures Spectral Fidelity for greatest sound.

Todays electronic instruments and superior recordings push amplifiers for power performance beyond the amplifier's capabilities destroying Spectral Fidelity and quality listening. Only with McIntosh Power Guard can you be assured of total power performance without the distortion of clipping. Only McIntosh 'High Tech' protects your listening.

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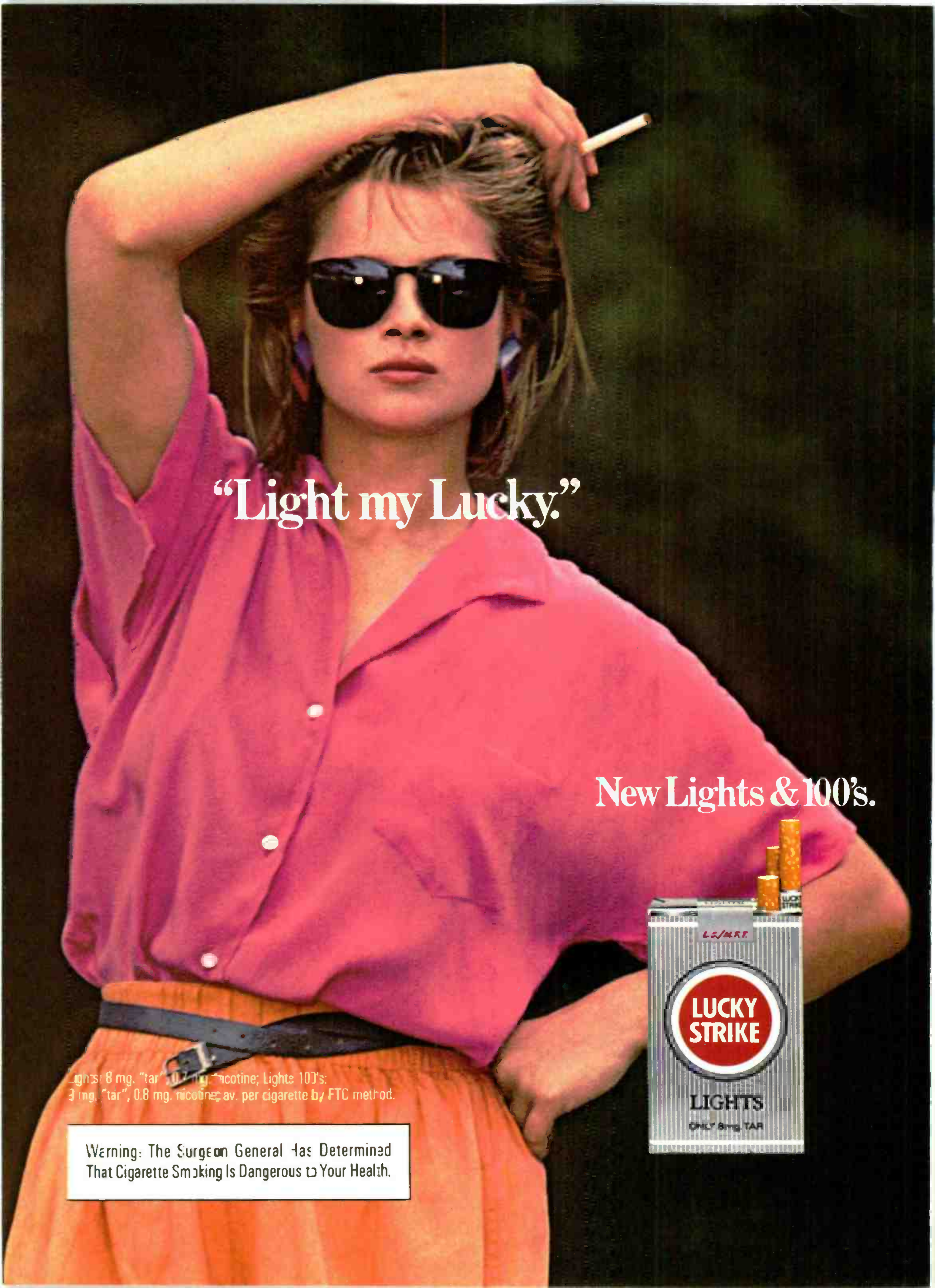
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New Lights & 100's.
LUCKY STRIKE
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Lights: 8 mg. "tar" nicotine; Lights 100's:
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Warning: The Surgeon General Has Determined
That Cigarette Smoking Is Dangerous to Your Health.

IVAN BERGER

LIRPA'S LOSS, OUR GAIN

Illustrations: Teresa Anderko

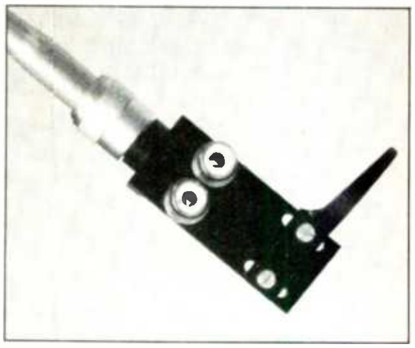
Return with Us Now . . .

"There was a time," says Dr. Lirpa, "when records were all cut directly—analog, of course—and at high cutting speeds, a time when there were no problems of phasing between channels. We intend to return to these excellent sound standards.

"Digital technology is taking us even further from the glory days of 78-rpm recording. But it also gives us the means of returning to them. Hence the Lirpa Original 78 Synthesizer."

Dr. Lirpa was, as usual, packing hurriedly when I last saw him, so I was unable to get full details of his LOSS-1. Apparently, it digitizes the signal, then filters it in the digital domain to get the desired sonic effects. I was, however, able to note some of the control designations: There was a "Mono/Reverse Mono" switch, a "Sapphire/Steel/Cactus" switch, and meters labelled "VU" and "Deja VU."

Perhaps, if the immigration authorities allow it, Dr. Lirpa will be able to revisit us with more details next year.



Shell Game

Not I, but Dave Fletcher of Sumiko, was vouchsafed a glance at yet another Lirpa advance, the ultimate answer to the problem of tonearm capacitance. The Lirpa Anti-Capacitive Kopf (German for "head"), or LACK, bypasses the arm's internal leads—and the problem—altogether.

Package Deal

Polygram has improved its jewel-box CD package. Where the original box had four tabs in its front cover to hold the label booklet, the new box has six. The two extra tabs not only hold the paper more securely, but help hold the disc down, too—it is possible for the disc to slip off the center-hold clasp of the current box.

Compact Risks

Mobile Fidelity recently announced a "High Reliance" coating for CDs. The HR coating, which will first appear on the company's Woodstock collection, is a thin, hard, acrylic resin coating which is said to help guard against scratching and abrasion. It is also designed to protect against warpage and damage from temperature extremes, both increasingly important as mobile CD players begin to appear.

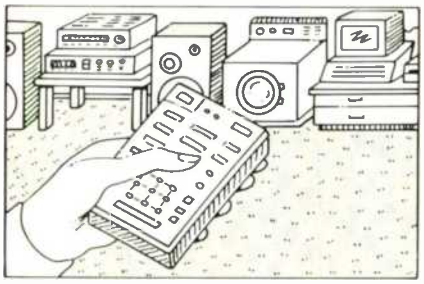
The HR coating will go on both the discs' transparent, lower surface, through which the laser reads the data, and on the upper, label side. Coating both sides helps prevent warpage; coating the label side also protects the data pits which make up the recording. That upper side is actually just a thin coating of lacquer over those pits.

All Aboard the Bus?

A while back, I noted the trend towards component systems sharing a single remote control. Three of the most interesting recent examples are RCA's Dimensia system (video and audio, including the first RCA-branded CD player), B & O's Beosystem 3000 and 5000 (with multi-room remote control), and Revox's 200-series components (which all interface to a common controller/timer unit, also with multi-room remote control).

At the time, I mentioned that the convenience of these systems was also a come-on, inducing you to keep on buying the same series of components once you'd bought the first. What we needed, I said, was a more universal system that would allow a single remote control for several manufacturers' equipment.

Well, now we have it—or at least



several beginnings thereof. For one, the Revox 200 components have serial ports allowing remote control from most home computers. (Not the first computer ports in home hi-fi equipment; Crown's DL-2 preamp and a Eumig cassette deck preceded them.) As computers grow more common, this approach should become more popular. All we need is code standards to prevent overlapped commands—it wouldn't be good if the same command that started the CD player also switched the preamp to the phono input. Another approach is taken by a new control unit from McIntosh, designed specifically to interface audio components made by all and sundry.

But the ultimate may be a home-control bus system, designed to interface everything from air conditioners to turntables. Various manufacturers and electronic-industry groups around the world (including EIA in this country) are working on such systems. And while a hi-fi company might not be eager to give its tuner a remote-control system compatible with its competitors' amps, that same company would probably be glad to interface to a system which everyone was already buying for their air conditioners and washing machines.

WOOFING IT UP

I would like to make some comments for those readers who are considering adding a subwoofer to their loudspeaker systems.

The August 1983 *Audio* featured a project, "New Lows in Home-Built Subwoofers," to construct a subwoofer sonically identical to the JBL line of subwoofers. I went ahead with the 4½-cubic-foot project, using the JBL 2235H driver, as suggested, since the box was tuned specifically for this driver. I might point out that building the enclosure not only gave me a great deal of satisfaction, but turned out to be one-third the cost of the factory unit. (For those interested in the 8-cubic-foot box with the 18-inch driver, the cost would be less than one-quarter of the factory unit.)

There are two things, however, to be careful of. The most important is the crossover used; the other is the equalization of the low-frequency response.

After building the subwoofer, I used the crossover/equalizer I already had in my system. There is a trend now to use asymmetrical crossovers to reduce the possible phase shifts which may cancel out portions of the bass response; this is especially true in active crossovers. The crossover in my system gave me an 18-dB/octave slope on the high side and a 6-dB/octave slope on the low side.

The JBL-designed, 4½-cubic-foot subwoofer system

This crossover would be great if you were biamping a three-way speaker and the crossover was around 800 Hz to 1 kHz. The low driver would have components of the midrange driver, which would not hurt its distortion characteristics. The mid/high driver would be sharply cut off, removing the unwanted low information which would cause distortion.

This arrangement is not, however, the optimum for a subwoofer application. The suggested crossover in the project article also has an asymmetrical crossover, but the slopes are reversed. The high-pass section in this crossover is passive, and the low-pass section, which also contains the needed equalization for the subwoofer, is active. I might also point out that the manufacturer uses a 63-Hz crossover point instead of the more usual 100 Hz.

So, what happens when you use the first-mentioned crossover in the system? You get way too much mid-bass, and the system becomes very boomy. You end up with three woofers in the range of 100 to 300 Hz.

Fortunately, I was able to modify the 6-dB/octave roll-off to a sharper 12-dB/octave slope. This removed much of the boomy, 100- to 300-Hz range from the subwoofer.

The point I'm trying to make is that you must be careful in choosing a crossover for subwoofer applications. If your speakers are of high quality, and already provide relatively good bass response, you should choose a crossover that gives you a sharp cut-off on the subwoofer side. If you are biamping existing speakers at a higher crossover, then the sharp cut-off should occur on the high-pass side to protect the mid/high drivers.

The other area to watch is equalization of the subwoofer response. Almost all subwoofers have to be equalized, unless you're using the 12-cubic-foot box described in the aforementioned issue. Most of us of moderate means cannot afford the monster enclosures and drivers necessary for an unequalized, flat-response subwoofer. The 4½-cubic-foot enclosure fits nicely in

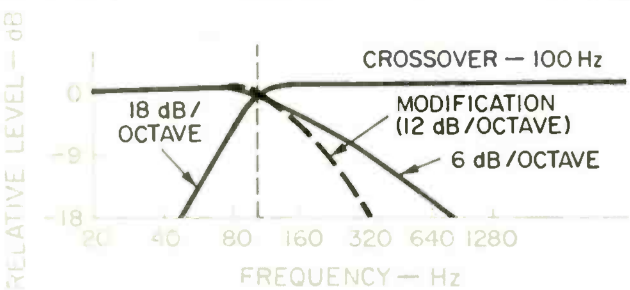


Fig. 1— The author's asymmetric crossover has an 18-dB/octave slope on the high side and 6-dB/octave (modified to 12-dB/octave) slope on the low.

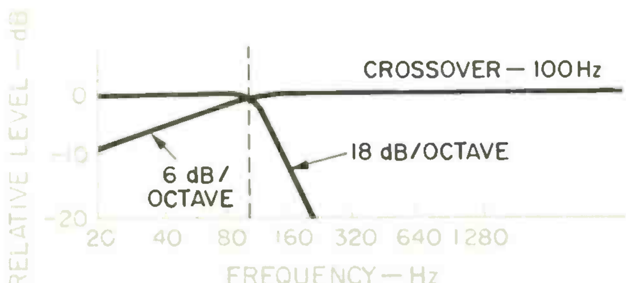


Fig. 2— The asymmetric crossover suggested in the subwoofer construction project has slopes reversed from the author's crossover.

my decor, and I do not need the extra 4-dB gain in efficiency provided by the "big" enclosure/driver. I am driving my "small" subwoofer with a bridged Hafler DH220 (350-watt) amplifier, and believe me, I can get bass levels that will make your ears bleed. In any event, my subwoofer requires equalization for a flat response to 26 Hz.

There are really two ways to equalize your subwoofer, and it depends on your taste as to which way is best for you. If you are a purist, you'll get out your real-time analyzer (RTA) and adjust your half-octave bass equalizer for a flat response. You may or may not, however, get the great improvements you expect, for a couple of reasons. First, bass is very susceptible to room acoustics (standing waves, resonance, etc.), and if your RTA mike was not *precisely* at your listening position, you probably won't hear the flat response you just cranked in. Most of us cannot invest in an acoustically perfect listening room. Your subwoofer is probably sitting in your living room (preferably between the two full-range speakers), and you're probably fighting with your spouse because you're rearranging all the furniture to fit your new toy in the sonically optimum position. That's pretty much what you have to do. Moving the subwoofer even 6 inches will affect its room acoustics, so keep shifting it around to find the best position (and take your spouse out to dinner).

After you've found the best spot for your subwoofer, you still may or may not hear that smooth, deep bass you're looking for. If not, the problem may be that your ears are not calibrated precisely to the overall weighted response curve (RIAA). Very few of us have perfect hearing. This brings us to the second method of equalization: Using your ears. I know the purist will cringe in horror at the thought of depending on something so imperfect, but that's where personal preference comes to bear. There are a number of records available that provide octave-by-octave pink noise; try using one to equalize that subwoofer to match your own imperfect ears.

An interesting experiment is to use both methods of equalization and note the difference in settings on your equalizer. You may notice rather large differences between the curves.

What further complicates the integration of a subwoofer to your audio system is that the problems I've described occur all at the same time. This requires a great deal of experimentation to determine where the problems lie. If you're like me, though, you'll have great fun in trying dozens of subwoofer positions, equalization curves, crossovers, etc. to find the setup that best suits you. Although your spouse will be a "subwoofer widow" for a few days, it will be well worth it when you're done. And you'll wonder how you could have done without a subwoofer all this time.

Gregory R. Jones

BERT WHYTE

ANSWERED PLAYERS

The Winter Consumer Electronics Show, convened in Las Vegas this year from January 5 through 8, again set a record—101,665 attendees. Although the mood was upbeat, poor sales in the last quarter of 1984 kept buying on the cautious side. It must also be noted that the vast majority of convention-goers were involved with telephones and other communications products, computers, video, and a heady and exciting new mix of audio/video products. Alas, in terms of audio, especially so-called "high-end" audio, it was rather a flat show, and there was some grumbling from the high-end audio enclave at the Riviera Hotel about the dearth of specialty audio dealers in attendance.

It is no secret that, whatever the reason, sales of high-end audio components in October and November of 1984 were among the worst on record. Companies expecting a resurgence of buying at the WCES were disappointed. However, "hope springs eternal in the human breast," and most audio companies are optimistic that this slump is merely a temporary aberration. In these times, technology moves ever forward, and in spite of some market problems there were a number of interesting new products.

We are now into third-generation CD players, ones not only technologically superior to the original CD players, but dramatically lower in price. Some CD players list for $299, which usually means they are discounted to $249; there have also been some $199 "close-outs" on early models. Most industry pundits believe the $199 *list-price* player will be a reality at the Summer CES in June. Some degree of stability has crept into the CD player market, with most people accepting a "you get what you pay for" philosophy. Thus, a number of companies have minimum-price, "bare-bones" players; a more expensive, step-up model, and finally a top-of-the-line unit, replete with all sorts of bells and whistles.

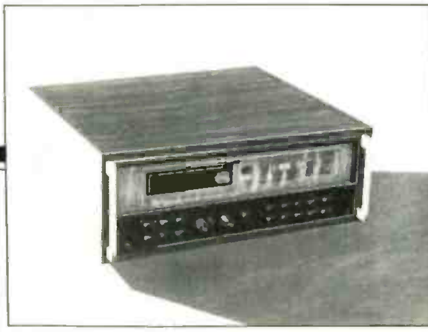
Mission DAD 7000

CD software is now generally available for $12.98 to $14.98 per disc. This, plus the lower prices of the CD players, has led to a really dramatic upswing in the CD sales picture. Software factories are working around the clock to keep up with demand. Those who thought the CD was just another passing fancy will be really stunned when they become fully aware of the technological sophistication and exciting new applications of the CD format.

Some 30-plus models of CD players were shown at the WCES, and it must be admitted that many of these units are very similar, me-too products. There are, of course, some notable differences, as I pointed out in my column on the Meridian CD player in the December 1984 issue.

It would seem that the British have a particular penchant for producing specialty CD players. In addition to the Meridian, there is now the Mission DAD 7000R CD player. The model that preceded it, the DAD 7000 (no longer available), was demonstrated at the WCES, but the associated audio equipment was so poor that no conclusions could be drawn as to its performance. Mission is a well-known British manufacturer of audio electronics and loudspeakers whose products have limited distribution in this country. While the Mission 7000R undoubtedly uses some key parts OEM-ed by Philips, apparently much of their player is of proprietary design and manufacture. The Mission 7000R uses the Philips four-times oversampling system (176.4 kHz) with 16-bit resolution. The unit features two separate D/A converters, with Philips' transversal pre-D/A filter and analog post-D/A filtering of Mission's own design. The 7000R has full programming and readout facilities, and up to 99 tracks can be sequenced in any order. There is a front-loading, motorized CD drawer, as well as a wireless remote control. Mission claims the usual CD specs, including phase linearity of an impressive 0.5°, but maintains that their special chassis design and the use of "audiophile quality" parts produce a superior sound. Price of the Mission DAD 7000R is $749.

Cambridge Audio, another British audio manufacturer, will be producing the Model CD1 Compact Disc player,



Artist's rendering, McIntosh MCD 7000

the most elaborate and expensive player from the U.K. The CD1 also uses the ubiquitous Philips four-times oversampling system. The unit has a Multiple Conversion system, using three, 14-bit D/A converters per channel in a "voting" arrangement—if one disagrees with the other two, its output is ignored. The filtering system uses three, linear-phase, shunt feedback filters. Switches allow selection of any filter or pair of filters—six choices in all—tailoring the sound to match the different filters used in recording various CDs. A volume control permits direct connection to a power amplifier, and there are serial, direct digital outputs. The Cambridge CD1 will be imported by the Michael Baskin Co. (4650 Arrow Hwy., F-4, Montclair, Cal. 91763) and will cost less than $2,000.

Not to be outdone by our British cousins, McIntosh has introduced a CD player, the MCD 7000 (by sheer coincidence, the same numerical designation as Mission's first CD unit). McIntosh also uses Philips' four-times oversampling technique, adding some proprietary ideas of their own involving "double digital filtering." Although some OEM Philips parts were used, most of this player is of McIntosh's own design. The MCD 7000's special anti-vibration motor has a PLL speed control which locks onto the phase as well as the frequency of the player's quartz master clock. Other provisions ensure that the motor's torque does not vary with speed. Synchronization-lock circuits are provided, preventing clicks and pops caused by the generation of "phantom" synchronizing signals. The player's single-beam laser pickup is smaller, lighter, and faster tracking than usual. An LED indicates when error concealment is taking place; on the rare occasions when discs are too badly damaged for these techniques, "soft muting" fades the sound out until the data stream resumes. The unit also has 20-selection random programming, three-speed music search and indexing, and a motorized loading drawer. Very high-quality parts in the analog electronics, combined with the special features, are claimed to provide superior sound. The McIntosh MCD 7000 should be available in May, at a price between $1,200 and $1,400.

Technics showed their third-generation, standard CD players—Models SL-P1 ($400), SL-P2 ($500, with remote control), and SL-P3 ($600, also with remote control). All feature advances in laser tracking, digital filtering and improved error-correction systems. However, pride of place must go to Technics' specialty CD players. For professional users (or for someone like J. R. Ewing) there is the $4,000 Model SL-P50. As you would expect in this type of table-top/console CD player, there are left/right VU meters and fluorescent displays that give all track information, including elapsed time and remaining time. There is an error-indicator light, a preview system which lets you hear a selection (through headphones or the built-in speaker) without generating an output signal, and many other functions, all remote-controllable. Needless to say, access time is ultrafast—as little as 0.1 S with an optional circuit board—and access accuracy is 13.3 mS! Its very superior specs also include 96 dB of dynamic range and a 96-dB S/N ratio.

On the other hand, maybe J. R. Ewing would prefer the Technics SL-P15, the unique CD changer that would allow him to play from a selection of 251 CDs for those barbecues on the family ranch. Shucks, folks, the $1,500 base price is just pocket change for old J.R., and this machine could supply continuous music for 7½ days before repeating a selection. (Now, *that* is a party!)

True, the basic SL-P15 is only equipped to play 51 CDs in sequence (50 stored in its magazine, plus one temporarily loaded through the front). The full 251-CD capacity requires adding four, 50-disc Multi Compact Disc Player Units (SL-P15U), interfaced through a Multi Compact Disc System Controller (SH-C15); prices for these options have not yet been set.

Sony, co-developer of the CD format with Philips, has brought its considerable resources to the introduction of several third-generation CD players, as well as some other very advanced and specialized digital hardware. These latter units, part of Sony's esoteric ES line of audiophile components, include the CDP-520 ES and CDP-650 ES, which share a great deal of new Sony technology. Both units use Sony's Unilinear Convertor, a high-speed D/A converter with two-times (88.2-kHz) oversampling, single-clock topology to reduce beat-frequency intermodulation distortion, and high-order digital filtering. Sony claims this combination affords excellent phase linearity, almost total attenuation of noise, and a frequency response of ±0.3 dB from 2 Hz to 20 kHz. The digital filtering is claimed to hold band-pass ripple within ±0.01 dB. These CD players also utilize Sony's VLSI CX-23035, a very high-density chip which controls nine digital functions, heretofore requiring three LSI chips.

The new Sony CD players also use a newly developed, miniaturized, laser pickup assembly, less than one-third the size of previous designs. Sony has made a major effort in the reduction of vibration thus the new laser pickup is combined with their new Linear Motor Tracking System, which uses a brushless, slotless, non-cogging motor. This system eliminates the worm gear and reduction gears of conventional tracking mechanisms. Sony claims the combination of the new laser pickup and the Linear Motor System gives these CD players more precise tracking and the fastest access time in the industry—they can go from the first selection on a CD to the last selection in less than 1 S! The CDP-520 ES and the CDP-650 ES both have elaborate programmability and display functions, which are duplicated on wireless remote-control units. The CDP-520 ES, equipped with a subcode port for use with future generations of graphics-encoded CDs, will be available by the time you read this at a price of $600.

Sony's top-of-the-line CDP-650 ES is a technological tour de force. Besides all it shares with the CDP-520 ES, it has a serial, digital output for connection to Sony's new, outboard D/A converter, the DAS-702 ES, in addition to the D/A converter and analog stages already built into the 650 ES.

Sony claims the DAS-702 ES is a glimpse into the future of digital audio. Initially, it will function as a super-fideli-

Sony's top-of-the-line CDP-650 ES, to be priced around $1,000, is a technological tour de force.

ty D/A converter for the 650 ES. However, in the future, the unit will be suitable for use with PCM processors, PCM digital tape recorders, and PCM satellite-broadcast tuners. To handle these sources the DAS-702 ES has sampling frequencies of 32, 44.056 and 44.1 kHz, and the professional 48 kHz used in DASH and other studio recorders. Switching to the incoming sampling rate is automatic. The DAS-702 ES uses dual monophonic, ladder-type D/A converters and oversampling digital filters. Special attention has been given to internal shielding to prevent radiation interference with the power supply or analog sections. The DAS-702 ES will be available in late spring, and I have been told it will probably cost around $1,000.

Back to the CDP-650 ES—the unit uses a copper-plated chassis, copper heat-sinks, and even copper washers on all screws in an effort to reduce the effects of magnetically induced distortion. There are separate power supplies for analog and digital sections and separate p.c. boards for digital, servo, audio and display circuits. Special floating subchassis and damping bushings are used to minimize vibration. As mentioned, the CDP-650 ES has a remote control for all program and display functions, and even for line-output volume control. Other nice touches are the use of polystyrene capacitors, 1% metal-film resistors, and the new Linear Crystal Oxygen-Free copper wire in the analog section. The CDP-650 ES will be available in late spring and the target price is, again, around $1,000.

Obviously, there is more than meets the eye (and ear) with CD technology. It has virtually unlimited potential in so many areas, all of which will ultimately impact favorably on its function as a prime music source.

An example is Denon's new CD-ROM (read-only memory) system. The disc, in the standard 4¾-inch CD format, will be read with the same laser pickup, while a special interface unit will couple the system to a personal computer. This will afford a very high-density storage system, to say the least. Each CD-ROM has a storage capacity of 550 megabytes, equivalent to 500 to 1,000 conventional floppy disks (and there is no danger of magnetic erasure). More than 275,000 pages of text can be accommodated on one CD-ROM, so the format obviously lends itself to reference works, dictionaries, encyclopedias, etc. Since the CD-ROM will be produced in the same plant as Denon's audio CDs, eventually the higher utilization of the facilities should lower prices for music CDs.

I have reported on recordable CDs previously and am told that progress continues, with a fair possibility that such discs could be demonstrated at the 1986 Summer CES! *A*

Finally, car audio as good as your car.

Very few companies selling car stereos are real *audio* companies. With 75 years of experience reproducing sound, Denon wishes to point out the level of their home audio technology present in the new DC-series of car audio equipment.

For example, the only audio components—home or auto—offering the level of circuit sophistication found on the new Denon Car Audio DCA-3250 Power Amplifier are Denon's own top-of-the-line receiver and separates.

Similarly, the Dynamic Range Expansion circuitry found on Denon's new Car Audio DCR-7600 AM/FM Stereo Tuner/Cassette Deck otherwise can be found only on Denon's DE-70 Dynamic Equalizer.

The *differences* between Denon car and Denon home audio equipment will become apparent the moment you sit behind the wheel. To build car audio for people who love good sound as much as fine cars, Denon created a very limited, ultra-high quality range of car audio components, specifically engineered to become *part* of the automobile. Controls fall to hand and information is displayed with the *driver* clearly in mind.

For the car lover, Denon Car Audio does more than offer true auto high fidelity—it becomes an integral part of the thrill of driving.

DENON

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SIGNALS & NOISE

What a Tangled Web . . .

Dear Editor:

I find it most perplexing, considering the current proliferation of Compact Disc players, that no manufacturer has yet put one inside a receiver—or rather put a receiver inside a CD player. One advantage of a CDeceiver (can anyone think of a better name?) would be the elimination of the traditional preamp and RIAA equalization circuitry, which is included with all receivers and integrated amps since they are designed to be used with turntables.

The CDeceiver could also come with a remote-control unit to select FM presets and CD tracks and to adjust volume, tone, and on/off functions; perhaps it could even be programmed to display the artist, CD title, and current track! Indeed, if the player could hold about 200 discs and catalog them all, the CDeceiver could be sold sans front panel since the remote control could access the entire library of music. Now, add a programmable equalizer (10 bands would be sufficient) and a tape deck, too (in which case kindly disregard what I said about no front panel); this would permit us to record cassette tapes from our CDs to use in the car (no—I'm not putting my meager collection of $20 CDs in *my* glove compartment). And, while we're at it, let's make sure the integrated amplifier is a Magnetic Field type (a.k.a. Carver) and that the tuner has something to do with Mr. Shotz; these things tend to improve marketability. There we have it, the CDeceiver—able to play CDs and FM (and why not AM stereo?), and record and play cassette tapes all in a single bound. Just add headphones and speakers (and 200 CDs—gulp) and plug it in. Include a microphone and mixing capability (I always liked this feature on my old Yamaha amp, and some day I shall honestly use it), so we can play our digital discs, sing along, add some guitar of our own liking, and record the whole mess onto cassette in Dolby C (remember—for the car) while preserving stereo sound and simultaneously mixing the singing and guitar into both channels.

What we're talking about here is the greatest thing in high fidelity since the Lirpa One-Brand System (*Audio*, April 1983). Granted, it won't do (or rather, play) dishes, but since it requires no lid, the up-to-now unsolved dilemma of right/left lid options (see Lirpa Labs Compact Dish Player, *Audio*, April 1984) would no longer be a problem. (Sorry, Professor.) Indeed, the function-selector button on the remote control should have a special tape mode—*karaoke* with "Digital Vocalizer (mistake?) Plus 2." This would allow the American-built CDeceiver to successfully penetrate the Japanese market! An optional preamp (order it, just in case) would permit us to play our un-Compact Discs if we so desire (and we do). And a front-panel button labelled "3WDS" (What's Wrong with Doug Sax?) would invoke Random Record Noise, or "RRN," in analog increments from a minor rumble to a devastating warp-3 crescendo.

As far as adding new technology, how about a computer-interface jack so that we can read CDs loaded with software (it's only a matter of time, and money), with our home computer accessing 500 or so megabytes at a time? Possibly, the CDeceiver could even come with a keyboard and 500K of RAM so we won't even have to buy a home computer.

When all of this is finished, and my product hits the market (as far as I know, the CDeceiver is my original idea), I certainly hope that I get at least *some* of the credit.

John P. Taylor
Eagle, Idaho

Take Direction

Dear Editor:

You are certainly to be thanked for publishing the December 1984 "Auricle" on the Dennesen Polaris indoor FM antenna. I am sure many people will find the antenna helpful. However, Leonard Feldman should briefly review Yagi antenna theory. From his description of how the passive element is adjusted and used, it is clearly a director, rather than a reflector, as Mr. Feldman identified it.

Charles G. Nelson
Sacramento, Cal.

Editor's Note: We, here at home base, must take the blame for this error which came about through somewhat too casual an editing job on this "Auricle." Please rest assured that Mr. Feldman knows what a director is.—*E.P.*

Split Personality?

Dear Editor:

The contrasts to be found within the pages of *Audio* continually astonish me; it is almost as if two magazines somehow manage to occupy the same covers.

Compare the hair-raising irrationality of most "Auricle" reviews with the rigorously scientific speaker reviews by Richard Heyser. Or compare a scholarly book review by Bob Berkovitz with Bascom King's casual damnation of a $2,300 power amplifier because its "spatial replication and localization were judged to be less precise than with the other amps used . . . ."

It seems to me that one of these magazines is diminished by the other's presence.

Roy Allison
Allison Acoustics
Natick, Mass.

Kudos Due

Dear Editor:

I have subscribed to your magazine for the last two years. Recently, I ordered a Tandberg stereo system from one of your advertisers, Reference Audio Systems of Gardena, Cal. I received excellent advice and super-fast service from them. My order arrived four days after I placed it. In fact, the salesman called me to verify that the order had arrived! I have ordered from other advertisers before, but none has equalled the service of Reference.

Jim Martin
Spring, Texas

Kudos Due II

Dear Editor:

It is not unusual to read complaints castigating manufacturers for their curtness, obstinacy, etc. But how about a letter concerning a company that goes out of its way to show good will and trust toward its customers? That company is Hafler.

After building the Hafler 500 amplifier kit, I found that the power-indicator light in the power switch did not function and that somewhere along the line a scratch appeared on the faceplate.

I wrote to Hafler, asking them how I could cover the scratch and suggesting that if they would send me a new switch, I would then return the faulty one. (I did not relish being without music for two to four weeks.) About three weeks later, a UPS parcel arrived, and, lo and behold, in that package was not only a new switch but a new faceplate as well. I was (and still am) truly pleased and astonished. I feel that incidents like this should be publicized. Truly, it is heartening to learn of reputable audio manufacturers who produce superior products and back them—and who have trust and confidence in their customers.

Ben Berris
Rancho Palos Verdes, Cal.

Kudos Due III

Dear Editor:

It is well known that Roy Allison of Allison Acoustics makes superb loudspeakers. It may not be as well known that he also provides superb after-the-sale service, above and beyond his 5-year *full* warranty. During the 5 years that I have happily owned Allison:Four speakers, I have had numerous questions regarding the speakers and various other aspects of my audio system, as they relate to speakers. And no matter how dumb my question or irrational my concern, I have always received a prompt reply by return mail, almost always from Mr. Allison himself. I have also received advice over the telephone, again often from Mr. Allison. This represents much more than just the individual attention one can receive from a small company interested in doing what is good for business. It also bespeaks tremendous personal integrity on the part of Mr. Allison, which infuses his products and his company. Such performance should be publicly lauded.

Marc Richman
Silver Spring, Md.

Erratum

In Fig. 3 of Richard J. Kaufman's article, "Frequency Contouring for Image Enhancement" (February 1985), connections between R6 and R8, leading to IC1B of the right-left to middle-side schematic, should be omitted. Please note, both the kit of resistors and op-amps and the demonstration and data to help create new musical works are available from Brunswick Tape Media, 580 Eighth Ave., New York, N.Y. 10018; the prices remain the same as mentioned in the article.

TAPE GUISE

NAMREH NIETSRUB

Another 12 months has rolled around, again bringing us the inimitable Prof. I. Lirpa. This time he submitted a guest Q & A column at the invitation of one of our contributing editors, who has taken a temporary leave of his senses. As many of our readers already know, and the rest will soon discover, Prof. Lirpa has an agile mind and an astonishing knowledge of audio. Never yet has he been found at a loss for an answer to any question whatsoever. His thought processes are unique because he thinks, speaks, and writes in a language that he himself invented and calls OCOL. The following was translated from the original by a colleague, Namreh Nietsrub.

Straight-Wire Amplifier

Q. *I have read that the ideal amplifier is a straight wire with gain. The power cord of my amplifier is tightly coiled. Should I straighten it?*—Desi Bell, Boulder, Colo.

A. Why not? It will cost you nothing and is simple to do. You don't even have to remove the power plug from the wall socket. Just disconnect all leads and note whether the cord is coiled clockwise or counterclockwise. If clockwise, lift the amplifier (with two hands if it's heavy) and turn it counterclockwise until the cord is uncoiled. Move the amplifier away from the socket until the cord is straight; this may require you to relocate your audio system. In my next column I will tell you what to do if the power cord is wound counterclockwise.

If you don't know clockwise from counterclockwise, fill your bathtub (or a friend's) with warm water and take a nice, refreshing bath. Be careful not to fall asleep or you might not find out what clockwise is. Pull the drain plug and notice how beautifully the water swirls and gurgles as it goes down the drain. Clockwise is the way the water swirls if you're in the Northern Hemisphere; next time I'll tell you how it swirls in the Southern Hemisphere.

Finally, reconnect all the leads. Simple, just like I promised you.

Weighty Question

Q. *I have been informed that a heavy weight, such as a brick or cinder block, will improve the performance of my power amplifier. Although I think this is a lot of rot, I would still like to know which is preferable, a brick or a cinder block?*—Phil R. Monnick, Los Angeles, Cal.

A. I like the way you put the question because it shows that you have an open mind, which you can take wherever you go the rest of your life. Now, in such matters as we are considering, it is best to experiment. First, try a brick on top of the amplifier; then try a cinder block instead. Now try a brick *underneath*, and after that a cinder block underneath. Next, try both a brick on top and a cinder block underneath, and then reverse the two. You may find this quite a bit of work, but there is no free lunch. Also, there is no free breakfast or dinner.

All this time you should be listening carefully for differences in the sound coming from your audio system. There is a possibility you will hear no differences. There is also a possibility that your ears, or your entire head, should be examined, but don't give up yet. Try other combinations, such as two bricks or two cinder blocks (matched pairs). Be careful not to drop a brick or cinder block on your foot. If you do, drop one on the other foot for stereo.

Three Heads vs. Two

Q. *What is the difference between a three-head tape deck and a two-head one?*—M. T. Moore, Minneapolis, Minn.

A. Three minus two equals one.

Choosing a Tape Deck

Q. *I'm trying to choose between two fine cassette decks which have very similar features and specs except for frequency response. Deck A is rated ±2 dB between 30 Hz and 21 kHz, and Deck B is rated ±2 dB between 40 Hz and 24 kHz. Which should I buy?*—Lynn E. Arrity, Brookline, Mass.

A. Fortunately, my vast collection of audio equipment includes two decks with exactly the same specifications as the ones you mention. With these decks I was able to do some important research, with the assistance of my schnauzer. (You see, my hearing is no longer so good.) When I played Deck A, saliva drooled from the right side of his mouth. When I played Deck B, saliva again drooled from the right side. At first I did not know what to make of this, but soon I had one of my special insights. I played both decks together, and saliva ran from both sides of his mouth. From this I conclude that you should buy both decks.

Pop Goes the Speaker

Q. *Whenever I make toast and the toast pops up, my audio system emits a loud and annoying pop. What can I do about this?*—Francis X. Ponential, St. Louis, Mo.

A. Wear a pair of earplugs when making toast.

Super Tuner

Q. *I have built just about every kind of audio kit there is to build, and am now ready to construct components on my own from the ground up. I plan to start with a super FM tuner that meets or beats the following specifications: Flat response within 0.1 dB from 20 Hz to 18.9 kHz, 90-dB separation, 50-dB quieting in stereo at 10 dBf, 100-dB S/N at 65 dBf, 0.001% harmonic and IM distortion, 0.5-dB capture ratio, adjacent channel selectivity of 30 dB, alternate channel selectivity of 100 dB, 100-dB AM rejection, multipath-free, and equipped for diversity reception. The only thing I need in order to get going is a schematic diagram.*—Lisa Jous, Urbana, Ill.

A. You have come to the right person. It so happens that I have already designed a tuner at least as good as what you describe, probably better. However, there is a minor problem. I recently moved to a safer location, and the schematic is lost someplace among 140 packing cartons. I don't know which one. Since it will take me a little time to find it, I can't print the schematic until my next column. In the meantime, you can build your own FM antenna from old umbrella ribs. Better make two for diversity reception.

Burning Question

Q. *Recently I purchased Gargoyle speaker cable, which was very expensive. One lead is identified as "hot" and the other as "ground." But I don't know which leads go to which termi-*

If you have a problem with tape recording, please don't bother Prof. Lirpa; he's got enough problems of his own. "You broke it, now you fix it" will be his standard reply to those of you who write in anyway.

nals of my speakers and amplifier. If I hook them up incorrectly, will the hot lead burn out my speaker or amplifier? Until I get your answer I have $7,000 worth of audio equipment just sitting around doing nothing.—Audie O'Phile, Dublin, N.H.

A. I think you are pulling my leg, because I notice that your letter is dated April 1. But I could be wrong, which would be the second time since 1952. So I will not only answer your question but also throw in some good advice. Connect the leads any which way, but not to each other. Now for the advice: Gargoyle cable is not for people who prefer a zippy sound to a nice, round, schmaltzy sound. If you want zip, use zip cord.

The Wrong Stuff

Q. *I've been around the audio game more than 40 years, and it's time to speak my piece. Plain and simple, I just don't cotton to most of the newfangled stuff. Take those Compact Discs and other digital gizmos; it sure gets tiresome listening to a bunch of ones and zeros. I wouldn't give you a plugged nickel for anything with transistors instead of tubes. I always say, if it doesn't light up, don't trust it. FM isn't nearly as rich and full as AM; there's more screech than music in anything above 5,000 cycles (I don't say Hertz because it sounds like canary food). Same for LPs, which don't come knee-high to 78-rpm records. Only problem is, I'm nearly out of cactus needles for my Victrola. Do you know where I can find some?*—Millie Volt, Edison, N.J.

Q. You can get them just five miles west of Needles, Ariz., a little north of Route 40. Be sure to bring a sharp knife with you.

Confidence Game

Q. *I have a problem with my semi-automatic turntable. The arm doesn't always land on the lead-in groove. Sometimes it lands an inch away, sometimes more, and sometimes it even lands on the label. Can you advise me what to do?*—Mike Rowatt, Waterloo, Iowa

A. Honestly, I am surprised at your question. Whatever made you ask? Of course I can advise you. There should be no doubt in your mind about the ability of Prof. I. Lirpa to advise you. Confidence is the name of the game. After all, audio is an illusion, and the illusion goes away if you have doubts. To make this clear, assume that your turntable is playing a symphonic record. No matter where the arm lands, except on the label, you have the illusion that there is an orchestra in your listening room. But you and I know, don't we, that this is an illusion and there really are not 100 people and their instruments in the room. Why, the typical listening room probably couldn't hold even 15 orchestra players, especially if some are playing the bass fiddle.

AUDIOCLINIC

JOSEPH GIOVANELLI

Vacation Recording

Q. I want to make recordings from FM while I am away from home. The owner's manual for my receiver states, however, that this model should not be used with a timer because its FM station memory will be erased after a few hours if it's plugged into a timer instead of a live a.c. outlet. Is there some kind of switch I can buy or make to overcome this problem? I'd also like to know if there is a way I can make unattended recordings on one deck and then onto a second deck.—John De Rosa, Mattapan, Mass.

A. In circuits of the kind you describe, power must be applied to the memory portion of the equipment at all times in order to keep the information in memory from being lost. Even when the power switch of your receiver is off, power needed by the memory is derived ahead of the power switch.

One solution would be to leave the receiver on during your whole vacation, either with the volume all the way down to avoid annoyance to your neighbors, or with the volume up high enough to make burglars think you're home. Of course, that will add to your electric bill. (If your receiver draws 3 amperes, or about 300 watts, it will consume about 8 kilowatt-hours per 24-hour day, or about 111 kW-h during a 14-day absence.) And there is also a very slight fire hazard in leaving receivers or other electrical devices turned on during long absences.

If you are handy, you could devise a relay circuit which employs a 117-V a.c. relay. The coil of this relay is plugged into the timer (just the way you would normally plug your receiver into it); the recorder must also be plugged into the timer in the usual manner. The normally open contacts of the relay would be shunted across the contacts of the power switch on your receiver. The receiver would be plugged into the wall outlet as usual.

In operation, the timer turns the recorder on and also energizes the relay. The contacts close, which, in turn, puts power into the circuits of the receiver just the way the power switch normally does. Of course, in order for this system to work, the receiver is turned off during your entire trip.

Probably the most difficult part of the scheme is to provide a means for switching from one deck to the next. One way to accomplish this is by means of a stepping switch wired in such a way as to switch from one machine to the next each time the timer supplies voltage to its convenience outlet. This circuit can be built, but now there is a better way. (I normally do not mention specific products, but in this case, I know of no product other than the one I will briefly describe.) Chrontrol is a digital clock timer which can be accurately set to the second. On/off times can be set to the second; days of the week on which no recordings are to be made can be skipped. Another fascinating aspect of this device is that there are four outlets mounted on the rear panel. The system can store and control up to 10 timing events, and each event can be set to operate whichever one of the outlets you specify when programming the unit. With a little planning, you can use three different decks and your receiver. Each time a cassette recorder is to run, you must also program the receiver to turn on. Thus, you may have to use two programs for each event, but it is the best solution to this problem that I know of. I have used this device for several years, and it has performed perfectly. The Chrontrol even includes battery backup in the event of power-line failure. (For more information, write to Lindburg Enterprises, 9707 Candida St., San Diego, Cal. 92126.)

Power, Hearing and dB

Q. I read that the smallest increment in sound level that the human ear can detect is 1 dB. How much power is required to raise the sound level this much? A friend says it requires twice as much power to do this.—Name withheld

A. Doubling (or halving) the power would represent a change of 3 dB, not 1 dB. A 1-dB change would mean you were raising power by only about 26% or lowering it by 21%. (The two ratios are unequal because the dB is a *logarithmic* ratio, while percentages are linear.) Thus, if your amplifier was delivering 10 watts of power at a given moment, a 1-dB level increase would raise that power only to 12.6—not 20—watts, while a 1-dB decrease would lower the power to 7.9 watts.

Your friend's confusion may stem from the fact that researchers did think at one time that we could only detect changes as small as 3 dB. But 1 dB is now accepted as about the smallest level change that can be detected as such by trained ears. Smaller level changes are also detectible, but they may be perceived as differences in sound *quality* rather than sound *level*.

Interconnecting Equipment

Q. I need information on interconnecting various kinds of equipment. Is there a manual on this subject?—Enrico M. Esposito, Brooklyn, N.Y.

A. To my knowledge there is no manual which explains how to interconnect the many possible combinations of equipment now available. There are so many possibilities, in fact, that I do not even know how such a manual could be written.

My suggestion is that you first consider what you want your system to do, and then draw a diagram of the audio signal flow needed to bring about these results. The less gear you have "on line," the simpler it is to deal with it.

The instruction manuals for your components should help. Also, there are a few rules to follow with equalizers and noise-reduction devices:

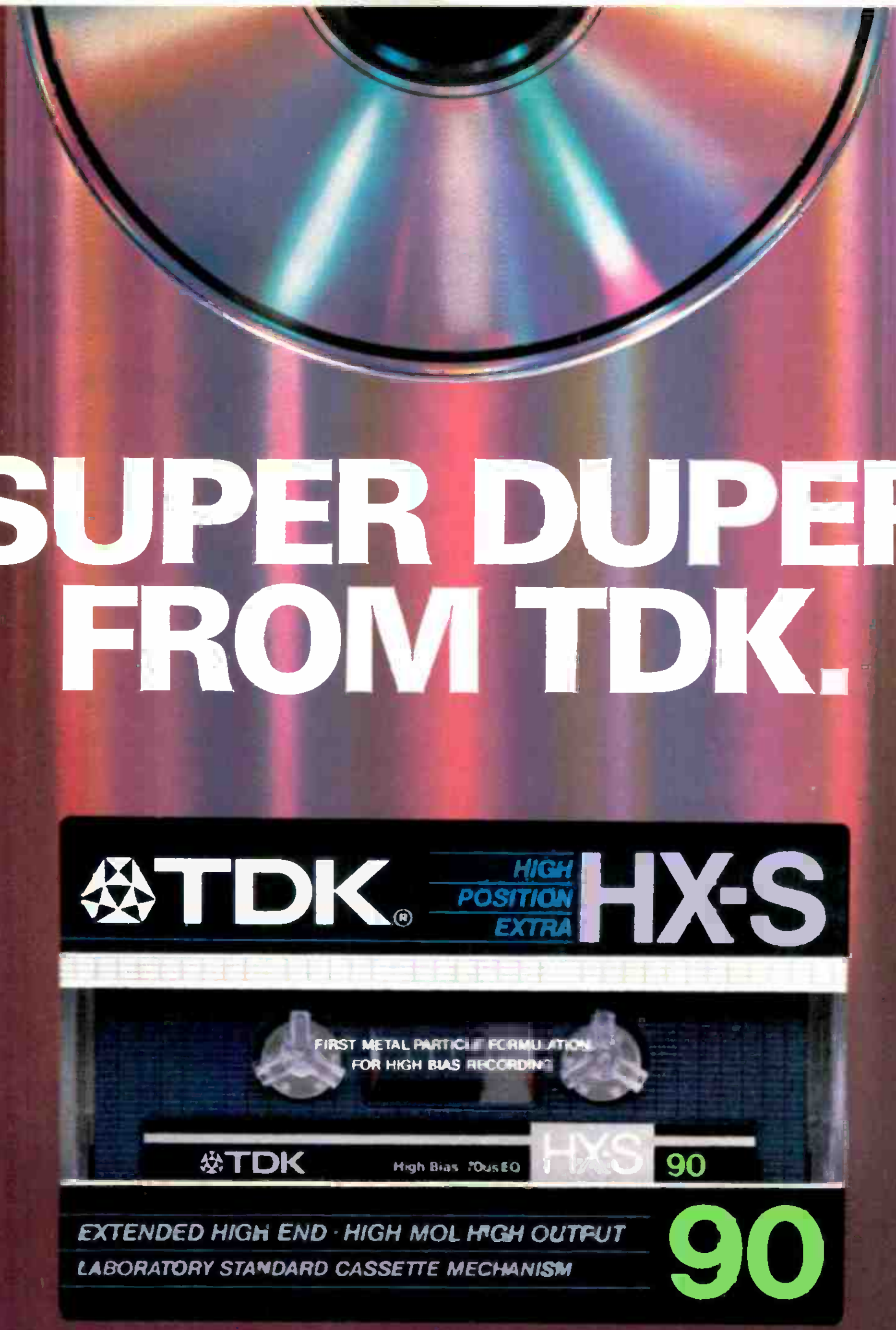
Where a noise-reduction unit is used with a recorder, you should consider the noise-reduction unit to be a part of the tape recorder. Thus, no device should be connected between the NR unit and the recorder's input, and no external device should be connected between the recorder's output and the tape-recorder input of the noise-reduction unit. The same advice applies to companders.

Time-delay or other devices to add or modify ambience should usually not be fed with equalized signals. I suggest you do any equalizing at the output of these devices.

Where there are many individual pieces of gear that will not all be used at any one time, it is better to use either a patch bay or perhaps a switching system to produce the desired set of connections only as required.

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

SUPER DUPER FROM TDK.



Capture all the dynamics of digital performance on your cassette deck. TDK HX-S blasts through the sonic barriers with high powered digital sound!

Its exclusive metal particle formulation reproduces a wider dynamic range and a higher frequency response to handle digitally-enhanced music sources on any cassette deck with a Type II (High-Bias) switch.

With four times the magnetic storage ability of any tape in its class, TDK HX-S virtually eliminates high frequency saturation, while delivering unsurpassed sensitivity throughout the audio spectrum. Additionally, HX-S excels in retention of high frequency MOL, which no other Type II formulation attains.

And to maintain its dynamite performance, TDK HX-S is housed in our specially engineered, trouble-free Laboratory Standard cassette mechanism for durability and reliability—backed by the TDK Lifetime Warranty.

So for optimum results with Type II (High-Bias) and digitally-sourced recordings on your cassette deck, get the only super-duper. TDK HX-S.

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THE PERF[...]
ZERO DIS[...]

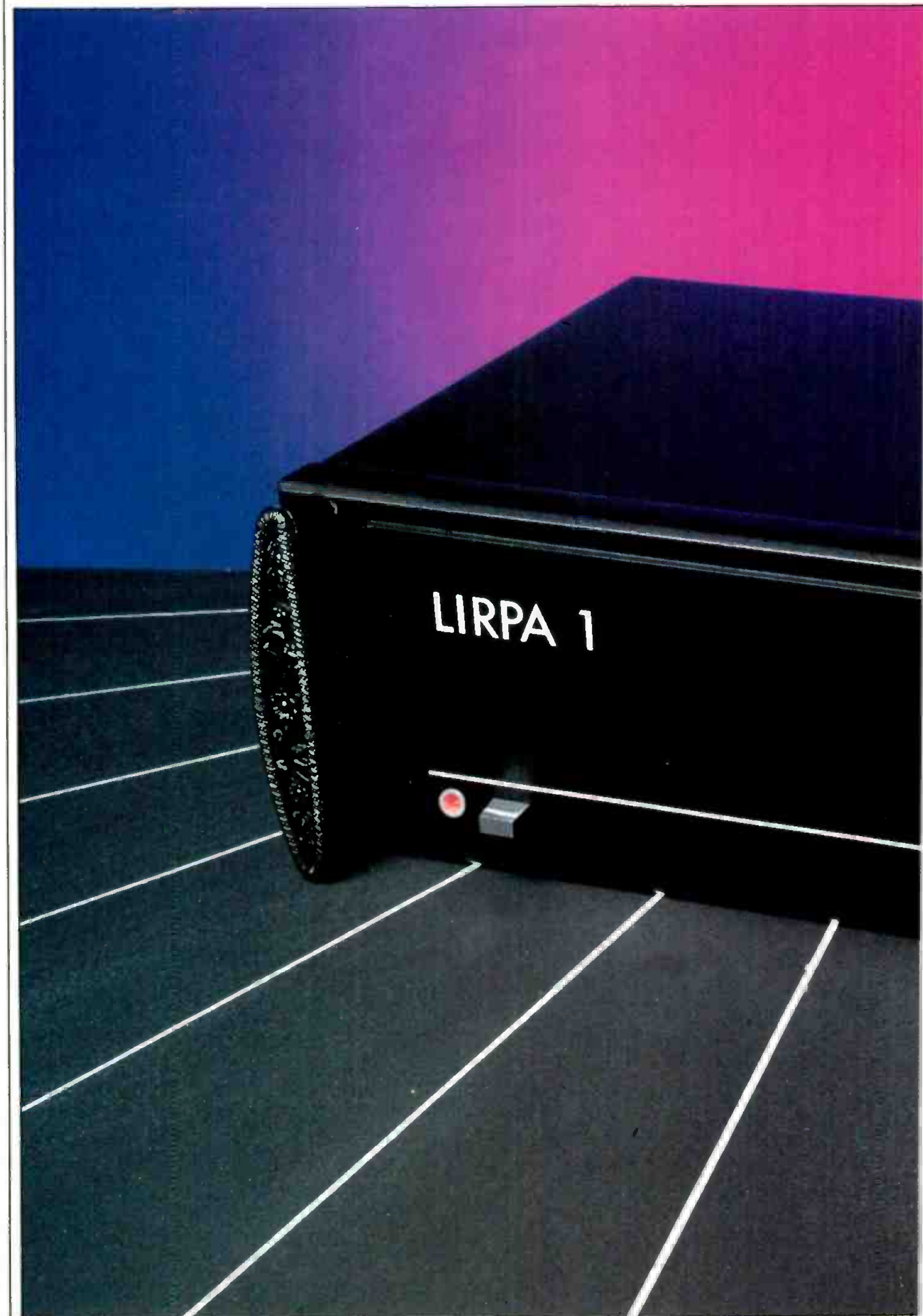
To design current, top-class hi-fi amplifiers for exacting users requires solving a great many technical problems and also satisfying demands that are sometimes directly contradictory. Among a designer's indisputable concerns, distortion is of primary importance since it influences sound quality to such a great extent. Although very remarkable results in reducing all kinds of distortion have been reached over the last few years, a truly distortionless amplifier still remains an unfilled dream of many designers. However, research and design work recently finished seems to suggest a successful method of producing an absolutely distortionless amplifier. Even the most precise measurement gear, used in conjunction with computer-aided audio analyzers, has not discovered even the subtlest difference (i.e., distortion) between input and output signal in the whole audio band when testing this amplifier.

Distortion in Amplifiers

In general, amplifiers are four-pole devices, as shown in Fig. 1. The signal source G drives the input with the signal V_{in}, while the output signal V_{out} feeds the load resistance R (usually, the complex impedance of a speaker). With an ideal, high-quality amplifier—that is, one without distortion—any change of the input signal V_{in} must cause an exactly proportional change of the output signal V_{out}. This condition is illustrated in Fig. 2 as a straight, solid line (A) tracking the ideal dynamic transfer characteristic.

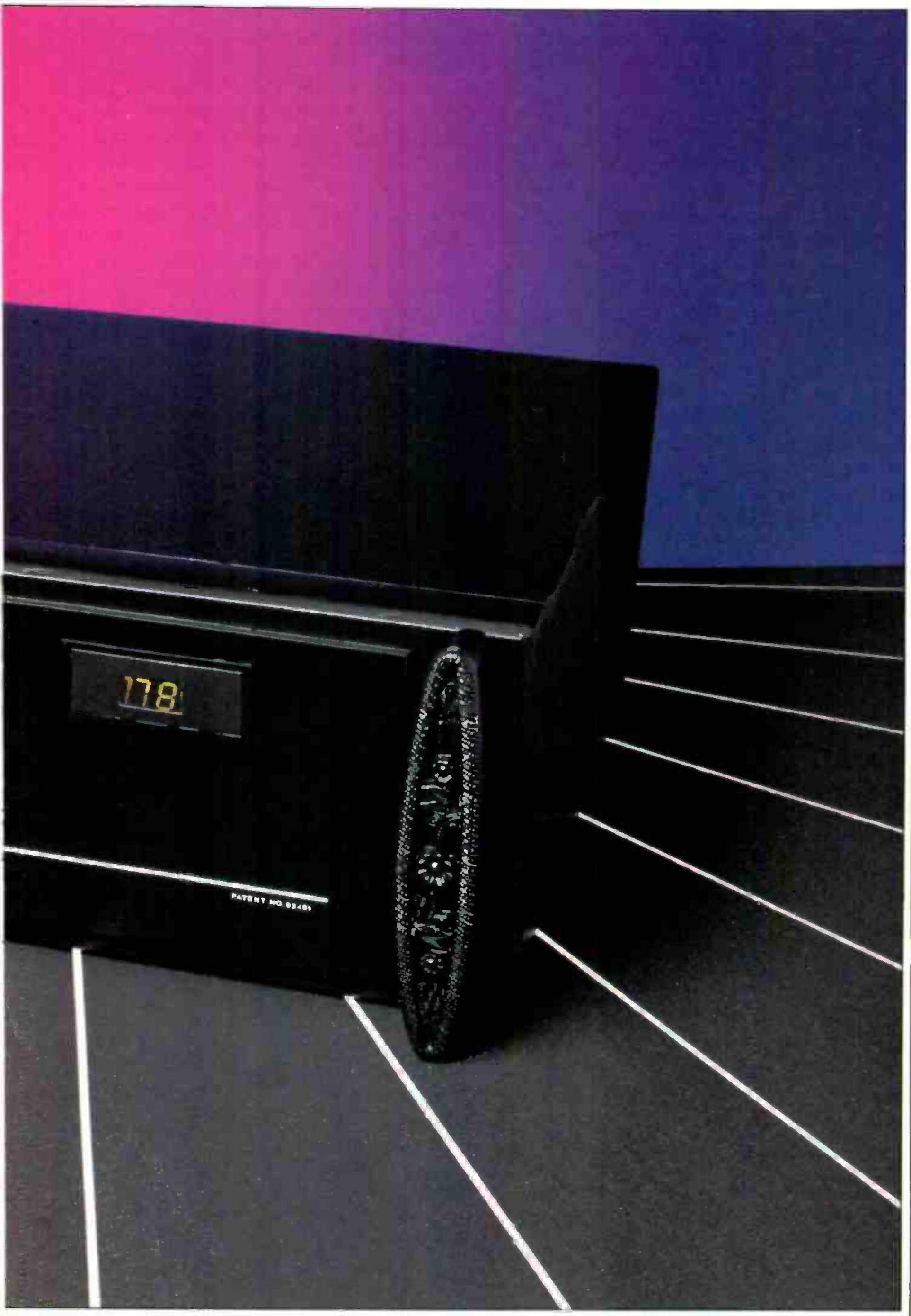
In any practical hi-fi amplifier, there is always some difference between input and output signal, which means there will be some distortion. The dynamic characteristic of such an amplifier is shown in Fig. 2 as a dotted line (B) bent from the ideal. Although exaggerated, the nonlinear deviation from the solid line clearly illustrates the main cause of nonlinear distortion which (to a greater or lesser extent) is contained in the output signal of any current amplifier, whether tube or transistor and no matter its price. Even negligible nonlinearity of the transfer characteristic causes some kind of nonlinear distortion, e.g., THD, IM distortion or newly discovered distortion phenomena such as TIM.

Any kind of distortion, no matter how negligible and regardless of its origin, can be detected by means of measurement instruments or by listeners' ears. Among hi-fi hobbyists, sound purists and reviewers, there are many golden ears able to concentrate so ex-



Diorama: James Nazz

ECT AMP: TORTION



clusively on those undesirable sound components that they easily pick up distortion even where ordinary music enthusiasts hear only an undistorted performance. The reason these extraordinary experts are able to hear and describe the various amplifier distortions is their thoroughly correct assumption that there simply *must* be some. They are absolutely right since, as we said at the beginning and illustrated in Fig. 2, there has, indeed, never been a truly distortionless amplifier. Even the best-known esoteric amplifiers, with distortion factors near zero, do not have truly linear transfer characteristics, since the distance from almost zero to true zero is—in reality—a long way.

Much effort has been expended on finding an amplifier design without even the most negligible trace of audible distortion. Transistor amplifiers have to be eliminated from serious consideration because of their "sound," which is caused by many factors, such as nonlinear characteristics of bipolar devices, low transition frequency or too much negative feedback, each combined with poor circuit design. Dissatisfaction with transistors among sound experts finally led to a renaissance of tube amplifiers, which for purely physical reasons do not contain the same distortion factors as semiconductor devices. Although

It's almost impossible to get absolute zero distortion by known, practical means. A wholly new approach is called for.

GEORGE V. DAJAN

Every success has to be paid for with some sacrifice, and this distortionless amplifier is no exception.

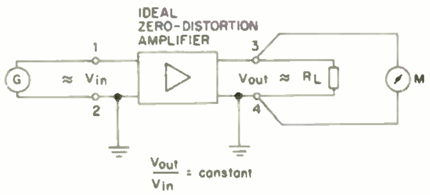


Fig. 1—Schematic of the ideal zero-distortion amplifier.

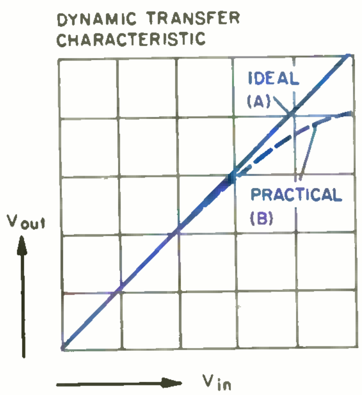


Fig. 2—Dynamic transfer characteristics (input vs. output), "ideal" (curve A) and "practical" (curve B) amplifiers.

TEST DATA

Parameter	Measurement
Power Output	60 watts
Output Load	4 ohms
Input Signal	15.5 V
S/N Ratio	Unmeasurable
Phase Shift	0, 20 Hz to 20 kHz
Group Delay	0, 20 Hz to 20 kHz
Frequency Response	0, 20 Hz to 20 kHz
THD*	0, 20 Hz to 20 kHz
IM*	0, 20 Hz to 20 kHz
TIM*	0, 20 Hz to 20 kHz

*Distortions measured by CAC (Computer Aided Comparison) method between input and output. Otherwise, generator distortion (even if very low) would be measured instead of the amplifier.

some expert listeners have been convinced that tube-amplifier sound is clean and distortionless, numerous other listeners doubt that conclusion, since tube amplifiers also contain some nonlinearity in their dynamic transfer characteristics, even if they are operated in Class A with constant operating current and, of course, below clipping. The reason is obvious if you understand the basic theory of Class-A amplification.

The Class-A triode amplifier has the lowest possible basic distortion of all tube circuits for high-fidelity amplifiers. But even the best vacuum triode amplifier contains some second-harmonic distortion, though it can be suppressed to a very low level by a proper circuit technique. Simply said, to get an absolute zero distortion by known and conservative means is practically impossible.

Design of a Zero-Distortion Amp

Mathematical analysis shows that a practical, distortionless amplifier can be designed only by using an entirely new approach based on the five following conditions:

1. The signal must not pass through any nonlinear circuit element.
2. Associated circuits must not include any nonlinear elements, to prevent possible penetration of nonlinearities into the signal path.
3. Parasitic capacities and inductances must be kept to the lowest possible limits because of their undesirable phase shift and distortion.
4. The basic circuit must exclusively contain components with the lowest possible distortion factor (triodes, high-Q polyester capacitors, metal-film resistors, etc.). The circuit must also be extremely simple since more parts and conductors always means the creation of more distortion.
5. The output signal must exactly follow the input signal, with no difference over the entire audible band.

A Practical Solution

In developing the totally distortionless amp, much experimental work showed several promising possibilities, and results were verified during detailed laboratory measurements and listening tests starting in 1982. The final circuit arrangement completely meets the five conditions mentioned above and ensures perfect signal transfer. A schematic diagram (Fig. 3) shows one channel of the final, transformerless, triode amplifier, which has a very small distortion factor and low output impedance so that it allows direct connection of medium-impedance speakers without any output transformer. Thus it entirely fulfills condition 4. Conditions 1 and 2 are met by using two special electrolytic capacitors C_i and C_O with internal arrangement according to a patent application [4; also see Appendix II]. They reliably avoid any undesirable interaction between a pure, useful signal and possible nonlinearities.

The most critical part, the one that ensures compliance with conditions 3 and 5, is a special switching transistor Q1. The reason for using a semiconductor device in an all-tube amplifier is that, except for a very high transition frequency, this transistor has an extremely low resistance. Its function is in accordance with a patent application [3] and is irreplaceable by any vacuum tube. To understand the way it works, let us assume that the output signal begins to fail, i.e., to differ from the input signal. In fact, this difference is distortion which would appear as an error voltage on the C-E junction of Q1. Because Q1 is completely open, a compensation current would flow over the junction C-E. Since the value of R_{CE} tends toward zero, the compensation current at junction C-E would be very high, even with very small deviations (i.e., distortion) of an output signal. Notice that the source of this compensation current can only be an error signal containing all the undesirable distortion components which are short-circuited by Q1 and thus cancelled. Thus, the output signal exactly follows the input signal in shape and phase, thereby fulfilling condition 5. Since the transfer characteristic (Fig. 2) is a precise, straight line without any deviation, the distortion factor of this amplifier is really an absolute zero over the whole audible band.

Conclusion

The amplifier reliably ensures an absolute identity of the input and output signal, which means its internal distortion factor (THD, IM and TIM together)

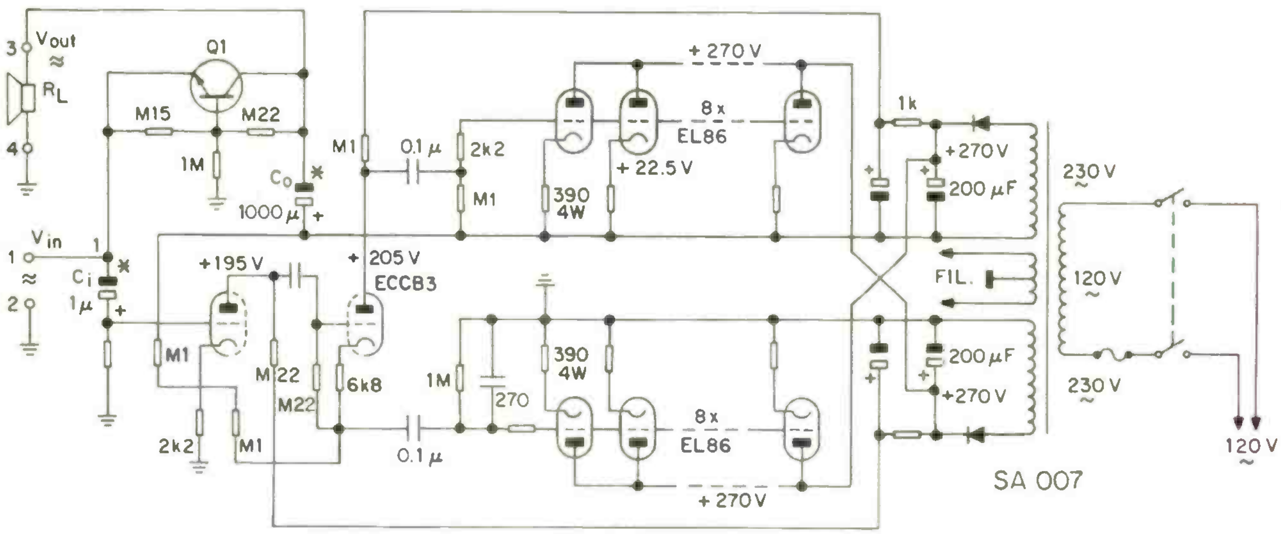


Fig. 3—Schematic diagram (one channel), transformerless triode amplifier with perfect signal transfer.

is really zero. This was confirmed both by objective measurement and subjective listening tests by experienced sound purists. The tests, however, evoked questions about possible disadvantages, since everybody knows that any great success has to be paid for with some sacrifice. This distortionless amplifier is not an exception; its exclusive characteristics are paid for with slightly higher driving needs than usual. As a driver, then, I recommend one of the following well-known components: Audio Research D250, Bryston 4B, conrad-johnson Premier Five, Krell KMA-200, MLAS ML-3, McIntosh MC 2500, or possibly New York Audio Laboratories OTL-1.

Appendix I

If the special transistor Q1 (Transiwatt 260213) is not available at your dealer, you may reform the C-E junction of any power transistor. Connect a source of 2.5 kV, 60 Hz, between the collector and emitter for at least 30 S until R_{CE} becomes of sufficiently low value to function in comparator Q1 [3]. *Caution!* Do not work without isolating gloves and helmet.

Appendix II

If the electrolytic capacitors C_i and C_O (type Condensa SA) are not available at your dealer, you can modify two conventional capacitors [4]. Open both very carefully and pull out of them all damp, shiny, wound strips which otherwise would create an undesirable parasitic capacity. *Caution!* Do not break connecting wires since the reassembled capacitors must be soldered into the amplifier.

References

1. Kellog E. W., "Design of Non-Distorting Power Amplifiers," Transcript of the IEEE, Vol. 44, 1925, pg. 302.
2. Terman, F. E., *Radio Engineering*, McGraw-Hill, New York, 1937.
3. Lirpa, I., "A Forming Process for Lowering Junction Resistance of Power Transistors," U.S. patent application No. 435918, October 22, 1984.
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5. Lirpa, I., "An Electromechanical Isolation of a Sound Channel Against Nonlinear Distorting Influences," *The Sound Purists' Highest Fidelity Review*, Vol. VIII, 1984, pp. 158-160.
6. Lirpa, I., "Nonlinearity in Sonic, Lithographic and Asexual Reproduction," *Zeitschrift für Zufallsunsinn*, Vol. XIII, 1939, pp. 2065-2066.

The transfer characteristics of even those esoteric amplifiers with distortion near zero are not truly linear.

MICROP

START WITH

ROBERT F. HERROLD

A microphone is a transducer, a device that converts one form of energy into another; in the case of a microphone, sound energy is converted into electrical energy. Although all microphones are transducers, the various types of microphones convert energy in different ways.

All microphones require a means to "gather" sound, to be able to reproduce it. Moving-coil or dynamic microphones gather sound by means of a movable diaphragm. Attached to the diaphragm is a coil of wire typically made of copper, aptly named a voice-coil, which surrounds a permanent magnet.

Elementary physics tells us that when a coil of wire moves in a magnetic field, an electrical voltage will be induced in the coil. When sound energy hits the diaphragm of the microphone, it responds sympathetically along with the attached voice-coil, creating an output voltage (see Fig. 1).

Because the output voltage of the microphone is very small, it requires amplification to be usable. The amplified voltage signal will eventually be converted back into sound energy via another type of transducer, either a loudspeaker or headphones. With the exception of the telephone mike, the moving-coil or dynamic microphone is probably the most widely used today. It is extremely rugged, and its output impedance is low. Impedance will be discussed later. (The voice-coil leads shown in Fig. 1 have been illustrated simply, for

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convenience. Typically, these fragile leads are internally dressed to keep them from being accidentally broken.)

Electret Condenser Microphones

The electret condenser microphone also reproduces sound via a movable diaphragm; however, there is nothing attached to the diaphragm as with the moving-coil microphone.

The term "condenser" may be confusing unless you know that it is merely another term for "capacitor." Electrical engineers tend to use "capacitor," while microphone engineers and users generally say "condenser." An electronic capacitor is a device that allows an alternating voltage or signal to pass through it. Due to its basic nature, the capacitor will not allow a d.c. (direct, nonalternating) voltage to pass through it. The electronic capacitor has two fixed, internal plates (as shown in Fig. 2).

The electret condenser microphone's element is similar to an electronic capacitor, but it incorporates one fixed plate and one moving plate (the "metallized surface" shown in Fig. 3). Sound hitting the moving diaphragm causes an output signal to be generated. For the electret condenser microphone, one other requirement must be met in order to successfully generate an output signal—a d.c. voltage potential, known as a bias voltage, between the two plates. The bias voltage is referred to as a permanent electret charge. (The term "electret" implies a permanent-charge situation.) In most current electret designs, the electret charge is placed in the fixed plate or back plate.

The output impedance of the electret condenser microphone is so high as to be unusable. To transform this ultra-high impedance into a usable impedance, an electronic circuit called an impedance converter is incorporated inside the microphone. The impedance

Robert F. Herrold is working on a book about microphones, and this article is adapted from portions of his manuscript. He is currently employed as Product Manager, Microphones by Audio-Technica in Stow, Ohio.

Photograph: David Hamsley

The chance of finding two microphones with the same frequency

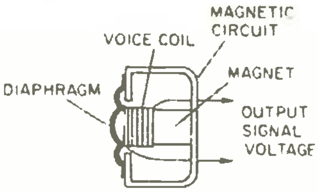

Fig. 1—Moving-coil or dynamic microphone. (After Martin Clifford, Microphones—How They Work & How to Use Them.*)*

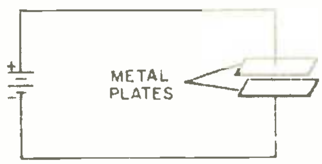

Fig. 2—Electronic capacitor. (After Clifford.)

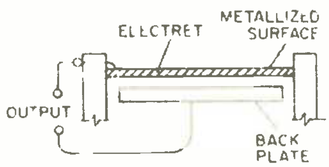

Fig. 3—Electret condenser microphone. (After John Eargle, Sound Recording.*)*

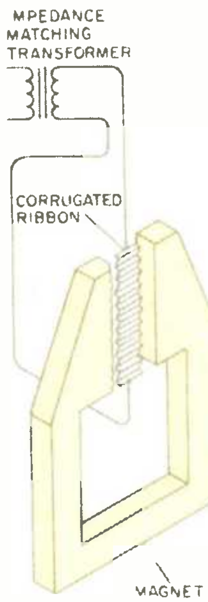

Fig. 4—Dynamic ribbon microphone. (After John M. Woram, The Recording Studio Handbook.*)*

converter consists of a device called a field-effect transistor, or FET, which requires a source of power to operate, just as an ordinary transistor does. The source of power can be an internal battery or an external phantom power source, depending on the design of the microphone. Phantom-source microphones are typically more expensive than their battery-powered, electret condenser counterparts.

The true (nonelectret) condenser microphone works in the same fashion as the electret condenser microphone, but it has no permanent charge between the two plates. The true condenser requires a special, internal, voltage-boosting circuit powered by an internal battery or an external power source. The voltage boost is required to obtain the proper bias voltage between the two plates.

Depending on the design, the electret condenser microphone can function on battery voltages ranging from 1.1 to 9 V. Requirements for phantom power voltages may range from 9 to 48 V. Modern-day, true condenser microphones use 48 V of external (phantom) power, and utilize a built-in, voltage-booster circuit as mentioned above. Older condenser mikes required an external power source of 200 V.

Condenser-type microphones typically yield the widest frequency response and the highest output sensitivity of any low-impedance microphone type.

Dynamic Ribbon Microphones

The ribbon microphone (Fig. 4) is another type of dynamic microphone Also called a velocity microphone, it works on the same principle as the moving-coil or dynamic. However, instead of utilizing a diaphragm and attached voice-coil, it uses a combination ribbon diaphragm/voice-coil which is pleated (or corrugated) to give it strength and stability. The metallic ribbon moves in the magnetic field of the permanent magnets in response to sound pressure; this results in a voltage generated along the length of the ribbon, the output signal. The pleated ribbon is susceptible to permanent stretching if a sudden blast of air hits it, altering the sound of the microphone. (Obviously, it is not a good idea to blow into such a microphone.) The output impedance of the dynamic ribbon microphone is low.

PZM Microphones

The PZM (or boundary) is a special microphone for special applications; "PZ" stands for pressure zone and "M" denotes microphone. The pressure zone is a constant area of pressure that exists within a few thousandths of an inch of a flat, hard surface. The PZM utilizes a small, omnidirectional or unidirectional electret condenser transducer in a housing suitable for mounting on a flat surface. The output impedance of the PZM is low.

Line (Shotgun) Microphones

The line microphone (Fig. 5), or shotgun, as it is often called, can use a moving-coil, a condenser, or electret condenser transducer. The best performance from the shotgun is achieved by using a condenser, because this type of transducer yields higher sensitivity and better polar and frequency response than the others. Condenser-type units can also be smaller in diameter and lighter in weight. (Sensitivity, frequency response, polar response, and impedance will be covered later.) The output impedance of the line microphone is low.

The line opening along the front portion of the microphone leads inside to a very narrow slot, or line, in a small-diameter tube. Sound enters the line opening and travels down the tube to the diaphragm. At frequencies that have wavelengths shorter than a certain selected wavelength, sound entering the line is cancelled except for sound approaching almost entirely along the axis of the microphone. Maximum cancellation occurs at 90°. This is why it is referred to as a shotgun microphone: It tends to pick up sound only from the direction in which it is pointed.

At frequencies in which the wavelength is longer, the line mike no longer functions so selectively, and the pickup pattern tends towards more uniformity with angle. Therefore, a rear entrance is added to make the line microphone into a cardioid (a heart-shaped directional pattern) at lower frequencies, where the line no longer functions. Because the shotgun microphone is very directional, it can be used to pick up sound at fairly long distances. It is often used to pick up dialog in television broadcasts and in the movies where it may not appear on camera.

response is about the same as finding two identical snowflakes.

Contact Microphones

The contact microphone is used to pick up the sounds of a guitar, for instance, by attaching it directly on the surface of the instrument. The contact microphone uses a piezoelectric transducer, two small squares of ceramic material permanently bonded to either side of a thin piece of metal, like a sandwich. The ceramic material contains a permanent electrical charge (somewhat like an electret condenser). The output impedance of the contact microphone is high.

Figure 6 illustrates a piezoelectric microphone transducer. In contact versions, the piezo sandwich is made so rigid that it will not respond to sound waves in the air. It must be physically attached to a vibrating surface, such as the sounding board of a guitar. The sound energy coming from the board causes the sandwich to flex. The flexing action causes an output voltage to be generated across the output leads of the device.

Wireless Microphones

A wireless microphone is so named because the microphone cable has been eliminated. It often uses a moving-coil or electret condenser microphone, though it could be used with other types as well. These microphones generate an output voltage in a typical fashion, but how does this signal reach the electronic input without a cable? The microphone being used has built into it, or plugs into, a small radio transmitter. The transmitted signal is received by a radio receiver placed somewhere in the vicinity of the microphone/transmitter.

As one might expect, wireless microphones cost more than regular types, and some cost thousands of dollars. A good rule of thumb is to multiply the cost of a regular microphone by a factor of at least 10 to determine the price of the wireless version. Most wireless microphones are used by TV or stage performers who need to be very mobile. Obviously, when a performer must execute a rapid dance number, for example, a microphone cord would get in the way.

Frequency Response

Frequency response is a familiar term to most people, especially those who own high-fidelity equipment. Most of us know that the range of frequency response a human can supposedly hear is from 20 Hz to 20 kHz. In reality, the average adult cannot hear the extremes of the audio spectrum. Also, I have yet to discover a loudspeaker system capable of reproducing 20 Hz, though it is quite easy for a tweeter to reproduce 20 kHz.

Of the many types of microphones available, few offer flat frequency response. If a microphone has a wide range and flat frequency response, it will obviously be capable of faithfully reproducing sound. But such a response is usually available only in units costing many hundreds of dollars. For that matter, wide-range response is not always desired.

Difficult as it is to design a microphone with a flat and wide frequency response range, it is even more challenging to manufacture quantities of microphones of a given design without individual variations, from one microphone to another, in frequency response. Manufacturers develop what are called production limits, an example of which is shown in Fig. 7.

Production limits allow for a controlled amount of variation from unit to unit. The more expensive the microphone, the tighter the limits (or tolerance). As an example, a microphone costing $500 or more would probably have limits that only vary by 0.5 to 1 dB. Microphones costing $200 to $400 might have limits that vary by 1 to 2 dB. Microphones costing $100 to $200 might have limits that vary by 2 to 3 dB, and very inexpensive microphones might not have any limits, to keep production costs down. (These numbers are not meant to be construed as gospel, of course.) The likelihood of finding two microphones with exactly the same frequency response is about the same as finding two identical snowflakes; however, minor variations in frequency response are undetectable even to the trained ear.

The central curve of Fig. 7 is the curve of the microphone. The top curve is the upper limit of frequency response; the bottom curve is the lower limit. The reference point for production limits is usually 1 kHz because microphone frequency response is normally stable in this area, whereas there tends to be some variation at very low and very high frequencies. The production limits for this microphone vary by approximately ±2 dB.

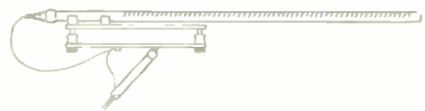

Fig. 5—Line (shotgun) microphone. (After Alec Nisbett, The Use of Microphones.)

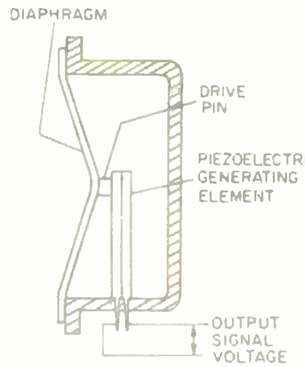

Fig. 6—Piezoelectric microphone. (After Clifford.)

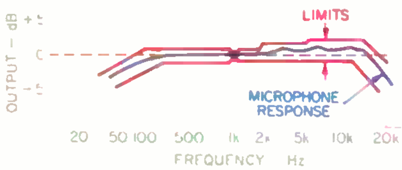

Fig. 7—Production limits of frequency response.

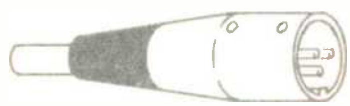

Fig. 8—Three-pin male cable connector.

Most microphones don't have wide, flat frequency response for the

Fig. 9—Three-pin female cable connector.

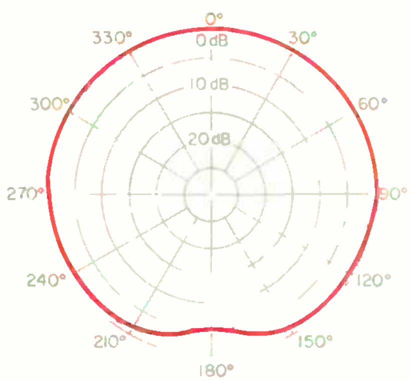

Fig. 10—Omnidirectional polar pattern. (After Woram.)

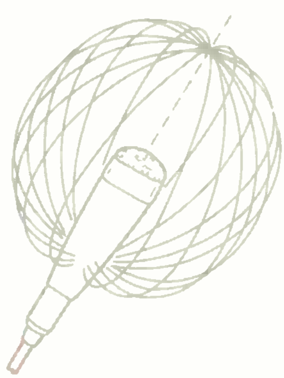

Fig. 11—Three-dimensional representation of omnidirectional polar pattern. (After Woram.)

Figure 7 allows us to determine several things about this particular microphone. It does not have a flat frequency response, nor does it have a frequency response of 20 Hz to 20 kHz. As the frequency response is usually thought of as the points at which the curve is 3 dB down from flat, it can be seen that this microphone's range is from 50 Hz to approximately 15 kHz. "Flat" is determined here with reference to the 1-kHz stable area of the microphone curve.

Sometimes a frequency response range for a microphone will be given in a manufacturer's literature, but no curve will be shown. In such cases it is not safe to assume, for instance, that the stated response is 3 dB down at the end points; it may be 3 dB up. You will be most likely to encounter this problem when dealing with very inexpensive microphones.

Most microphones that are designed to reproduce the entire audio spectrum are expensive, calibrated laboratory types, used for highly accurate acoustical measurements. The majority of microphones today do not have a flat, wide-range frequency response, for a good reason. Microphone applications vary widely and require different types of response curves to meet them. This is why frequency response curves are so important; we may incorrectly assume that the frequency response stated by the manufacturer is flat, just as we may erroneously assume the frequency response to be 3 dB down at the extremes.

Many microphone users prefer a rising high-frequency response; however, microphones exist which have responses that are flat, rising, falling, or rolled off. Typically, flat microphones and those with a rising high-end are used in recording. Microphones with rising response and low-end roll-off are preferred for up-close vocals or speaking. Microphones with a rising high-end are also liked in live applications for picking up cymbals, brass, etc.

Impedance

Impedance means something that is a hindrance. In audio usage, impedance hinders the flow of an alternating current in an electronic circuit. The unit of measurement used for impedance is the ohm.

Technically, impedance is made up of two basic components, the first of which is resistance. A resistive electronic device is called a resistor. The second component of impedance is reactance, which can consist of a capacitor or an inductor (coil). (Usually a small coil of wire is used in an electronic circuit.) The value of a resistor remains fixed unless it is subjected to excessive current flow, in which case it could be damaged. But the value of a capacitor or inductor varies with frequency. The impedance of a microphone is normally measured at a single frequency and is considered constant or resistive in nature. However, if one were to measure the microphone impedance at different frequencies, there would be a significant change in value. The sum of the values of the resistive and reactive components at a given frequency determines the total value of the impedance of the microphone. This is the value stated on the microphone's specification sheet.

There are two basic microphone impedance classifications in wide use today, low impedance (Lo-Z) and high impedance (Hi-Z). It is important to use Lo-Z microphones with Lo-Z equipment and Hi-Z microphones with Hi-Z components. But what if you don't know what the input impedance of your equipment is? Simply plug in the microphone and find out if it will work. You don't have to worry about doing any damage, either to the microphone or to other stereo components. If you plug a Lo-Z microphone into a Hi-Z input, the resulting sound output will be very weak and you will have great difficulty in speaking or singing loudly enough to be heard. If you plug a Hi-Z microphone into a Lo-Z input, the sound will be loud, probably distorted. It will also have an overabundance of bass, and high-frequency response will be totally lacking. Obviously, if you plug in the microphone and everything comes out sounding good enough and loud enough, the impedance match is correct.

Low-impedance microphones used in pro and semi-pro recording normally are wired in a three-conductor, balanced-line configuration to reduce noise pickup and hence permit the use of longer cables. A three-pin male audio connector (Fig. 8) at the output end of the cable mates with a three-pin female panel connector at the equipment's input. (A three-pin female connector is shown in Fig. 9.)

very simple reason that many applications demand something else.

There are some Lo-Z microphones in use today that have a ¼-inch phone-plug output-cable connector; these are usually inexpensive types for use with cassette recorders. The ¼-inch phone plug mates with a ¼-inch phone jack on the recorder.

Some cassette recorders have miniature phone-jack inputs. Adaptors are readily available to convert a standard ¼-inch phone plug into a mini-phone plug. High-impedance microphones also use a ¼-inch phone plug on the equipment end of the microphone cable, which would mate with a ¼-inch phone-jack input connector.

Examples of Lo-Z equipment using three-pin input connectors are more expensive reel-to-reel tape recorders and microphone mixing consoles (mixers). Examples of Hi-Z equipment using ¼-inch phone-jack input connectors are inexpensive mixers, guitar amplifiers, and older cassette decks and open-reel tape recorders. Some cassette decks are made to work properly with both impedance types by using an automatic, impedance-compensating network.

Microphone Sensitivity

Microphone sensitivity (or output level) is the measure of the output voltage of a microphone which is subjected to a known amount of audible sound pressure level (SPL) input. For the sake of uniformity, all manufacturers have an accepted sound pressure standard they use to specify the sensitivity of a microphone. This makes it easy to compare models from different manufacturers. The standard sound pressure level used is 94 dB.

A typical sensitivity specification for a low-impedance dynamic microphone might be:

$$-56 \text{ dB re: } 1 \text{ mW}/10 \text{ dynes/cm}^2. \quad (1)$$

At first glance this appears to be written in Greek, but upon closer inspection, it becomes obvious that most of the terms used are standard abbreviations. To understand what the above specification is saying, each term needs to be looked at individually. First, −56 is a negative number which implies that it is less than another, more positive number. (More will be said about this in a moment.) The abbreviation dB can be recognized as the decibel; "re" is an abbreviation for the term "referenced to." Continuing, mW stands for the term milliwatt. The prefix milli means 1/1,000; watt is a unit of power. Therefore, 1 mW is 1/1,000 watt—not much when compared to the power utilized by a light bulb. The next term, dyne, is a metric unit of force much smaller than an ounce. Last, cm^2 stands for centimeter squared, or square centimeter. There are approximately 2.5 centimeters to an inch. Dynes/cm^2 is a short way to say dynes per square centimeter. By definition, a force per given area is pressure, so 10 dynes/cm^2 is the amount of pressure that is exerted upon the diaphragm of the microphone.

It can be pointed out here that 10 dynes/cm^2 is equivalent to 94 dB SPL, which is the standard pressure for measuring microphone sensitivity.

Plainly stated, equation (1) says that the microphone in question has a sensitivity that is 56 dB less than the arbitrarily agreed-upon 0-dB reference, which is 1 milliwatt per 10 dynes per square centimeter.

The pressure—10 dynes/cm^2—can appear on specification sheets in several different forms, as follows:

$$10 \text{ dynes/cm}^2 = 10 \text{ microbars} = 1 \text{ Pascal} = 1 \text{ Newton/meter}^2 = 94 \text{ dB SPL}. \quad (2)$$

One could replace 10 dynes/cm^2 in equation (1) with any of these other terms and still have the same equation. Equation (1) can be further abbreviated by writing it as −56 dBm. Many specifications show the sensitivity in this abbreviated form, where "m" stands for 1 mW/10 dynes/cm^2 and automatically implies the milliwatt reference.

If a microphone is 6 dB more sensitive, say, than the one described in equation (1), its specification would be written −50 dBm. Therefore, the less negative the sensitivity number, the more sensitive the microphone. Dynamic microphones normally fall in the sensitivity range of −50 to −65 dBm. Condenser types generally fall in the −35 to −55 dBm range.

So far, only the sensitivity of low-impedance microphones has been discussed. The sensitivity specification for high-impedance microphones is stated differently, but this does not present a problem.

A typical specification for a high-im-

Fig. 12—Head diffraction, omnidirectional microphone.

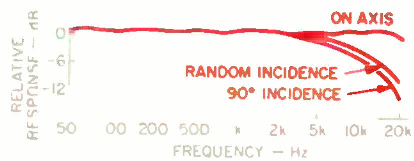

Fig. 13—High-frequency roll-off due to case diffraction, omnidirectional microphone.

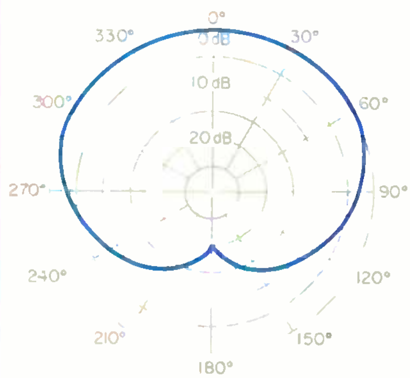

Fig 14—Cardioid polar pattern. (After Woram.)

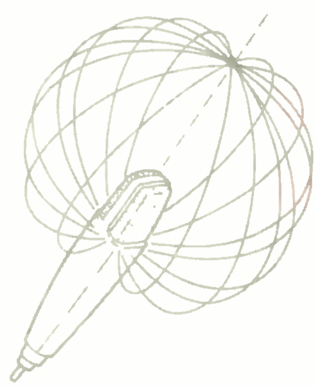

Fig. 15—Three-dimensional representation of cardioid polar pattern. (After Woram.)

High sensitivity is a drawback when a microphone is very close to

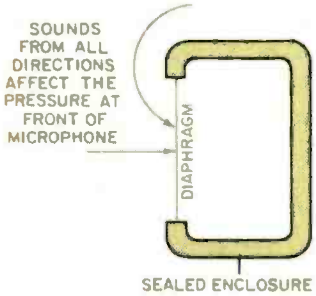

Fig. 16—Omnidirectional microphone capsule. (After Woram.)

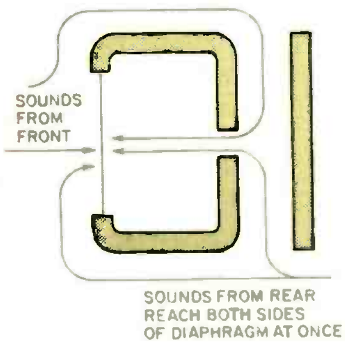

Fig. 17—Cardioid microphone capsule. (After Woram.)

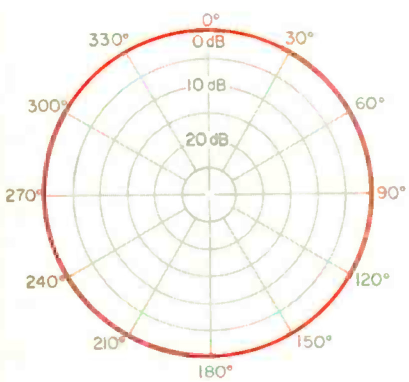

Fig. 18—Boundary (PZM) microphone polar pattern.

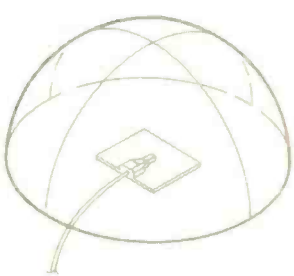

Fig. 19—Three-dimensional representation of boundary microphone's polar pattern.

pedance microphone might resemble:

$$-75 \text{ dB re: } 1 \text{ V/dyne/cm}^2 \qquad (3)$$

Looking at equation (3), it is seen that the sensitivity number is negative, as before, but it is obvious that the reference has changed. In lieu of 1 mW is 1 V, where V stands for volt. Also, 10 dynes/cm^2 has now become 1 dyne/cm^2, a change by a factor of 10 in the force on the diaphragm. A factor-of-10 change means a 20-decibel change. Therefore:

$$\begin{aligned} 1 \text{ dyne/cm}^2 &= 1 \text{ microbar} \\ &= 0.1 \text{ Pascal} = 0.1 \text{ Newton/meter}^2 \\ &= 74 \text{ dB SPL.} \qquad (4) \end{aligned}$$

When testing high-impedance microphones, manufacturers still use the standard 94 dB SPL, but they mathematically adjust the resulting sensitivity downward by a factor of 10, or 20 dB.

Equation (3) can also be simplified by rewriting it as −75 dBV, where V stands for 1 dyne/cm^2 and automatically implies a voltage reference.

At this point, one might ask a very logical question: "When should I use a high-sensitivity microphone in preference to a low-sensitivity microphone?" Low or high sensitivity is not a function of whether the microphone has low or high impedance, so I'll discuss sensitivity in terms of low-impedance microphones, the type used in the majority of applications today.

High-sensitivity microphones are preferred in those applications in which the microphone must be placed at some great distance from the source of sound, such as on a movie or TV set, or when recording an orchestra, recording a choir, or picking up a play. High sensitivity is appropriate for these applications, since it affords the best signal-to-noise ratio by allowing mixing-console and amplifier gain (volume) to be set at a minimum. The lower the gain settings on electronic devices, the less internal self-noise is amplified, thus minimizing hum, hiss and other electrical or electronic noises.

High sensitivity is a drawback when a microphone is going to be used very close to the source of sound, such as when close-miking a trumpet, a rock vocal, a kick drum, or an amplified instrument. A high-sensitivity microphone puts out considerably more voltage than one of lesser sensitivity. Indeed, when exposed to a loud sound source, such a microphone puts out a surprising amount of voltage—enough to overload the input of a mixing console or tape recorder.

Input overload means that the maximum input voltage rating of the tape recorder, mixer, amplifier, or other electronic device has been exceeded, resulting in a very noticeably distorted sound. People are often quick to place the blame for this on the microphone, but usually it is the input of associated equipment that is distorting, not the microphone.

When a signal greatly exceeds the maximum input voltage of the electronics, there will be flat spots in the most positive and the most negative portions of the signal; these portions will not pass through the equipment and so will be lost. Such a signal is referred to as a square wave; it results in sound that is very distorted to the ear.

A microphone with lower sensitivity will often correct this situation. If not, an input attenuator (pad) should be used. These devices are available with fixed values of 10 or 15 dB, or with 10-, 20- and 30-dB steps.

Although there is no specific point at which a microphone's sensitivity can be classified as "high" versus "low," I feel that microphones having an output sensitivity in the range of −54 to −35 dBm, or greater, can be considered to have high output sensitivity. Those microphones in the range of −55 to −75 dBm, or less, can be considered to be of low sensitivity.

Though the dynamic microphone will seldom distort, there are situations in which the microphone itself can cause distortion. Well-designed condenser types will not distort unless the sound pressure they are exposed to exceeds 135 to 140 dB. Some of these microphones have switchable internal pads that will add another 10 to 15 dB of headroom before distortion occurs.

The electret condenser that is internally powered with a 1.5-V battery will typically distort if SPLs of 125 to 130 dB are exceeded. This is equivalent to a rather loud vocal, so the problem is not cause for undue alarm.

At this point it might be useful to summarize some of the main points made here about microphone sensitivity. When two microphones are subjected to the same sound input, the one that generates the largest output

the source of sound, such as when close-miking a trumpet or drum.

voltage is said to have the greatest sensitivity. For low-impedance microphones, this is expressed in decibels relative to 1 milliwatt; for high-impedance units it is given in decibels relative to 1 volt. High-sensitivity microphones are good to use for pickup of distant sounds, while low-sensitivity models are good for close-up sounds. All microphones, but particularly those with high sensitivity, can overload equipment, causing distortion; this can be eliminated by using an attenuator (pad). Low-voltage condenser microphones can also cause distortion when exposed to very loud sounds.

Polar Response (Directionality)

Most people have difficulty visualizing and understanding polar patterns because they are normally depicted in a two-dimensional form on paper. In reality, they are three-dimensional.

The three-dimensional aspect of polar response can best be explained by considering the simplest pattern, the omnidirectional. As its name implies, the omnidirectional microphone picks up sound from *all* directions. This is illustrated in Figs. 10 and 11.

Regardless of where a sound source is located along the circle shown in Fig. 10, an omnidirectional microphone at the center "hears" the sound just as though it were coming from directly in front. In other words, the omni microphone picks up sound from all directions equally well. Other microphone types that do not have this capability will be discussed later.

If Fig. 10 were made to be three-dimensional, it would take on the appearance of a balloon as shown in Fig. 11. If a person were to stand anywhere on the surface of the balloon and talk, it would have the same effect as if he were standing directly in front of the microphone.

The omnidirectional microphone described so far is actually an idealized model. In reality, omnidirectional microphones exhibit some directionality (the tendency to be other than omnidirectional) at higher frequencies, due to their shape. To be truly omni, the microphone housing must be cylindrical (tubular) and measure ½ inch or less in diameter.

With a reasonable shape for an omni microphone, the handle is cylindrical but the head is not, and it is larger in diameter than the handle. High frequencies have difficulty trying to get around the head when approaching from the rear. Figure 12 shows high frequencies diffracting off the head, thus causing the sound intensity at these frequencies to be reduced. Lower frequencies have longer wavelengths and are able to turn corners.

In Fig. 10, the perimeter of the circle represents the ideal omni. The inner, curved line represents loss of high frequencies due to the aforementioned "head" or case diffraction.

The concept of polar patterns still may not be entirely clear. You may be asking, "Exactly what frequencies does the inner curve represent?" If the microphone were truly an omni, the outer circle would represent *all* frequencies. But because the high-frequency loss becomes greater as the frequency increases, the inner curve shown in Fig. 10 can only be true for a single frequency. From the standpoint of the high-frequency loss concept, however, the curve serves its purpose.

Figure 13 should help to clarify this concept. The top curve shows the on-axis (0°) response of the microphone, and the others show high-frequency roll-off due to diffraction off the case. As previously mentioned, the roll-off becomes more pronounced as frequency increases.

From a consideration of the omnidirectional microphone's polar pattern, we can more easily understand the polar pattern of the most widely used microphone today, the cardioid. The term unidirectional is often used in place of cardioid, even though it is a misnomer. Unidirectional implies only one direction, and such a device does not yet exist. The word cardioid means heart-shaped.

Figure 14 shows a cardioid (heart-shaped) line indicating how the microphone actually responds at the different angles. In comparison, the outer perimeter of the circle represents what an omni microphone response would be under the same conditions, if it were to replace the cardioid. Figure 15 shows that the cardioid polar pattern, in three-dimensional form, has somewhat the appearance of an apple.

At the 90° and 270° positions in Fig. 14, it will be noticed that the output of the cardioid is lower than the omni. At these positions, the output of the cardioid is half that of the omni, or 6 dB less. At 180°, the output of the cardioid mi-

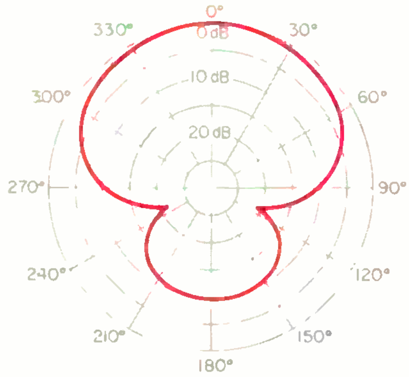

Fig. 20—Hypercardioid polar pattern. (After Woram.)

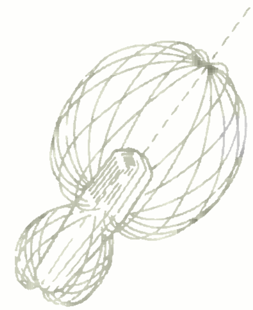
Fig 21—Three-dimensional representation of hypercardioid polar pattern. (After Woram.)

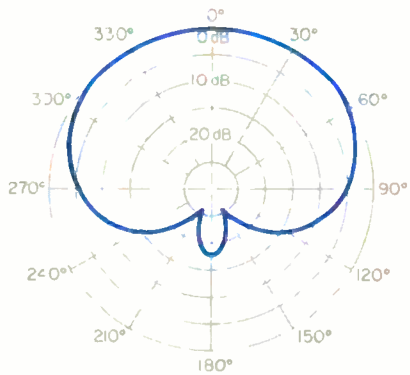

Fig. 22—Supercardioid polar pattern. (After Woram.)

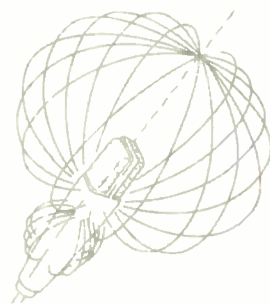
Fig 23—Three-dimensional representation of supercardioid polar pattern.

At high frequencies, the shotgun mike will act like a flashlight.

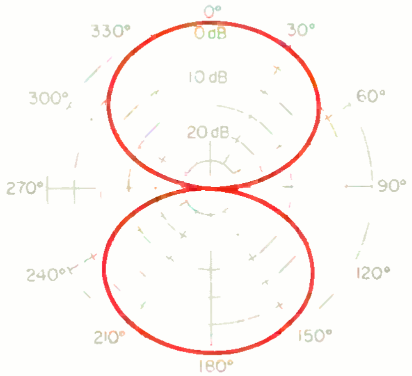

Fig. 24—Bidirectional polar pattern. (After Woram.)

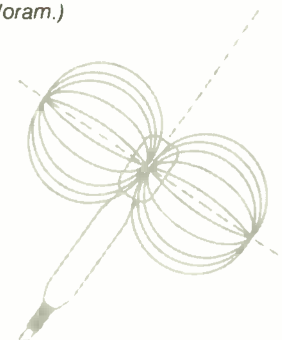

Fig. 25—Three-dimensional representation of bidirectional polar pattern. (After Woram.)

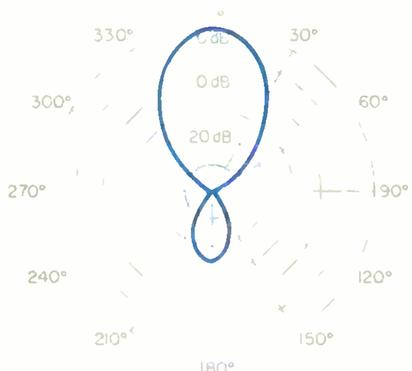

Fig. 26—Line (shotgun) microphone polar pattern. (After Woram.)

Fig. 27—Three-dimensional representation of line microphone's polar pattern. (After Woram.)

crophone is at its minimum (maximum rejection of unwanted sound occurs), possibly one-tenth or less of the output of an omni.

Fig. 16 shows an omnidirectional microphone capsule exposed to sounds converging upon it from various directions. Notice that *all* sound must converge to the front of the microphone, at the diaphragm. This is why its polar pattern is spherical.

Figure 17 shows a cardioid microphone capsule exposed to sounds arriving from various directions. Notice that sound can converge directly on the front of the diaphragm *and* indirectly on the rear of the diaphragm, through the rear opening.

The front and rear openings of a cardioid microphone are acoustically balanced for several reasons:

Sound approaching directly from the front of the microphone hits the diaphragm first and produces sound output from the microphone. Sound also enters the rear opening, but it is (purposely) slightly delayed in order to be out of phase with the sound entering from the front. This delayed rear sound also produces a sound output from the microphone.

Sound approaching the microphone from the sides arrives first at the front of the diaphragm, but the sound entering the rear openings arrives at the rear of the diaphragm just a little later, thus reducing the sound output by half (−6 dB).

Sound approaching from the rear of the microphone enters the rear opening first. It is delayed (by an internal acoustical-delay mechanism) so that it arrives at the rear of the diaphragm at the same time as the sound reaches the front of the diaphragm, resulting in little or no output from the microphone due to cancellation.

Because the cardioid microphone discriminates against sound approaching it from the rear, a big benefit is derived: The reduction of feedback. Feedback is a howl or squeal that can occur when a microphone is in the same room with the loudspeaker that is reproducing the sound. If the amplifier is turned up too high, the microphone can "hear" itself in the loudspeaker. Suddenly, a point is reached at which the original signal from the microphone is amplified rapidly over and over again, resulting in a sustained howl or squeal.

The cardioid microphone provides a significant reduction in feedback and background noise compared to an omni microphone. In addition, a cardioid has two other distinct advantages over the omni. The distance from the sound source to the cardioid can be twice that of the omni and still provide the same quality of sound pickup. When used at the same distance from the sound source as the omni, the cardioid will reduce background ambience by two-thirds.

Other types of polar patterns exist. Figures 18 and 19 show a hemispherical polar pattern associated with boundary, or PZM, microphones. Figures 20 and 21 depict a hypercardioid pattern associated with certain ribbon and condenser-type microphones made for particular applications. In Figs. 22 and 23, a supercardioid pattern is shown. This is associated with certain dynamic and condenser microphone types used for special applications. Figures 24 and 25 show a bidirectional or figure-eight polar pattern, which is most often associated with ribbon microphones. Figures 26 and 27 depict the polar pattern of a shotgun (line) microphone.

Because the line microphone is a significantly different type, it is appropriate to give a more detailed explanation. The line or shotgun microphone is extremely directional at high frequencies (typically, above 1 kHz) and hypercardioid at frequencies below 1 kHz (though there is no *sharp* transition at 1 kHz from hypercardioid to line). Therefore, at low frequencies, refer to the hypercardioid polar pattern of Figs. 20 and 21, and for high frequencies refer to Figs. 26 and 27.

At high frequencies, the shotgun microphone will act like a flashlight, in that you have to point it at the sound source to pick it up well. Keep in mind that the "lobe" size of Fig. 26 varies with frequency. It will be larger at 1 kHz than it will be at 10 kHz.

Properly used, polar pattern information can provide the user a tool with which to build an entire sound system for a church, auditorium, meeting room, etc. Or it can be used to design a recording or broadcast studio. Proper understanding of polar characteristics can aid in reducing feedback and ambient noise, which will make for a much higher quality sound pickup and reproduction.

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1

McINTOSH MC 2002 AMPLIFIER

Manufacturer's Specifications

Power Output: 200 watts per channel continuous, 8 ohms, 20 Hz to 20 kHz; 300 watts per channel continuous, 4 ohms; 600 watts continuous into 8 ohms in bridged mode.

Rated THD: Less than 0.01% maximum, from 250 mW to rated power per channel, 20 Hz to 20 kHz.

Frequency Response: 10 Hz to 100 kHz, +0, –3 dB, for 1-watt output.

S/N Ratio: Hum and noise, 100 dB below rated output, 90 dB IHF.

IM Distortion: Less than 0.01% from 250 mW to rated output, for any combination of frequencies from 20 Hz to 20 kHz.

Damping Factor: Greater than 100.

Input Impedance: 20 kilohms.

Input Sensitivity: Switchable for either 1.4 or 2.5 V.

Dimensions: Front panel, 16-3/16 in. (41.1 cm) W × 7⅛ in. (18.1 cm) H; chassis, 14¾ in. (37.5 cm) W × 6½ in. (16.5 cm) H × 14½ in. (36.8 cm) D, including connectors.

Weight: 50 lbs. (22.7 kg).

Price: $1,850.

Company Address: 2 Chambers St., Binghamton, N.Y. 13903.

For literature, circle No. 90

Photograph: © Bill Kouirinis

The McIntosh MC 2002 is a Class-AB solid-state stereo power amplifier rated at 200 watts per channel into 8-ohm loads. Physically, the unit is of average size for a Class-AB design, though somewhat lighter than former McIntosh amplifiers of this power rating because it has no potted output transformer or autoformer. McIntosh's massive and expensive bifilar-wound transformers gave them an edge on the competition in the tube designs of the 1950s. When solid-state designs came along, McIntosh used a different device, an autoformer, which used the same core but with a single winding of heavy wire that allowed impedance matching over a broad range.

The front panel sports McIntosh's traditional, rear-illuminated, black-glass construction with gold and black anodization and gold and teal-green nomenclature. The large, square power switch is the only front-panel control, and it glows red when activated. "Power Guard" indicators for each channel monitor clipping quite effectively; between them is a temperature indicator which signals when one or both channels have been shut down because of overheating. Two large, peak-responding power output meters, which use full-wave detection to respond to both positive and negative peaks, occupy the left and center of the panel.

On the rear panel are two RCA signal-input connectors, a screw-clamp barrier strip for the four speaker wires, an unswitched a.c. outlet rated at 100 watts or 1 ampere maximum, a 15-A line fuse, and slide switches for mono/stereo operation and input-sensitivity selection. The line cord is nondetachable.

The chassis construction is an exercise in simplicity. The sides, front, back, top, and bottom are all moderate-gauge (0.048-inch) steel. Four vertical heat-sink extrusions, each containing four TO-3 case output transistors, are bolted to both bottom and top, thus strengthening the assembly. The single, massive power transformer is mounted just behind the front panel, its weight carried by a steel U-section that runs from side to side along the bottom plate. To either side of the transformer are the driver circuit boards. The chassis components are held together by self-tapping screws. The threads in the thin, steel panels were well-formed, but it would be easy to crossthread the bolts on reassembly. The mounting holes in the heat-sinks are pretapped. All in all, this amplifier's mechanical construction is better than average for a home product in its price category.

The quality of the 11 glass-epoxy circuit boards in the McIntosh MC 2002 is very high. Boards are 1/16-inch, single-sided, with milled rather than sheared edges. Solder mask is used but there are no component designators; this should pose no problem, though, because the uncrowded layout allows easy component identification from a chart. Component quality is good to excellent, although no Wonder Caps are used. The correct component types are used throughout, and bias and meter calibration trim pots are sealed from airborne contaminants. Parts are well-secured and run cool. This amplifier, in the McIntosh tradition, should provide 10 to 20 years of maintenance-free service.

Circuit Description

The circuit of the MC 2002 is unusually simple for such a high-performance amplifier. McIntosh's design philosophy is to achieve high performance with stability and reliability by using a simple topology, with selected components operating in their most linear range.

The input signal passes through an attenuator set at 0 or −5 dB by a rear-panel switch. It is then a.c.-coupled to one input of a differential amplifier stage. Negative feedback from the amplifier output is applied to the other input; output of this stage connects to a positive-drive, cascode-connected pair for further current and voltage amplification. This feeds a push-pull complementary, triple-Darlington, emitter-follower output stage. The final transistors are four positive and four negative TO-3 case devices per channel, with large (0.5-ohm) emitter resistors.

The power supply uses a single, oversized transformer, a 35-A bridge rectifier, and two 12,000-µF electrolytic capacitors, which have 77 joules of energy storage. The front-panel power switch actually controls the d.c. supply to a heavy-duty relay; this, in turn, switches on a.c. voltage to the power transformer's primary. The 16 output transistors are convection-cooled, eliminating potentially noisy fans from the design. Output voltage is ±80 V d.c.

The metering and protection functions use as much circuitry as the basic amplifier path itself. A 2-S turn-on signal delay is provided by an input-shunting FET. The amplifier

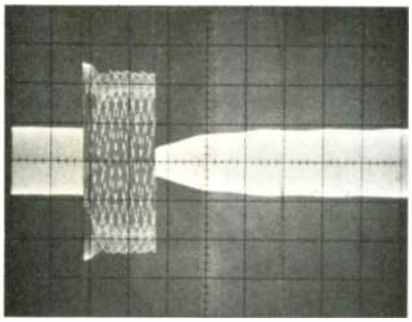

Fig. 1—Characteristics of the Power Guard circuit. (See text.) The continuous signal is 10 kHz, 50 watts into 8 ohms, to which a 1-kHz burst is added so that the resulting signal is +10 dB re: 200 watts. Note that several distinct stages occur. First, there are the horns due to clipping before the circuit acts; next, with the strong signal still present, the gain is reduced to below clipping. Finally, with the 1-kHz overdrive gone, the circuit restores the 10-kHz signal to proper level. (Scales: 20 mS and 15 V per div.)

The MC 2002, in the McIntosh tradition, should provide 10 to 20 years of maintenance-free service to its owner.

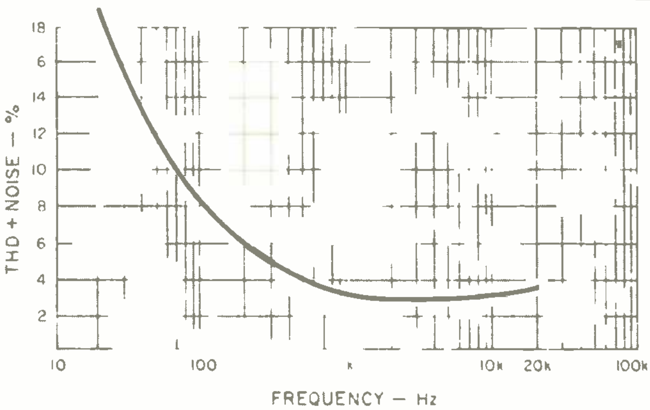

Fig. 2—Total harmonic distortion plus noise vs. frequency at 10 dB over rated output into 8 ohms, steady-state, showing the effect of the Power Guard circuit.

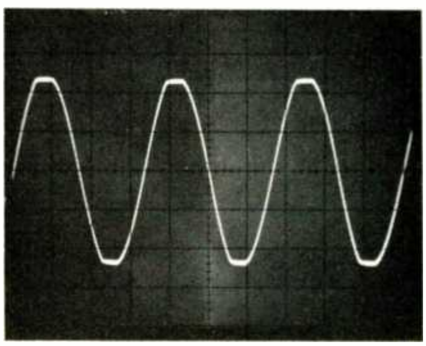

Fig. 3—Response to 300-Hz sine wave at 10 dB over rated 200 watts into 8 ohms. (Scales: 1.0 mS and 20 V per div.)

does not generate a transient, so its output is left free of series relay contacts. If a sustained d.c. offset is detected at the output, an SCR crowbar circuit shorts the power transformer's secondary and causes the line fuse to blow. The amplifier is protected from power-line surges by clamp components in the power supply. If the heat-sink temperature reaches 200° F, thermal cutout switches open and remove the −80 V supply to the driver boards, stopping bias to the entire channel. A volt-clamp limiting circuit also protects the output transistors.

McIntosh's proprietary Power Guard circuitry, a special feature of this amplifier, monitors the summing point at the input differential amplifier. The amplifier input and feedback signals are fed, respectively, into the noninverting and inverting inputs of the Power Guard amplifier/comparator. Any voltage difference here means that the overall negative feedback is inadequate to cancel distortion; this might occur from voltage clipping, current limiting, or slew-rate limiting. The sensed voltage is rectified by a bridge rectifier, filtered by a capacitor, and fed to an LED. The front-panel LED indicators, one for each channel, illuminate if distortion is present, causing reduced resistance in a light-dependent resistor. This photoresistor shunts just enough input signal to ground to eliminate the overdrive. In our use with music, only voltage clipping activated the indicators, confirming the high speed and current capacity of the MC 2002. The Power Guard circuit is nondefeatable.

Music waveforms are often "clipped" off because the owner may demand higher sound levels and higher voltages than the system can supply. Still, very few manufacturers offer true clipping indicators on their home amplifiers, though this feature is considered essential for professional audio work. We have tested a number of amplifiers that do not snip off the voltage cleanly and thus cause more distortion than necessary when overdriven. McIntosh does not have this head-in-the-sand attitude about the realities of electronic music reproduction. Even if we nitpick details of McIntosh's Power Guard circuit, it is much appreciated as a first-order solution to a common problem.

Measurements

The McIntosh MC 2002 was first run for 1 hour at 33% of rated power, about 66 watts per channel into 8-ohm loads with a 1-kHz test signal. The chassis top became warm, but the amplifier didn't thermally shut down.

Voltage gain was measured to be 29.0 dB at the 1.4-V switch setting into an 8-ohm load; at the 2.5-V switch setting, gain was 23.8 dB. The IHF sensitivity for 1 watt into 8-ohm loads at 1 kHz was 2.82 V.

Power output was measured into a variety of load conditions, as shown in Tables I, II and III. Using a rating of 0.1% THD, minimum continuous power output per channel was 220 watts (42.0 V) into 8 ohms and 333 watts (36.5 V) into 4 ohms. Bridged operation resulted in a mono signal with a minimum continuous power output of 757 watts (38.9 V). Setting the amp at rated output voltage, THD was 0.0071% for 8-ohm loads (40.0 V), 0.01% for 4-ohm loads (34.64 V), and 0.0044% (38.9 V) in bridged configuration.

The IHF signal-to-noise ratio, A-weighted re: 1-watt output into 8 ohms, measured 90 dBA for the right channel and 92 dBA for the left.

Crosstalk versus frequency was measured by driving one channel and measuring the leakage into the other, with the unused input terminated by a 1-kilohm resistor not connected to external ground. Crosstalk was found to be better than −68 dB from 20 to 500 Hz, rising to −48.4 dB at 10 kHz, and peaking to −42.0 dB at 20 kHz in the left channel. The left-to-right crosstalk is dependent on the load on the left channel; if one removes the load, the crosstalk becomes unmeasurable. This suggests grounding problems or that the long leads to the heat-sinks talk to the other channel.

The characteristics of the MC 2002's Power Guard circuit were measured using a special test setup. A 10-kHz signal was set to drive the amp at −6 dB (20.0 V, 28.28 V peak, 50

When the amp was subjected to the biggest bass-drum whacks Telarc's CDs could deliver, no audible clipping was heard.

watts output). A lower frequency transient at 1 kHz was added such that the combined peak value was 10 dB greater than the rated continuous output (126.4 V, 179 V peak, 2,000 watts). Power Guard attack and release times were then observed from the signal envelope, as shown in the 'scope photo of Fig. 1; they proved to be of the "fast" (5 mS) attack, "slow" (50 mS) release variety. A normal amp would clip heavily, showing "horns" and a brightening outline on the trace for the duration of the 1-kHz added pulse, then would instantly (a good amp can recover quickly) put out the 10-kHz, −6 dB signal. Horns do appear briefly at the beginning of the overdrive pulse block in the 'scope photo, but vanish as the circuit acts quickly. When the overdrive is suddenly cut off, the signal collapses to an area smaller than baseline and gradually expands as the circuit action decays.

Is it better to clean up the clipping and sacrifice a "hole" in the following low-level signals for 50 mS, or to clip and instantly recover to play the low-level signals? Overall, the technique used in McIntosh's Power Guard seems best to us because musical transients do not end abruptly, actually allowing the circuit to recover as they die out. Also, the 5-mS attack time keeps the circuit from acting on extremely short overdrives. A "tick" cannot cause a 50-mS "suckout."

Because of the action of the Power Guard circuitry, gradually increasing the overdrive causes a smooth increase in distortion, not the step function seen with most solid-state amplifiers. Beginning at 0.0018% at rated power (0 dB), the amp's THD rises to 2.2% at 4 dB overdrive, and 3.0% at 10-dB overdrive. Figure 2 shows THD + N for the audio bandpass, with the amplifier driven to 10-dB overdrive into 8-ohm loads. Distortion increases above 3.0% below 1 kHz, reaching a peak of 19% at 20 Hz under these conditions. Figure 3 shows the 'scope appearance of this 10-dB overdrive state at 300 Hz, and the waveform looks much more like a sine wave than would one produced by a conventional amplifier, which might deliver 40% THD + N, quite close to the perfect square waveform seen with 50% THD + N.

Figure 4 illustrates the MC 2002's square-wave response at rated power, 200 watts per channel into 8 ohms at 20 kHz. Power Guard has been switched on, resulting in the tiny overshoot peaks at the leading edges. (These peaks are not seen before the Power Guard cuts in.) Adding a 1.0-μF capacitor causes minimal ringing of the output network, with a 0.2-dB increase in sine-wave output at 20 kHz, but no instability.

The 1-watt frequency response into 8 ohms showed the amplifier to be within ±0.1 dB from 20 Hz to 20 kHz. The high-frequency, −3 dB downpoint was at 100 kHz for the 2.5-V input position and at 250 kHz for the normal, 1.4-V input position.

The low-frequency damping factor was measured at 285 for 8 ohms and 143 for 4 ohms. The wide-band damping factor was measured at 53 for 8 ohms and 27 for 4 ohms.

The slew rate measured 23 V/μS up and 40 V/μS down (asymmetrical). IHF slew factor into 8 ohms was 4.0 (80 kHz); into 4 ohms it was 5.0 (100 kHz).

Dynamic headroom measured 1.4 dB (42.3 V, 223.7 watts) at a pulsed clipping from a steady-state level of 200 watts rated power into 8 ohms; the 4-ohm IHF headroom was 1.7 dB (47 V, 552.3 watts). These figures indicate a power supply with medium voltage regulation.

Our new test of maximum output current utilizes a 20-mS pulse (repeated at a 0.5-S rate) driving one channel of the amplifier into a 0.1-ohm load. Under these conditions, the McIntosh MC 2002 delivered a 14.8-A rms pulse before clipping, showing itself to be average in terms of current delivery among high-powered amps on the market today. (For an explanation of the authors' test procedure, see "Short-Circuit Current Test" accompanying this issue's review of Sansui equipment.)

The McIntosh's meters proved to have a VU-type action rather than the peak action claimed. A period of 0.4 S is required for the pulse to reach 50% power indication in the

Table I—Power output per channel and distortion, 8-ohm loads.

Freq., Hz	V	Power, Watts	THD, %
LEFT CHANNEL			
20	42.0	220.0	0.002
200	44.1	243.0	0.0017
2k	44.8	251.0	0.0019
20k	45.0	253.0	0.0035
RIGHT CHANNEL			
20	42.0	220.0	0.0030
200	44.0	242.8	0.0022
2k	44.7	250.0	0.0028
20k	45.0	253.0	0.0071

Table II—Power output per channel and distortion, 4-ohm loads.

Freq., Hz	V	Power, Watts	THD, %
LEFT CHANNEL			
20	36.5	333.0	0.0034
200	39.7	394.4	0.0025
2k	39.8	396.0	0.0033
20k	39.7	394.0	0.0043
RIGHT CHANNEL			
20	36.5	333.0	0.0050
200	39.4	388.0	0.0025
2k	39.8	396.0	0.0033
20k	39.7	394.0	0.0100

Table III—Power output and distortion, mono channel, bridged 8-ohm loads.

Freq., Hz	V	Power, Watts	THD, %
20	39.4	776.0	0.0030
200	39.6	784.0	0.0024
2k	39.7	788.0	0.0030
20k	38.9	757.0	0.0044

The McIntosh's strong suit was its field depth, soundstage rendition, spatial replication, and instrument localization.

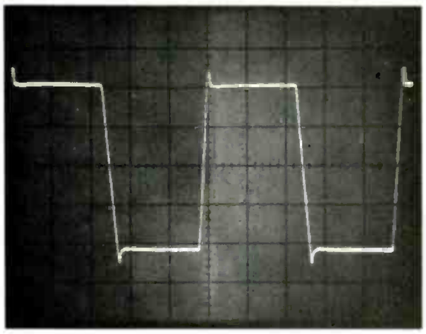

Fig. 4—Response to 20-kHz square wave at 200 watts into 8 ohms, Power Guard circuit activated, with input increased to get 200 watts output. (Scales: 10 μS and 20 V per div.)

20 Hz to 20 kHz range. At 1 kHz, steady-state signal measurements were accurate at 200 watts, with the error increasing to 127% as power output was decreased to the 2-watt level. With a 1-cycle pulse of 200 watts into an 8-ohm load, the meters read 20 watts at 20 Hz, 15 watts at 200 Hz, 8 watts at 2 kHz, and 0 watts at 20 kHz. In general, the Power Guard indicators served as true clipping monitors, often firing in the presence of minimal meter action.

Use and Listening Tests

Equipment used to evaluate the McIntosh MC 2002 included a Linn Sondek turntable with a Magnepan Unitrac 1 arm, Yamaha MC-1000 and Shure V15 Type V-MR cartridges, Meridian and Philips Compact Disc players, Mark Levinson ML-7 reference preamp, Mark Levinson ML-9 and Crown Micro-Tech 1000 solid-state power amps, and B & W 801F Special and Snell Type A/III loudspeakers. Controlled listening tests also were carried out with an ABX Co. comparator after matching outputs of the McIntosh MC 2002 with the ML-9 to within 0.001 V using the CBS STR-151 test record. New Monster Cable was used, with co-author Greenhill's usual X-Terminators removed so the cable's spade lugs would fit the McIntosh's speaker-connector barrier-terminal strip. (See "Comparator-Controlled Listening Tests," which accompanies this issue's review of Sansui components, for more details on the A/B/X double-blind testing procedure and the equipment used.)

The MC 2002 was auditioned on the Snell Type A/III speakers. First subjective impressions with an amp can be misleading, as was the case here. Greenhill first detected a lack of highs, as well as a grain, glazed midrange and lack of textural detail on low-level sounds. After tightening all the speaker-wire connections, things improved greatly. The veils lifted, detailing improved markedly, and Greenhill became aware that the McIntosh's strong sonic suit was its soundstage rendition, spatial replication, instrument localization, and depth of field. The reference ML-9, though clearly brighter in the midrange and far more detailed in the highs, could not match the McIntosh's field depth. On the other hand, the Levinson outstripped the MC 2002 in deep bass, yielding more solidity and impact on CD bass-drum notes. The Power Guard lights flashed frequently during these bass tests, in which Greenhill subjected both amps to the biggest bass-drum whacks Telarc's CDs could deliver, but no audible clipping was heard from the MC 2002.

The MC 2002's limiter circuit was auditioned to determine if it would interfere with the amp's sonics by blunting transients or coloring the sound under near-clipping conditions. We enlisted the help of B & W 801F loudspeakers, which feature their own protection circuits. Both the Levinson and Crown could be pushed into audible clipping, producing an awful shredding of the sound, whereupon the B & W's protection circuits cut in and temporarily shut off the speakers. The McIntosh MC 2002's nondefeatable limiter allowed the amp to maintain its aplomb under the same overdriven conditions, and no shredding of sound was heard. The McIntosh's Power Guard prevented the amp from clipping and thus would protect a loudspeaker without the B & W's safeguards. Midrange transients were quick without being overbright or steely, and deep bass transients had plenty of punch.

Below clipping, the MC 2002 again lacked vitality and air in the upper midrange while showing better than average depth of field. Bass definition was good to excellent, holding up well during Power Guard operation, but not going quite as deep as the Levinson. The Crown Micro-Tech 1000 proved to have a faster attack on transients than the 2002, but was brighter and zippier.

The controlled, double-blind A/B/X test failed to support these subjective sonic differences found during uncontrolled listening sessions. Using the B & W 801F speakers, Greenhill was able to identify the randomly selected amp in only 10 out of 16 trials, a rate which reaches only 68% statistical significance rather than the desired 95%.

The McIntosh operated smoothly during all bench and listening tests. A slight turn-off pop could be heard in the speakers, but no turn-on thump was present. The A/B/X switching relays caused no problems with the McIntosh's protection circuitry, as it did with another amp being tested.

In summary, we find the McIntosh MC 2002 amplifier to offer good quality, high reliability and elegant engineering design. Co-author Clark was particularly impressed with the high performance achieved from the MC 2002's simple and relatively cost-effective circuit topology. The Power Guard circuitry, with its very desirable clipping indicators, is a well-thought-out design for preventing audible distortion and speaker damage from intense clipping. The controlled tests, however, reveal no significant sonic differences (below clipping) between the McIntosh and the reference ML-9 amplifier, confirming Clark's belief that well-designed amplifiers today differ little sonically. Greenhill's subjective impressions of the MC 2002, when it was inserted in the audio system described above, continued to be positive about the amp's spatial replication and critical of its midrange clarity—even when he couldn't document his reactions under blind, A/B/X-controlled conditions.

Laurence L. Greenhill and David L. Clark

See dealer listing on page 124

2

NAKAMICHI DRAGON-CT TURNTABLE

Manufacturer's Specifications
Drive: Direct.
Motor: Quartz PLL d.c., brushless, slotless, coreless Super Linear Torque.
Speeds: 33.3 and 45 rpm.
Pitch Control Range: ±6%.
Main Platter: 1.4 kg, aluminum die-casting, 310-mm diameter, 18 mm thick.
Center Search Platter: 550 grams, glass, 303-mm diameter, 6 mm thick.
Startup: Within one revolution.
Speed Deviation: Unmeasurable with quartz lock.
Speed Drift: Unmeasurable with quartz lock.
Wow & Flutter: 0.008% wtd. rms, FG direct; 0.03% wtd. rms after Center Search.
S/N Ratio: Greater than 78 dB (DIN B).
Moment of Inertia: 380 kg/cm^2.
Dimensions: 21½ in. (54.6 cm) W × 9-1/16 in. (23 cm) H × 16-9/16 in. (42.1 cm) D.
Weight: 44 lbs., 1 oz. (20 kg), including tonearm.
Price: $1,740, including tonearm.
Company Address: 19701 South Vermont Ave., Torrance, Cal. 90502.
For literature, circle No. 91

Nakamichi has earned an enviable reputation for making the best audio cassette recorders in the world. Years ago, they manufactured cassette machines for such companies as Harman/Kardon and Fisher. I remember the original Harman/Kardon audio cassette recorder because it set such high standards for quality that it changed the way people thought about such machines. When Philips invented the audio cassette system, they intended it for portable dictation, and audio quality was of secondary importance. The recorder Nakamichi built for Harman/Kardon changed all that. Arne Berg, who was a consultant for Harman/Kardon, was responsible for a great deal of the innovations incorporated in the design. He later co-founded TASCAM, which set new standards in the semi-professional recording business. Nakamichi decided to produce machines under its own name a few years ago; they continue to provide improvements in state-of-the-art audio cassette recorders.

Now, Nakamichi is making a similar name for itself with turntables. Over the years, improvements in turntable performance have been achieved by better motor design, electronic-control circuitry, suspension systems, etc., but until lately nothing innovative had happened in a long time. The new Nakamichi Dragon-CT turntable made me think about how symphonies were written by such composers as Haydn, Mozart, and Beethoven—each building upon the last but not changing the basic form very much. Along came Berlioz and *voilà*: The "Symphonie Fantastique," a symphony with a fifth movement! Nakamichi may have had similar thoughts when they added a "fifth movement" to their turntable. Perhaps the Dragon-CT was to consume all the other turntables or at least breathe a little fire into the turntable business. In any case, the Dragon-CT does add something new to the game. I'll look at this turntable and then review the remarkable synergy of its arm with the Shure V15 Type V-MR phono cartridge in the next profile.

For years we have all watched our tonearms weave back and forth at 5.6 cycles per second. Then we watched them weave back and forth at 5.6 Hz: we had changed the name but not the game. Enter Nakamichi with a solution: A rod to move the edge of the turntable platter so that the record groove is centered exactly within ±0.02 mm. Now we can be hypnotized by the music, not by an undulating tonearm. (Actually, this innovation was incorporated a few years ago in Nakamichi's first turntable, the TX-1000, but the Dragon-CT is much more affordable.)

This answer to the record-eccentricity problem which uses a microprocessor and a rather complex algorithm to determine when concentricity has been achieved, does have a practical rationale. Modern cartridges, amplifiers, and loudspeakers can respond to the 0.56 Hz produced by an eccentric record groove. High-pass filters are often built into amplifiers to keep this low-frequency signal from causing intermodulation distortion in amplifiers and loudspeakers, but they can't prevent what has already occurred at the cartridge: Low-frequency modulation of the music, otherwise known as wow.

With its lightly smoked, black dust cover closed, the satin-black Dragon-CT reminds me of an austere Oriental jewel box except for the long, narrow control panel mounted on its front. Before even lifting the lid, the tiny gold lettering on this control panel would make anyone suspect that there was something different inside. The first thing I noticed was the Center Search arm, a second, short, pivoted arm at the rear of the main platform. It has a diamond stylus, and, since it is only used a few seconds for each record, it should outlast the rest of the turntable.

It isn't obvious at first that the lid hinges are not attached to the main platform, but to a lower platform which has the leveling feet. Mounting the lid in this way keeps it from transmitting airborne vibrations to the main platform. A small enclosure at the left front of the main platform, near the turntable, contains both the light, which illuminates the strobe pattern in the turntable rim, and the Center Search control rod, which pushes the glass plate that lies on the main turntable platter into exact record groove concentricity. Both the main platform and the subplatform are wood, painted black. The rest of the turntable is metal except for the oversized glass plate and rubber mat, which sit on the main platter, and the black control buttons and pitch-control knob, which are plastic. At the four corners are round towers; by popping off their top caps, I could see the suspension-spring adjustments which provide low-frequency vibration filtering as well as a means of leveling the turntable. The feet of the towers have combination elastomeric and felt vibration filters and these too can be adjusted to level the turntable. A satin-black tonearm with a fixed headshell is mounted on the main platform. The overall impression is of solid—albeit rather austere—reliability.

Features

The Absolute Center Search system sets the Dragon-CT apart from all other turntables. This system checks for eccentricity of a record's final, locked groove while the disc is

MEASURED DATA

Parameter	Claimed	Measured	Comment
Speeds	33.3 and 45 rpm	+0.19%*	See Below
Speed Stability	**	0.13%	Excellent
Wow, DIN Unwtd.		0.11%	Excellent
Wow, DIN Wtd.		0.08%	Excellent
Flutter, DIN Unwtd.		0.10%	Excellent
Flutter, DIN Wtd.		0.03%	Excellent
W & F, DIN Unwtd.		0.16%	Excellent
W & F, DIN Wtd.	0.03%	0.07%	Excellent
Long-Term Drift	**	0.20%	Very Good
Rumble, Unwtd.		−66 dB	Excellent
Rumble, Wtd.	−78 dB	−87 dB	Excellent
Suspension Resonance		1.39 Hz	Damped

*The tone on the B & K test record may be a little high in pitch.

**Unmeasurable

The Dragon-CT uses a microprocessor as the heart of a special system to center records perfectly on the platter.

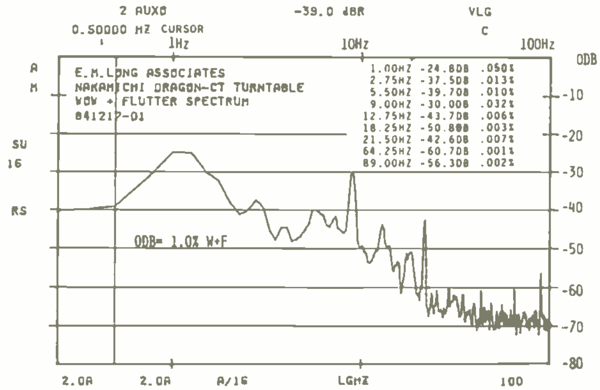

Fig. 1—Wow and flutter spectrum. Note that Nakamichi's Absolute Center Search system reduces wow considerably, and that the peak at 9.0 Hz is due to the resonance of the arm and cartridge.

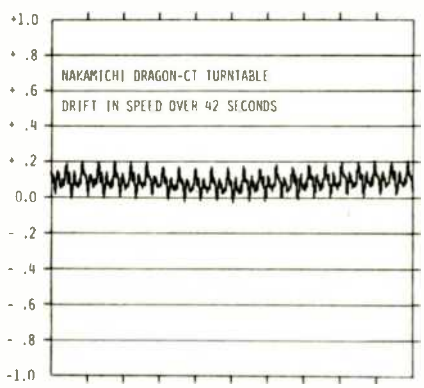

Fig. 2—Speed drift over a 42-S period. Cyclic variations are at 1.8 S or 0.56 Hz and are related to one revolution at 33.3 rpm. This is the lowest variation so far measured.

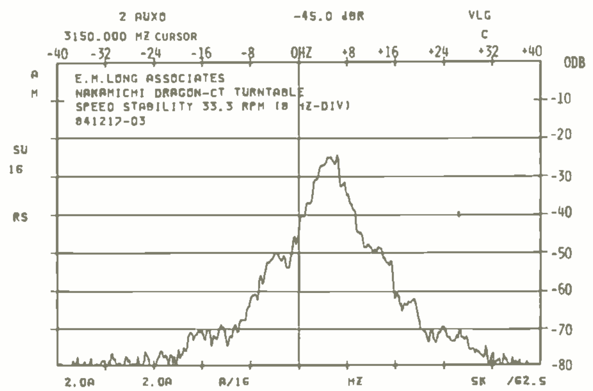

Fig. 3—Speed stability. The 0-Hz reference is to the 3,150-Hz tone on the B & K 2010 test record, band 8. Although the speed is a little fast, the tone may be slightly high in pitch on the test record. The measurement here is excellent; piano recordings will sound very realistic.

turning at a quartz-locked speed of 33.3 rpm. The platter then stops, and the system moves the platter's oversized glass plate to the proper spot, centering the record perfectly. The testing and correcting algorithm allows three cycles of test and correction, after which an error light comes on if the record has not been exactly centered to within 0.02 mm. Play can continue, if you wish, or you can try to visually recenter the record and begin the Center Search process again. (Using the Absolute Center Search feature is optional; you can play a record without ever invoking it.) Record manufacturing standards such as IEC 98A allow for up to 0.2 mm of eccentricity. Since Nakamichi controls the diameter tolerance of their spindle, they are in a good position to calculate a worst-case scenario for their algorithm.

Here is a more-detailed description of the Absolute Center Search system: After placing a record on the turntable platter, you push the button on the top of the center spindle to set the record, rubber mat and glass plate to the nominal center position. Then you place the record weight over the spindle so it rests on the label and presses the record into firm contact with the rubber mat. With the tonearm unlocked but still on the arm rest, you press the start button. The turntable will begin rotating and the Center Search arm will activate, moving out to trace the position of the inner groove. At the rear of this arm is a shutter blade which is in the path of a photocell and a light source. The shutter modulates the amount of light hitting the photocell according to the amount of eccentricity; the more eccentricity, the greater the variation in light. The photocell converts this to a variation in electrical output, the amount of variation equalling twice the value of the eccentricity correction needed. This variation passes through an analog-to-digital converter and thence to a microprocessor.

To determine the exact point on the platter rim which must be pushed to effect the proper correction, another photocell and light source count the pulses produced by slits cut into the periphery of the turntable platter. By counting a specific number of pulses after the maximum output of the Search arm's sensor system, the turntable can be stopped at the right position. Next, the system activates the Center Search rod-control motor, which drives the positioning rod through a speed-reduction gear system. The rod moves out of the small housing at the left of the main platter and nudges the oversized glass platter. The rod retracts and the turntable platter begins to revolve again while the Center Search arm retraces the locked groove. If the error is still greater than ±0.02 mm, the process begins again. Three attempts are made to center the record exactly, after which the record is centered or the error light flashes. In either case, the turntable remains running and the record can be played. The initial pass of the Center Search system takes about 40 S; the next passes take about half that time.

Nakamichi has done some calculations which show the effect of record eccentricity upon wow and interchannel phase, and also upon variation in tracking force. These calculations show some pretty shocking things. Even if a record is within specification tolerances, as much as 0.6% unweighted and 0.2% weighted peak wow is produced at the inner grooves. Nakamichi claims that most manufacturers specify wow and flutter by measuring the motor directly,

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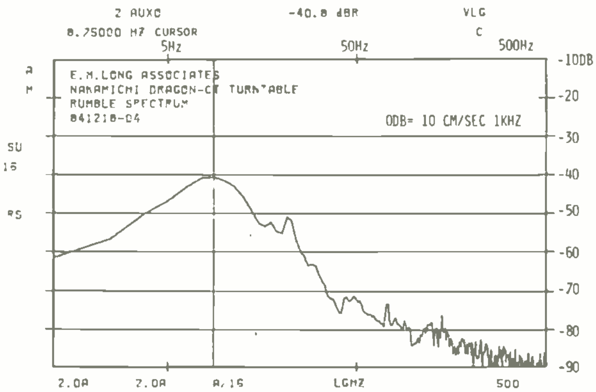

Fig. 4—Rumble spectrum, with main output due to the tonearm/cartridge resonance at 9 Hz. The rumble is extremely low; most records will have more inherent rumble than was produced by the Nakamichi Dragon-CT turntable itself.

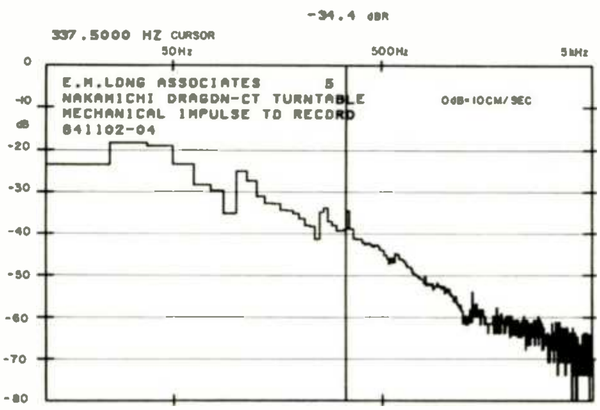

Fig. 5—Spectrum to 5 kHz due to a mechanical impulse applied to the edge of a stationary record. The cursor is at 337.5 Hz, an artifact of the Dragon-CT tonearm, where the output is −34.4 dB below 10 cm/S.

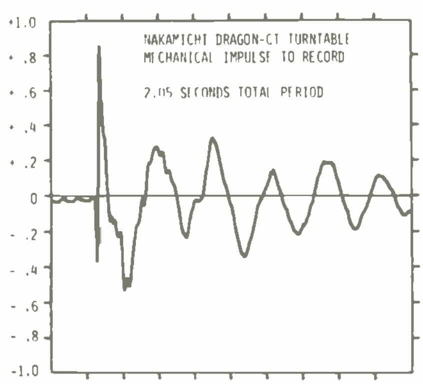

Fig. 6—Response to mechanical impulse applied to a record's edge.

rather than using a test record. No wonder I have had trouble matching some turntable specs! I have always been very careful to center test records, because I can see the results at 5.6 Hz on the FFT spectrum analyzer and easily hear the effect upon test tones. The tones are steadier in both pitch and amplitude when the record is properly centered. Anyone who has a subwoofer system can see the reduction in excursion of the woofer cones after a record has been properly centered. The Nakamichi Absolute Center Search system makes this easy.

Measurements and Listening Tests

If you have read any of my past reports, you know that I think technical measurements are best used to determine the reasons for comments made by members of the listening panel during listening tests. I try to correlate their impressions with artifacts of the technical measurements, and suggest possible explanations for their comments. Since the Dragon-CT turntable allows the record to be centered much better than I can do it manually, it is unlikely that the centering of the record on the reference turntable was as accurate during the listening sessions. The Nakamichi Absolute Center Search system was used throughout the listening session and the technical measurements. I did make one comparison, during the listening session, of a piano record played with and without centering. All of the panel members could hear the difference; most noted an increased clarity of piano tone when the record was centered. I also made measurements without centering to check the results against those made with it.

Figure 1 shows the spectrum of wow and flutter. The results are very good and compare favorably with those of past reports. A Shure V15 Type V-MR was used for this report, and the increase in output at about 9 Hz coincides with the arm/cartridge resonance. The measurement was made without the Shure's damper brush engaged; the Q is 13.24, which is quite high. With the damper brush operating, the results are much better. (The damper brush was used during the listening tests.) As in the past, I compared the Nakamichi turntable to my reference turntable, selected not because it is the best in the world (although it might be) but because I need a high-quality reference to which I, and the members of the listening panel, may compare performance. Favorable comments were made by the panel regarding the clarity of the sound produced by both the Nakamichi and the reference turntable.

Figure 2 shows the variation in speed over a 42-S period; it is the lowest I have measured so far. There is a curious artifact, however—the small variation at approximately each half-rotation. I don't have a solid explanation for this, but it doesn't appear to affect the performance compared to the reference turntable.

Figure 3 indicates the drift in terms of the variation in pitch over a long period of time. This is as good as I had measured on the reference turntable and correlates well with the comments made by the listening panel about clarity, especially regarding piano recordings.

The rumble measurement also is very good, with the main output due to the undamped tonearm/cartridge resonance. This is shown in Fig. 4.

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The listening panel had great difficulty in sorting out the tiny differences in sound between the reference and the Nakamichi Dragon-CT.

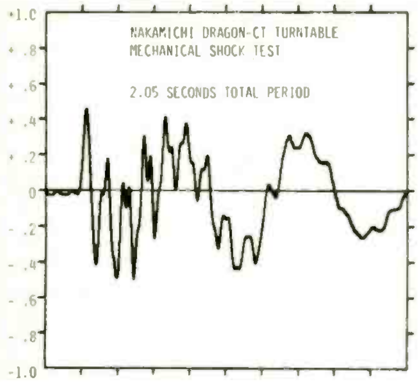

Fig. 7—Response to mechanical shock applied to the platform upon which the turntable and base rested.

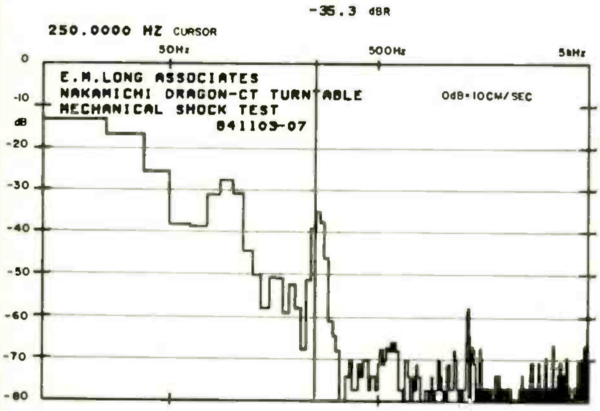

Fig. 8—Spectrum of output caused by a mechanical shock applied to the platform upon which the turntable and base rested. The isolation to shock is not as good as it might be, with the output at 250 Hz indicative of this problem.

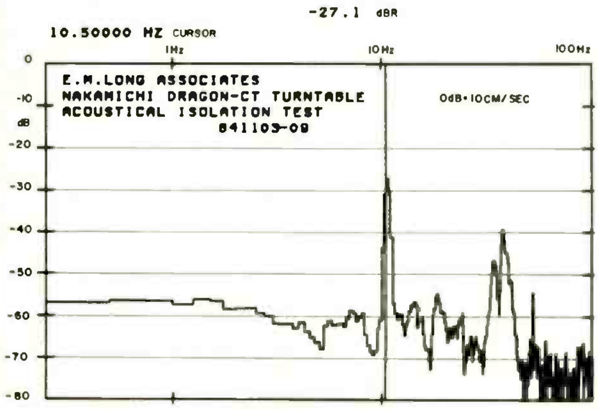

Fig. 9—Spectrum to 100 Hz due to a 100-dB SPL acoustic field at the surface of a record. The stylus of the Shure cartridge was in a stationary groove near the middle of the record. Acoustical isolation is only fair.

Figure 5 shows the average spectrum produced at the output of the Shure V15 Type V-MR phono cartridge, without the damper brush, for a series of mechanical impulses applied to the edge of a stationary record while the stylus is resting in a quiet groove. The output versus time for one of the impulses is shown in Fig. 6. This test is made to determine the effectiveness of the turntable mat and weight combination in removing from the record energy which could produce delayed mechanical input to the cartridge. This could cause a blurring in the detail or enhancement of the sound. The energy removal is not as great as it could be, but the spectral distribution is fairly uniform except at 100, 270 and 337.5 Hz. The "fuller" quality of a recorded male voice, which one member of the listening panel commented on, could be caused by the delayed energy "enhancement" in this region. The metal platter resonances at 650 Hz, and at 1.2 and 1.8 kHz, are very well damped by the rubber mat and are barely visible. The resonance at 650 Hz is about −46 dB from the reference level of 10 cm/S.

Figure 7 shows the output versus time for one of a number of mechanical shock impulses applied to the massive platform which I used to support the turntable during testing, and Fig. 8 shows the spectrum of the output for this test. There is very little breakthrough of mechanical energy above the peak at 250 Hz. When the damper brush was engaged, the energy was also reduced at the lower frequencies. Viscous damping is available for the Nakamichi tonearm also, but I chose not to use it during the tests because the cartridge's damper was very effective and could be engaged and disengaged easily. None of the panel members made any negative comments about sound quality that could be attributed to inadequacy in the turntable's mechanical isolation system.

Figure 9 shows the spectrum of the output due to acoustical breakthrough produced by a 100-dB SPL acoustical field at the surface of the turntable platter. The energy at 9 Hz is caused by tonearm/cartridge resonance and is easily reduced by using the cartridge's damper brush or by the viscous damping system of the tonearm. The output at 34 and 37.5 Hz was reduced by closing the plastic cover on the turntable; it was also reduced considerably by using the damper brush.

Conclusions

The greatest difficulty for the listening panel was sorting out the tiny differences in sound between the Dragon-CT and the reference turntable. They were extremely close in all categories, though the Dragon-CT was preferred slightly on male voice. Drums sounded about the same to all but one panel member, who thought the Dragon-CT produced a slightly "tighter" sound. The piano sound produced by both systems was judged superb by all.

I liked the Absolute Center Search system because, although I have gotten pretty good at manually adjusting records to rotate in a circular rather than an elliptical orbit, I enjoy having a microprocessor work for me. Now, if they would only make the turntable go up and down to compensate for record warp! Meanwhile, the Nakamichi is certainly worthy of consideration for any top-quality audio system.

Edward M. Long


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3

NAKAMICHI DRAGON-CT TONEARM/ SHURE V15 TYPE V-MR PHONO CARTRIDGE

Manufacturer's Specifications
Nakamichi Tonearm
Type: Straight balanced, viscous-damped.
Total Arm Length: 12 in. (305 mm).
Effective Arm Length: 9.3 in. (237 mm).
Effective Arm Mass: 14 grams (without cartridge).
Tracking Force Adjustment Range: 0 to 3 grams.
Allowable Cartridge Weight: 4 to 11 grams.
Cartridge Offset Angle: 21.5°.
Stylus Overhang: 0.59 in. (15 mm).
Maximum Tracking Error: +2.5° to −1°.
Price: $1,740, included with Dragon-CT turntable.
Company Address: 19701 South Vermont Ave., Torrance, Cal. 90502.
For literature, circle No. 91

Shure Cartridge
Channel Balance: Within 1.5 dB.
Channel Separation: 25 dB or greater at 1 kHz, 18 dB or greater at 10 kHz.
Tracking Force, at Stylus Tip: Optimum, 10 mN (1.0 gram); maximum, 12.5 mN (1.25 grams).
Tracking Force, Total Tonearm Setting with Dynamic Stabilizer: Optimum, 15 mN (1.5 grams); maximum, 17.5 mN (1.75 grams).
Tip Geometry: Micro-Ridge, 3.8 × 76 microns (0.15 × 3 mils), long contact area.
Trackability at 10 mN (1 Gram) Tracking Force: At 400 Hz, 30 cm/S; at 1 kHz, 46 cm/S; at 5 kHz, 80 cm/S; at 10 kHz, 60 cm/S; all figures typical in cm/S peak velocity.
Vertical Tonearm Resonance: Less than 5-dB rise at 14 Hz in SME Series III arm (without SME damper).
Output Voltage: 3.2 mV rms at 1 kHz at 5 cm/S peak velocity, typical.
Frequency Response: 10 Hz to 28 kHz.
Recommended Load: 47 kilohms in parallel with 250 pF (including tonearm wiring, connecting cables, and preamplifier input). Capacitive loading from 100 to 400 pF will cause negligible change from the recommended 250-pF loading.
Resistance: 815 ohms, typical.
Inductance: 330 mH at 1 kHz, typical.
Weight: 6.6 grams.
Price: $275; replacement stylus, $125.
Company Address: 222 Hartrey Ave., Evanston, Ill. 60204.
For literature, circle No. 92

In the preceding review, I have discussed the Nakamichi Dragon-CT turntable and its innovative Absolute Center Search feature. This system assures that the record rotates with perfect concentricity, thus eliminating the effects of laterally induced wow. The Dragon-CT turntable comes with an integral tonearm which, without fanfare, proved to be of very high quality. I installed a Shure V15 Type V-MR cartridge and this perhaps unlikely combination produced remarkable performance. Shure has steadily improved its V15 series of cartridges, and the V-MR offers a level of performance which is truly outstanding. The company has been consistent in its progress, in the sense that they have gained a reputation for producing better and better products, over the years, without sacrificing reliability.

I learned a great deal about the synergy between a cartridge and a tonearm while investigating this combination. Bear in mind that I am not saying that the Shure V15 Type V-MR should *only* be used with the Dragon-CT tonearm or vice versa, but I do believe that the characteristics of each should be a guide to finding other compatible tonearm/cartridge combinations.

I must admit that I didn't think the Dragon-CT tonearm and V15 Type V-MR cartridge would produce the level of sound quality that it did, in fact, achieve. The appearance of the Dragon-CT tonearm, to me, is very businesslike. And Nakamichi, in its promotional material, plays up the features of the turntable while, by relative lack of emphasis, implying that the tonearm is little more than a worthy partner to an exceptional turntable. For its part, Shure has never played to the "cartridge of the month" crowd, and I sometimes wonder if they are also victims of the "a prophet is without honor in his own country" syndrome. I am probably as guilty as anyone in this regard.

My first visual impression about the Nakamichi tonearm was the fact that the mechanism for coupling the headshell was placed at the back of the arm tube, near the main pivots of the tonearm. This is a smart move for a number of reasons. Placing the mass of the coupling away from the end of the arm reduces the effective mass; also, the joint between the headshell and the arm tube can be made solid, reducing the tendency for short-wavelength, high-amplitude, reflected energy while retaining the advantage of easily interchangeable cartridges.

The Shure V15 V-MR cartridge was easier to mount than most cartridges. In addition to the usual hex nuts, they supply threaded inserts that slip into lips on each side of the cartridge body. After the proper shim, also provided by Shure, is put in place, the cartridge is fastened securely to the headshell/arm tube. The shim is necessary because the tonearm height is fixed; the height of the cartridge and shim must be combined to place the cartridge in the correct position relative to the record surface.

My first really interesting impressions came when I began to listen to music. I had not expected such openness and clarity; I am rather jaded about this, too, as I have been fortunate because I have heard some really great sound reproduction over the years. The listening panel was really put to the test this time, because the level of performance was excellent and so closely resembled that of the reference system. Discerning differences was very difficult.

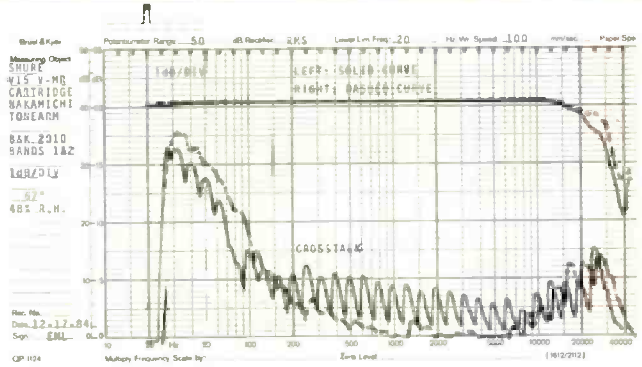


Fig. 1—Frequency response and crosstalk, Shure V15 Type V-MR cartridge in Nakamichi Dragon-CT tonearm.

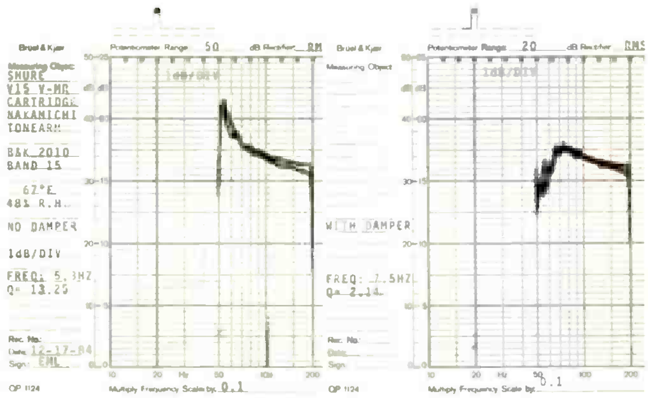


Fig. 2—Low-frequency tonearm/cartridge resonance is at 5.3 Hz with a Q of 13.25 without the cartridge's damping brush. With the damping brush, resonance is at 7.5 Hz and Q is 2.14.

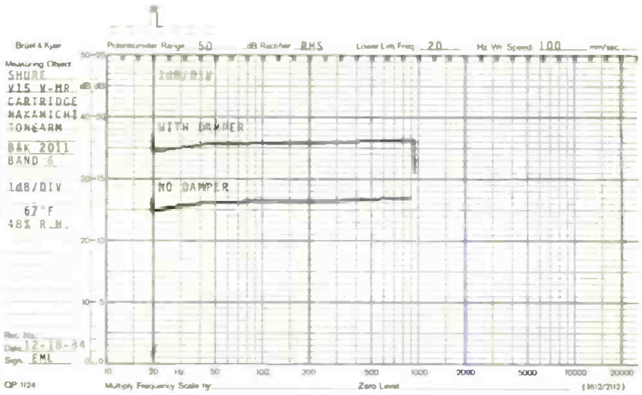


Fig. 3—Slow sweep from 20 Hz to 1 kHz to check for resonances in Dragon-CT tonearm.

I have heard great sound reproduction over the years, but I was not prepared for the clarity of this arm/cartridge pair.

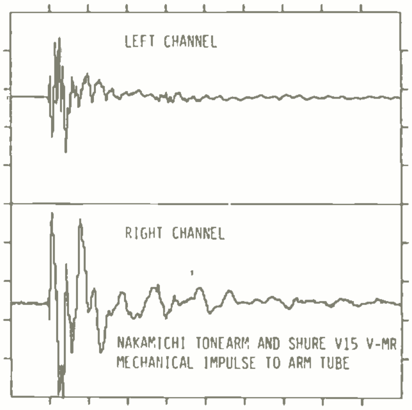


Fig. 4—Output of tonearm/cartridge to mechanical impulse applied to arm tube, with tonearm on arm rest. Left channel shows more high-frequency output; right channel shows more lows.

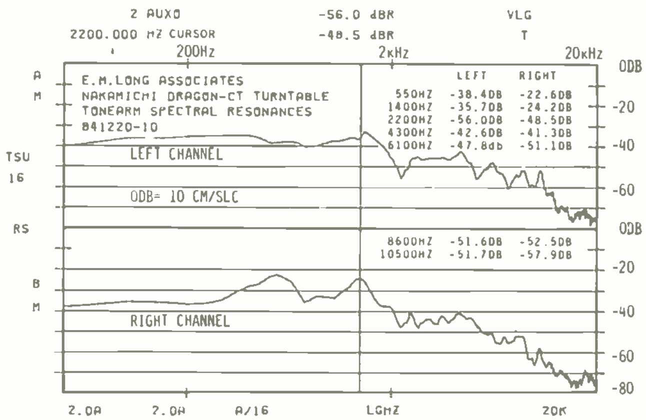


Fig. 5—Spectral output of Nakamichi tonearm due to mechanical impulses applied to the arm tube (16 impulses have been averaged). Most of the energy appears in the middle register, which could add to perceived brightness.

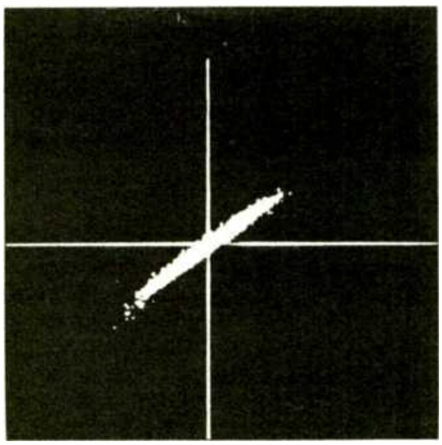


Fig. 6—Left vs. right channel interchannel phase using B & K 2011 test record, band 7, pink noise. Response is the best ever seen by the author for any tonearm/cartridge combination.

The base of the Dragon-CT tonearm is mounted directly to the turntable, with no way to adjust for cartridges of different body heights. As I mentioned before, shims are supplied by Shure for this purpose. It appears that Nakamichi has allowed for any known cartridge and then added a little extra height just to be safe, so I imagine that every cartridge will require the use of some shimming. There are those who claim the best way to mount a cartridge to a headshell is directly and tightly. I tend to agree with their rationale, which is to provide a continuous path from the cartridge to the arm pivots for any mechanical energy. If there is a weak point in the Nakamichi/Shure combination it is here, where they meet. This will be looked at later in the technical measurements for the pair.

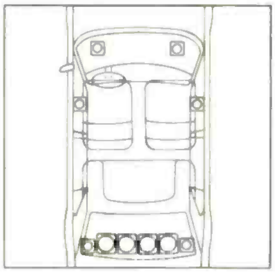
The tracking force is adjusted by turning a counterweight at the rear of the tonearm. The arm is first balanced with this counterweight, and then a calibration ring is set to zero. Turning the counterweight to move it toward the main pivot sets the tracking force. I found the calibration to be excellent when I checked it with a separate precision gauge. It was off by less than 0.1 gram from 0.5 to 2.0 grams. The counterweight is viscous-damped by silicone fluid and has a very snug feel about it. It is set very close to the main pivots when a 6- to 7-gram cartridge is balanced, which is the best position to reduce effective dynamic mass. Side-thrust compensation is provided by a calibrated knob at the side of the main pillar. The main pivot bearings are excellent, exhibiting very low friction and no discernible play.

The V15 Type V-MR has a newly developed stylus tip design called Micro-Ridge, which is closer to the shape of a disc-cutting stylus than any stylus Shure has ever made. The tip is highly polished by a method Shure calls MASAR-polishing, which tends to reduce record wear and distortion. The beryllium cantilever is formed into a thin-walled tube which is very light and strong. The specified inductance of the fixed magnetic coils is 330 mH; this, coupled with the coil resistance of about 815 ohms, results in a moderate value of generator impedance. The V15 Type V-MR was affected very little by variations in load resistance and capacitance because of this. Normally, a change in coil design to achieve lower impedance would result in reduced electrical output from the cartridge. Shure has compensated for this change in coil design by using a high-efficiency magnet structure. The internal parts are encapsulated to hold them rigidly in place to avoid resonances.

A viscous-damped Dynamic Stabilizer is another integral part of the V15 V-MR. It includes a brush with conductive fibers that not only clean the grooves but dissipate the static charge which builds up on the record and affects tracking force.

Years ago, when other manufacturers were racing to claim the highest value of compliance for their cartridges, Shure came to the rescue of the industry by introducing the concept of trackability. Each manufacturer was increasing the low-frequency tracking capability of their cartridges by increasing the amount of compliance, but the trade-off was high-frequency distortion. Later on, Shure enhanced the trackability concept by including the whole range of recorded signals; they called this the Trackability Factor (TF). Shure's latest concept appears to be another rescue mis-

HI-WAY HI-FI



The Deciding Factor

As a "music room," a car presents considerable problems: tight and cramped, half upholstery, half glass – and filled with road noise. What's true in the living room is especially true here: good sound depends upon the loud speakers and their positioning.

New! From Canton

With the new Set 200 and Set 300 line of flushmount woofers and tweeters, Canton now offers added versatility to the installation of automotive sound systems. Whether mounted in the front, the side doors or the back deck, Canton offers you auto fidelity with strong bass, rugged durability and excellent dynamics – it is these "Sets" that received the highest test awards in Germany's Stereoplay magazine 3/84 for quality in accurate, powerful sound reproduction.

Other Solutions and Complements

To round out our auto sound product line, we offer surface mount speakers as well. Our HC 100 pictured above is also available in a self-contained, bi-amped configuration for added versatility (AC 200). In addition, we offer the Pullman 3-way system for rear deck mounting as another innovative solution to quality auto sound in surface mount configuration.

Comments from Canton

Klaus Dotter, Canton's chief acoustic engineer, stresses that there is no one "right" solution for every auto installation. However, choosing quality components, from the electronics to the speakers, should be first and foremost in your selection of quality auto sound.

Find out more about Canton quality home and auto sound – write or call for our informative full line brochure.

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An old recording of "Rhapsody in Blue," which has high modulation and some vertical warp, sounded magnificent.

sion. At a time when adopting the shape of the original disc-cutting stylus seems to be the goal of other stylus manufacturers, the Shure Total Trackability Index (TTI) takes into account the effect of the stylus tip and tracking force upon wear of both the tip and records. The ability of a cartridge shape to track heavily modulated, high-frequency record grooves, and therefore claim a high TF, is balanced by looking at its Indentation Factor (IF), which relates to the combination of stylus geometry and tracking force. The more the stylus tip indents the groove wall, the harder it is on the record. Arbitrarily, the spherical tip was chosen as the reference and given an IF of 1.00; the V15 V-MR has an IF of about 0.9 at 1.5 grams. A cartridge with a high TF and a low IF thus attains a high TTI because of its optimum trade-off of design qualities. The V15 V-MR's TTI rating is 104.1, the best of any cartridge in the Shure line to date.

Measurements and Listening Tests

Figure 1 shows the left- and right-channel frequency response and crosstalk for the Shure V15 Type V-MR cartridge in the Nakamichi Dragon-CT tonearm. The low-frequency crosstalk is mainly caused by the B & K 2010 test record, which I use because it has a lower amount of middle-register crosstalk than other test records. The response of this record extends to 45 kHz, albeit with some inherent roll-off. The graph shows almost ruler-flat response to 15 kHz, and part of the roll-off above this point is due to the test record. Another factor is the relatively high capacitance (137 pF) of the phono cable supplied by Nakamichi. The difference between channels is well within Shure's 1.5-dB specification. I also checked the effect of different values of capacitance and found that a total load capacity of 230 pF caused a little flatter output to 30 kHz. Changing the load resistance to 100 kilohms had little effect.

One reason that I thought the V15 V-MR cartridge might be a good match for the Dragon-CT tonearm was the reasonably low internal capacitance of its wiring, which I measured to be 50 pF. This level would not adversely affect either low-impedance MC or moderate-impedance MM cartridges. The other reason was the high internal lead resistance, which *would* affect the output of low-impedance MC cartridges, but not the moderate impedance of the V15 V-MR. I would have expected Nakamichi would design the Dragon-CT tonearm to be used with low-impedance MC cartridges, but this rather high internal lead resistance means that only the newer, moderate-impedance, high-output types should be used.

Figure 2 shows the low-frequency resonance caused by the combination of the cartridge's compliance and the tonearm's effective mass. The Q without any damping is a high 13.25; the resonant frequency is 5.3 Hz, which can make it very susceptible to vertically induced warp wow. Although the tonearm has a viscous damping system near the pivots, I chose to use the cartridge's Dynamic Stabilizer damper-brush system because it is located near the stylus—where it is more effective in reducing warp-induced problems. As you can see, it not only reduced the Q to a very acceptable 2.14, but it raised the resonant frequency slightly, to 7.5 Hz. When I played an old recording of Gershwin's "Concerto in F" and "Rhapsody in Blue" by the Eastman Rochester

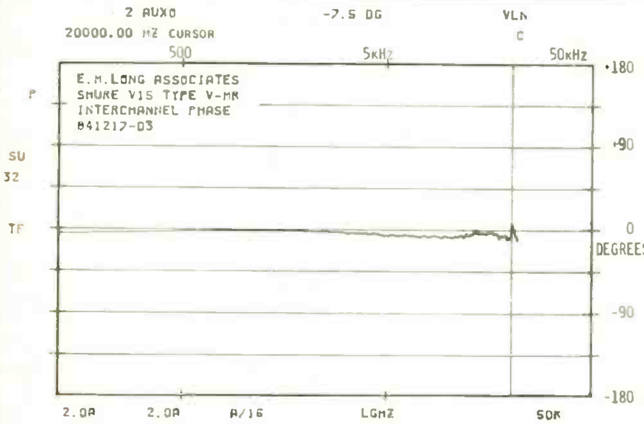

Fig. 7—Interchannel phase using B & K 2011, band 7, pink noise. Phase difference at 20 kHz is −7.5° (1.0 μS).

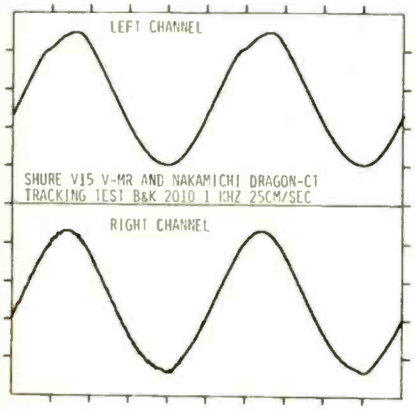

Fig. 8—Output of the tonearm/cartridge with band 3 of the B & K 2010 test disc, where slight mistracking occurred. This is the highest level on the disc and is remarkable performance.

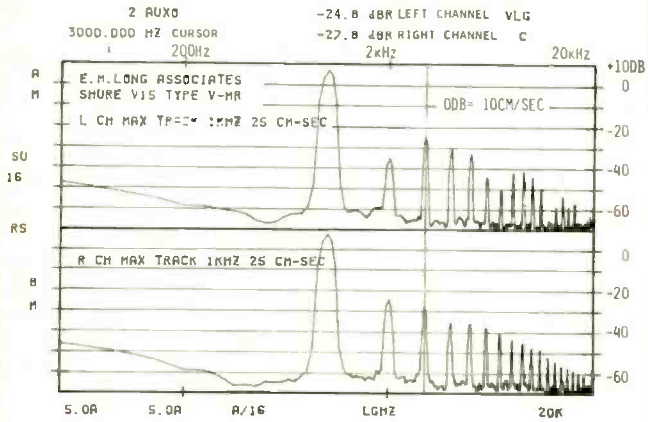

Fig. 9—Spectrum of output shown in Fig. 8, band 3 of the B & K 2010. Most cartridges cannot track this band, a 1-kHz tone at 25 cm/S. Cursor is at third harmonic and level is 2.8% left and 2.0% right. (Measurements taken without Shure cartridge's damping brush.)


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In reproducing trumpet and cymbals at high recorded levels, this pair was better than the reference.

Orchestra, which has very high modulation and some vertical warp, it sounded magnificent, without a hint of trouble. (I was there when this recording was being made by Bob Fine for Mercury, and I first met Bert Whyte and his wife in the garage next to the Eastman Theater where Bob had parked his recording truck. Rochester, N.Y. is my hometown, and, being young and daring, I just walked in and proceeded to watch and learn.) Further, the comments made by the listening panel about the piano sound on other recordings were all very positive, and they had great difficulty in finding any difference between the Nakamichi/Shure combination and the reference system.

Figure 3 shows the results of a slow sweep, from 20 Hz to 1 kHz, which is intended to excite any resonance in the tonearm/cartridge combination. Very small effects can be seen at 40 and 80 Hz which might be due to the coupling near the pivot; this is reduced slightly by using the damper brush. The other effect, at 550 Hz, is a tonearm resonance which is verified by the results of the mechanical impulse test (Figs. 4 and 5). When the damper brush is used, the resonance is reduced and moves to 410 Hz. This resonance might be one reason for the comments made by some panel members about the "more resonant" quality of male voices heard on the Dragon-CT as against the reference.

Figures 4 and 5 show the output of the tonearm/cartridge combination for a mechanical-impulse test I devised to check for resonances. The difference in the channels is due to the method and angle of application of the impulse, which excites each channel differently. (I am refining this test to eliminate this difference; in the meantime, I think the results are still worth showing.) In Fig. 5, the resonance at 550 Hz is clearly visible; other resonances are listed along with their relative levels. The absolute levels don't mean anything because, although referenced to a 0-dB level of 10 cm/S, they are caused by a mechanical impulse of arbitrary value. What is worth noting are the resonant frequencies and their *relative* levels.

Figures 6 and 7 show the interchannel phase, the best I

MEASURED DATA

Nakamichi Dragon-CT Tonearm

Parameter	Measurements/ Comments
Pivot to Stylus	9.33 in. (23.7 cm)
Pivot to Rear of Arm	2.17 in. (5.5 cm)
Height Adjustment Range	None; nuts supplied for different cartridge sizes
Tracking Force Adjustment	0 to 3 grams, counterweight rotation
Tracking Force Calibration	Exact within less than 0.1 gram
Cartridge Weight Range	4 to 11 grams
Counterweights	One
Counterweight Mounting	Direct to arm; silicone damping
Sidethrust Correction	Calibrated knob
Pivot Damping	Silicone fluid
Lifting Device	Electronic, pushbutton-activated, damped
Headshell Offset	Slots in headshell allow adjustment
Overhang Adjustment	As above
Bearing Alignment	Excellent; no play
Bearing Friction	Less than 40 mg; too low to measure accurately
Bearing Type	Jewelled pivots
Lead Torque	Negligible
Arm Lead Capacity, pF	Internal, 50; external, 137; total, 187
Arm Lead Resistance, Ohms	Internal, 1.9; external, 0.09; total, 2.0
External Lead Length	48 in. (122 cm)
Structural Resonances	550 Hz; 1.45, 2.2, 4.3, 6.1, 8.6, and 10.5 kHz
Base Mounting	Premounted directly to wood deck plate

Shure V15 Type V-MR Cartridge

Parameter	Measurements/ Comments
Coil Inductance	350 mH
Coil Resistance	875 ohms
Output Voltage	0.48 mV/cm/S
Tracking Force	1.3 grams without brush, 1.9 grams with brush
Cartridge Mass	6.8 grams
Microphony	Very good
Hum Rejection	Excellent
High-Frequency Resonance	32.3 kHz
Rise-Time	18 µS
Low-Frequency Resonance	5.3 Hz without brush, 7.5 Hz with brush
Low-Frequency Q	13 without brush, 2 with brush
Recommended Load Resistance	47 kilohms
Recommended Load Capacitance	250 pF

The Nakamichi tonearm should do well with high-quality cartridges that require a moderate impedance.

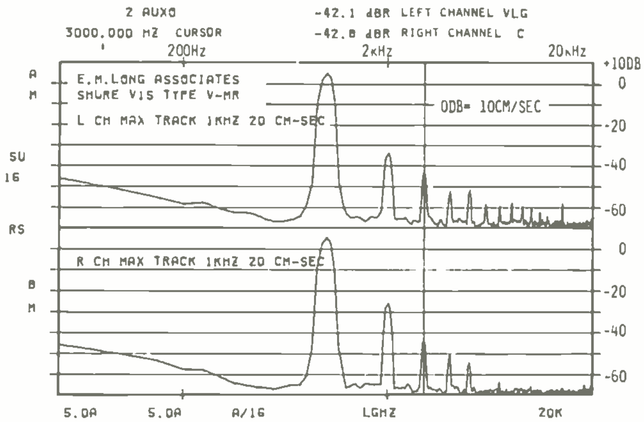


Fig. 10—Spectrum due to 1-kHz tone at 20 cm/S, band 4 of B & K 2010 test disc. Although most cartridges have difficulty tracking this band, the Shure/Nakamichi combination tracked it easily. Cursor is at third harmonic and level is 0.40% left and 0.37% right. (Measurements taken without damper.)

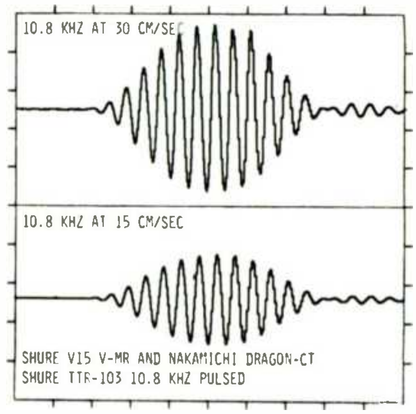


Fig. 11—Tests of 10.8-kHz tone burst from Shure TTR-103 test record, bands 1 and 4. Any mistracking results in low-frequency output which will color the sound.

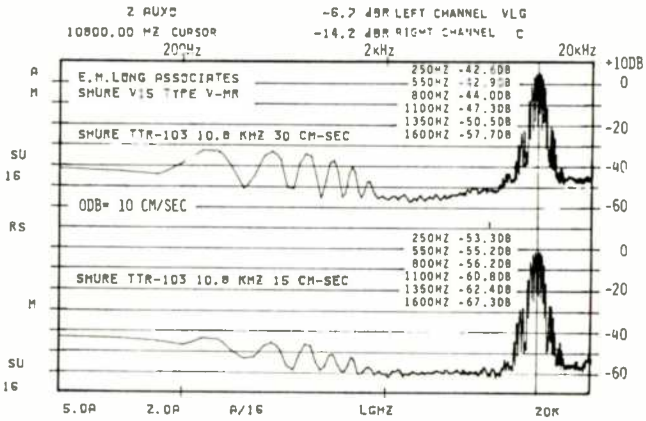


Fig. 12—Spectrum of distortion for 10.8-kHz tone burst of Fig. 11. Top: 30 cm/S, which is +8 dB above reference level of 10 cm/S. Bottom: 15 cm/S. The 250-Hz output is about 0.3%, which is very good. See text.

have ever seen for any tonearm/cartridge combination. The comments made by the listening panel regarding localization were really enlightening when considered with the interchannel phase performance indicated by these figures. The system used in listening tests includes two very coherent, phase-matched, Time Align reference loudspeaker systems which I designed especially for such tests. When listening to the Nakamichi tonearm/Shure cartridge combination with this system, panel members could clearly hear the difference between spaced-microphone and coincident-microphone recordings—a difference not even the reference tonearm/cartridge system revealed so distinctly. When coincident recordings were played, anyone sitting on the center line between the loudspeakers had only to move his head very slightly to shift centered images to the left or right. Such is the price for perfectly matched channels in a stereo system! The tonal quality of voice was also changed by moving the head toward one channel or the other. This is due to the fact that, when the channel-to-ear time delay is changed, the frequencies for which addition and cancellation occur are also changed, yielding a perceived change in tonal quality or timbre.

When some really high-level recordings were played during the listening sessions, the Nakamichi/Shure combination was judged slightly better than the reference system in reproducing trumpet and cymbals. This is probably related to its remarkable tracking capability. Figures 8 and 9 show the output versus time and the spectrum due to tracking the highest level 1-kHz band of the B & K 2010 test record, which is cut at a level of 25 cm/S. This is the best result for any combination I have tested so far. The spectral distribution gives clues to how the sound will be perceived when tracking such high levels. The right channel tracks pretty well and shows a smooth distribution of harmonics, while the left channel exhibits some mistracking and favors the third, fourth, fifth, eighth, ninth and tenth harmonics. This could be perceived as a shift in timbre balance, although none of the panel members mentioned anything which could be linked to this. That doesn't mean it wasn't happening, however.

To be fair to the Nakamichi/Shure combination and to allow comparisons with other combinations evaluated in previous reports, I also tracked the next lower band of the B & K 2010 record, a 1-kHz tone at 20 cm/S. This is the band which some fine cartridges just manage to track; the performance of the Nakamichi/Shure combination is shown in Fig. 10. Some indication of the spectral imbalance is still

TECHNOLOGY REPORT

SFI's new flat wave speaker technology achieves optimum digital sound reproduction.

SFI has been involved in loudspeaker driver design through its brother company in Japan, Sawafuji, since 1922. SFI's continuing research into transducer technology has led to a number of international patents and an enviable reputation among equipment manufacturers as a high-quality design and manufacturing source.

Sawafuji-produced ribbon tweeters, flat-diaphragm headphone elements and other transducer devices are found in the most respected high-end audio components throughout the world.

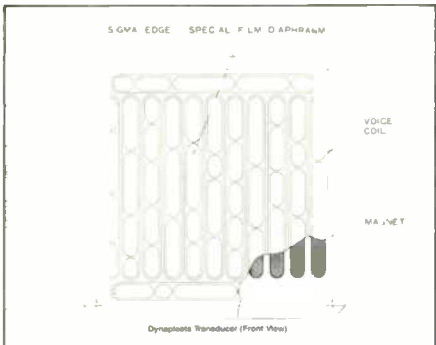
SFI recently developed a new generation of flat wave loudspeaker transducers — full frequency drivers with dramatically improved sound quality.

THE PROBLEM To appreciate what SFI has achieved, it's necessary to understand the essential problems that have troubled conventional loudspeakers for almost 60 years. Conventional diaphragms tend to store energy, buckle, and break up into resonant modes under the impact of the large forces applied in a small area by the voice coil. This results in distortions in phase, amplitude, frequency, and dispersion — which covers just about everything that goes wrong in a loudspeaker.

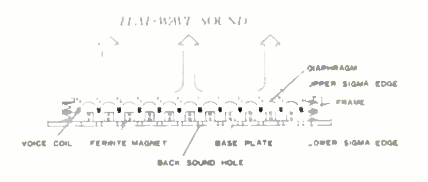
THE SOLUTION A driver with a very low-mass, non-resonant diaphragm that is linearly driven over its *entire* radiating surface. However, the practical realization of such a planar speaker system is certainly not easy — as previous and current producers of such designs have discovered. The challenge is to combine the transient response, definition, and openness of an electrostatic transducer with the reliability, dynamic range, bass performance, and non problematic drive requirements of a standard electromagnetic cone transducer.

SFI'S DYNAPLEATS Sawafuji's engineers abandoned the conventional cone and cylindrical voice coil concept. Instead, they developed a flat voice coil etched on the entire surface of a Polysolpon™ film diaphragm. The diaphragm, which is only a few thousandths of an inch thick, is immersed in an intense magnetic field.

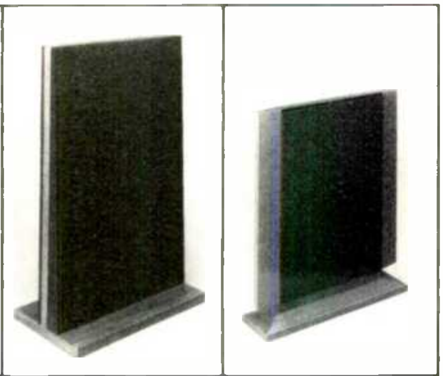
Applying the distributed-drive, voice-coil principle to a low-frequency transducer required an enormous amount of engineering time. Bass reproduction demands large air movements which, in turn, require large diaphragm excursions; a difficult task for a flat wave transducer. Sawafuji engineers persevered, and the Dynapleats transducer emerged from their laboratories.



Dynapleats Transducer (Front View)



Dynapleats Transducer (Top View)



Shown above the SFI Digital Reference (left) and the SFI Digital 20 (right).

The diaphragm of the Dynapleats, 6½ x 6½ inch, low-frequency driver utilizes a Polysolpon™ diaphragm that is aerodynamically pleated with the voice coil integrated into the entire surface of the driver. (See side-view diagram). An array of high-energy strontium bar magnets set within the ridges interacts with the distributed voice coil, and a unique high-compliance, long-excursion Sigma edge suspension supports the diaphragm perimeter. This proprietary arrangement ensures thermal stability and ruggedness, wide dynamic range, and extended bass response

SFI SPEAKER SYSTEMS The state-of-the-art SFI systems, (the SFI Digital Reference) employs an array of sixteen 6½" x 6½", low-frequency drivers, four 6½" x 6½" midrange drivers and four ribbon tweeters installed on a handsome 35 x 56 x 3-inch dipolar radiating baffle. The low-frequency array has far more "cone" surface than an 18-inch woofer, while simultaneously providing the resonance-free fast rise time of light-weight diaphragms. Crossover is at 600 Hz to the four midrange drivers arranged in a vertical line-source configuration for wide, but controlled, dispersion. The four tweeters, crossed over at 5,000 Hz, form another vertical array for enhanced dispersion. The SFI systems, with their flat wave drivers, are inherently phase accurate.

For a demonstration of SFI's Digital Reference, Digital-20 and other systems currently available, all using the state-of-the-art SFI flat wave drivers, visit your SFI dealer. You will hear, for the first time, the solid bass and dynamic range of the best of the conventional systems, combined with the open, transparent qualities and superb definition of the finest electrostatics. This is achieved without the limitations of electrostatics, i.e., special amplifiers and limited bass responses.

For more technical information on these speakers and other products, along with the address of your nearest SFI dealer, write to:

SFI
Sawafuji America Corp.

23440 Hawthorne Boulevard
Suite 130, Torrance, CA 90505

The Shure V15 V-MR is ruler-flat up to 15 kHz, where roll-off is in part due to the test disc.

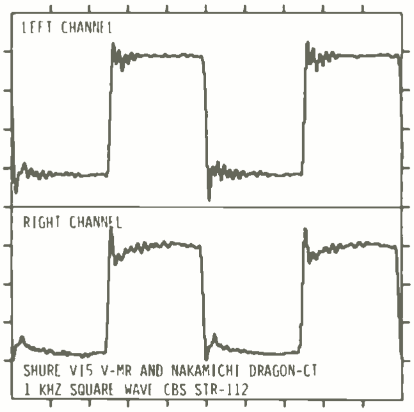


Fig. 13—Response to a 1-kHz square wave.

apparent at this level, but the third-harmonic distortion in each channel is below 1%, which is remarkable.

Shure's TTR-103 test record was used to make the 10.8-kHz tone-burst tests shown in Figs. 11 and 12. Even the 30-cm/S level results in distortion well below 1%. In Fig. 12, I have shown these numbers in dB below the reference level rather than percentages because I believe it is easier to think in terms of sound levels expressed in dB when relating such levels to perceived effects.

Figure 13 shows the square-wave output of the Nakamichi/Shure combination and indicates a slight difference between the channels in the middle register. This confirms the data regarding spectral-level differences shown in the previous figures. The dip in the right-channel output's waveform also correlates wel with the curves shown in Fig. 1, because the right channel does show a sharper cutoff at the high-frequency limit.

Conclusions

The Nakamichi Dragon-CT tonearm and Shure V15 Type V-MR cartridge proved to be a really compatible combination and produced excellent sound reproduction, indicating that the tonearm is well suited to high-quality, moderate-impedance cartridges. As I stated earlier, I learned a great deal about the interaction of tonearm/cartridge matching while evaluating this combination. If you have read the report without jumping right to this part, I hope that you have also. But I must add that I really feel sorry for those hard-working engineers at Shure. How are they going to top the V15 Type V-MR? If they can, we will all hear something truly fantastic!

Edward M. Long

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4

SANSUI C-2301 PREAMP AND B-2301 AMP

Manufacturer's Specifications

Preamplifier

Frequency Response: Line inputs, d.c. to 500 kHz, +0, −3.0 dB; MM phono inputs, RIAA 20 Hz to 20 kHz, ±0.2 dB.

Maximum Output: 20 V and 1 kHz.

THD (New IHF Standard): 0.005%, phono; 0.003%, high level.

IM Distortion: 0.005%, phono; 0.003%, high level.

Phono Input Sensitivity for 0.5-V Output at 1 kHz: 2.0 mV input for MM (47 kilohms) or High MC (100 ohms); 70 μV (3 ohms) for MC (Trans Low) or 200 μV (30 ohms) for MC (Trans High).

Phono Input Overload: 350 mV at 1 kHz for MM; 40 mV at 1 kHz for MC input.

S/N Ratio: 80 dB, short-circuit, A-weighted, for 5-mV signal at MC input.

High-Level Sensitivity: 150 mV.

Phono Input Impedances: 47 kilohms for MM cartridges; selectable 3/30/100-ohm input impedance for MC cartridges.

Dimensions: 18-11/16 in. (47.5 cm) W × 6-5/16 in. (16 cm) H × 16-5/8 in. (42.2 cm) D.

Weight: 46 lbs. (20.9 kg).

Price: $2,700.

Power Amplifier

Power Output: 300 watts rms per channel continuous, 20 Hz to 20 kHz, into 8 ohms.

Rated THD: Less than 0.003% at or below minimum rms power output.

Frequency Response: D.c. to 300 kHz, +0, −2 dB for 1-watt output at the maximum input-level control position.

S/N Ratio: 120 dB, inputs shorted, A-weighted.

IM Distortion: Less than 0.003% at rated output.

Slew Rate: ±400 V/μS (internal).

Damping Factor: 300, stereo; 150, mono; 50 Hz into 8 ohms.

Input Impedance: 15 kilohms unbalanced or 1 kilohm balanced, switch selectable.

Input Sensitivity: 1.0 V for rated output at normal inputs, 2.0 V for balanced inputs.

Dimensions: 18-11/16 in. (47.5 cm) W × 8-15/32 in. (21.5 cm) H × 19-11/16 in. (50 cm) D.

Weight: 81.4 lbs. (37 kg).

Price: $2,600.

Company Address: 1250 Valley Brook Ave., Lyndhurst, N.J. 07071.

For literature, circle No. 93

Sansui's B-2301 amplifier and C-2301 preamplifier are the company's top-of-the-line separates, intriguingly designated on the front panels with "Basic Audio Legacy Vintage" labels. Chassis size, choice of wood-veneer paneling, and user ergonomics are first-rate on both units, and the high prices are justified by high performance and exacting specifications.

Among the design features incorporated into these units is what Sansui calls "X-Balanced circuitry." Balanced inputs and outputs have long been used by broadcast and recording studios to overcome the effects of magnetic and electromagnetic radiation from a.c. power lines, broadcast signals, and other sources. When this radiation strikes the two twisted conductors of a balanced interconnecting cable, it produces the same voltage or current in each. A balanced input rejects this "common mode" signal while accepting the desired audio signal. The audio signal is transmitted in a "differential mode" as a voltage *between* the conductors by the preceding balanced output. The twisted pair is generally shielded, as well, to reduce high-frequency interference which, in practice, is not always effectively rejected by balanced inputs.

In the past, recording and broadcast studios have utilized transformers to obtain balanced, floating (not ground-referenced) inputs and outputs. Today, professional equipment usually employs electronically balanced inputs (ground-referenced) and floating transformer outputs. Good transformers are very expensive, and even the best have much greater distortion and frequency-range limitations than amplifier circuitry. Electronically balanced outputs which are ground-referenced but symmetrical are used, but they are not directly compatible with unbalanced inputs.

The Sansui engineering team of S. Takahashi and S. Tanaka ("Fully Balanced Bridge Amplifier," *Journal of the Audio Engineering Society*, Vol. 32, No. 6, June 1984, pp. 415-421) developed a prototype amplifier with balanced differential inputs and balanced outputs with separate power-supply grounds for the first and final stages. This amplifier was electrically equivalent to a transformer with a frequency response from direct current to several hundred kilohertz, low total harmonic distortion, and large power-handling capacity. Sansui feels that there are subtle distortions and loss of detail that arise from conventional grounding schemes in home audio.

Control Layouts

The C-2301 preamplifier's cabinet is surfaced with a dark, rich, persimmon-wood veneer. Heavier than most preamps, it tips the scales at 46 pounds. Although it measures the standard 19-inch rack width, the C-2301 does not have the decorative mounting brackets found in some high-end home audio gear today. Rotary controls on the front panel are, from left to right, "Tape/PCM Play," "Master Volume" and "Input Selector." Below these controls are the "Output Selector," "Balance," "Attenuator," "Mode," "Rec Selector" and "Cartridge Selector." Square pushbutton switches include "Power," "Source Direct," "Subsonic," "Muting," and "Adaptor." Each switch position illuminates an LED display

Sansui's top-of-the-line separates, the B-2301 amp and C-2301 preamp, feature first-rate styling and usability, but they are rather costly.

on the otherwise black faceplate. On the rear panel are the usual signal connections: Two unbalanced RCA phono jack inputs, a large variety of high-level inputs (including RCA jacks for three tape decks, a CD player, and an equalizer), RCA output jacks labelled "Normal," a balanced XLR output jack for each channel, and six a.c. outlets with two switched (200-watt total capacity) and four unswitched (400-watt total capacity). There is also a pair of binding posts for connecting the chassis to signal common. The preamp does not have any balanced inputs, which could have carried Sansui's X-Balanced circuitry to the source.

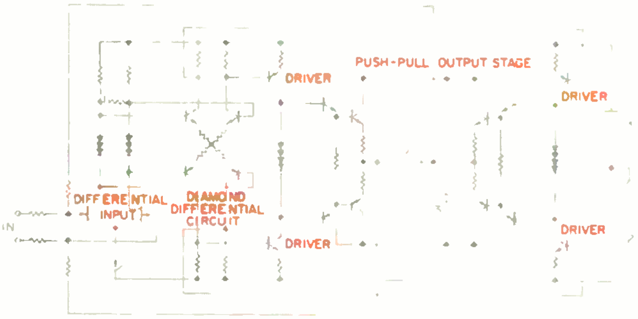

Fig. 1—Partial schematic of the Sansui B-2301 amplifier.

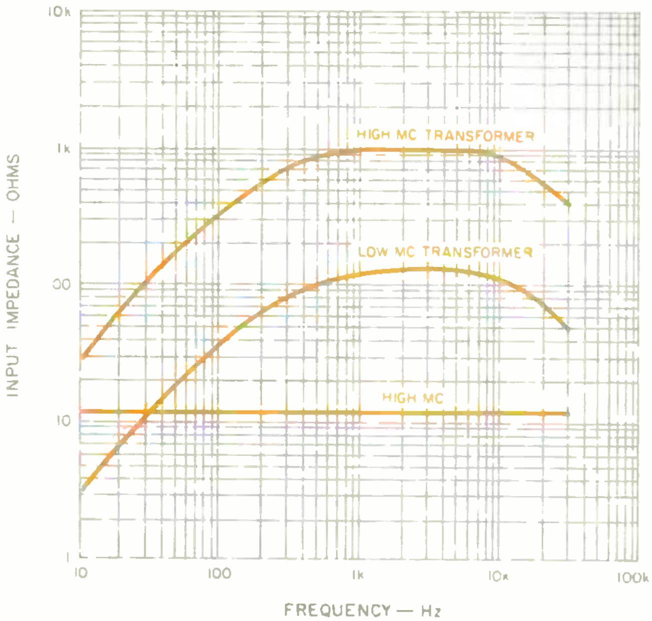

Fig. 2—Input impedance vs. frequency of the MC transformer, Sansui C-2301 preamp.

The B-2301 amplifier exactly matches its companion preamp in exterior finish, and its stunning appearance makes it the finest-looking high-power amplifier we have so far encountered. The chassis is rack-width, but no mounting brackets are supplied for this 82-pound block—a sensible move on Sansui's part since the B-2301 is intended for home use. Front-panel pushbuttons, from left to right, include "Power," "Peak Hold" and a "Display" switch to turn off the unit's large, 32-element, LCD power meters which have logarithmic scales. Other front-panel LEDs include an "Over Swing" clipping indicator, a "Protector" indicator to show activation of the protection circuit, and a "DC Leak" indicator. The back panel includes standard RCA input jacks as well as balanced XLR inputs, selectable via an input selector switch; individual, detented, rotary level controls are located next to each input as well. A ground terminal and an a.c. outlet are provided. Both the preamp and the amp feature two-prong a.c. line cords, in accordance with Sansui's ground separation philosophy.

Mechanical Construction

Amp and preamp were carefully inspected and found to utilize similar construction. Sansui mostly uses aluminum and steel in these products, though copper is also frequently utilized as a structural material. For example, a large, copper chassis plate, 17 inches wide by 6 inches deep, holds up the transformer and circuit boards in the middle of the preamp. This is a somewhat unusual application of this soft material, and according to Sansui, it is intended to provide utmost isolation of the audio signal from both internal and external magnetic distortion. Ordinarily, isolation screens surround the circuitry on all sides. The metal is a better conductor than steel, though it is expensive and soft for a chassis component. Other, more usual features appear inside where the preamp's highly styled internal modules have short blurbs on circuitry and performance screened on their covers; our preference would have been to leave the copy out.

The preamplifier's chassis consists of an extruded aluminum front panel attached to steel side panels which, in turn, are bolted to a steel back panel. Dark, persimmon-wood side panels, favored in several high-end Japanese components, decorate the steel inner chassis. Circuitry is mounted on 11 circuit boarcs, seven of which are mounted on the large, copper subchassis that covers most of the inner space. All major metal parts are fastened together with thread-forming sheet-metal screws.

Circuit boards in the preamp are very high-quality glass-epoxy, single-sided, with solder mask and component designators. Circuit-board interconnects mainly use nickel-plated contacts in nylon housings; the cartridge-level internal wiring, on the other hand, utilizes thick cable and gold-plated RCA connectors. Component quality is very high, e.g., 1% resistors predominate. A particularly nice design touch in the C-2301 is the use of cable controls for the front panel's selectors. Each drives a push-pull steel band in a

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These Sansui "Vintage" components use some cost-cutting construction techniques and some that are very expensive.

plastic sheath that winds its way to a printed-circuit slide switch near the rear panel. This keeps input selection switching near the input jacks, so long leads do not run to the front panel, acting as antennas for hum, r.f.i. or crosstalk from the other channel.

The B-2301 amplifier chassis is built from four U-section channels running from front to back, with various sheet-metal and extruded assemblies attached to them. Heat radiators for each channel are parallel to the sides and designed for vertical air flow through the matching slots in the top and bottom panels. Amplifier circuit boards run parallel to the heat radiators and are fastened to them at their edges and by the output devices in each channel. Pairs of output transistors are bolted to four blocks which are, in turn, bolted to the radiator for each channel. The ability of the circuit board to flex a small amount reduces mechanical stress in the output devices from thermal cycling. Lead length is still desirably short, and service access is reasonable.

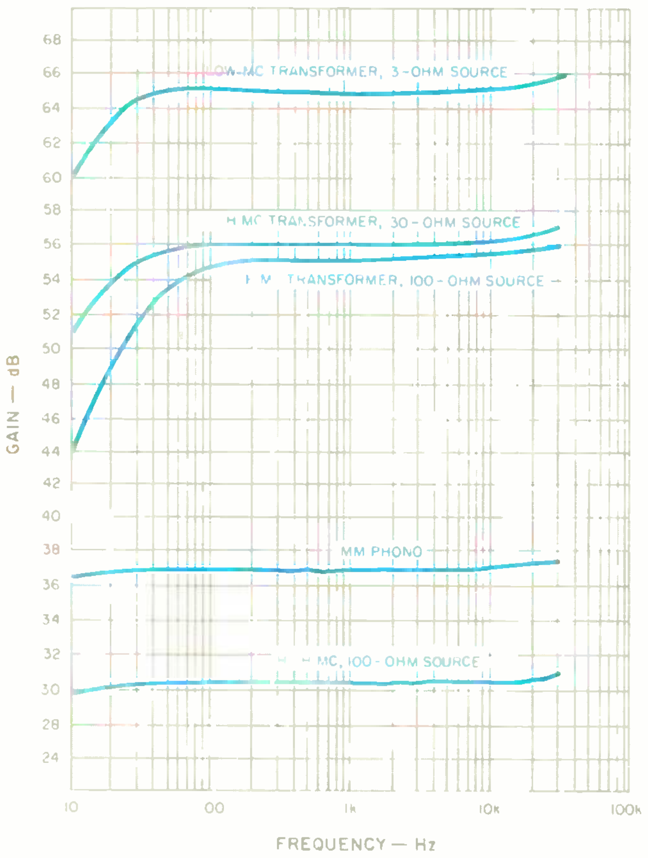

Fig. 3—Gain vs. frequency for the various phono inputs of the C-2301.

The large power transformer and four filter capacitors occupy the center portion of the amplifier. The power-supply regulator board is under the transformer and accessible from below. A copper subchassis attaches to the frame and holds the filter capacitors and front-panel components. Copper can be bent more easily than steel, and we found one small bracket had indeed been deformed, apparently through rough handling during shipping, so that it was only 1/16 inch from 120 V a.c. on the power switch terminal—a potentially dangerous situation.

Front and rear panels are aluminum, and each holds several circuit boards in conjunction with nearby terminals and controls. As with the C-2301 preamp, all the amp's panels that make up the chassis are fastened together with thread-forming screws. Using them eliminates a separate threading operation and, Sansui tells us, makes for a more rigid chassis. Unfortunately, small metal particles from the forming operation were found inside the chassis and are potential short-circuits on p.c. boards. For repeated-access rigidity, we prefer costlier tapped holes or threaded steel inserts, which we associate with instrument-grade products.

Circuit-board component quality and wiring are good but not exceptionally so. The glass-epoxy boards are well finished and laid out, and are screened with component designations and solder mask. Electrolytic capacitors, rated at an adequate 85° C, and the many polypropylene capacitors are stand-up mounted. Nickel-plated, push-on connectors are widely used to interconnect the circuit boards, a contrast to the gold-plated connectors used for external inputs and in the phono stage of the preamp. The ones carrying high currents could fatigue and provide poor contact in the unlikely event that a lot of service work had to be done. In our experience, push-on connectors can be a major source of service problems, though these were tight and secure.

Preamplifier Circuitry

The signal circuitry in Sansui's C-2301 preamp features their X-Balanced design. Overall, there are two blocks of gain, consisting of a phono preamp/equalizer and a balanced output amplifier. A second, identical output amp is driven in opposite polarity to form the other half of a balanced output symmetrically referenced to ground. The preamp's line output would have been a good place to apply Sansui's new floating, balanced output circuit, but the *floating* circuitry is reserved for the power amp's output. The conventional output used here shorts one of the output amps when connection is made to a usual unbalanced power-amp input.

The MC transformer in the preamp added distortion to an otherwise clean design, so we recommend an external step-up unit.

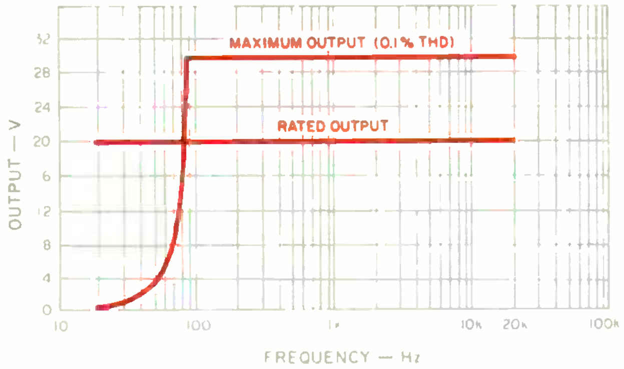

Fig. 4—Frequency vs. rated output and maximum output at 0.1% THD + N from the C-2301's "High MC" transformer input to tape output with a 30-ohm source.

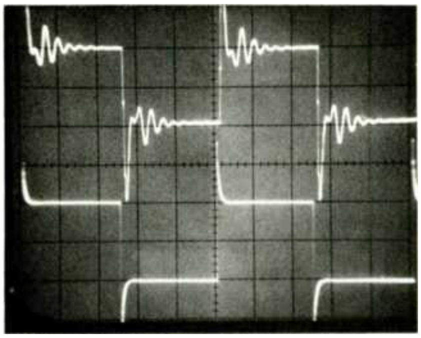

Fig. 5A—C-2301's response at tape output to pre-equalized square waves. Top: 10-kHz signal from 3-ohm source into "Low MC" transformer input. Bottom: 1-kHz square wave into MM input. (Scales: 20 µV and 0.5 V per div.)

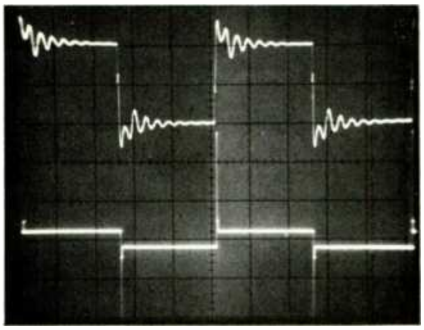

Fig 5B—C-2301's response at tape output to pre-equalized 10-kHz square waves fed from a 30-ohm source. Top: Input at "High MC" transformer. Bottom: Input at "High MC" with no transformer. (Scales: As in Fig. 5A.)

The RIAA preamp is capacitively coupled at its output as opposed to using the popular servo-amp approach of eliminating d.c. offset. The designers use four paralleled capacitors of different dielectric types, and this bundle of capacitors is coated with a gooey substance to reduce rattles.

The circuits used in the phono section and in the two halves of the balanced output consist of similar, discrete-transistor gain blocks. The first stage of each is an unbalanced differential-FET input and transistor cascade. The collector outputs feed a balanced dual-differential stage followed by two more stages of balanced push-pull transistors. The RIAA version uses feedback equalization overall, while the output amp uses flat feedback.

Does this design provide any sonic benefits? Sansui claims their balanced circuit yields clearer sound, with less interference from external electrical fields or internal power-supply ripple currents. The telephone company, for one, agrees with them and has used balanced circuits since the invention of the telephone pole. We would like to have seen a full realization, including balanced cartridge leads and tonearm cables to feed the preamp. The cartridge signal is already balanced, and Sansui could have preserved this state in the very hum-prone interconnects and inputs all the way to the loudspeaker.

Amplifier Circuitry

The B-2301 amplifier is basically a bridged design. It has balanced differential inputs and balanced outputs with separate power-supply grounds for the first and final stages. The B-2301 features six separate power supplies, three per channel. The Diamond Differential circuit used in the bridge amplifier has four outputs in a symmetrical and complementary configuration, and it simultaneously drives a pair of push-pull output stages. In this balanced bridge design, distortion is reduced by both feedforward and the usual negative-feedback networks. The circuit utilizes each output stage as an error amp for the other.

The basic feature of this power amp is that the first stages drive the final stages through a constant-current source. The unit's Diamond Differential circuit puts out a constant current, regardless of the voltage required. The output voltage is not referenced to the input ground terminal or the power-supply ground terminal. This is in contrast to normal bridged operation, where the two amps forming the bridge operate at a stiff, constant voltage referenced to ground. In the Sansui, the output terminals are floating and designated either "hot" or "cold." Unlike conventional bridged amps, no damage is caused when one side of the B-2301's output is short-circuited to the chassis. The impedance between the ground and the amplifier is kept high, and little current flows between them. The hot or cold terminals can float up or down, independent of ground, and provide the same performance. The power-supply circuit of the amplifier is also floated from ground.

Figure 1 shows the basic circuit of the balanced bridge amplifier. There are three amplifying stages. The Diamond Differential circuit is used as the second stage to drive a pair of push-pull stages that follow. These stages are powered by ground-based positive and negative supply source E1 and E2, and the final stages are powered by a

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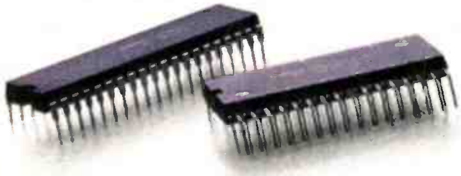

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Listening tests on these two units were made with both blind A/B and open (or subjective) procedures, giving an unusually thorough comparison.

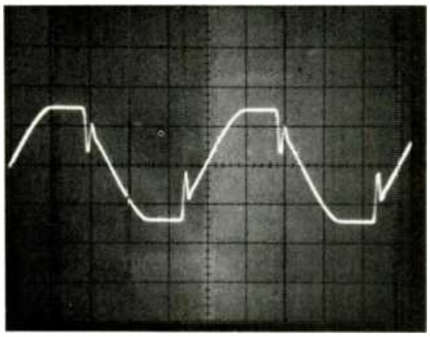

Fig. 6—Response of B-2301 amplifier to large-signal, 20-kHz sine wave driving an 8-ohm load. (Scales: 10 μS and 50 V per div.)

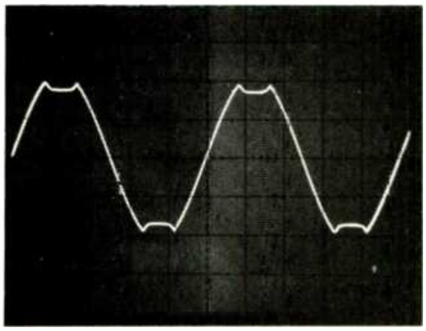

Fig. 7—Response of B-2301 when driven into clipping, no load, with 200-Hz sine wave. (Scales: 1 mS and 50 V per div.)

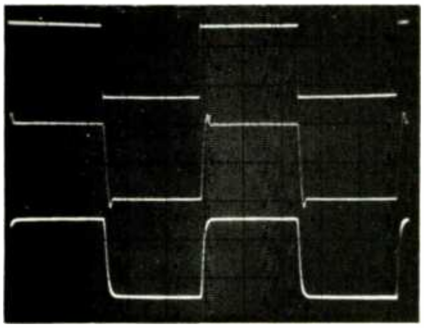

Fig. 8—Response of B-2301 to 20-kHz square waves at various signal levels into 8-ohm loads. Top: 1-watt output; scale is 1 V per div. Middle: Clipping; scale is 50 V per div. Bottom: Below clipping; scale is 25 V per div. Time base is 10 μS per div. for all.

separate floating source E3. Feedback is applied from the two outputs to the two inputs of the initial differential circuit.

Preamplifier Measurements

Designers of MC transformers have three main problems, which the transformer in the C-2301 exhibits in varying amounts. The first is distortion. To achieve high inductance, transformer coils are usually wound on a magnetic material such as an iron alloy. If the magnetic properties of these alloys are not perfectly linear with magnetic field strength, the transformer will be prone to low-frequency distortion from this source. The second problem is irregular frequency response. At high frequencies, inter-winding capacitance resonates with the transformer's inductance, causing peaks and dips in the response if steps are not taken to damp them. In the case of the Sansui transformer, these resonances are above the audible range, but lend a small high-end boost. The third problem is the most serious because it is audible: The transformer's input impedance drops as frequency drops, causing the output of moving-coil cartridges to drop off severely below 100 Hz due to excessive loading of the source by the transformer.

The MC inputs marked 30 ohms and 3 ohms utilize this transformer and are both gain and input-impedance options, with maximum gain available at the lower impedance. The IHF standard for measuring noise, gain, and response of MC inputs calls for a 100-ohm source. Because this yields poor results with the Sansui's transformer inputs, we assumed that 30- and 3-ohm sources were required. An MC cartridge of lower output impedance will have lower output, all other things being equal; to relate our noise measurements of the Sansui transformer inputs to IHF standards, we assumed output proportional to impedance. This results in a 71.2-dB S/N at 30 ohms and a 62.6-dB S/N at 3 ohms.

The 30- and 3-ohm inputs do not indicate true input impedance but only a nominal level. Figure 2 shows that input impedance is a function of frequency and that it drops at low frequencies. This drop in impedance causes roll-off of 6 dB at 20 Hz (Fig. 3) because it loads the cartridge, thus reducing output.

The transformer added frequency-dependent distortion to this otherwise clean preamp (Fig. 4). We tried to drive the inputs to produce the rated 20-V output, but the preamp would not deliver the full 20 V at lower frequencies. The 'scope showed ringing in a pre-equalized 10-kHz square wave, both at 3 ohms (Fig. 5A) and at 30 ohms (Fig. 5B) in comparison to both the moving-magnet (MM) phono input and the "High MC" inputs. One can avoid the problems of the transformer by using the "High MC" phono input, which bypasses the transformer, but with a loss in gain. This phono input's circuitry is simply a 100-ohm load and an attenuator ahead of the MM RIAA preamp, thereby dropping the "High MC" input's gain below that of the MM input. In any case, the low 30.3-dB gain of this input position makes it inappropriate for many MC cartridges; the other MC stages of the C-2301 each have about 60-dB gain. The bottom line is that the Sansui preamp will function most linearly with a moving-magnet cartridge. For flat response with a moving-coil cartridge, an external step-up device plugged into the MM phono stage is recommended.

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A new short-circuit current test is designed to show how well the test amp will drive a speaker that is a difficult load.

Standard preamplifier measurements are shown in Table I. Phono equalization error versus frequency for a resistive source was very flat for the phono MM input, but there was rolled-off bass response of its transformer inputs. However, the preamp's nonstandard, 100-kilohm MM phono input impedance means that some MM cartridges will not have flat response, since a few cartridges might respond oddly to this load impedance. The subsonic filter had a shallow cutoff slope of 6 dB per octave starting at 20 Hz, not fully adequate to filter out the effect of warped records, and it does not filter the tape outputs.

Phono crosstalk is measured by driving one channel to 0.5-V output and measuring the output of the undriven channel with input terminated in accordance with IHF standards rather than a short. Results show −54.2 dB of leakage at 20 kHz, which is not on a par with the performance of the quietest competition.

The Sansui preamp's high-level section performed in an exemplary manner. It provided 18 dB of gain at a signal-to-noise ratio of 89.2 dB, A-weighted. It had a slew rate of 25 V/µS at 10-V peak-to-peak output. Oscilloscope observations suggest this stage is bandwidth-limited, which is preferable to slew-rate limiting. THD + N measured below 0.005%, 20 Hz to 20 kHz, at 0.5-V out. The C-2301 was capable of putting out 27 V at 20 kHz with less than 0.1% THD + N when driven "CD" in to "Normal" out.

Amplifier Measurements

The Sansui B-2301 coasted through the FTC's 1-hour, ⅓-power preconditioning at 8 and 4 ohms without "thermalling out." The top plate became only slightly warm and is not connected to the internal heat-sinks.

Voltage gain of the B-2301 amplifier loaded with 8 ohms was 24.0 dB, which is 2 dB below the usual power amp gain of 26 dB. Its steady-state power measurements easily exceeded Sansui's published ratings into 8 ohms (Table II). Minimum power was 316.3 watts into 8 ohms from 20 Hz to 20 kHz, and 443.1 watts into 4 ohms from 20 Hz to 20 kHz. Measurements were also made into 2-ohm loads (a condition not rated by the manufacturer), and the amplifier comfortably delivered a minimum of 141.3 watts per channel, limited only by Sansui's 15-ampere line fuse. THD + N at the amp's rated power output of 300 watts per channel (48.99 V into 8 ohms) was 0.0016% at 2 kHz, rising to a maximum of 0.0035% at 20 kHz and 0.088% at 50 kHz.

IHF dynamic headroom into 8-ohm loads proved to be 1.75 dB, with the amp putting out 59.9 V (448.5 watts per channel) at 1 kHz into 8 ohms using a 20-mS on/480-mS off

SHORT-CIRCUIT CURRENT TEST

Modern power amplifiers are designed to deliver an output voltage that is independent of load impedance, within limits. A short-circuit at the output terminals would quickly destroy an amplifier if it did not have protection. Partially reactive loads, like real loudspeakers, do require output current at the instant the voltage waveform is passing through 0 V. This instantaneous condition is similar to the continuous requirements of a short-circuit; thus, the protection circuitry may be activated even though there is not a true short-circuit present.

The tone-burst test for maximum current into a short is designed to simulate the requirements for driving a reactive load. The test consists of a 0.1-ohm output load, which is almost a short, and a 20-mS burst of a 1-kHz sine wave once every 0.5 S. The level of the input signal is gradually raised until distortion of the output voltage waveform appears. The peak-to-peak value of this waveform is recorded from the oscilloscope trace. The rms value of this current during the 20-mS burst is derived by calculation from Ohm's Law.

The rated current of an amplifier can also be derived from the power and load resistance ratings by another version of Ohm's Law: I equals the square root of P/R (rated power divided by resistance). Thus, an amplifier rated at 200 watts into 8 ohms has a rated current equal to the square root of [200 divided by 8], or 5 amperes. If the short-circuit current is equal to or greater than 5 A, the amp will drive a purely reactive load of 8 ohms, or virtually any loudspeaker that is rated at 8 ohms, without activating its protection circuitry.

It should be mentioned that no correlations yet exist to show that amplifiers yielding high current ratings on this test can be successfully differentiated from lower current amplifiers during double-blind listening tests.

A detail important to the accuracy of the short-circuit current measurement is also worth mentioning. Contact and wire resistance can cause inaccuracies unless a "four-wire" technique is used to derive the current. The voltage across the resistor must be measured at the resistor terminals and not at the amplifier terminals, as shown in Fig. B1. The important parameter is not the exact total load on the amplifier (even if various lead resistances brought the total up to 0.2 ohm, it would still be very nearly a short), but the voltage across precisely 0.1 ohm of the total. This voltage and resistance can be used to calculate the true current.

—*L.L.G. and D.L.C.*

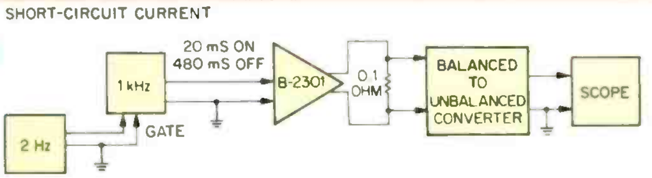

Fig. B1—Circuit for testing instantaneous current delivery capacity of amplifiers such as the B-2301.

Into 8 ohms, the amp delivered 316 watts, with 443 into a 4-ohm load. Several of the other measurements were likewise superb.

pulse. At 1-watt output, no harmonic distortion was detectible; only noise was found.

Other measurements on the amplifier proved to be superb. Damping factor was over 267 at low frequencies and 32 wide-band. IHF slew factor was 3.0, and the amp exhibited a slew rate of 80 V/µS. Large-signal rise-time is shown in Fig. 6, where the Sansui amplifier achieved a rise-time of 2.5 V/µS at 10 kHz, at 49-V out. With a 20-kHz square-wave input, the amp is stable, with some ringing from the output decoupling network, into a load consisting of 8 ohms and any capacitance up to 1.0 µF. The frequency response rises at 20 kHz by 0.2 dB when the amp has a 1.0-µF load. Otherwise, the small-signal frequency response is ±0.5 dB, 10 Hz to 150 kHz, and ±2.0 dB, 10 Hz to 300 kHz. The signal-to-noise ratio is 90.5 dBA from 1.0 watt in the left channel, and crosstalk is better than −71.3 dB at 20 kHz, worst case.

The B-2301's gorgeous, 32-element amber (on) and orange (off) LCD meters span the range from below −55 dB (0.001 watts) to greater than +2.0 dB (500 watts), referenced to 8-ohm loads. Driven by a single-cycle tone burst at 300-watts out, the meters read −6 dB at 10 kHz and −20 dB at 20 kHz, when they should have read 0 dB. For sustained signals, the meters showed +2 dB at 20 kHz and −6 dB at 20 Hz.

Clipping behavior is shown in the 'scope photos in Figs. 7 and 8. When the amp is driven at 10-dB overdrive at 300 Hz, small "horns" of high-order harmonics appear on the clipped waves. There is no sign of line-frequency modulation, indicating independence from power-supply ripple. At 20 kHz, slight clipping caused mutual conduction, with the current draw rising from 17 to 22 amperes quickly, the amp shutting down after 3 S, then resetting.

Author Clark has devised a test setup, shown in Fig. B1 and described in the sidebar entitled "Short-Circuit Current Test," to gauge an amplifier's instant current delivery. Clark drove a 1-kHz pulse, 20 mS on/480 mS off, into the B-2301 amp, which was driving a 0.1-ohm load. This amp was able to deliver a peak of 2.8 V into this load—which means 20 A rms was delivered into a virtual short! This is a *substantial* output for any amplifier.

Use and Listening Tests

Initial listening tests suggested that the C-2301 preamplifier suffered from a lack of bass, as no deep bass was evident on organ recordings in comparisons between the Sansui and Greenhill's preamp. This was tested with an ABX comparator, which randomly switched the moving-coil cartridge output between the Sansui and the reference preamp. Details of this procedure are listed in the sidebar entitled "Comparator-Controlled Listening Tests." Under double-blind conditions, Greenhill was able to accurately identify the Sansui's comparative lack of bass in 16 out of 16 attempts, after both amps had been matched to within 0.2 dB at 1 kHz using the CBS STR-151 test record and a digital voltmeter. This finding has very high statistical significance.

On a more subjective basis, the Sansui preamp presented a flattened sonic perspective, with little depth of imaging. Dynamic range on a number of percussion recordings was compressed. Gain for the moving-coil was adequate using

Table I—Preamplifier measurements, Sansui C-2301.

Circuit Stage Gain, dB	
Phono to Tape Out	
MM	36.9
MC, Transformer High	56.2
MC, Transformer Low	64.6
MC, High (No Transformer)	30.3
CD Input to Main Out	18.0
S/N, Worse Channel, dB	
High-Level Inputs to Main Out	
IHF (0.5 V In/Out)	89.2
Maximum Gain	93.2
MM Phono to Tape Out	85.9
MC Phono to Tape Out	
Transformer High	71.2
Transformer Low	62.6
No Transformer, High, 100 Ohms	66.8
Phono EQ Error, 20 Hz to 20 kHz, dB	
MM Phono Input, 100 Kilohms	+0, −0.1
MC, Transformer, 30 Ohms	+1.0, −2.0
MC, Transformer, 3 Ohms	+1.0, −2.0
MC, No Transformer, 100 Ohms	+0.1, −0.1
Subsonic Filter Roll-Off, dB	
20 Hz	−0.5
10 Hz	−2.0
5 Hz	−5.1
Crosstalk, CD Input to Main Output, dB	
20 to 200 Hz	−87.0
1 kHz	−81.1
2 kHz	−76.7
5 kHz	−67.9
10 kHz	−62.3
20 kHz	−54.2
Phono Overload at 1 kHz, mV	
MM Phono Input	414.0
MC, Transformer High	44.9
MC, Transformer Low	17.1
MC, High (No Transformer)	487.0

Table II—Power output per channel and distortion, 8-ohm loads, Sansui B-2301 amplifier.

	LEFT CHANNEL		
Freq., Hz	**V**	**Power, Watts**	**THD, %**
20	51.0	325.1	0.003
200	50.3	316.3	0.0017
2k	50.9	325.9	0.0017
20k	51.0	325.1	0.0051
	RIGHT CHANNEL		
Freq., Hz	**V**	**Power, Watts**	**THD, %**
20	51.0	325.1	0.004
200	50.5	318.8	0.004
2k	50.7	321.3	0.003
20k	51.0	325.1	0.007


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On a double-blind basis, the preamp's phono section lacked bass; this had been detected earlier during subjective listening tests.

the "Low" transformer position, but was insufficient on the transformer bypass position ("High MC") using a Yamaha MC-1000 MC cartridge. In addition, the Sansui preamp was more susceptible to hum fields than comparable units. The panel lights tended to flicker when controls were switched.

These drawbacks are unfortunate, for the ergonomic design of this C-2301 preamp is outstanding. The record-selector switch allows for recording one source (such as a tuner) while listening to another source (for example, records). In addition, the small attenuator control (with its detents) proved to be very useful; by switching to source direct, the line amps in the preamp are bypassed and the small attenuator takes over for the master volume control. This can be very helpful when one wishes to leave the central volume control at a precise setting for comparing preamps but wishes to adjust the volume in the meantime without disturbing the main setting.

The B-2301 amplifier is an excellent product. Speed, power and ultra-bandwidth have been emphasized, and this involves some rational design trade-offs, such as the mutual conduction at 20 kHz and the horns that appear on the waveforms when the amp is clipping.

Externally, the amp has few peers. Its color combination of reddish-black persimmon wood with the amber and orange of the LCD meters is visually stunning. The meters have the most attractive combination of peak-and-hold function we have come across, even if their accuracy was less than laboratory grade. The peak setting remains for 4 S, but the instantaneous display continues. This is more useful and interesting than the display in the Accuphase P-600 amplifier (reviewed in the August 1984 issue), which allowed only peak readings or instantaneous readings.

The amp does very well sonically. Subjectively, Clark

Table III—Power output per channel and distortion, 4-ohm loads, Sansui B-2301 amplifier.

Freq., Hz	V	Power, Watts	THD, %
LEFT CHANNEL			
20	43.9	482.9	0.005
200	43.1	464.4	0.005
2k	42.1	443.1	0.0023
20k	42.7	455.8	0.008
RIGHT CHANNEL			
20	42.6	453.7	0.004
200	42.8	457.9	0.004
2k	42.3	447.3	0.0038
20k	42.5	451.6	0.008

COMPARATOR-CONTROLLED LISTENING TESTS

Controlled listening tests are designed to avoid biases on the part of the critic and maximize psychoacoustical fairness. That is, in order to keep the critics' pet biases about the weight, appearance, cost or brand from influencing their sonic opinions, these tests are double blind so that neither the listener nor the test administrator (in this case, the same person) knows whether the reference amp or the amp being reviewed is playing. In our case, switching between different amps was practically instantaneous (less then 50 mS) in order to make subtle sonic differences as apparent as possible, since the human ear-brain system has a notoriously poor ability to store sounds well over time.

To make possible such an instantaneous-switching, double-blind test, we use a laboratory-grade audio comparator from the ABX Company. It consists of control circuits and relays that can rapidly switch between different inputs. The listener compares sounds and decides whether a particular source, designated X, is sonically the same or different from each of two known sources, designated A or B; X actually is either A or B, depending on the random connection made by the comparator's logic for that particular trial. The critic writes his response on a test paper. Digital memory circuits store the sequence of connections for retrieval and analysis at the end of the test.

The ABX comparator system generates data in a statistically similar manner to flipping a coin and predicting whether it will come up heads or tails. Each of the two results is equally probable, so random predictions are likely to be correct 50% of the time, as with Clark's comparison of the Sansui B-2301 and his reference amplifier in the accompanying review. Since each of our comparisons comprised 16 trials, a critic could obtain a score of 8 correct if he could hear no differences and were just guessing. Any score much above 8 correct is thus better than chance and might be significant. How far above 8 the results must be to determine significance depends on how certain one wants to be of the result.

Using published tables of the binomial statistical distribution, we have calculated the likelihood of correct scores for each listening test. We found that obtaining a score of 12 correct out of 16 trials gives a confidence level of 95% or more that the outcome was not due to chance. Results at this confidence level are the minimum commonly accepted by sciences such as medicine before they're judged to be statistically significant.—*L.L.G. and D.L.C.*

(*Editor's Note:* Readers of *Audio* are entitled to be aware that Author Clark is a director and partner in the ABX Co., makers of the comparator used in these tests, and potentially stands to gain from sales of the unit. I should say, too, that I know of no comparable product with all the features required for such testing.—*E.P.*)

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Stax electrostatic earspeakers have been used by discerning audiophiles, professional musicians, and record companies for over twenty-five years. On the subject of headphones, audiophiles and audio critics agree that Stax electrostatic earspeakers offer more realism in detailing, dimensionality, and musicality than any other.

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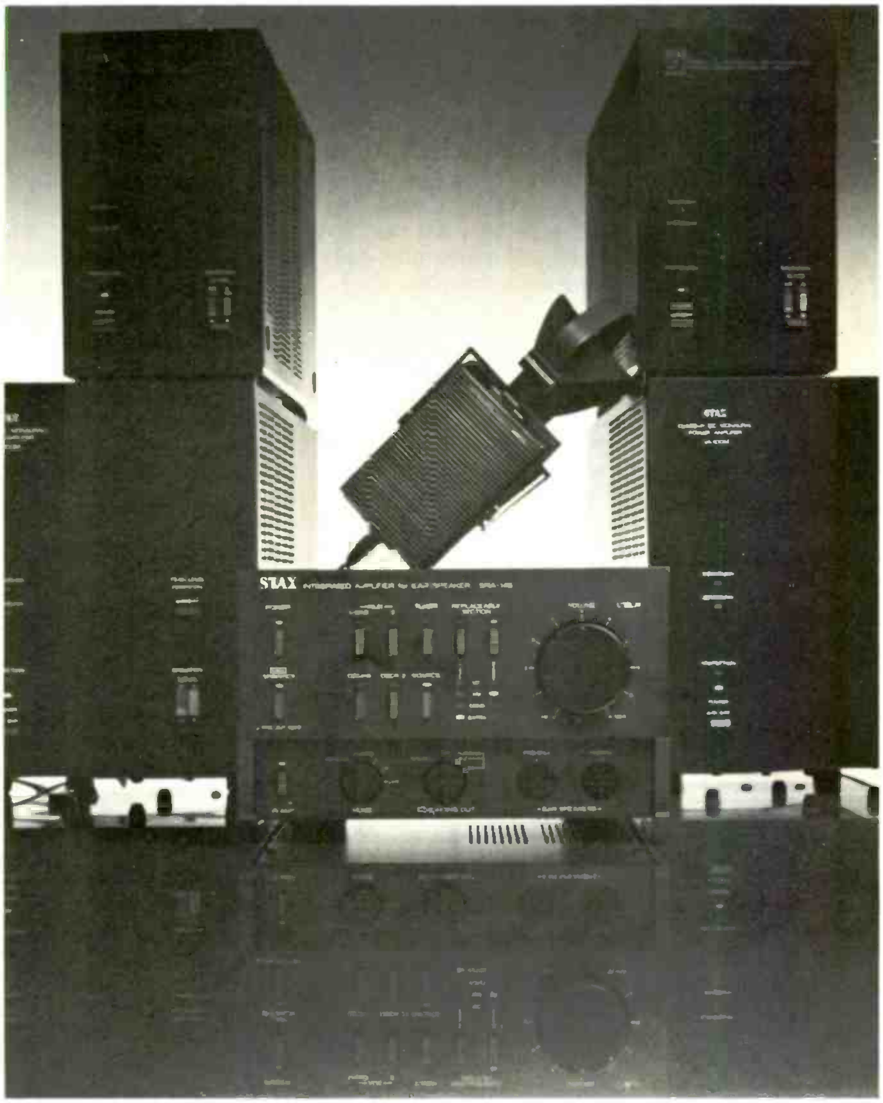
Now there are two ways to enjoy the fabulous realism reproduced by the SR-Lambda Professional earspeaker. The SRM-1Mk2 Professional direct drive class A amplifier connects directly to the output of a pre-amplifier, compact disc player, tape deck, or tuner. It can also be interfaced into the tape monitor loop of a receiver. The new SRA-14S Professional Integrated amplifier combines the direct drive class A amplifier of the SRM-1Mk2 Professional with an audiophile Preamplifier. It can be connected to serve as the heart of any audio/video system.

Please audition the full line of Stax electrostatic earspeakers. We are convinced that you will find them to be the most rewarding personal listening devices available.



DA-50M Monaural Poweramplifier	SR-Lambda Professional Earspeaker	DA-50M Monaural Poweramplifier
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The amp showed deep bass and etched highs during subjective listening tests, but double-blind tests showed no difference from the reference.

found it produced a rich, full bass and etched highs. Greenhill also observed the amp had a full bass, a boost in the warmth audio region, and good depth of imaging, with an openness and spaciousness heard on few other amps. The deepest bass of the organ and bass drum was not equal to that heard on Greenhill's reference Levinson ML-9 240-watt-per-channel (tested) amplifier driving Snell A/III speakers. Subjectively, the B-2301 seemed less apt to clip on mid-band orchestral music when driving B & W 801 loudspeakers than the reference amp when precisely gain matched and switched in; that would be expected. Greenhill's reference amp clips at 378.4 watts per channel into the 4-ohm loads presented by the Snell A/IIIs, while the Sansui puts out about 1 dB or 69 watts per channel more (447 watts per channel at clipping) at the same frequency.

Greenhill was unable to corroborate the subjective impressions of the B-2301's bass response during an A/B/X double-blind test against the reference amp, scoring 9 correct out of 16. Clark also carried out double-blind A/B/X testing in his listening room, but only correctly identified the Sansui amp 50% of the time when compared to a popular 115-watt-per-channel amplifier. These are chance scores.

What do the listening evaluations mean? Author Clark concluded that the B-2301 is an expensive, sonically neutral power amp. Greenhill pointed out that both of them had independently heard the amp's rich, full bass response and the etched highs in two different listening rooms with very different associated equipment. Didn't that mean anything? Clark responded that amplifiers housed in dark, rich persimmon wood often turn out to sound rich and full in bass response when reviewed by subjective critics. In the case of the Sansui B-2301, the double-blind listening tests didn't support the casual listening impressions. Greenhill replied that the amp continued to sound rich and full, even after he knew the results of the controlled tests.

In conclusion, we feel that the Sansui components examined here are physically beautiful and wonderful to operate. The lack of enthusiasm about the Sansui preamp comes from the frustration of finding a marvelously functional preamp hobbled by sonic limitations, particularly for MC cartridge lovers (the very folks most apt to buy this unit). A few internal circuit problems give us reservations about the C-2301 preamp, including the MC transformer, the subsonic filter and the MM phono load impedance. We believe such problems should not occur in a $2,700 preamp—but you must decide whether these are problems large enough to keep the C-2301 off your potential-purchase list. We would strongly recommend the B-2301 as a high-current amplifier with a subjectively (unproven in the double-blind comparisons, unfortunately) rich bass response and very smooth highs that provide strong revelation of detail.

Laurence L. Greenhill and David L. Clark

5

PARASOUND DR40 RECEIVER

Manufacturer's Specifications
FM Tuner Section
Usable Sensitivity: Mono, 9.3 dBf.
50-dB Quieting: Mono, 15.3 dBf; stereo, 38.1 dBf.
Selectivity: 68 dB.
Stereo Separation: 44 dB at 1 kHz; 36 dB at 10 kHz.

Amplifier Section
Power Output: 40 watts continuous per channel, 20 Hz to 20 kHz, 8-ohm loads.
Rated THD: 0.04%.
Frequency Response: High level, 20 Hz to 40 kHz, ±1.0 dB; phono, RIAA ±0.2 dB.
SMPTE-IM Distortion: Less than 0.03%.
Dynamic Headroom: 1.0 dB.
Damping Factor: 150 at 20 Hz.
Input Sensitivity: Phono, 2.0 mV; high level, 160 mV.
S/N: Phono, 80 dB re: 5-mV input; high level, 95 dB re: rated output.
Phono Overload: 220 mV.
Tone Control Range: Bass, ±10 dB at 100 Hz; treble, ±10 dB at 10 kHz.
Subsonic Filter: −6 dB at 20 Hz, 12 dB/octave slope.

General Specifications
Price: $299.95.
Company Address: 680 Beach St., San Francisco, Cal. 94109.
For literature, circle No. 94

What can you get for under $300 in an integrated stereo receiver? In the case of Parasound's DR40, quite a bit of power, if that's what you're after—as much as 40 watts per channel, with some margin of reserve at mid-frequencies. On the tuner side, the DR40 offers frequency-synthesized AM and FM tuning; however, the sensitivity, distortion and noise performance may leave something to be desired if, like me, you seek the absolute ultimate in FM performance.

As to controls, the DR40 has a true, separate loudness control, something you rarely find in receivers costing much more than this one. The frequency-synthesized tuning system here also gives you up to five AM and five FM presets, for instant recall of your favorite station frequencies. And then there are the standard, but essential, items, including bass and treble controls and the usual number of program-source inputs (with the high-level pair glamorized by silk-screened panel designations that have been changed from the familiar "AUX" to the now-fashionable "CD/Video").

Still, the DR40 is very much a budget-priced receiver; thus, there's only so much you can expect from it. In some respects, it delivered more than I had expected, while in others it fell short.

Control Layout

A "Power" on/off pushbutton at the upper left of the all-black front panel is augmented by a two-color LED (green for normal operation and red for a short-circuit or overload condition). Immediately below are a pair of speaker-selector buttons, while to the right are a tuning-mode switch (manual or automatic scanning) and a "Memory" switch, used in

While the DR40 fell short of my limited expectations for a budget receiver in some respects, it surpassed them in others.

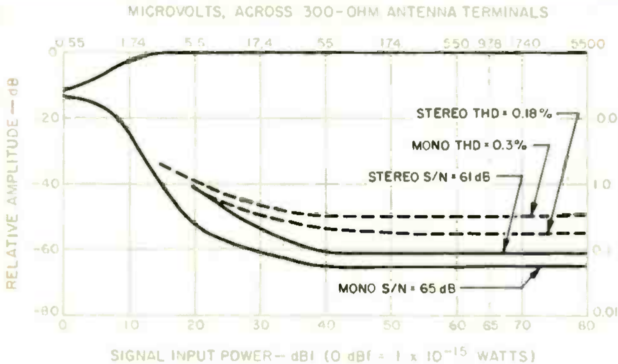

Fig. 1—Mono and stereo quieting and distortion characteristics, FM section.

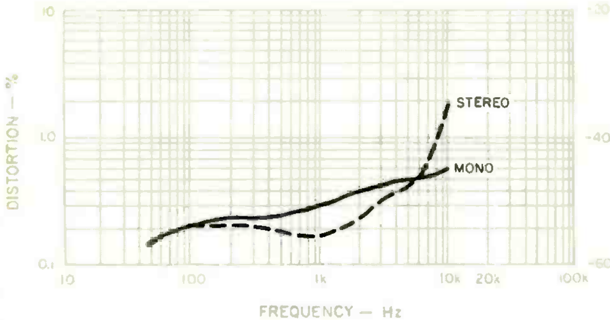

Fig. 2—THD vs. modulating frequency, FM section.

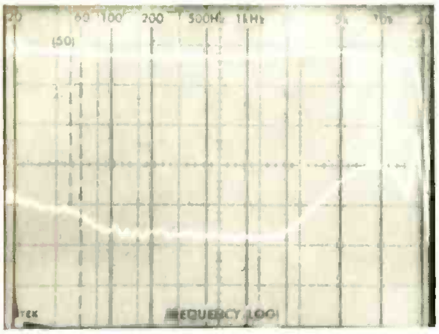

Fig. 3—Frequency response (upper trace) and separation vs. frequency, FM section.

conjunction with the five station-preset buttons located just across the panel. In the manual tuning mode, pressing the "Up" and "Down" buttons (located alongside the presets) increments tuning in 50-kHz steps for FM or 10-kHz steps for AM. Near the upper center of the panel is the station-frequency display, with a single LED to show whether a received signal is in stereo and a five-LED signal-strength indicator. The latter uses two red LEDs for weak signals, an amber LED for marginal signals, and two green LEDs to show strong-signal conditions.

Along the lower edge of the panel are a stereo-headphone jack plus rotary controls for "Bass," "Treble," "Balance," "Loudness," and "Volume." I was pleased and surprised to find a variable loudness control on such an inexpensive unit. Normally, loudness compensation is tied to the volume control on low-cost (and even some expensive) receivers, making it difficult, if not impossible, to adjust this circuit for proper compensation at low listening levels. With the separate, rotary loudness control, you can adjust "Volume" to preferred listening levels and then adjust "Loudness" to boost bass response just enough for perfect auditory compensation. Pushbuttons below the row of presets and "Down"/"Up" tuning buttons handle program selection, control the single tape-monitor circuit and mono/stereo operation, and activate the subsonic filter.

The rear panel is equipped with 300- and 75-ohm FM antenna terminals, an external AM antenna terminal, a hinged AM ferrite-rod antenna, the usual pairs of input and tape-output jacks, a ground terminal, two sets of color-coded speaker terminals, a pair of a.c. outlets (one switched, the other unswitched), and a main fuse-holder. A battery holder, also on the rear panel, is designed to hold a pair of AA batteries. These serve as backup for the preset memory if there is a power failure or if the unit must be disconnected from the a.c. supply for any reason. I'd have welcomed the aesthetic touch of even a cheap plastic cover over the battery compartment, but since it is on the rear panel it will usually be out of sight.

Tuner Measurements

Although the owner's manual is only a fold-out brochure the equivalent of eight pages in length, two of these pages are dedicated to a full schematic diagram. From it, I surmised that the FM circuit is fairly basic, employing an FET r.f. stage and bipolar oscillator and mixer stages. I.f. and multiplex-decoder functions are handled, by and large, by multi-purpose ICs. The minimal amount of circuitry may account for the DR40's average FM performance.

Usable sensitivity in mono fell short of the claimed 9.3 dBf, measuring 12.0 dBf. Stereo usable sensitivity was governed by the stereo threshold, which was about 15 dBf. I found that 50-dB quieting in mono occurred with a signal strength of 18 dBf; in stereo, the 50-dB quieting figure of 26.0 dBf was actually much better than claimed. The most disappointing aspect of the FM tuner section's performance was its signal-to-noise ratio, which, even with strong signals, never exceeded 65 dB in mono or 61 dB in stereo. Figure 1 shows how signal strength affects signal-to-noise ratios as well as harmonic distortion (for a 1-kHz, 100%-modulated signal) in mono and stereo. In mono, THD measured 0.3%, The FM circuits seem fairly basic and perform accordingly, especially in signal-to-noise ratio and harmonic distortion.

but in stereo it was actually somewhat better, measuring only 0.18%.

Harmonic distortion as a function of frequency, for mono and stereo operation, is plotted in Fig. 2. Frequency response of the FM section was flat within ± 1.0 dB from 30 Hz to 10 kHz, but it was down 5.0 dB at 15 kHz.

The 'scope photo of Fig. 3 shows overall frequency response and stereo separation as a function of frequency. I measured stereo separation as 38 dB at 1 kHz, 37 dB at 100 Hz, and 27 dB at 10 kHz. Capture ratio measured 2.5 dB, and alternate-channel selectivity was 65 dB. I.f. and spurious rejection were better than 80 dB, while AM suppression measured 50 dB.

Figure 4 shows the crosstalk and distortion components that appear in the unmodulated (right) channel when a 5-kHz test signal is used to modulate the opposite (left) channel. The tall spike at the left is the desired 5-kHz left-channel output signal; all the components to the right are either distortion components or subcarrier components appearing at the output of the unmodulated channel. The number and amplitude of these unwanted products are greater than I have encountered in tests of any other tuner or receiver within recent memory; however, a letter received from Parasound just as I was completing this review indicates that distortion may well be lower in later production runs.

Frequency response for the AM tuner section (whose circuitry consists largely of a single IC) is shown in Fig. 5. Response was down some 6 dB at around 2.5 kHz, referred to 1 kHz. This is about what I have come to expect from most AM tuner circuits found in low- to mid-priced receivers and even in a few high-priced models. Some designers of these circuits argue that increasing the AM bandwidth would result in annoying whistles and interference beats, especially at night, due to the crowding of the AM band in the United States and some other areas. I suppose that's true, but it is also true that, as a result, the AM section of this receiver—and of many others with similar AM circuitry sophistication—delivers sound that is no better than and sometimes inferior to what you can hear from a table model or hand-held radio.

Amplifier Measurements

The power amplifier section was able to deliver its rated power (40 watts per channel into 8-ohm loads) and then some, at all frequencies from 20 Hz to 10 kHz. At 20 kHz, THD rose a bit higher than the claimed 0.04%, to 0.07%. At mid-frequencies, maximum power output for the rated THD of 0.04% was 50 watts. A three-dimensional plot showing distortion as a function of power output *and* frequency is presented in Fig. 6.

Damping factor measured 100, using a 50-Hz test signal and referred to an 8-ohm load. Dynamic headroom measured 1.2 dB, a bit better than the 1.0 dB claimed by Parasound. I measured three types of IM distortion for this receiver. At rated output, SMPTE IM was 0.3%, decreasing to 0.05% just below that output level. CCIF IM, using twin tones at 19 and 20 kHz, was 0.01%. This form of distortion takes into account only the 1-kHz "difference" signal generated by the two high-frequency test signals. IHF IM, on the other hand, takes into account *all* intermodulation components in the spectrum up to 20 kHz, and, as you can see from Fig. 7, there were many such distortion components, generated at 1-kHz intervals from around 4 to 20 kHz. Calculating their equivalent percentage, the IHF-IM distortion figure turned out to be a rather high 0.65%—higher than I would have expected from just the THD and SMPTE-IM numbers recorded earlier.

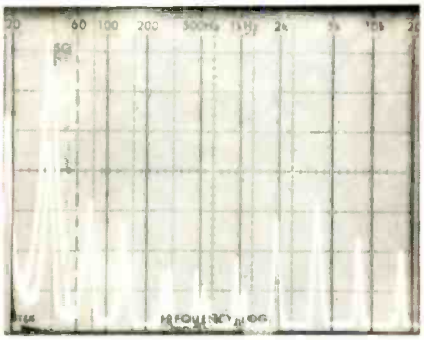

Fig. 4—Crosstalk and distortion components for a 5-kHz, FM modulating signal.

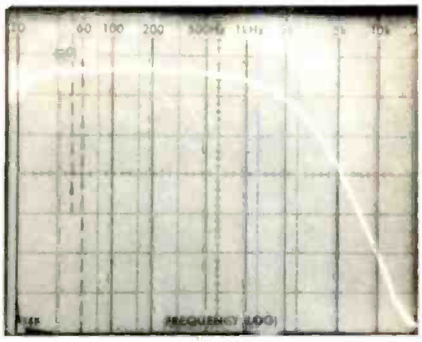

Fig. 5—AM frequency response.

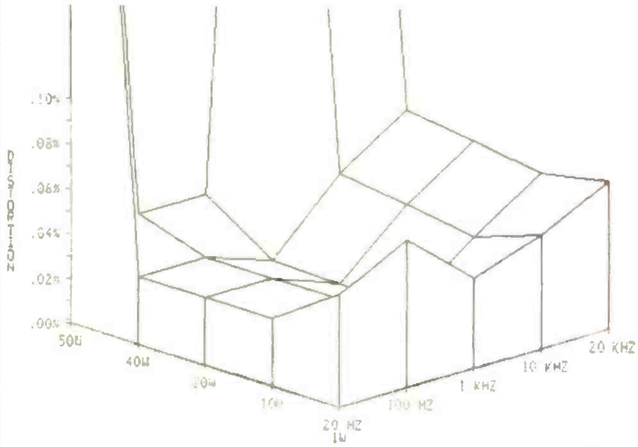

Fig. 6—Power output vs. frequency vs. THD.

At moderate levels, the amplifier sounds quite good, again raising old questions about how relevant static distortion measurements are.

Preamplifier Measurements

Phono input sensitivity, referred to 1 watt of output, measured 0.35 mV, while 20 mV was required to produce 1 watt of output via the high-level ("CD/Video" or tape) inputs. Frequency response for the high-level inputs was flat within 1.0 dB from 4 Hz to 40 kHz and within 3 dB out to 80 kHz. Although RIAA equalization of the phono preamplifier circuitry was accurate to within 0.5 dB at the high end, I observed a deviation from the RIAA curve of −3.1 dB at 50 Hz. It is possible that the designers of this preamp circuit tailored its response to the modified curve proposed by the IEC (International Electrotechnical Commission), with its extra low-end roll-off, rather than the official RIAA curve.

Phono overload, though acceptable at 100 mV for the standard 1-kHz signal, fell far short of the 220 mV claimed by Parasound, who don't say what *frequency* they used to check phono overload. The EIA Amplifier Measurement Standards, which I use, call for this important parameter to be measured at a test frequency of 1 kHz. By using a higher test frequency (say, 2 kHz or even higher), Parasound could have achieved their higher overload figure. If that's what they did, then they should have said so. But, as I say, the DR40's performance here is acceptable.

Hum and noise for the phono circuits was a satisfactory 75 dB below 1-watt output, referred to a 5-mV input signal at 1 kHz. I measured 79 dB of signal-to-noise ratio for the high-level inputs, again referred to 1-watt output, this time with 0.5 V of input signal applied. Turning the volume control all the way down resulted in a further reduction of noise output, down to −81 dB below 1-watt output.

Figure 8 shows the maximum boost and cut range of the bass and treble tone controls, while Fig. 9 shows the bass-boost curves that can be obtained at various settings of the separate loudness control. The subsonic filter, when activated, resulted in an attenuation of 4.2 dB at 20 Hz.

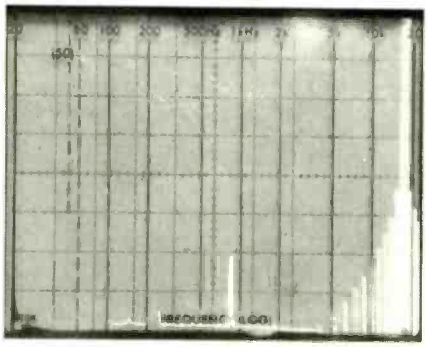

Fig. 7— Distortion products from the IHF-IM twin-tone test using 19- and 20-kHz test signals.

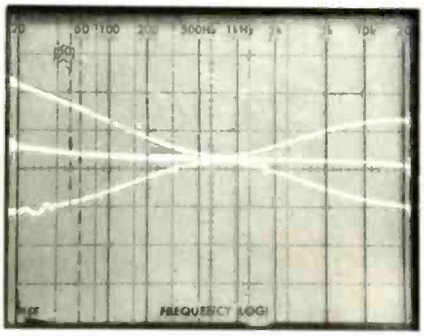

Fig. 8— Tone control characteristics. Vertical scale: 10 dB/div.

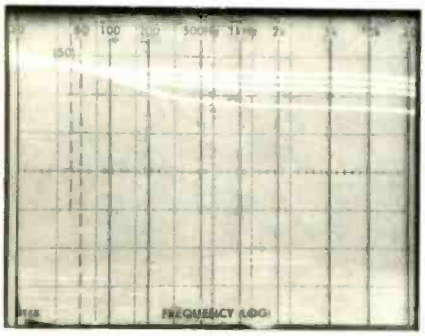

Fig. 9— Bass boost for several settings of the variable loudness-compensation control.

Use and Listening Tests

There is much about the Parasound DR40 that is commendable. Certainly, a 40-watt-per-channel, all-in-one receiver that sells for less than $300 represents an achievement in itself. Frequency-synthesized tuning in such a low-cost, relatively high-powered receiver is also very worthwhile. On the other hand, I was disappointed by the inability of the FM tuner section to deliver even 70-dB signal-to-noise ratios (the minimum that I consider acceptable for today's program sources, with their dramatically increased dynamic range). After all, many FM stations are now playing CDs with increasing regularity, and, with a good tuner, the advantages of CDs are immediately apparent. Here, their quiet background will be marred if the tuner's signal-to-noise ratio is marginal.

If you keep the volume control at safe levels and don't try to push this receiver's amplifier section too hard, the high intermodulation distortion levels which I noted on the test bench don't become a disturbing factor. In fact, at moderate listening levels the amplifier sounds quite good—again raising the age-old question concerning the relevance of measured distortion under static, test-signal conditions. Push the amplifier a bit harder, though (as you would do with medium- to low-efficiency loudspeakers), and the slight graininess associated with dynamic forms of intermodulation distortion becomes subtly apparent. Used with efficient speakers in a moderate-sized listening room, the amplifier section will do reasonably well. In strong-signal areas, FM will also be acceptable, especially if you keep volume levels low enough so that background noise remains below the threshold of audibility.

All in all, the DR40 does represent quite a lot for its price, but—in the last analysis—in audio equipment you still get what you pay for. *Leonard Feldman*

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6

ULTRX R100 RECEIVER

Manufacturer's Specifications

FM Tuner Section

Usable Sensitivity: Mono, 12 dBf; stereo, 17.23 dBf.

50-dB Quieting Sensitivity: Mono, 21.45 dBf; stereo, 39.17 dBf.

S/N Ratio: Mono, 70 dB; stereo, 65 dB.

THD: Mono, 0.2%; stereo, 0.4%.

Frequency Response: 20 Hz to 15 kHz, ±1.0 dB.

Alternate-Channel Selectivity: 70 dB.

Capture Ratio: 1.5 dB.

Image Rejection: 85 dB.

I.f. Rejection: 90 dB.

Spurious Response Rejection: 90 dB.

AM Suppression: 55 dB.

Channel Separation: 45 dB at 1 kHz.

Pilot Suppression: 60 dB.

SCA Rejection: 60 dB.

AM Tuner Section

Usable Sensitivity: 400 µV/m.

S/N Ratio: 45 dB.

Selectivity: 40 dB.

Image Rejection: 50 dB.

I.f. Rejection: 40 dB.

Amp and Preamp Sections

Output Power: 100 watts/channel, 20 Hz to 20 kHz, 8-ohm loads.

Rated THD: 0.009%.

Dynamic Headroom: 2.0 dB.

SMPTE IM: 0.009%.

Frequency Response: Phono, RIAA ±0.5 dB; high level, 10 Hz to 40 kHz, +0, −1.0 dB.

Input Sensitivity: MM phono, 2.5 mV; MC phono, 250 µV; high level, 150 mV.

Phono Overload: MM phono, 75 mV; MC phono, 6 mV.

S/N Ratio: MM phono, 80 dB; MC phono, 60 dB; high level, 95 dB.

Headphone Output Level: 420 mV into 8 ohms.

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

Subsonic Filter Response: 6 dB per octave, 30-Hz cutoff.

Loudness Control Action: +10 dB at 100 Hz (volume control set at −30 dB).

Channel Separation: 55 dB at 1 kHz, all inputs.

General Specifications

Power Consumption: 250 watts.

Dimensions: 16½ in. (42 cm) W × 5⅜ in. (13.7 cm) H × 14-15/16 in. (38 cm) D.

Weight: 27.3 lbs. (12.4 kg).

Price: $599.95.

Company Address: 1200 West Artesia Blvd., Compton, Cal. 90220.

For literature, circle No. 95

Though it isn't obvious from looking at the front panel, the ULTRX R100 receiver is a product of the well-known Sanyo Corporation, and here we should distinguish between American Sanyo and Japanese Sanyo. The former owns the ULTRX brand name and is, itself, owned by Japanese Sanyo, which also owns the Fisher brand. In this country and with many types of products, Sanyo and Fisher compete on head-to-head terms, but ULTRX is an upscale move by Sanyo to a more exclusive market, where Fisher existed even prior to its sale to Sanyo. Thus, what exists in the U.S. between Sanyo, Fisher, and now ULTRX is more nearly a case of sibling rivalry than anything else.

Be the marketing questions as they may, the R100 has a tremendous number of features going for it. Its PLL frequency-synthesized tuner section provides 20 station-memory presets and tuning, as well as an automatic station-search system. Major control functions are performed electronically, using rocker switches for varying volume, channel-balance, and bass and treble settings. A stereo synthesizing circuit can liven up such mono program sources as VCR and TV sound. A full encode/decode dbx circuit has been included, as has a DNR (Dynamic Noise Reduction) single-ended dynamic filter for reducing hiss and noise when listening to noisy program sources. There are inputs for two tape decks, with provisions for dubbing in either direction. Even more noteworthy is an infrared remote-control module which performs the basic functions of volume adjustment, up and down tuning, and selection of the preset station frequencies.

The front panel, which gives excellent access to all these features, is itself a model of good, contemporary design. It has no protruding knobs, and its colorful displays, indicators and graphics make operation easy, even for the audio neophyte. However attractive and useful these features might be, they should be evaluated after the basic performance is considered. And when turning to measured performance versus specification, in light of the competition, the ULTRX R100 does pretty well for itself. I should mention at this point that two samples of the R100 were tested; the first unit, which I discovered later was a preproduction sample, did meet specification, while the second and full-production unit did better and is reported on here.

Control Layout

Along the lower edge of the front panel are a power on/off button; a stereo headphone jack; speaker-selector buttons; an FM i.f. bandwidth-selector switch; dbx encode and decode buttons; pairs of buttons for bass, treble, and channel balance; a subsonic filter switch; a mono/stereo switch; a loudness control button, and three "Tape Copy" buttons. The center section of the panel contains the "Up" and "Down" tuning bars, an "Auto/Manual" tuning selector button, 10 preset tuning buttons (each accesses either of two memorized frequencies with the aid of an additional button labelled "1-10/11-20" that works like a typewriter or computer shift key), an AM/FM selector button, tape monitor switches, program-selector buttons ("Tuner," "CD," "TV/VCR," "AUX," and moving-magnet and moving-coil phono), volume "Up" and "Down" buttons, and stereo synthesizing and DNR switches.

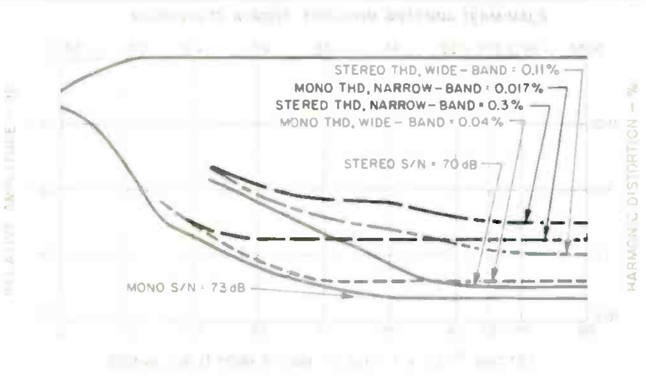


Fig. 1—Mono and stereo quieting and distortion characteristics, FM section.

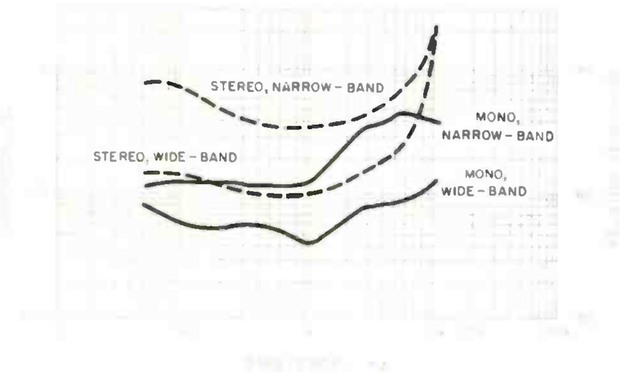


Fig. 2—THD vs. frequency, FM section.

The entire upper section of the front panel is dedicated to a host of displays and indicating lights. Station preset number (from 1 to 20), selected AM or FM frequency, status of the volume control (in numerical indications from 1 to 10), and signal strength (in numbered, graphic symbols from 1 to 5) are all augmented by more than a dozen alphanumeric displays as well as graphic displays which show the status of the tone and balance controls, selected program source, and instantaneous power-output levels. The power-output meters take the form of a pair of ascending ramps of fluorescent graphics, one rising to the left, the other to the right. No actual bells and whistles, but there are plenty of flashing lights!

The rear panel of the ULTRX R100 is considerably less flamboyant. There are the usual pairs of inputs and tape-

Why dbx and DNR in one receiver? We're spoiled by noise-free digital program sources, and want our older ones just as noise-free.

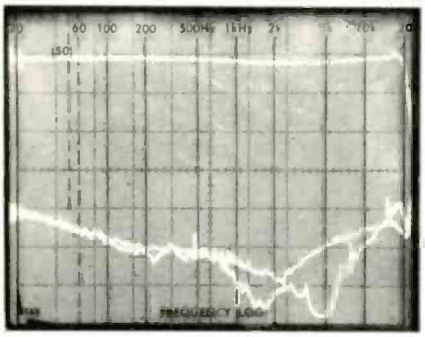
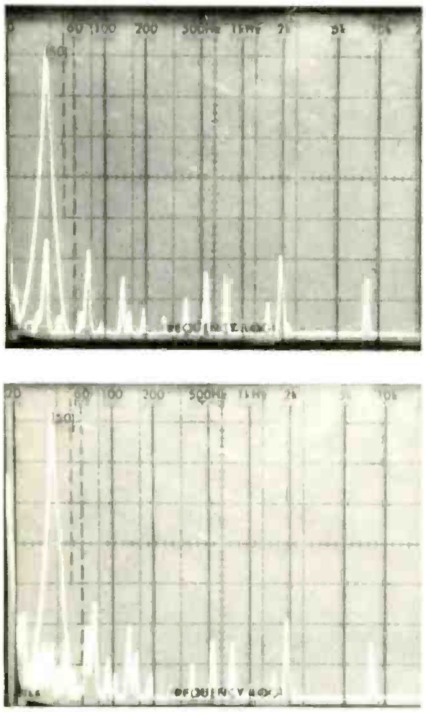


Fig. 3—FM stereo frequency response (upper trace) and separation in narrow and wide i.f. modes (lower traces).



A

B

Fig. 4—Crosstalk and distortion products resulting from 5-kHz modulation in one channel, as seen at opposite channel's output. Results here were almost identical between tests made in wide i.f. mode (A) and narrow i.f. mode (B).

output jacks, two complete sets of spring-loaded speaker terminals, a pair of a.c. convenience outlets (one switched, the other unswitched), and a pivotable AM loop (which comes packaged separately, is snapped into place, and is then connected to the AM antenna terminals). For connection of an FM antenna, 300- and 75-ohm coaxial terminals are provided. There are also a pair of screwdriver adjustments for tape-related uses of the dbx circuitry and a second pair for adjusting playback of dbx-encoded discs. The owner's manual correctly states that, with most tape decks, the factory settings of these adjustments will work nicely, outlining a simple procedure for readjustment if you happen to own the "exceptional" tape deck that isn't tracking properly.

Tuner Measurements

Usable sensitivity of the FM tuner section, in mono, measured 12 dBf, exactly as claimed. In stereo, however, usable sensitivity was determined by the muting threshold (muting is defeated only in the mono mode), which was set at about 22 dBf. The 50-dB quieting point occurred in mono with an input level of 16 dBf; in stereo, it took 37 dBf to reach that level of quieting. Although quieting characteristics were virtually the same in both the wide and narrow i.f. modes, distortion was, of course, markedly higher in the narrow-band mode than in the wide. This trade-off must be made to improve selectivity when interference from adjacent- or alternate-channel signals makes it impossible to listen to FM in the low-distortion, wide-band mode. THD for a 1-kHz, 100%-modulated FM signal at 65-dBf input level was only 0.04% in mono when the wide-band i.f. setting was used; in stereo, under the same conditions, THD was 0.11%. Both of these figures are much better than the manufacturer's published specifications. In the narrow i.f. mode, THD increased to 0.17% in mono and 0.3% in stereo, still well below published specs. Quieting and THD as a function of r.f. input-signal strength is shown in Fig. 1, while Fig. 2 shows how distortion varies with frequency in mono and stereo and in the narrow and wide-band i.f. modes.

Signal-to-noise performance was a bit disappointing to me, however, measuring only 73 dB in mono and 70 dB in stereo. I realize that these results do slightly surpass the published figures, but these days, I just expect that tuners and tuner sections of receivers will be able to do somewhat better than that.

Frequency response deviated from flat by no more than ±0.6 dB from 30 Hz to 10 kHz but exhibited a slight rise (2.1 dB) at 15 kHz. This was caused, no doubt, by less than perfect termination of the multiplex decoder's low-pass filter. Stereo frequency response and separation in the narrow and wide i.f. modes are shown in Fig. 3. Notice that separation didn't change much when switching from the wide to narrow i.f. mode; only the frequency of maximum separation shifted slightly. In the narrow mode I measured separations of 45, 40.5, and 36 dB at 1 kHz, 100 Hz, and 10 kHz respectively. Switching to the wide i.f. mode, separation measured 48, 43, and 39 dB for the same test frequencies.

Figures 4A and 4B show what comes out of the right-channel output of the tuner section when the left channel is modulated 100% by a 5-kHz test signal. In both 'scope

The R100 will accept all your program sources, pick up all the FM stations you'd expect, and power most any speaker to an adequate level.

photos, the tall spike at the left is the desired 5-kHz signal, while the signal contained within it is the 5-kHz component observed at the opposite channel's output. Additional signals to the right represent other undesired crosstalk and distortion components. Strangely, though the crosstalk components had about the same amplitude whether measured in the wide or narrow i.f. mode, the 5-kHz separation was actually better in the narrow mode then it was in the wide. At first glance this seems unusual, until you look back at Fig. 3 and realize that 5 kHz happens to be the point of best separation for the narrow i.f. mode. At all other frequencies, there is the expected slight deterioration of separation as you switch from wide to narrow.

SCA rejection was a rather poor 58 dB. This means that, if there are FM stations in your area that broadcast an SCA subcarrier (either for private subscriber background music, data transmission, or any of the many other purposes now permitted by FCC rules), you may very well hear faint "swishing" sounds during quiet passages of music. Don't blame these on multipath problems. More likely, what you are hearing is crosstalk from an SCA subcarrier used by the offending station.

Figure 5 shows the frequency response of the AM tuner section, which was about what I have come to expect in most stereo receivers. There wasn't much output above 3 kHz or below 50 Hz.

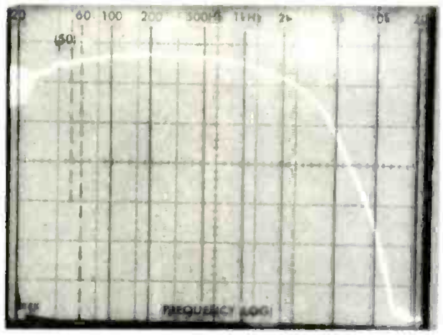


Fig. 5—Frequency response, AM tuner section.

Amplifier Measurements

Using a 1-kHz test signal, the power amplifier section of the R100 more than realized its claimed power output at its rated distortion of 0.009%, measuring only 0.0046% at 1 kHz. It produced a bit more harmonic distortion at the audio frequency extremes: 0.0065% at 20 Hz and 0.0057% at 20 kHz, for 100 watts per channel into 8-ohm loads. The SMPTE-IM distortion was lower than claimed, measuring only 0.004% at rated power output. Damping factor measured 44 (referred to 8 ohms), and dynamic headroom measured 1.8 dB as against 2.0 dB claimed. CCIF IM was less than 0.0033%, while IHF IM was below 0.03%. Amplifier clipping, for a 1-kHz signal input, occurred when output levels reached 124 watts per channel.

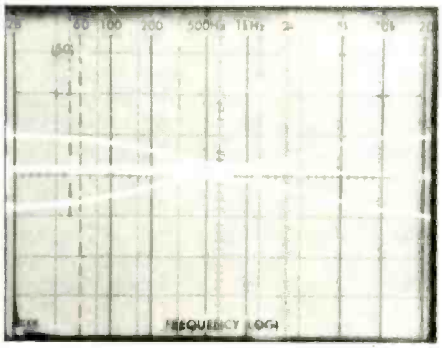


Fig. 6—Range of bass and treble controls.

Preamplifier Measurements

Input sensitivity for the phono inputs, referred to 1-watt output, was 0.25 mV for MM and 25 μV for MC. It took 15 mV of input at the high-level inputs (or at the tape inputs) to produce 1 watt of output with the volume adjusted to maximum. Phono frequency response deviated from RIAA by no more than ±0.7 dB. Phono overload via the MM inputs was 125 mV, considerably better than the published rating of 75 dB, which I would have considered inadequate. Using the MC inputs, overload occurred with an input level of 12 mV, twice the overload level claimed. Frequency response for the high-level inputs extended from 8 Hz to 42 kHz for the −3 dB cutoff. With the subsonic filter activated, response was down by 3 dB at 40 Hz, a bit higher in frequency than I would have liked and higher than the 30 Hz claimed by ULTRX.

Signal-to-noise ratio in the MM phono setting was 75 dB referred to 5-mV input and 1-watt output. At the same

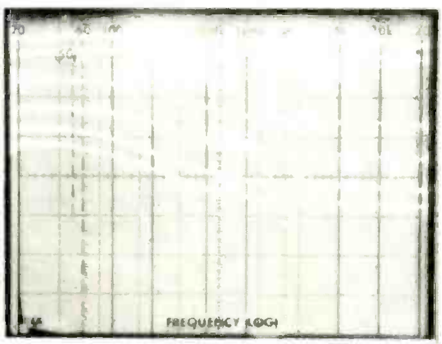


Fig. 7—Loudness-control response at various settings of volume control.

The tuner, amp, and preamp sections sounded good enough to make the R100 a winner on a price vs. sound-quality basis.

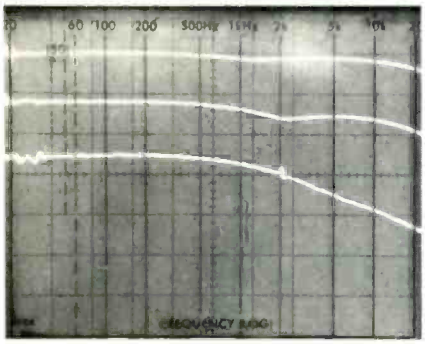


Fig. 8—Response sweeps made at low signal levels to demonstrate action of the dynamic low-pass filter system used in the DNR circuit.

referenced output level, and with 0.5-mV input, S/N for the MC inputs was 63 dB. Via the high-level inputs, using a 0.5-V input and again referred to 1-watt output, S/N was an undistinguished 73 dB, increasing to −88 dB of residual hum and noise when the volume was set to minimum.

Figure 6 shows the maximum boost and cut range of the bass and treble tone controls, while Fig. 7 shows the action of the loudness-compensation circuitry at various settings of the volume control. Notice that this particular loudness circuit affects only the bass frequencies; no treble boost is introduced even at low listening levels.

In Fig. 8 I have tried to show how the DNR circuit works. Using relatively low-level signals, I swept from 20 Hz to 20 kHz with my spectrum analyzer. DNR, as its full name implies, is a *Dynamic* Noise Reduction circuit; it can also be described as a dynamic low-pass filter. That is, when there is an abundance of high-frequency *musical* information in the input signal, the filter "opens up" and passes all audio frequencies. When only low-level, high-frequency information is present, the system looks upon this as "noise" or hiss, and closes down or attenuates the highs. As you can see in Fig. 8, by applying a very low-level sweep (lowest of the three traces), I "tricked" the circuit into believing that the "highs" in the sweep were really noise, and so it attenuated them. At a slightly higher level, the circuit wasn't quite sure whether it was seeing noise or musical highs, and so it let the highs through with only slight attenuation. At still higher levels, the circuit was certain that it was dealing with "musical" treble tones, and passed them on with virtually no attenuation.

Use and Listening Tests

Sometimes, trying to cram too many features and making them overly user-friendly carries with it certain disadvantages. When using the ULTRX R100 for entertainment and musical listening purposes, I was bothered by at least three things that are a direct result of all the electronically adjusted parameters of this receiver. The electronically adjusted volume control works in discrete steps. Normally, that would be fine (I've gotten used to step-detented mechanical volume controls that do the same thing); in this case, each step is accompanied by a slight popping sound from the speakers. No doubt FET or other solid-state switches are being used to change the volume level, and they introduce noise and pops during the adjustment process. I found that the bass and treble controls, as well as the balance control, which also operate in electronically controlled steps, seemed to take forever to get where I wanted them to. I have nothing against rocker switches and pushbuttons, as they sure make a front panel look sleek and elegant. But every now and again, I yearn for the days when a simple, smooth twist of a rotary knob brought me to the exact control setting I wanted in less than 1 S.

Once I got all the adjustments out of the way, the tuner, preamplifier and amplifier sections worked adequately well and sounded good enough to justify the price of this receiver. All the extra displays, of course, are needed to tell you what a marker dot on a knob could have told you at less cost. However, I have no real objection to their use, since, on a sound quality versus price basis, the R100 is a winner. Whether its price would have been lower without all those front-panel displays is, I suppose, moot. On the very positive side, there are all too few receivers that offer built-in dbx as well as DNR noise reduction, and I must say that both of these circuits worked extremely well. As ULTRX points out in one of their advertisements, with so many of us getting used to noise-free reproduction from digital program sources, we tend to get spoiled and want our older, analog program sources to be just as free of noise. The dbx NR system is one way to accomplish this for the tapes you record, not to mention that it allows you to record much greater dynamic range than would otherwise be possible. By the same token, DNR helps out older program sources as well as noisy FM broadcasts whose background noise can't easily be eliminated in any other way.

I haven't mentioned the stereo synthesizing circuit (ULTRX calls it a stereo matrix) simply because I regard such circuits as poor substitutes for the real thing. I suppose, though, if you are piping video sound into this receiver and if that program source (whether from a TV broadcast or a VCR) is in mono, there's some sonic excitement to be derived from the quasi-stereo effect of the ULTRX circuit. If you don't like it, you can always switch it off and go back to mono—I did.

The extra high-level inputs on the R100, over and above the usual AUX inputs, were most welcome. These days, most people have more and more program sources to hitch up to their central audio components, what with stereo TV on the way, CD players catching on and VCRs coming out with hi-fi sound. The ULTRX provides for all of these, with no need for external switchboxes or patch bays. It offers adequate power output for virtually any pair of speakers housed in any reasonable size of listening room. It picks up all of the FM stations I would expect it to, and makes it easy to access up to 20 stations at the touch of a button. In short, the ULTRX R100 is a no-nonsense receiver on the inside, notwithstanding some of its front-panel flash on the outside.

Leonard Feldman

Audio

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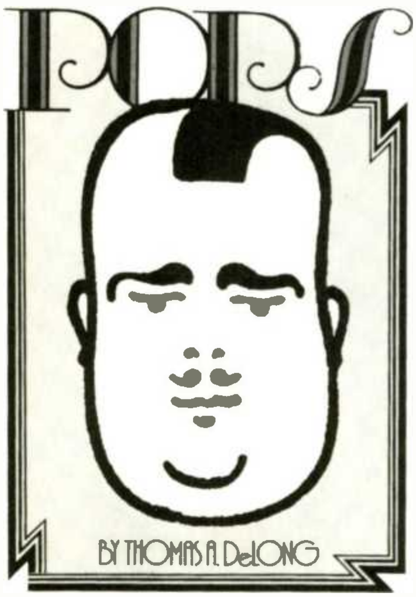
POPS: THE CHAMPAGNE



POPS: Paul Whiteman, King of Jazz by Thomas A. Delong. New Century Publishers, 360 pp., $17.95.

Paul Whiteman, who died at the age of 77 in 1967, is almost totally forgotten today. His 800+ recordings made for Victor, Columbia, Decca, and Capitol over a 22-year period remain out of print. Yet this one-time King of Jazz and Dean of American Music stood as a colossus in the world of popular music and is a fit subject for a biography. Written by Thomas A. Delong with the cooperation of Whiteman's handsome former-movie-star wife, Margaret Livingston, *POPS* pulls few punches in outlining the career of the most successful of all bandleaders.

Born in 1890 to Wilberforce Whiteman, superintendent of music for Denver's schools, Paul Whiteman was never able to please his puritanical father, who felt that only classical music was worth pursuing. Paul suffered from typhoid fever as a youngster, losing much of his hair, and he developed a tremendous appetite which caused his weight to balloon to over 300 pounds for much of his life. A poor student who avidly sought life's pleasures, he eventually became a good musician, but he had to leave Denver to find himself.

In California, he drifted back and forth between symphonic work and jazz. In 1920, Whiteman opened a new hotel in Atlantic City with his own band, and began a recording career with Victor Records. He might well have become just another of many successful bandleaders, except for a concert entitled "An Experiment in Modern Music" presented at New York's Aeolian Hall early in 1924. With the composer George Gershwin at the piano, he introduced "Rhapsody in Blue" and newly commissioned works by Zez Confrey and Victor Herbert, one of ASCAP's founders. The concert "made a lady out of jazz" and made Whiteman, then earning $3,000 a week leading his band at the Palais Royal on Broadway, an overnight sensation, the King of Jazz.

From then on, Whiteman presented new works by composers ranging from Aaron Copland and John Green to Dana Suesse and Duke Ellington. Throughout a career that spanned more than four tumultuous decades, he performed live concerts with his more than 30-piece orchestra as well as over radio and, later, television.

Paul Whiteman liked and admired jazz musicians. He hired Red Nichols, Frankie Trumbauer, Bix Beiderbecke, the Dorsey and Teagarden brothers, Joe Venuti, Eddie Lang, Bunny Berigan, Miff Mole and George Wettling, and helped make stars out of singers like Bing Crosby, Mildred Bailey, Red McKenzie, Durelle Alexander and Joan Edwards.

Despite his uninterrupted public successes and the huge fees that enabled him to live as he pleased, his private life, even with an enduring, happy marriage to Margaret Livingston, gave him constant problems. His son and daughter from an earlier marriage often led chaotic and unfulfilled lives, and an adopted child died tragically. He suffered from claustrophobia, agoraphobia and acute alcoholism, against which he constantly struggled, sometimes succeeding, sometimes not.

This well-written, often absorbing book is filled with detail and many interesting and valuable photographs, and it offers a balanced portrait of a man often misunderstood. Despite Whiteman's King of Jazz appellation, his band rarely played jazz, although it did feature some of the best jazz players of two generations. He paid some of the highest salaries to prominent sidemen like trumpeter Henry Busse and the gifted pianist and one-time bandleader Roy Bargy, who stayed with him for 12 years. (The author is incorrect in stating Bargy was hired from the Isham Jones Orchestra. Bargy, who had been paid $350 a week to join the Jones band in 1924, remaining until Jones disbanded in 1926, was leading his own band in Chicago before joining Whiteman in 1928.)

This is a book worth adding to one's library, as it offers much information not only about Whiteman's bandleading career, but about his successful involvement with radio and television after that career was over.

Frank Driggs

Album Cover Album 3 compiled by Roger Dean and David Howells; text by Bob Fisher and Colin Greenland. St. Martin's Press, paperback, 138 pp., $15.95.

This is the third collection of LP cover art compiled by Dean and Howells. Like its predecessors, it is a high-quality, full-color, large-format book that's a real service to professionals in the visual arts. It will also appeal to pop-music fans and those who enjoy the wallpaper in their local record stores.

Album Cover Album 1 remains the most appealing because of its breadth, detailing nearly four decades of covers, from 1939 to 1977. *Album Cover Album 2* examines the years 1978 to 1982, when New Wave music became a popular success. Now, *Album Cover Album 3* presents the years 1980 to 1984. Budgetary *and* musical austerity (a product of the New Wave), along with certain trends in graphic design and illustration, have conspired to produce the "new look" that graces the pages of *ACA 3*, a tiptoe through the tulips of 20th-century art. Cubism, fauvism, expressionism, surrealism, and magic realism are being resuscitated by young designers, illustrators and photographers hired to give new music its own cachet. Their work is showcased here, along with more conventional treatments.

Album art is a rich and eclectic vernacular. Trends catch up to themselves and become homogeneous. Dean and Howells amplify this dynam-

ic by grouping covers by theme, and this really adds coherence to the subject, although in some cases an eye-glazing repetition occurs.

Least noteworthy are the portrait covers, loved by fans, I suppose, but tied down by too many conventions to be very interesting. These "pinups" are grouped early in the book, and from that nadir rise cover after cover of astonishing variety.

As I said, *ACA 1* remains the most generally valuable book, but I will cherish all three editions, at least in 10 years or so when this unique medium lies buried under the tidal wave of the digital revolution. *Philip Anderson*

The Record Producers by John Tobler and Stuart Grundy. St. Martin's, paperback, $10.95.

All You Need Is Ears by George Martin. St. Martins, paperback, $7.95.

"Record producer" has always been a nebulous term. "Production" usually refers to the sonic quality of the recording, but many successful producers know little about engineering. For those who don't know what a producer actually does, or for those who do but seek a bit of inside information, both of these books provide insight into the function of producers.

The Record Producers is an extremely thorough compendium of individual studies of famed/important record producers. On the American side are comprehensive interview/articles with Leiber & Stoller (early R&B), Tom Dowd ('60s R&B and Southern rock), Richard Perry (MOR pop), Bill Szymczyk (The Eagles, et al.) and Todd Rundgren (New York Dolls to Meatloaf), with an informative look at Phil Spector (although he declined to do an interview). Brits include George Martin (The Beatles), Mick Most (manipulative pop), Glyn Johns (the engineer's story), Tony Visconti (Bolan to Bowie), Chinn & Chapman (from Mickie Most clones to Blondie's producer), Roy Thomas Baker (the man who brought back overproduction), and Chris Thomas (the epitome of taste). All of these mysterious figures explain a little bit of what they actually do when they're sitting behind the console, and the authors have provided an accurate discography of each producer's work. There is such an incredible wealth of information here (not only discussion of production, but also amusing anecdotes involving each of the groups produced) that we can recommend this book to just about any music fan, regardless of how interested you are in the physical act of production. If you simply are curious about the art and business of making records, *The Record Producers* is the best book ever to accurately document the process.

George Martin is England's gentleman producer, the guy who coached The Beatles through almost all of their records, but never really milked his credit for what it was properly worth. He has produced a few other acts, but considering the quality and breadth of his work with The Beatles, his work since has been relatively spare and low-profile. *All You Need Is Ears* documents Martin's entire life and career. It is fairly informative when it comes to nailing down exactly what Martin's forte is and how his own musical theories concerning popular music and pure art relate to one another. However, Martin reveals comparatively little of the behind-the-scenes facts regarding The Beatles' recordings, which is especially unfortunate because everyone else has been so tight-lipped as well. The closest he comes to divulging any great secrets is an admission that The Beatles could have been John and Paul and any other two guys, which few have heard from the mouths of anyone who was there. This book is a fine companion to the Mobile Fidelity box-set on The Beatles, but not exactly a Pandora's box of dark secrets about them. *Jon & Sally Tiven*

BRAVURA BOWING

Illustration: Barbara Kelley

Bravura: Cho-Liang Lin, violin; Sandra Rivers, piano.
CBS Masterworks MK 39133.

This CD showcases the musical talents of Chinese violin virtuoso Cho-Liang Lin. His piano accompanist is Sandra Rivers.

This is an interesting CD in several ways. For one thing, it was recorded in New York at the Lehman College Center for the Performing Arts, a relatively new hall and a recording venue I was eager to hear. For another, the CBS engineers used the Soundstream digital recorder with the new Brüel & Kjaer 4003 omnidirectional microphones.

Engineer Bud Graham struck a nice balance between the violin and piano, with the violin slightly forward and completely articulate. The hall acoustics seem fairly warm and spacious, and the instrumentalists are well-delineated yet have plenty of air around them. This adds up to a nice, clean, highly detailed sound with good, high harmonics. My only quibble is that Lin's violin tone was a bit on the lean side; however, he leaves no doubts as to his complete mastery of his instrument. He is a most accomplished technician and, as time goes by, will probably acquire a fatter, warmer tone.

Lin's program is well-chosen, from the de Falla "Suite Populaire Espagnol" to the Kreisler miniatures and similar music. He shows his dexterity and assured fingering and bowing in showpieces like Kreisler's "Chinese Tambourine" and Sarasate's "Introduction and Tarantella." I'd like to hear what Lin can do with some of the major concertos. *Bert Whyte*

Sundance: Kevin Eubanks
GRP-D-9506 DIDX 42.

Kevin Eubanks' fingers are hooked directly into his soul. There are a number of technically proficient guitarists out there who can spew out impressive flurries of notes, but their music is often a display of soulless virtuosity. Eubanks is blessed with both the fleetest of fingers and a sensibility that guides them to produce thoughtful, imaginative, memorable music.

The eight jazz selections on *Sundance*, Eubanks' second solo album, are his own compositions, and remarkable they are for their contrasts—in texture and tone, in mood and movement. Take, for instance, "The Sting," which opens this CD. It leaps out of the cleanest of digital silences with an agitated jangle of sound. Eubanks' wiry guitar pushes forward and halts abruptly, continuing this kind of thrust and parry over the equally frenetic accompaniment of his three bandmates. Just one cut down the road is "Ever Blue," with its drifting, beautiful melody and plaintive guitar lines in stark contrast to the nervous volatility of "The Sting." The contrast holds for aural texture as well as for mood. In "Ever Blue," Eubanks' electric guitar takes on an almost exotic, honeyed quality, a quality so soft and appealing that it seems not to have come from the same source as the harsh and insistent guitar of "The Sting." "The Sundance Began," from which the album gets its title, also holds intriguing contrasts. The cut drifts in, slow and easy, with a pleasant melodic figure leisurely repeating itself. Suddenly, a sharp burst of guitar sets off a frenzied rush in the manner of "The Sting." Just as suddenly, the rush ends and the drowsy melodic drift resumes.

Eubanks' acoustic work equals his amazing, bare-fingered electric technique. "Distant Focus" features an exquisite acoustic solo standing in sharp, sweet definition before a great, distant wash of windy synthesizer. This particular cut exhibits a marvelous sense of openness and space not present on most of the other selections.

The sound quality of this digitally mastered CD is quite good, with splendidly clean silences and generally clean sound. The production by Chris Hinze (for all but one cut) is also good, although it lacks the kind of clarity that really makes use of the CD medium. Eubanks is recorded at phantom center, where he belongs. In general, the excellent instrumentals—by Tommy Campbell on drums, Barry Brown on electric bass, and Gerry Etkins on synthesizers and Fender piano—branch outward from the center. Accompanying instrumentals are frequently split into left and right channels simultaneously, to very good effect.

The seven Hinze-produced cuts,

which were previously released on Keytone Records in Holland, are just a shade below the GRP recording standard. Executive producers Dave Grusin and Larry Rosen have well-deserved reputations for outstanding production work. The one instrumental on this album which they produced directly, "It's All the Same to Me," has a subtle sense of clarity. Here, Eubanks' acoustic guitar is a substantial presence; each tender squeak comes through with precision.

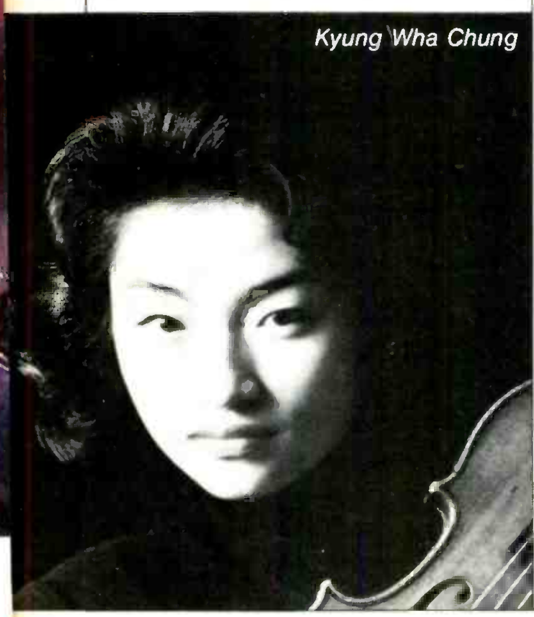
No matter what format he comes in, Kevin Eubanks is a talent to be reckoned with. He has made a splendid album and a good, if not perfect, CD.

Paulette Weiss

Berg: Violin Concerto; Bartók: Violin Concerto No. 1. The Chicago Symphony Orchestra, Sir Georg Solti; Kyung Wha Chung, violin.
London 411804-2LH.

I have always had great regard for the talent of violinist Kyung Wha Chung, ever since I heard her brilliant traversal of the Tchaikovsky violin concerto on a London/Decca recording of some years ago.

On this CD, she is now paired with the redoubtable Sir Georg Solti and his fabulous Chicago Symphony Orchestra. The Berg and Bartók violin concertos are an acquired taste; their atonal structures are not palatable to many people. Nevertheless, even in this music the lush, sweet tone of Chung's violin is nicely captured. So, too, is her obvious command of this difficult music. Chung's bowing and fingering are masterful.


Kyung Wha Chung

The recording is very clean and generally well-balanced, although the violin has a bit too much forward projection at times. The orchestra plays superbly, and now that the engineers have learned how to increase the reverb time in Orchestra Hall (with plywood panels and vinyl sheeting over all the seats), the orchestra plays in a nice, warm ambience. *Bert Whyte*

Richard Strauss: Don Juan, Dance of the Seven Veils, Till Eulenspiegel, First Waltz Sequence from Der Rosenkavalier. The Cincinnati Symphony Orchestra, Thomas Schippers.
Mobile Fidelity Sound Lab MFCD 811.

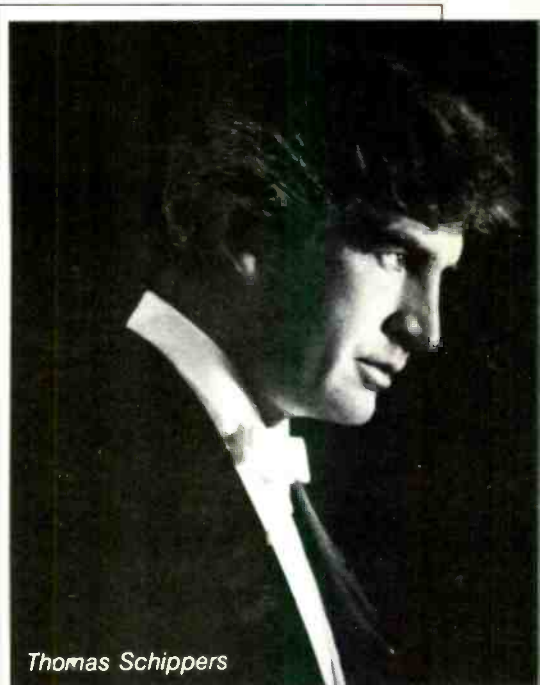
This release from Mobile Fidelity is taken from the catalog of Vox Turnabout. Original recording and production were by Marc Aubort and Joanna Nickrenz, with the usual high quality that we have come to expect of this team. Recorded in 1976 in analog Dolby A format, the program comes across in CD as well as—or better than—many recent digital originals.

What is important is that Aubort avoids the pitfalls of multi-miking. His approach is to use only a few microphones, perhaps no more than three or four, across the front of the orchestra at a distance that gives the desired orchestra-to-hall relationship. From that point on, it's all in the hands of the conductor and players. There is genuine fore/aft, as well as lateral, imaging.

Thomas Schippers was in his prime when he died, and the work he was doing with the Cincinnati Symphony Orchestra was significant. In these works of Strauss, we hear him at his best. The orchestra is in top form, and the interpretations bear a stamp of originality without eccentricity.

I feel this release is typical of the superb analog material that exists in many record-company vaults. And once the newness of the CD has passed, we will, I hope, see more companies reaching for such 10- and 15-year-old treasures for reissue.

John M. Eargle

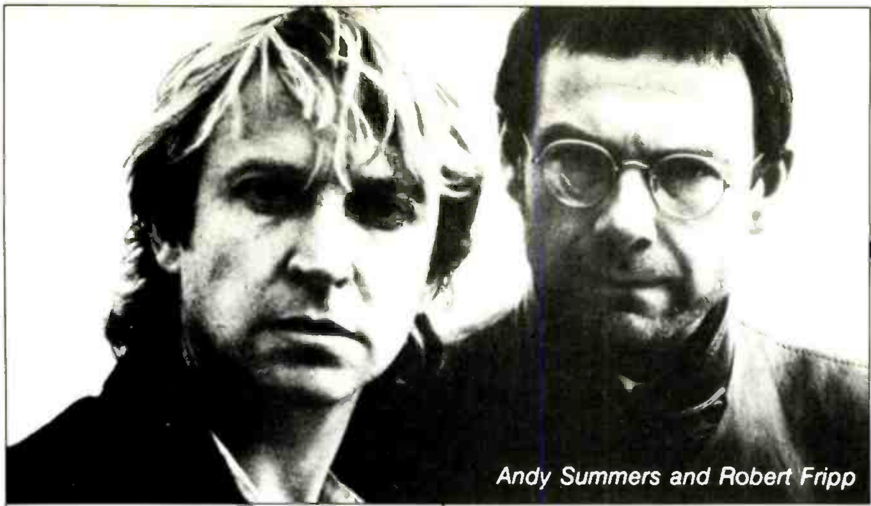

Thomas Schippers

Bewitched: Andy Summers and Robert Fripp
A&M CD-5011 DIDX 84

Bewitched is the stuff dreams are made of: Drifting, atmospheric manipulations of sound and hypnotic, suggestive interweaving of aural textures. Some disperse with the insubstantiality of smoke, while others swell and intensify, taking on almost tangible, monolithic proportions. This is the latest collaboration of guitar and synthesizer wizards Andy Summers, better known as one-third of The Police, and Robert Fripp, better known as the founder of King Crimson and exponent of Frippertronics, an early echo-delay system devised by Brian Eno.

It is also the stuff of a bewitching Compact Disc. Although there is some acoustic instrumentation here, this album creates a totally artificial listening experience with its banks of synthesizers and studio mixing and remixing. Conceivably, *Bewitched* could be reproduced in concert with the proper tape loops and prepared synthesizer programs, but its true place of origin is the studio, and it is best heard on record, period. The digital reproduction of the original analog disc allows every shimmer and honk to come through in pristine clarity; the extended dynamic

Bewitched is the stuff dreams are made of. The material, rich with texture and nuance, provides multiple possibilities for each cut.


Andy Summers and Robert Fripp

range captures the fade of an electronic whisper with the same sharp fidelity as it does the deepest boom of a TR 909 drum machine. Spatial presencing is almost irrelevant, although there is a stunning sense of movement as sounds seem to swell into the foreground or shrink and disappear into the left or right channel, or are swallowed up in the distant background.

Despite the fact that these 10 instrumental selections contain hints of melody and vague shadows of recognizable structure, they do not have the beginnings, bridges, and ends that we associate with conventional pop pieces. Their subject is sound itself; they float or scurry or thrum relentlessly and leave pictures forming in the listener's mind. For instance, the Spanish-inflected acoustic guitar in "Maquillage" may conjure up faint images of sun-splashed gardens in Madrid, a lace mantilla in the moonlight, or whatever association the listener's mind is stirred to make by the piece's provocative musical texture. Although entitled "Train," the fourth cut on this disc left me with an image of one of those atmospheric black-and-white movies of the '30s and '40s in which a white-robed woman walks, trance-like, into the misty swamps, drawn by the throbbing drums and rhythms of *macumba* (the black magic born in Brazil and practiced throughout the Caribbean). The great electronic "thonk" pattern that opens this cut and dominates the foreground comes out of total silence; an eerie synthesizer figure drifts behind the rhythmic "thonk" like dark mist over mysterious waters. Summers and Fripp may have been thinking of a train, but my willful brain insists on conjuring up images of its own. The material on *Bewitched* is so rich with texture and nuance that it provides multiple possibilities for each cut, despite the title chosen by its composers.

Keep in mind that you can't dance to it, you can't hum its tunes, and it is unlikely that you'll see videos for these complex tidbits on TV. This is repetitious, hypnotic music to be absorbed viscerally, not intellectually. Try *Bewitched* with headphones and a snifter of brandy or your favorite brand of funny cigarettes. A special CD for those with eclectic tastes in pop music.

Paulette Weiss

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MICHAEL TEARSON
JON & SALLY TIVEN

GIVING CREEDENCE TO THE PAST

Centerfield: John Fogerty
Warner Bros. 25203-1, $8.98.

Sound: B– Performance: A

It has been nine years since John Fogerty, erstwhile singer/songwriter of Creedence Clearwater Revival, that primal American band, was last heard from on album. Despite the elapsed time, Fogerty has remained true to the swamp sound, with its fusion of rock and country elements, that was the hallmark of CCR. He remains a rock 'n' roll classicist in much the same way Bruce Springsteen, a huge Fogerty fan, is: Both regularly use key riffs from great songs of the past as taking-off points for their new ones. On *Centerfield*, for example, "Rock and Roll Girl" recalls "Come On Let's Go," "Searchlight" is built on the thumpy structure of "Take Me to the River," and "Big Train (From Memphis)" is a lot like the Elvis Presley arrangement of "My Baby Left Me," which was the big E's first record. Nothing wrong with the practice. Heck, it's a time-honored tradition that Fogerty follows better than most, as he has the good taste to borrow only from the best.

One thing that has always elevated Fogerty's work is the social consciousness with which he has imbued his songs, as evinced by such Creedence classics as "Fortunate Son," "Who'll Stop the Rain," "Bad Moon Rising" and "Have You Ever Seen the Rain." For "I Saw It on T.V." John has reached back to his childhood for images of the Eisenhower, Kennedy and Johnson eras to present the anguish of a parent whose baby-boomer son died in Vietnam, and he puts all of this imagery through the glass eye of television. "Mr. Greed" is a full-frontal assault on the Big Money Boys. "Big Train (From Memphis)" is about the railroads slowly vanishing—taking a piece of American romance with them. "Centerfield" harks back to the days when major-league baseball was a game for the boys of summer and not so much a money grab. More specifically, it is about John Fogerty's childhood dream of playing center field for the New York Yankees.

Dreams are a lot of what *Centerfield* is about. On the inner sleeve Fogerty dedicates the album to "Gossimer Wump . . . and dreams that survive." The reference is to the hero of a wonderful children's record originally done in the 1940s with narration by Frank Morgan, best remembered today as the man who played the Wizard of Oz in the movie. Gossimer Wump was a lad who had a burning dream of becoming a musician and, in specific, playing the triangle. The record tells of his adventures on the way to becoming a success. The moral of the story was, "You *can* be a big success if you just keep triangling." *Gossimer Wump* must have had a primal effect on the young John Fogerty, for he obviously took the story to heart and has been true to it with his music ever since.

It also dovetails with his recording style. As on the previous Fogerty solo album and the album he did as The Blue Ridge Rangers, Fogerty recorded *Centerfield* as a one-man band, overdubbing all the parts including guitars, bass, keyboards, drums and saxophones. He is not as concerned with virtuosity as he is with getting the feel right, and his success on this score is the real key to the album, which achieves the feel and visceral energy of a real band.

Centerfield is an album of great heart and conscience. I like it more each time I play it, and I suspect that its stature in my mind will keep growing as time keeps passing.

Michael Tearson

It'll End in Tears: This Mortal Coil
4AD CAD 411, U.K. import, $9.98.

Sound: B+ Performance: B

This is one of the most unlikely projects ever: A bunch of musicians and singers from England's more artsy contingent banding together to make a deliberately obscure record. Not only is there practically a different band on each track, but the material is chosen from such writers as Tim Buckley, Roy Harper and Alex Chilton, in addition to original material. Only in the U.K. could such a record get made.

It works, with members of Cocteau Twins, Colourbox, The Wolfgang Press, Dead Can Dance, Modern English, Xmas Deutschland, Cindytalk, and the inimitable Howard DeVoto (ex-Buzzcocks, Magazine) making their unique individual contributions to This Mortal Coil. The British press and public seem to be lapping it up, which is a mild surprise, and if this sort of supersession among the New Wave appeals to you, *It'll End in Tears* deserves high recommendation. *Jon & Sally Tiven*

Frontier Days: The Del-Lords
EMI/America ST-17133, $8.98.

Sound: C– Performance: B

The Del-Lords' debut album is a no-frills rock 'n' roller as the band plays straight ahead, without gadgetry. Best of all, they are one of those rare outfits for whom conscience is an active part of their music. This shows in the very first song, which is also the album's only cover—a Depression-era, Alfred Reed song, "How Can a Poor Man Stand Such Times and Live?" The Del-Lords do it righteously.

It is hard not to hear echoes of Creedence Clearwater Revival's swampy sound in The Del-Lords. It is a fun influence that adds infectiousness even if The Del-Lords don't have a singer to equal CCR's John Fogerty. But who does?

The album's production is no better than average. Thus, it is up to the band's good spirits to carry the show. They do just that, and in so doing they make the album special.

Oh, one more thing. You might wonder where the band's name comes from. It is a tribute to the man who directed most of The Three Stooges' shorts—Del Lord. *Michael Tearson*


Janey Street

Heroes, Angels and Friends: Janey Street
Arista AL8-8219, $8.98.

Sound: B– Performance: B

Janey Street's songs come from the place where Bruce Springsteen meets Rickie Lee Jones, thematically and musically. Jimmy "Teeth" Ienner's production serves Janey well with a big, meaty sound that contains lots of subtle touches hidden in the arrangements—things like cellos breaking into "I Will Follow Him" during a pause in "Me and My Friends," and sleigh bells in places where you'd expect a simple tambourine. It's a rich brew.

The songs revolve around the value of friends at all times, certainly not a blazingly new idea, but Janey Street has so much invested here that her sincerity is undeniable. Her songs feel like they come out of real life, and they breathe despite the familiarity of the situations. "Say Hello to Ronnie" takes place when high school pals meet after years to reminisce. They find that things turned out different from what they expected and that the good old days really were good. The song has a melody that rumbles in my mind over and over again. "Jimmy (Lives in the House Down the Block)" is more than a little similar to Rick Springfield's "Jessie's Girl," inverting the lovelorn boy to a girl. The songwriting may not have dazzling new insights, but Street manages to sound fresh. No masterpiece, this, but *Heroes, Angels and Friends* is a solid and memorable work that Janey Street can take deserved pride in.
Michael Tearson


The Del-Lords

Better an Old Demon Than a New God: Various Artists
Giorno Poetry Systems GPS 033, $7.98. (Available from Giorno Poetry Systems Institute, 222 Bowery, New York, N.Y. 10012.)

Sound: B– Performance: B+

This isn't an album for every taste, but very little of worth can appeal to everyone. What we mean is that this record is deliberately aimed at a rather narrow audience, anthologizing the works of 10 cult heroes associated with (a) the poetry/rock scene, (b) the New Wave scene, and/or (c) poetry. Not all of them are terrific, but at least most aspire to something other than just getting on the radio. There's David Johansen, who leans more to the rock side even though his delivery is more recitation than singing; William S. Burroughs reciting one of his works; Jim Carroll recalling his encounter with "A Peculiar-Looking Girl" (no music on his

The depth and maturity Wynton Marsalis displays simply belie his youth. Clearly, he has the tools to become a giant in music.

track, although he's been known to make music on many occasions), and Richard Hell delivering a humorous sermon of sorts. Also present are John Giorno, Psychic TV, Lydia Lunch, Anne Waldman, and Arto Lindsay.

This is quite an interesting collection of works and probably most easily acquired by mail. It's not particularly danceable, nor is it recommended for the passive listener, but it's a good 37 minutes of intellectual entertainment.

Jon & Sally Tiven

Hot House Flowers: Wynton Marsalis
Columbia FC 39530, digital.

Sound: A — Performance: A

What a wonderfully elegant album this is! *Hot House Flowers* is a very romantic album, largely made up of standards arranged for a small ensemble and augmented by a full string section, the kind of arrangements I usually have a serious aversion to. Here I am quite charmed by the lush sounds since the goal is not sweetness, but rather smoothness with a tart aftertaste.

The combo is a stellar one that, besides Wynton Marsalis on trumpet, includes brother Bradford Marsalis on saxophones, Kent Jordan on flute, Kenny Kirkland on piano, Jeffrey Watts on drums and Ron Carter on bass.

Marsalis opens *Hot House Flowers* with a lovely arrangement of "Stardust," surely a bold move at this late date. In any case, it sets the stage perfectly for what is to follow. There are introspective, thoughtful pieces like "Lazy Afternoon," "For All We Know" and Duke Ellington's "Melancholia." (Somehow this is one album that would have seemed incomplete without a taste of Ellington.) There is "When You Wish Upon a Star." "I'm Confessin' (That I Love You)" has a playful bit of bop in the arrangement, closing the set in an upbeat mood. Marsalis' one compositional contribution is the lovely, complex title tune.

Wynton Marsalis

Wynton Marsalis is barely 23, yet he has already won Grammies for jazz as well as for his "serious" efforts under Columbia's Masterworks imprint. He has developed a magnificent sense of tone and absolutely believable versatility. The depth and maturity he displays on *Hot House Flowers* simply belie his youth. Clearly he has the tools to become not just a giant in the jazz world, but a giant in music. He has the talent, vision, and sensibility to do whatever

The Kinks play splendidly and with some fire on *Word of Mouth*, but they can't make more of the songs than what they are.

Ray Davies

he wants. And when he can do it with the beautiful digital sound he has on this album, he has my blessings.

Hot House Flowers is a record I suspect I'll still be listening to 20 years from now as a highly treasured item.

Michael Tearson

Perfect Strangers: Deep Purple
Mercury 824 003-1 M-1, $8.98.

Sound: C – Performance: C

The members of the regrouped Deep Purple are the same as in the glory days: Ritchie Blackmore, Ian Gillan, Roger Glover, Jon Lord, and Ian Paice. I'm not so sure about the cover sticker that says, "Destiny brought them together." I figured it was the promise of some regular paydays.

Deep Purple doesn't have the fire here that they had a decade ago. Their recorded sound is surprisingly bland, polite in comparison to the hammering sound of their best work. Now it is smoother, almost homogenized. The songs are also pretty bland, predictable metal circa '84, with titles like "Mean Streak" and "Under the Gun." The album's best shots are on side two, in the title song and "A Gypsy's Kiss." But then there is the self-indulgent "Hungry Daze" which reflects back on the "Smoke on the Water" era.

I expect the boys to draw very well as they tour. However, this record is tepid, proving that metal music is the hardest of all to go back and do anew after age 40.

Michael Tearson

Word of Mouth: The Kinks
Arista AL8-8264, $8.98.

Sound: C + Performance: C

This has not been an easy year for The Kinks. Following a spat between the brothers Davies, brother Dave left the band (again) and did a tepid solo album. For now he seems to have (again) returned to the fold. Still, *Word of Mouth* is a rather ordinary Kinks album. Brother Ray's songs, this time around, consist of his usual bitching about life's day-to-day difficulties, but they truly feel like retreads, with nothing to elevate the album beyond the ordinary. In their defense, the band plays splendidly and with some fire, but they can't make more of the songs than what they are.

Michael Tearson

The musical style of Wah! conjures up the post-punk Clash or the Dylanish phase of Mott the Hoople.

Wah!

The Way We Wah!: Wah!
Eternal/WEA WX11 240532, U.K. import, $9.98.

Sound: B Performance: A

A few months back we sung the praises of one of England's premier pop artists, The Mighty Wah!—a.k.a. Wah!, a.k.a. Wah! Heat, a.k.a. J. F. Wah (real name: Pete Wylie). The Liverpudlian has had several British hits without even getting a single record released in the United States—a mean feat for an English-speaking artist—and his recent *Word to the Wise Guy* album was just too strong an artistic statement to go unheralded in the U.S. press. In the wake of Pete Wylie's chart resurgence, his former label has issued *The Way We Wah!*, a compilation of early hits by the many incarnations of Wah!, and—to reiterate our enthusiasm—no serious rock-cum-pop maniac can do without this collection.

Wylie's persona is the celebration of the underdog, distinctly influenced by his musical predecessors and yet modern at the same time. "The Story of the Blues" is not—as its title suggests—bluesy, but rather a neo-Spector pop tune; "Remember" charges along to a Motown beat; and Wylie even sings a cover, Johnny Thunders' "You Can't Put Your Arms Around a Memory." But the musical style Wylie conjures up has more to do with the post-punk Clash or the Dylanish phase of Mott the Hoople than any '50s or '60s throwback. So much for descriptions, reference points, and endorsements—get the record(s) and judge for yourself, America. *Jon & Sally Tiven*

Where the Sidewalk Ends: Shel Silverstein
Columbia FC 39412.

Sound: B– Performance: A–

Where the Sidewalk Ends finds Shel Silverstein talking, singing, shouting, and whispering his way through 36 poems, songs, and stories. It is a wonderful children's album—for children and adults. Silverstein has always been a man of many hats and no hair. He is a painter and cartoonist, raconteur and author, songwriter, playwright, singer and actor, all on this record. (All except painter, anyway.)

His stories and songs touch on many topics from the wry to the ridiculous, the ludicrous to the serious. Uncle Shel is very comfortable and animated here in the simple setting of solo performance and straightforward production. The only instrumentation is his occasional guitar.

Where the Sidewalk Ends is a warm and funny album, if sometimes grotesquely so. It is wonderful entertainment for the child bottled up in anyone.
Michael Tearson

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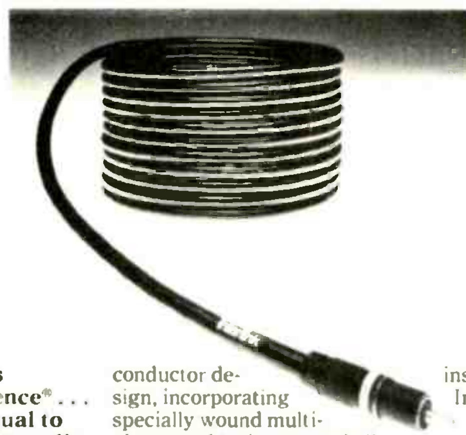

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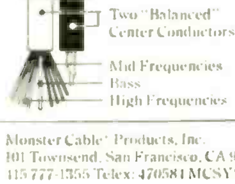

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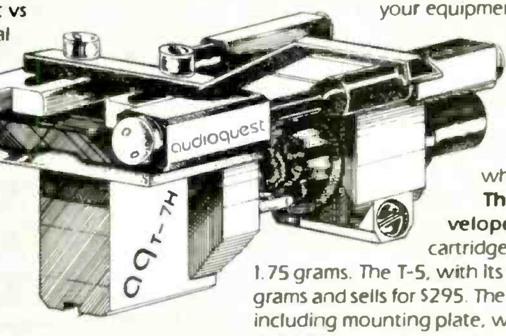

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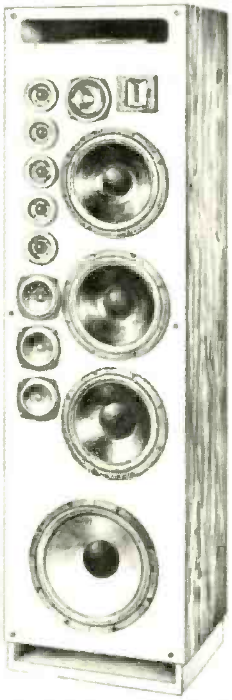

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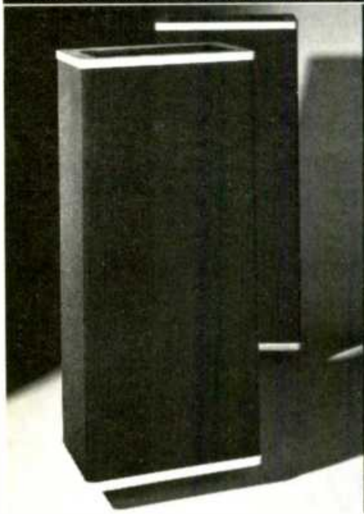

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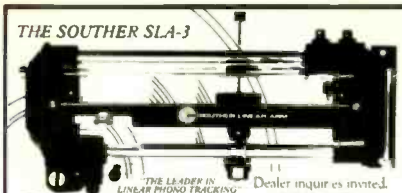

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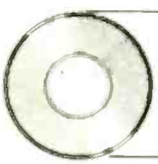

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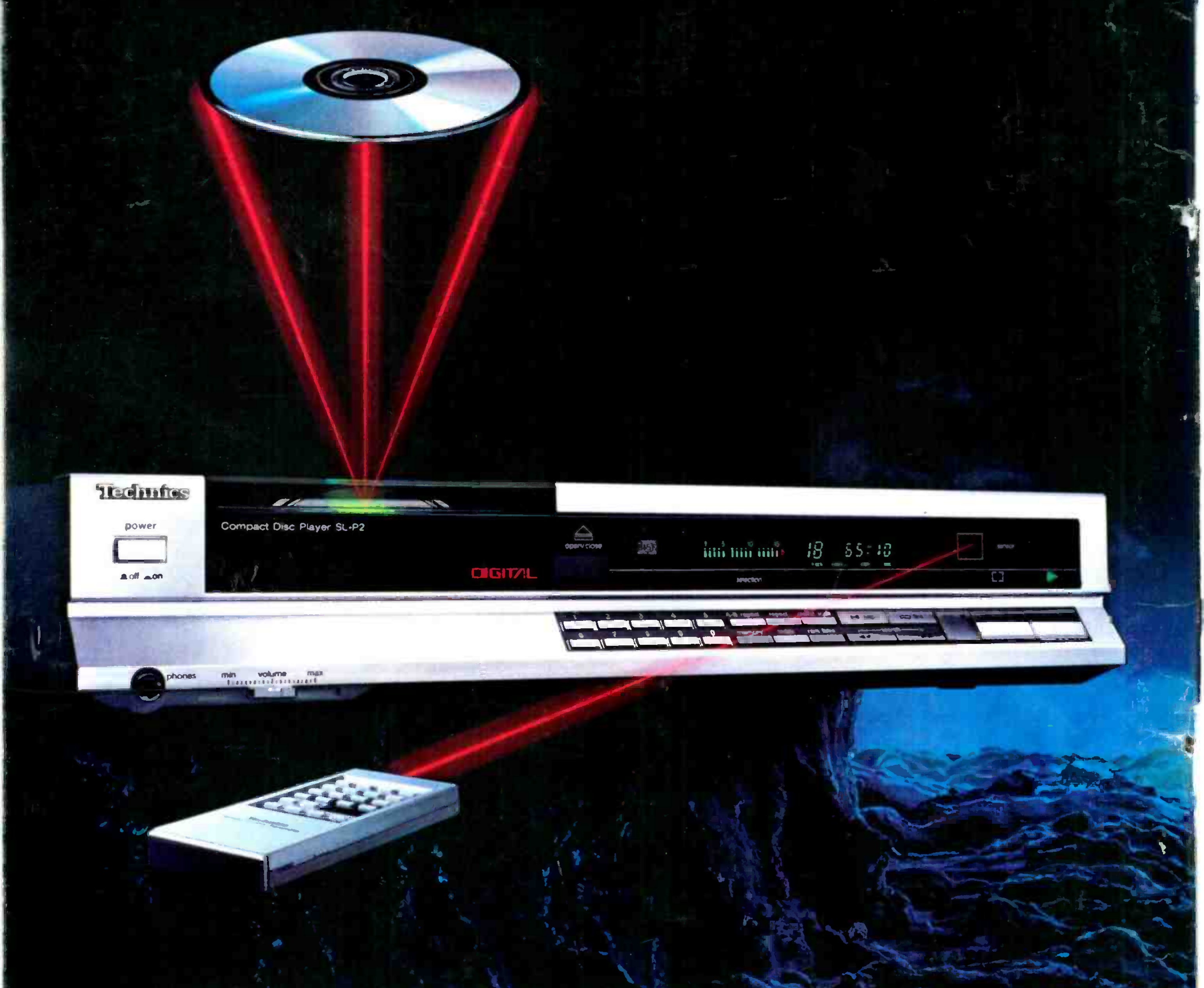
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