Audio

NOVEMBER 1987 • $2.50

DO CDs SOUND DIFFERENT?

VELODYNE ULD-15 SUBWOOFER
NOTHING COMPARES

MASS CASSETTE TEST
WE REVIEW 35 TAPES

TESTED
SUMO POLARIS AMPLIFIER
LINN BASIK TONEARM/
K9 CARTRIDGE
ELECTROCOMPANIET EC-1 PREAMP

"Polk Builds State-of-the-Art Components."

Consistently Superior Technology Results in Dramatically Better Sounding Loudspeakers for You.

Matthew Polk's genius is multifaceted. In addition to breakthroughs like SDA technology which totally revolutionized the whole concept of stereophonic reproduction, it is also responsible for the advanced and exclusive component technology present in every Polk loudspeaker which results in unequalled high definition musical sound quality.

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Polk loudspeakers are true high definition systems which reproduce sonic images with life-like clarity and detail, much like a high resolution camera captures a visual image with all the subtle detail and focus intact. When you listen to a pair of Polks, notice how you can hear each and every individual instrument clearly and distinctly, even when there are many instruments playing at the same time. This high resolution capability is in large part due to the consistently excellent transient response of all the drivers as well as the seamless blending achieved by the Isophase Crossover systems.

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Tweeter voice coils are centered with exacting precision by a sophisticated machine designed and built by Polk Audio engineers.

response. Additionally, they don't deteriorate over time as do foam surrounds. They incorporate high-temperature aluminum voice coils which allow high power operation without burnout. Optimized Flux Density magnet structures are used for perfectly balanced operation assuring clearer, more highly defined, more musical sonic performance.

The Polk Isophase Crossover

The crossover network is the most important component in a high quality loudspeaker system. It is responsible for properly blending the sound of the individual drivers together into the homogeneous sounds of individual instruments and voices. The crossover acts like the "musical conductor" of the loudspeaker, telling each driver just when to come in and exactly how loud to play. The elaborate Polk Isophase Crossover Systems utilize huge copper coils and precision capacitors and resistors to assure the lowest possible harmonic, IM, and transient distortion with complex high level musical signals. Close tolerance, extremely costly mylar and silver mica capacitors are used in many models to achieve even higher sonic definition. In addition, driver equalization is optimized by the sophisticated and complex circuitry, while isophase (phase coherent) operation is maintained by careful control of the various phase relationships in the system. Many loudspeaker manufacturers skimp on this critically important component because it is usually hidden from sight, but Polk builds crossovers correctly so that our speakers will sound better for you.

Polk's Exclusive Silver Coil Dome Tweeter Technology

This state-of-the-art transducer is the only tweeter in the world which utilizes a voice coil wound with costly silver coated wire for more extended frequency response. The extremely light polyamide dome allows exeptionally quick transient response while the inherently well damped material eliminates annoying resonances. The small diameter diaphragm assures wide dispersion of high frequencies throughout your listening room. In addition, the huge magnet structure combined with the low mass moving system results in vanishingly low distortion, superb wave form accuracy and high efficiency. A specially contoured non-resonant faceplate improves dispersion, lowers diffraction and helps eliminate resonant distortion.

Polk Fluid Coupled Subwoofers

Most Polk home speakers utilize a fluid-coupled subwoofer system for tight, quick, deep, powerful and room-filling bass response. This system realizes the performance advantages of both large and small diameter woofers at the same time. Small diameter woofers have faster transient response, better midrange and dispersion. Large diameter bass drivers couple better to your room and produce more bass. The Polk Fluid Coupled Subwoofer System excels in all these areas. It utilizes the low frequency energy produced within the enclosure by the small bass/midrange driver to hydraulically energize the large diameter low resonance subwoofer below approximately 60 Hz. The result is remarkably clear, well-defined low frequency reproduction, exhibiting exceptional upper bass detail which extends smoothly and seamlessly down through the sub-bass and cleanly up into the midrange.

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Where to buy Polk Speakers? For your nearest dealer, see page 45.

"Matthew Polk Has a Passion for Perfection!"

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The genius of Matthew Polk has now brought the designer styling, advanced technology and superb sonic performance of his award winning SDA Signature Reference Systems into the new Signature Edition SDA 1C and SDA 2B.

"They truly represent a breakthrough." *Rolling Stone Magazine*

Polk's critically acclaimed, 5 time Audio-Video Grand Prix Award winning SDA technology is the most important fundamental advance in loudspeaker technology since stereo itself. Listeners are amazed when they hear the huge, lifelike, three-dimensional sonic image produced by Polk's SDA speakers. The nation's top audio experts agree that Polk SDA loudspeakers always sound better than conventional loudspeakers. Stereo Review said, "Spectacular... the result is always better than would be achieved by conventional speakers." High Fidelity said, "Astounding ...We have yet to hear any stereo program that doesn't benefit." Now all 5 SDAs incorporate many of the 3rd generation advances in SDA technology pioneered in the Signature Edition SRS and SRS2 including full complement sub-bass drive, time-compensated phase-coherent driver alignment and bandwidth-optimized dimensional signal.

Why SDAs Always Sound Better

Stereo Review confirmed the unqualified sonic superiority of Matthew Polk's revolutionary SDA Technology when they wrote, "These speakers *always* sounded different from conventional speakers — and in our view better — as a result of their SDA design.

Without exaggeration, the design principals embodied in the SDAs make them the world's first true stereo speakers. The basic concept of speaker design was never modified to take into account the fundamental difference between a mono and stereo signal. The fundamental and basic concept of mono is that you have one signal (and speaker) meant to be heard by both ears at once. However, the fundamental and basic concept of stereo is that a much more lifelike three-dimensional sound is achieved by having 2 different signals, each played back through a separate speaker and each meant to be heard by only one ear apiece (L or R). So quite simply, a mono loudspeaker is designed to be heard by two ears at once while true stereo loudspeakers should each be heard by only one ear apiece (like headphones). The revolutionary Polk SDAs are the first TRUE STEREO speakers engineered to accomplish this and fully realize the astonishingly lifelike three-dimensional imaging capabilities of the stereophonic sound medium.

"A stunning achievement" *Australian HiFi*

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

"Literally a New Dimension in the Sound *Stereo Review Magazine*

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

"Mindboggling, astounding, flabbergasting" *High Fidelity Magazine*

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

"You owe it to yourself to audition them." *High Fidelity Magazine*

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

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Polk Audio's dedication to quality is apparent in every detail of design, construction and performance.

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Matthew Polk and his extraordinary new Signature Edition SDA 1C and SDA 2B.

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MUSIC REVIEWS

DEPARTMENTS

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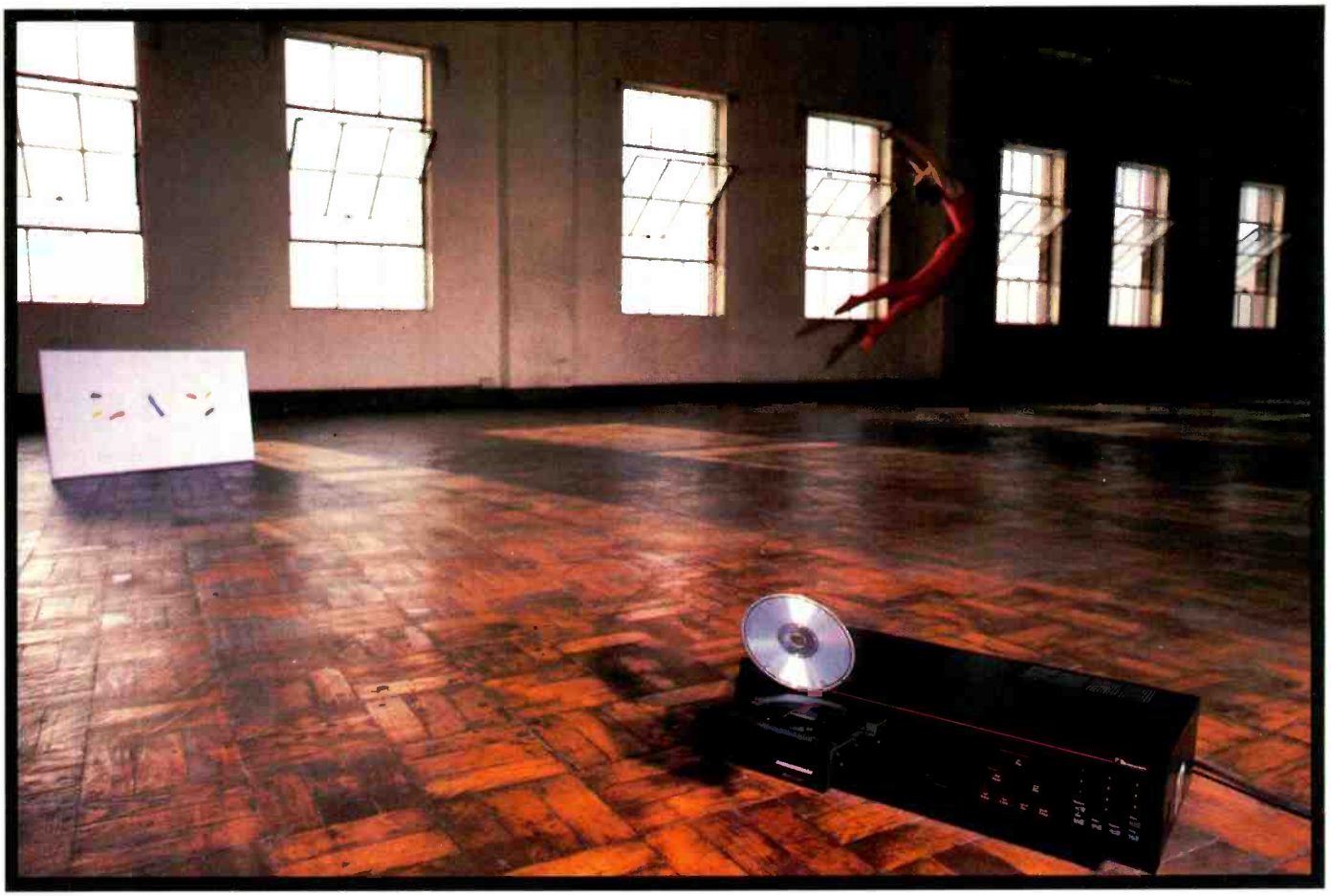
You may have heard music like this in a dream.



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SIGNALS & NOISE

Going Too Far

Dear Editor:

I have been an avid reader of *Audio* for many years, and although I expect I'll never have enough excess money to invest in the ultra-high-end equipment you review, I'm usually entertained and impressed with your commentary on the creative engineering that produces such outstanding audio products.

I feel compelled to tell you that your August 1987 report of arc welding, using $9,600 worth of Levinson power amps, clearly went too far; as it happens, though, I really like folks who go too far, and your momentary molten stereo flash helped strengthen the bond that secures my ongoing readership. Viva *Audio*!!

Gerald R. Martin, Ph.D
Richfield, Minn.

Stuff Dreams Are Made Of

Dear Editor:

I was delighted to read the recent reviews in *Audio* of the Threshold SA/1 (January 1987) and the Mark Levinson No. 20 mono amplifier (August 1987). It's good to see how these Class-A high-power amps perform in *objective* tests. I hope that you'll now round out this set of reviews with an evaluation of the Krell power amps. After all, descriptions of "affordable audio gear" are not enough to sustain the dreams of your readers. Keep up the good work!

Robert Pascal, Jr.
Princeton, N.J.

Hearing Should Be Believing

Dear Editor:

In your August 1987 profile of the Mark Levinson No. 20 mono amp, Laurence Greenhill and David Clark say, "Recognizing that the controlled [A/B/X] tests had failed to correctly identify the No. 20s . . ." Surely they meant, "Despite costing more than most domestic automobiles, the No. 20s were audibly indistinguishable from amplifiers costing thousands less."

I find their casual dismissal of such irrefutable, objective results in favor of subjective psychobabble inexcusable in a review—and in a journal—purporting expertise in these matters. Mr. Greenhill and Mr. Clark claim they have not heard an amplifier that sounds as good, but as their A/B/X tests prove, they have. Too bad they don't believe their ears.

Where's Julian Hirsch when we really need him?

Ronald W. Stone
Lusby, Md.

Revealing Review

Dear Editor:

I much enjoyed the August 1987 issue: Leonard Feldman's information regarding the DAT spoiler chip and Don Davis' article on LEDE were most informative. I was also intrigued by Laurence Greenhill and David Clark's review of the Mark Levinson No. 20 mono amplifier.

I suspect you will get a number of letters pointing out that one can buy a very good arc welder for about one-twentieth the price of a pair of Levinson 20s. I wonder if anybody has measured the frequency response, headroom, and distortion of arc welders. . . .

More seriously, I applaud the inclusion of an A/B/X comparative listening test in the Levinson 20 review, along with the authors' subjective impressions. I wonder, however, if Mr. Greenhill and Mr. Clark realize just how revealing this is. Since they could hear no difference during the A/B/X test, their subjective impressions of differences in sound must be completely imaginary and heavily influenced by expectations. By extension, this could cast doubt on the validity (or, more charitably, the usefulness) of *Audio*'s usual practice of presenting a reviewer's subjective impressions of subtle differences between similar components, frequently to the favor of the more expensive. Amplifiers and CD players spring to mind.

I hasten to add that I am not attempting to sling mud or arrows, but merely identifying an issue I would be grateful to see you address.

Bruce D. Bender
Jamestown, R.I.

Always a First Time

Dear Editor:

I've been enjoying *Audio* since 1960, and your June 1987 issue is the first one that I've found difficult to grasp.

George F. Bittancourt
San Francisco, Cal.

Audio

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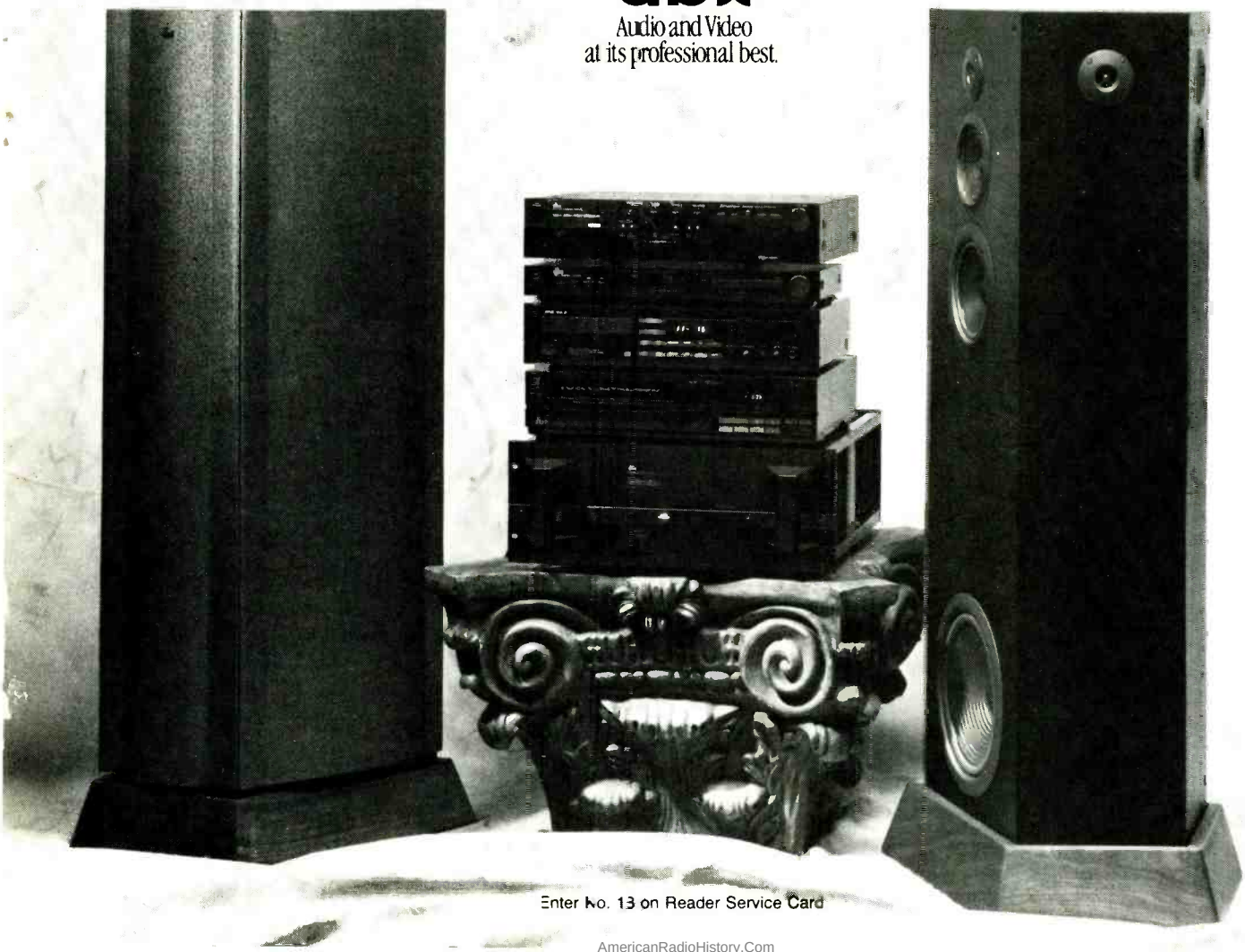

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AUDIOCLINIC

JOSEPH GIOVANELLI

Attenuation of Sound

Q. What is attenuation, especially regarding sound?—Glenn McGregor, Freeport, N.Y.

A. In electronics and acoustics, attenuation means a reduction in a signal's strength. The main cause of *sound* (or acoustic) attenuation is absorption—chiefly by the surfaces and furnishings in a room, but also, slightly, by passage through air.

Where there are no reflective or absorptive surfaces, sound level varies inversely with the square of the distance between the source and the hearer. For example, if you get twice as far from the sound source, you'll hear one-fourth the sound level heard at your original position. In this case, the total sound energy has not diminished much, but it is spread over a wider area.

Getting the Most From an AM Tuner

Q. I am looking for a good AM tuner. Basically, what I want is good sensitivity, selectivity, and frequency response. In most combination AM/FM tuners I have seen, the sensitivity and selectivity of the AM sections are so poor that they barely pick up the local stations. Frequency response has also been poor, rolling off very quickly above 3 kHz. I believe that such a tuner, in addition to good selectivity and sensitivity, should have provisions for connecting an external antenna. Does such an AM tuner exist? If not, what can I do in order to receive AM as well as possible?—Eric Nelson, Landisville, Pa.

A. In AM tuners, unfortunately, selectivity and wide frequency response are mutually exclusive. Narrowing the bandwidth of the i.f. stages would improve rejection of unwanted signals, but it would also reduce high-frequency response. With conventional i.f. transformers, the audio roll-off must begin at some relatively low frequency, such as 2 kHz, to ensure adequate selectivity. With ceramic i.f. filters, which have a steeper slope than transformers, the roll-off frequency can be raised to perhaps 5 kHz and still avoid adjacent-channel interference. Some tuners (even in car stereos) have automatic or manual i.f. bandwidth adjustments, allowing wide-band listening when appropriate and narrow-band reception when necessary.

Please understand that the sidebands of undesired adjacent-channel signals will often extend into the passband of the tuner's i.f. filters. If these signals are strong enough, you will hear some odd "chatter" or "splatter" in the background of the station you are listening to. These effects are stronger during evening hours; if your tuner has adjustable bandwidth, it is well to use its narrower setting at night, sacrificing fidelity for the sake of uncluttered sound.

You mentioned sensitivity as a consideration when purchasing an AM tuner. It is really not as much a factor as you might think. The noise heard in the AM broadcast band is determined more by atmospheric and man-made noise than it is by the internal noise of the tuner.

If you live in a quiet area (one free from man-made radio-frequency interference) and you wish as good sensitivity and selectivity as you can find, I suggest you check the features of the various shortwave, general-coverage receivers available. I have seen some which have wide-band and narrow-band i.f. settings, just what you might enjoy. You may not be interested in shortwave, but these receivers are often the best overall receivers for AM. Who knows? You might even enjoy shortwave listening—although that surely must be done with narrow i.f. settings.

Along with the sensitivity and selectivity these receivers provide, they are often very good with regard to another important factor: Image rejection. You mentioned external antennas. When these are used, signals are strong enough that image and other spurious responses definitely become a factor in less well-designed tuners.

Noise from Amps and Preamps

Q. Which component is the source of noise in a music system, the power amplifier or the preamplifier?—Wonseok Lee, Tarrytown, N.Y.

A. Both the amplifier and preamp, like all electronic equipment, produce noise. However, the preamplifier's noise is more likely to be audible from the loudspeakers. In part this is because preamplifiers, having more gain, have more noise; in part it is because noise from the preamplifier is further amplified (along with the signal) by the power amp. In any case, the amount of noise produced by the overall system (exclusive of tape hiss or surface noise on phonograph records) should be virtually inaudible at normal volume settings unless you place your ear against one of the loudspeakers.

Range Expanders and CDs

Q. Does a dynamic range expander offer any enhancement or effect on Compact Discs? Is the dynamic range of CDs of such high magnitude that a sound processor would be superfluous?—Name withheld

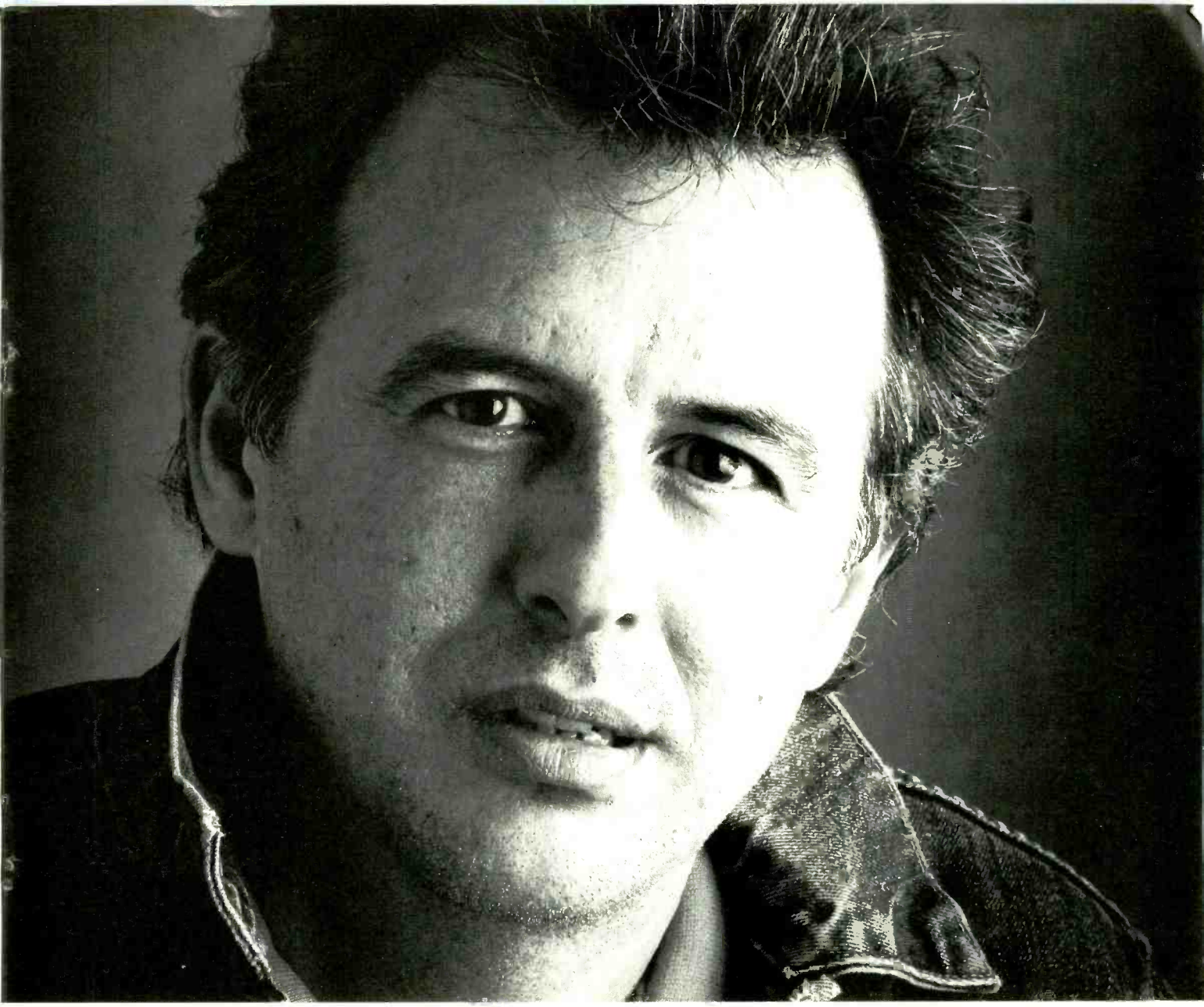
A. I see no value in using a dynamic range expander with Compact Discs unless you know that the dynamics on a given disc are restricted. After all, the CD is capable or reproducing about as wide a dynamic range as one encounters when listening to live music. Any further expansion would not be high-fidelity reproduction. Worse, the loudest passages would certainly be heard at ear-damaging volume, unless the softest passages were too low to be perceived.

Noises in Headphones

Q. When I turn on my amplifier, I hear through my headphones a buzzing noise which rises in intensity until it reaches a maximum. Then it drops off, followed by a hissing sound which increases in volume until a steady level is reached. The hiss continues for the entire time the equipment is on. When I turn off the amplifier, the noise slowly decreases to inaudibility. This noise is heard only with headphones. The position of the input selector is of no consequence here. When inserting the headphones into their jack, I notice (with the amplifier turned off) that there is intermittent static as the plug slides into the jack. Does this mean I have a faulty headphone jack?—Name withheld

A. You will be glad to know that you have no problem with your headphone jack. There is always some back-

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.



"How Big An Amp Do I Really Need?"

Contrary to popular belief, lots of amplifier power isn't necessarily the solution to getting lots of dynamic range from your system.

Fact is, amplifier power alone has little effect on the dynamic range we hear in compact discs and other modern recordings. Your speakers have far more effect on dynamic range than the amplifier or any other component in your system.

We compared a KLIPSCH® Loudspeaker with four other models from various makers. (The KLIPSCH model was not the most expensive.) Doubling, even tripling the power to the speakers had little effect on their dynamic range.

Compared to the KLIPSCH model, the other speakers required at least 30 times more power to achieve a normal listening level. And regardless of the total power consumed by the other speakers, the KLIPSCH model still had 20 dB higher output.

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ground hiss in electronic equipment. The hiss may be too low in volume to hear through your loudspeakers. With sensitive phones coupled tightly to your ears, hiss and other noises are often more dramatic than with loudspeakers.

There is usually an attenuation network between the true amplifier output and the headphone jack. By adjusting the values of the components in this network, greater signal attenuation to the headphones is possible, and the hiss will be virtually removed. (I cannot offer any specific guidelines here; you will have to obtain a schematic of your particular equipment before making any changes.) To compensate for the reduced signal, you will notice that you will have to turn up the volume slightly higher than you are used to.

In lieu of these changes, using less sensitive headphones would also help.

It is quite usual to hear various crackling sounds as a pair of phones is plugged in. For whatever the reason, if there is a difference in voltage between the sleeve of the phone plug and either the tip or the ring, that difference (however small) will be sufficient to produce sound in the phones. If the noise is really loud, something is wrong. Perhaps the output stage is out of balance or there is a leaky coupling capacitor. If the crackling is very light, forget it.

Imbalance in a New Light

I read with a great deal of interest Arthur Stoddard's question, in the January 1987 "Audioclinic," concerning his channel imbalance problem. I have had the same problem for a number of years, and I believe I have identified a cause that you did not mention. I suggest that he check out two very vital components of his audio system: His own two ears.

About five years ago, I began to notice that I had to adjust the balance control to favor the right channel in order to obtain what was, for me, a balanced image. At first I attributed this to a misaligned balance control on a kit-built preamplifier. When the phenomenon persisted through changes in sound equipment and three changes of listening rooms, I began to suspect that the problem might be an artifact of my hearing rather than an equipment problem. The phenomenon was also present while listening via headphones (which effectively ruled out room acoustics as the cause).

I have not consulted a hearing specialist, but, after experimentation, I have concluded that I have suffered a slight but noticeable hearing loss in my right ear. I am satisfied that this explains the channel imbalance problem—at least in my own case.—Allen R. Meals, Houston, Tex.

Connecting Phones to a Preamp

Q. I bought a preamplifier which lacks a headphone output. Nevertheless, I still wish to listen to FM and other sources via headphones. Is it possible to connect headphones to the output of the preamplifier? I could install a headphone jack and volume control. My preamplifier has a 2-V output level; my headphones' impedance is 600 ohms.—Dan Welton, Shelton, Conn.

A. I am uncertain as to whether you can obtain satisfactory sound by connecting headphones to the output of your preamplifier. The preamp could well be designed for a load impedance higher than 600 ohms. Even where the nominal preamplifier output impedance is low (perhaps 100 ohms), the size of the preamp's coupling capacitors could limit the amount of bass sent to the phones. You can try it, of course. If low frequencies are not as prominent as you know they should be with your phones, you might increase the value of the coupling capacitors.

If you get the desired results from a temporary hookup, you might then consider installing a headphone jack. I do not believe you need to install a separate volume control; the existing control should operate very well.

Distortion Near Record's End

Q. I have been having problems with my turntable. As the end of most records approaches, I hear more and more distortion. I have adjusted tracking force and anti-skating to what appear to be the correct settings. Could these settings be incorrectly calibrated?—O'Neal Douglas, Ruston, La.

A. It is possible that your anti-skating force has not been set properly, but it seems to me that it would have to be way off the mark to produce the results you have described.

In order to get this force at least close to the correct setting, do the following: Obtain a blank disc from a recording studio. If this is not practical, use the blank side of an Eva-Tone Soundsheet (one of which was bound into our March 1987 issue). Place it on the turntable, blank side up, and "play" the disc. Adjust the anti-skating control to a position where the tonearm drifts neither inward nor outward, no matter where the arm is placed on the disc. If there is no setting at which drift is absent, set the anti-skating adjustment so that the drift will be outward on some parts of the disc and inward on others. This will be a good compromise rather than a perfect adjustment, because it does not take dynamic forces such as groove friction into account. Still, if your previous adjustment was nowhere close, you will have better sound reproduction under these conditions than before.

I believe, however, that the distortion will still be present. Distortion can be the result of a badly worn or damaged stylus or can come from too low a tracking force. You might wish to check tracking force with an accessory force gauge rather than relying on the one included with your table. Of course, if you did not balance the arm initially, such built-in tracking force gauges can give erroneous readings.

I can recall working on a turntable which exhibited the same symptoms as you have described. It was a matter of tracking force, all right, but there was a subtle aspect to it. Many turntables (such as the one I was working on) are equipped with a cueing lever which raises and lowers the tonearm. This turntable's lifter was just slightly bent. Thus, as the arm approached the inner grooves, the tonearm was lifted slightly—not enough to raise it from the surface, but enough to reduce tracking force to the point where distortion became serious. To add insult to injury, the lifter also added drag, which would further increase distortion as well as increasing wear on both the stylus and the record-groove walls.

If your tonearm's stylus overhang is adjustable, perhaps this adjustment should be checked. If the error is sufficiently large, inner-groove distortion is possible. Also make sure that the cartridge is straight in the headshell.

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TAPE GUIDE

HERMAN BURSTEIN

The What and How of Bias

Q. I'm confused about what the bias frequency is supposed to do in recording. I have seen bias described as a signal that (1) promotes flat frequency response during recording; (2) excites the magnetic particles in the tape coating, promoting a stronger recorded signal by making the magnetic particles more receptive; and (3) allows the tape to record loud and soft sounds evenly and proportionately. Which definition is accurate?—Steve Turner, Pepperell, Mass.

A. The second definition is easily the best, although incomplete because it fails to point out that bias, very importantly, also reduces distortion. The third definition is next best, but nebulous because "evenly and proportionately" doesn't tell us enough. The first definition is outright wrong; bias in fact causes treble loss.

Let's start over. What bias does is to greatly increase the amount of audio signal that can be recorded on tape for a given amount of signal applied to the tape; it also greatly reduces distortion. *How* bias does this has been explained in two basic ways.

Perhaps the more common explanation refers to the tape's transfer function, which is the relationship between the magnetizing force (signal applied to the tape) and the remanence (signal recorded on the tape). Ideally this relationship should be linear, so that the recorded signal varies in direct proportion to the applied signal. However, remanence lags with respect to magnetizing force, a phenomenon called hysteresis. The result is a transfer function which is nonlinear when recording the lowest amplitude portions of the applied signal waveform, then linear as the waveform's amplitude increases, and finally nonlinear again as the amplitude becomes great enough to saturate the tape. Adding bias in the correct amount (typically about 10 times the maximum audio signal level) carries the low-amplitude portions of the audio signal into the linear portion of the transfer function. Thus, the recorded signal is largely free of distortion and recorded at high amplitude. So goes the first basic explanation, of which there are several variations. (For this explanation in detail, see "Dynamic Bias Control with HX Professional" by J. Selmer Jensen and S. K. Pramanik, *Audio*, August 1984.)

The second basic explanation is pretty close to your second definition, stating that magnetic domains in the tape's coating are excited by the bias current so that they respond more readily—with less distortion and greater amplitude—to the applied audio signal. In his book *Magnetic Recording Techniques* (McGraw-Hill, New York, 1972), Charles E. Lowman writes: "From the studies of magnetism it is known that the domains are tightly locked together. To loosen these magnetic bonds and allow the signal [to be recorded], a large amount of magnetic energy is required. It would appear that until a particular threshold of response is reached, little or no signal recording can take place . . . . Once unlocked [the domains] move with relative ease."

Another version of this explanation comes from Dale Manquen ("Magnetic Recording and Playback," *Handbook for Sound Engineers*, Howard W. Sams & Co., New York, 1987): "The magnetization of the tape particles is not easily changed, due to the memory force or hysteresis of the particles. In fact, we could think of the particles as lethargic—sleepy little particles that must be aroused before they will do anything, and then being quite content to immediately fall asleep as soon as the excitation stops. This lethargy produces a jerky recording characteristic that ignores weak signals and responds only to strong signals. Since the resulting distortion levels are intolerable for audio application, a method of waking up the sleepy particles must be employed. If a rapidly varying signal of sufficient amplitude to just begin magnetizing the particles is added to the audio flux signal, the magnetic particles will more readily conform to changes in the audio waveform. The high-frequency biasing signal produces a hysteresis-free or anhysteretic recording." Manquen also writes: "The high-frequency bias signal provides enough excitation to jolt the magnetic particles into an active state."

Turning to the relationship between bias and frequency response (stated incorrectly in your first definition), the bias signal has an erasing effect akin to that produced by the erase head; this grows more severe as the audio frequency rises because the high frequencies are less deeply imbedded in the tape than are the lower frequencies. This erasing effect increases with bias. In short, treble loss increases with bias. Treble boost in the record electronics helps overcome treble loss due to bias and other factors. But there is a limit to the amount of treble boost which can safely be used, and therefore to the amount of bias. At a high recording level, excessive treble boost can cause tape saturation and a situation called fold-over, where the recorded treble is actually decreased rather than remaining at the saturation level; this is accompanied by excessive distortion.

In cassette recording, bias typically must be at a level below the amount required for minimum distortion. However, too little bias produces excessive distortion. Therefore, the deck manufacturer strives for optimum bias, which achieves a satisfactory combination of low distortion and extended treble response. Listening tests conducted by Dolby Laboratories indicate that the trade-off between distortion and treble response should somewhat favor low distortion. Optimum bias also takes into account minimization of noise and the maximum record treble boost that can safely be used.

Deck-to-Deck Compatibility

Q. Many tapes I record on my Nakamichi deck sound muddy when played back on other decks, presumably because, as I understand it, Nakamichi decks use their own equalization curve. Does owning a Nakamichi isolate me from all other decks? Does everything recorded on a Nakamichi have to be played back only on a Nakamichi?—Anthony Hudaverdi, Santa Monica, Cal.

A. First, let me point out that Nakamichi employs standard equalization, conforming with RIAA and NAB Standards. Where Nakamichi units deviate from some decks is in applying some treble boost at the very high end in playback to compensate for gap loss

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

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A distance of 3 inches between a cassette and a strong magnetic field is usually sufficient to avoid damage to the tape.

at the playback head. But this is consistent with the Standards.

Your problem may lie in azimuth misalignment—either of the Nakamichi or of the other decks. I suggest that you have your deck's azimuth checked out by an authorized service shop.

Another possibility is that of mistracking, if you are using Dolby B or C noise reduction. Recording and playback levels have to be matched if Dolby NR is to work properly. If there is serious mistracking, this can cause treble loss, leading to what you describe as "muddy" sound. Is your problem less serious when you record without Dolby NR? If so, this suggests the culprit is mistracking, in either the Nakamichi or the other decks.

Damage from Magnetic Fields

Q. I have read several times about the importance of keeping recorded tapes away from magnetic fields. It has been my habit to place recorded tapes on top of one of my speaker cabinets for long periods. Recently it dawned on me that this might be harmful, so I put a compass on top of the cabinet to check things out. I was shocked when the needle, which had been pointing north, spun to the south when I put the compass on the cabinet. The tweeter is only about 2 inches below the cabinet top, the midrange speaker about 6 inches below, and the woofer about 18 inches below. Have I done my tapes much harm?—Philip H. Leak, Roseville, Cal.

A. I doubt that you have harmed your tapes, although I can't be sure. Usually a distance of about 3 inches between the tape and a strong magnetic field is sufficient protection. In your case, the distance is less, but I presume it is only a moderate field. You can check whether your practice is harmful by recording two cassettes from the same source, placing one of them on your speaker, and then playing both. If the one that was on the speaker has duller treble response, harm has been done—namely, some erasure of high frequencies.

For more information on the dangers presented by magnetic fields, see my article "Magnetic Shielding" in the April 1979 issue.

Effects of Wrong Bias

Q. I have an old cassette deck without switchable bias, and therefore I have always used normal-bias cassettes. If I were to use high-bias cassettes, would I damage or decrease the life of my tape heads?—Ivo Rokovich, Hialeah, Fla.

A. You will not harm your tape heads or tape deck by using other than normal-bias cassettes. What will happen, if you use Type II (chromium dioxide, ferricobalt, and a few metal) tapes or Type IV (the majority of metal) tapes, is an increase in high-frequency response and in distortion. These effects will be largest with Type IV.

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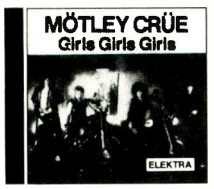

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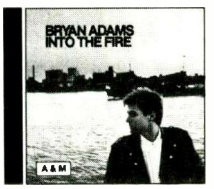

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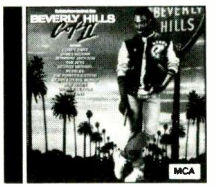

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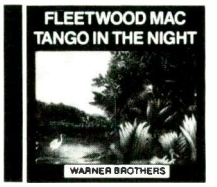

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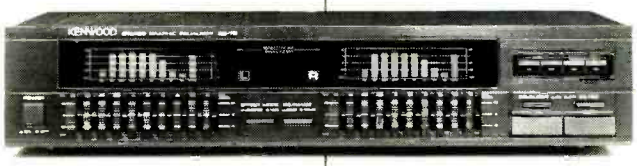

switchable to either ±10 or ±5 dB. Other controls allow equalized recording, reverse-curve equalization, and selection of line or tape inputs. Price: $240.
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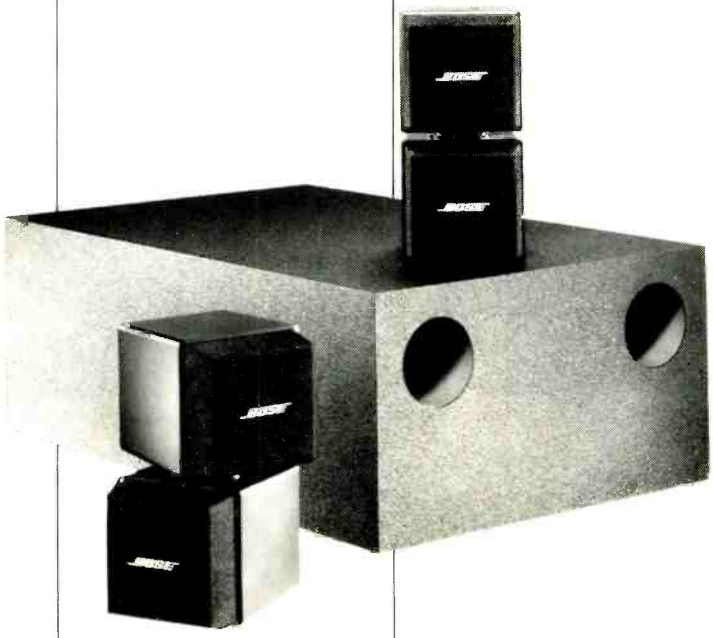

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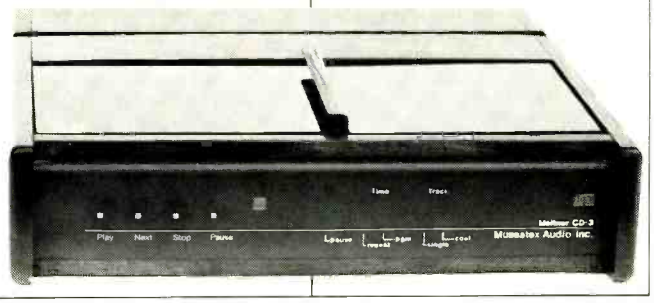

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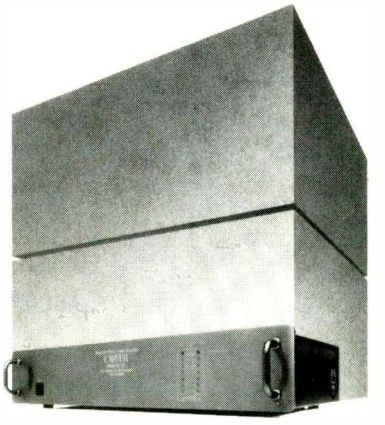

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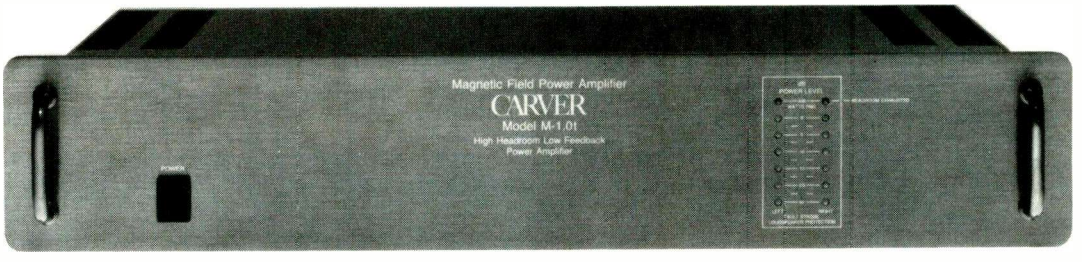
- Delivers 1000 watts continuous sine wave output at 8 ohms in bridging mode without switching or modification.
- Is capable of handling unintended 1-ohm speaker loads without shutting down.
- Includes elaborate safeguards including DC Offset and Short Circuit Power Interrupt protection.

SHARE THE RESULTS OF VICTORY. We invite you to compare the new M-1.0t against any and all competition. Including the very expensive amplifiers that have been deemed the M-1.0t's sonic equivalent. You'll discover that the real winner of Bob's remarkable challenge is you. Because world class, superlative electronics are now available at reasonable prices simply by visiting your nearest Carver dealer.

SPECIFICATIONS: Power, 200 watt/channel into 8 ohms 20Hz to 20KHz, both channels driven with no more than 0.15% THD. Long Term Sustained RMS power, 500 watts into 4 ohms, 350 watts into 8 ohms. **Bridged Mono power,** 1000 watts into 8 ohms. **Noise,** -110dB IHF A-weighted. **Weight,** 20 lbs.



CARVER P.O. Box 1237, Lynnwood, WA 98046

POWERFUL MUSICAL ACCURATE

Enter No. 11 on Reader Service Card

Distributed in Canada by: evolution technology

Altec Lansing Weatherproof Speaker

Unlike most bookshelf speakers, the Altec Lansing Model 55 is weatherproofed for outdoor as well as indoor use. Its 4-inch woofer and 20-mm tweeter are made of moisture-proof materials; the cabinet, of glass-filled ABS plastic with rubber gaskets, is an acoustic-suspension design with no vents or ports. Frequency response is rated at 85 Hz to 20 kHz, ±3 dB. The cabinets have keyhole receptacles for wall hanging, and may be painted if desired. Price: $250 per pair.

For literature, circle No. 105

Harman/Kardon Tuner

The TU920 FM/AM tuner features the Active Tracking circuit previously introduced in Harman/Kardon's Citation Twenty-Three tuner. This circuit tracks the modulation of the FM broadcast being heard, to increase selectivity without degrading stereo separation or increasing distortion. With Active Tracking engaged, *adjacent*-channel selectivity is 30 dB. The TU920 also features presets for 16 stations, bidirectional seek and manual tuning, and switchable muting. Price: $395.

For literature, circle No. 104

Yamaha CD Player

Although Compact Discs are 16-bit recordings, Yamaha's CDX-1100U uses an 18-bit digital filter and 18-bit D/A converters; according to the company, these techniques (plus quadruple oversampling) yield a 16-fold improvement in resolution and a 20-dB improvement in S/N, compared to conventional techniques. Features include a floating suspension system, 24-track programming, and remote control. Price: $1,099.

For literature, circle No. 106

dbx Preamplifier

Designed for combined audio/video systems, the dbx CX1 preamplifier includes such video-oriented features as Pro-Logic Dolby Surround, continuously variable stereo separation (from mono to enhanced stereo), and combined audio/video switching and dubbing. Connections and switching are provided for five signal sources (with both MM and MC gain settings for the phono stage), three tape decks (including one VCR and one more video source), and one external processor. The bass control has selectable 120- and 300-Hz turnover frequencies, and the treble control can operate normally above 4 kHz or gently "tilt" the spectrum above 200 Hz; both controls can also be switched out of the circuit. The external processor loop can be switched into either the record output or the playback section of the preamp. In addition to Dolby Surround, the CX1 has three ambience settings, including pure delay. The delay system is digital, using second-order delta modulation at 12 MHz, with a dynamic range of 96 dB on the surround channels. Price: $1,500.

For literature, circle No. 107

ther audio engineers may listen to live music. Denon engineers also record it.

DENON

DESIGN INTEGRITY

Denon. Where playback components are designed by recording engineers.

For the typical audio engineer, live music offers a chance to get reacquainted with the ultimate reference in audio reproduction. But for Denon audio engineers, live music represents an essential part of their day-to-day experience.

Every month, from the Semper Opera House in Germany to Clinton Studios in America, from Aoyama Tower Hall in Tokyo to The Hall of Artists in Prague, Denon audio engineers are producing records. In this exacting enterprise, nothing is overlooked. Microphone selection and placement. Hall reverberation and stereo imaging. Tonal balance. Phase integrity. Our technicians control, discuss and sometimes fight about every factor that determines sound quality.

In the process, Denon audio engineers have created award-winning operatic, symphonic, vocal and jazz recordings. They've developed an unrivalled sensitivity for the integrity of live music. And they've acquired technical expertise that fuels the advancement of Denon studio recorders, broadcast equipment, blank recording tape, and Denon audio components for the home and the car.

Look inside a Denon component and you'll find tangible evidence of our work in the recording studio. The Super Linear Converter in every Denon CD player is a direct outgrowth of Denon's early research into studio digital recording. The Non-Slip Reel Drive of Denon cassette decks reflects years of mastery in building open-reel machines. Even Denon receivers demonstrate this heritage. Their circuit design results from Denon experience at achieving playback accuracy in the recording studio.

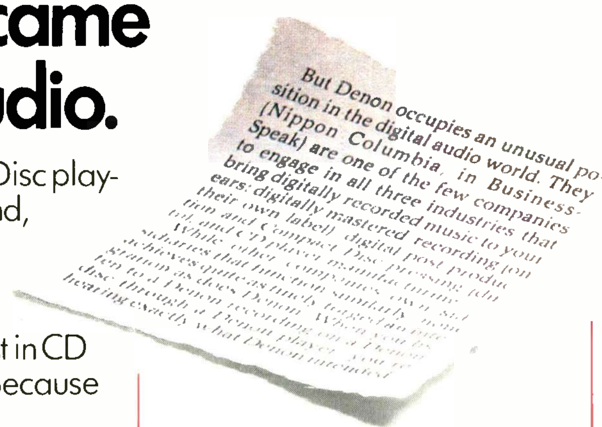
More than circuits and transistors, our studio expertise defines a philosophy. It dictates the uncompromising pursuit of better sound, the obsessive concern for musical nuance, and the eagerness to subject new designs to intensive listening tests.

At Denon, this symbiosis of recording and playback technology is nothing new. It dates back to the founding of our parent company in 1910. It stands behind Denon's reputation among the world's audiophiles. And it explains the rave reviews we've received from the world's audiophile magazines.

On the pages that follow, you'll see some of those reviews and learn about the Denon components that earned them. But no amount of words will substitute for the evidence of your own ears.

Your Denon dealer has all the expertise necessary to explain Denon audio clearly. And all the facilities to demonstrate Denon audio properly. So you can hear for yourself one simple truth. It's a lot easier to make audio sound like live music when you know what live music sounds like.

How a 77 year-old became the first name in digital audio.

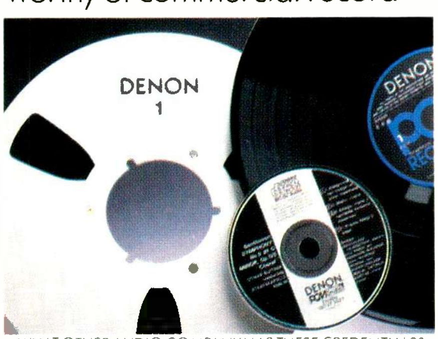

But Denon occupies an unusual position in the digital audio world. They (Nippon Columbia, in Business-Speak) are one of the few companies to engage in all three industries that bring digitally recorded music to your ears: digitally mastered recording (on their own label) digital post produ

Denon's been involved in every phase of music reproduction since the days of wind-up record players. So after seven decades of breakthroughs in studio recording, disc pressing, home high fidelity and professional equipment, we were uniquely prepared to take the next step. A tape


EVERY DENON COMPONENT REFLECTS LESSONS LEARNED IN THE RECORDING STUDIO

recorder so fundamentally different, it would obsolete every previously accepted notion of how good recorded sound could be.

In 1972, Denon researchers achieved their goal. The world's first digital recorder worthy of commercial record



WHAT OTHER AUDIO COMPANY HAS THESE CREDENTIALS?

production, the legendary Denon DN-023R. We quickly put our digital innovation to use, producing digital processors, digital editors, digital mixers, and the world's first digitally-recorded LPs.

Today, Compact Disc players, regardless of brand, reflect the influence of the original Denon DN-023R. But this heritage runs strongest in CD players from Denon. Because

"One of the most finely engineered pieces of audio gear on the planet." Ken Pahlmann, *Digital Audio*, on the DCD-3300

the same engineers who design Denon pro machines design

as "a winner on every count," "the player I recommend most highly," "superlatives have to be used," and "in several respects, the best I've ever heard."

Reactions which simply demonstrate one point. It's a lot

THE NEW DCD-1500II ITS SUPER LINEAR CONVERTER COMES STRAIGHT OUT OF DENON STUDIO RECORDERS

Denon home audio. And the same ears that guide Denon recording sessions evaluate the sound of Denon playback components.

Perhaps that's why each succeeding generation of Denon CD players is eagerly anticipated by the world's audio critics. And why they've variously hailed our CD players

"A look into the interior of this player reveals that Denon engineers were not taking any shortcuts whatsoever." Germany's *Hi-Fi Vision*, on the DCD-1500

easier to make audio sound like music when you really know what music sounds like.

DENON
DESIGN INTEGRITY

Clipping excerpted from the August, 1987 issue of *Digital Audio*. Reprinted with permission.

What happens when studio recording engineers also design home tape recorders.

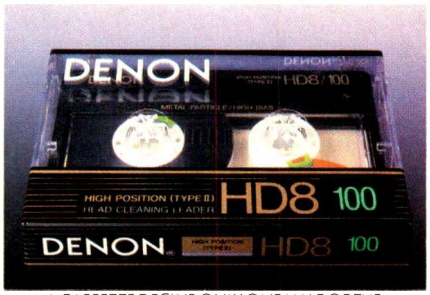
What qualifies a company to build audiophile cassette decks? Try seven decades of intimate knowledge in every aspect of the recording process. Creating award-winning blank tape. Recording award-winning classical and jazz releases. Building transcription-quality open-reel recorders, multi-track

THE SAME EARS THAT GUIDE DENON RECORDING SESSIONS ALSO EVALUATE THE SOUND OF DENON HOME COMPONENTS.

decks for studio work, and finally the world's first digital recorder good enough for commercial record production.

Only one company has all these qualifications. That company is Denon.

Consider Denon's DR-M30HX Cassette Deck. This machine's professional heritage is evident in the three-motor drive system for flawless tape movement, the high-overload heads with oxygen-free copper



A CASSETTE DECK IS ONLY ONE HALF OF THE RECORDING SYSTEM. HERE'S THE OTHER.

coils for the barest minimum noise, and the wideband DC playback amplifier for ruler-flat response. Even the power supply has separate windings for the audio circuits—for absolute minimum distortion.

Although not highly publicized, the control of supply reel back tension can be a cassette deck's Achilles' Heel. Over time, the typical friction clutch can wear down, disturbing tape-to-head contact and degrading high frequency response. That's why Denon borrowed the

"Top Class"

Germany's *Stereo* Magazine on the DR-M30HX

Under test, its metal tape overload (MOL) margin is incredibly high, at +6db being as good as the best Nakamichis! This is without use of Dolby HX Pro or excessive bias either. Overload margins on chrome and ferric tape were high too, so the benefit is a general one, if not being quite so marked with ferric tapes (IEC Primary Reference Standard tape). This new head gives the DR-M20 a +2dB headroom advantage over other decent decks with metal and chrome tape: so recordings can be taken up to a higher level (+8 on the indicators), so making hiss less noticeable.

cult types of music on the Denon DR-M30HX. You'll hear steady, unwavering pitch on sustained piano chords. And you hear cymbals and harpsichords with all their distinctive overtones.

You might expect audio components of this caliber to come with high-caliber price tags. Yet Denon cassette decks

THE DENON DR-M30HX. THREE MOTORS, THREE HEADS, DOLBY B, C, AND HX PRO DON'T BEGIN TO TELL THE STORY.

open-reel concept of Non-Slip Reel Drive—servo-controlled back-tension that will not degrade over time.

Denon incorporates such studio technology for one purpose only: its direct effect on sound quality. The proof is in the listening. Record the most diffi-

"Best Buy"

Britian's *Hi-Fi Choice* on the DR-M20

start at less than $250.* So for the price of far lesser audio components, you can do what studio engineers all over the world do. Record on a Denon.

DENON

DESIGN INTEGRITY

*Suggested retail price. Clipping reprinted with permission from *Hi Fi Review*, November/December, 1986 issue

How Denon turned receiver design inside out.

Of equal importance, though, is the fact that much of the circuitry used in the DRA-95VR was developed for the company's exotic components, and the result is a full featured receiver that will delight even the most ardent component separatists.

Audio companies must have a fairly low opinion of the receiver customer. How else to explain the bewildering array of buttons, lights and winking fluorescent displays that festoon so many of today's receivers? These outward trappings may impress the innocent, but they contribute not one iota to better sound.

THE SAME ENGINEERS WHO DESIGN DENON PRO EQUIPMENT DESIGN DENON HOME AUDIO.

With their rugged anodized metal front panels, Denon receivers are certainly as handsome as any on the market. But Denon never forgets that it's inside, among the transistors, power supplies and heat sinks, that sound quality is determined. That's why Denon takes the typical priorities of receiver design...and turns them inside out.

DENON RECEIVER VS. DENON INTEGRATED AMP. ANY RESEMBLANCE IS STRICTLY INTENTIONAL.

For the results, look inside any Denon receiver. You'll find discrete output transistors, not cheap IC "power packs." You'll notice ample power supplies that handle the most demanding dynamic passages. In fact, the Pure Current Power Supply of the DRA-95VR reduces dynamic IM distortion by an impressive 60 dB.

"Distortion is, in a word, negligible."

High Fidelity Magazine

The circuit topology of every Denon receiver truly epitomizes the Denon credo, "Simple is Best." For example, the DRA-95VR conquers distortion without resorting to the negative feedback that can degrade transient performance. And Denon's Non-Switching Class A output stage combines the purity of Class A with the efficiency of Class B.

Anyone with a Hi-Fi VCR will appreciate Denon's video switching. It makes audio/video integration a practical reality. Anyone with an easy chair will enjoy the remote control supplied with Denon's top two models. It operates not only the receiver, but also a choice of Denon cassette decks and CD players.

While you might expect to pay more for a Denon, our receivers start at under $300.*

AS BEAUTIFUL AS OUR DRA-95VR IS ON THE OUTSIDE, IT'S EVEN BETTER ON THE INSIDE.

"The amplifier section is the 95VR's highlight."

High Fidelity Magazine

If they seem different from similarly-priced competitors, there's a good reason. At Denon, we pay more attention to the laws of acoustics than the dictates of fashion.

DENON

DESIGN INTEGRITY

*Suggested retail price. Clipping reprinted with permission from *Audio/Video Buyers' Guide*.

For people who love music as much as they love their car.

If you love music, you won't settle for the inaccurate, inadequate sound of so many factory-installed systems. And if you love your car, you want to enhance it. You'd never do anything to compromise its looks or reduce its resale value. Like re-work the entire dashboard just to install a receiver. Or put up with a trunk that looks like an electronics store.

A DENON RECEIVER MATCHES THE DASH SO WELL, IT LOOKS LIKE ORIGINAL EQUIPMENT.

At Denon, we feel the same way. That's why Denon speakers fit most cars without tedious modifications. Denon amps make even sophisticated multi-channel systems simple. Denon receivers all have DIN-E chassis so they install with a minimum of disruption. You can mount them permanently or pull them out to protect both your system and your car from Midnite Auto Inc. For a modest additional cost, the receiver lights can even be matched to

THE DCR-5520, LIKE ALL DENON RECEIVERS, HAS CONTROLS YOU CAN IDENTIFY BY TOUCH.

the color of your dashboard lights. So instead of clashing with your car's interior, a Denon system integrates seamlessly.

Of course, we never forget that superior performance is the only attribute that makes high-end car audio worth the money.

That's why we endow our car audio with such advanced technologies as the Denon Optimum Reception System to tailor FM tuning to the reception conditions. Or our Dynamic Expansion to restore depth and vibrancy to compressed broadcasts and prerecorded cassettes.

Dual Azimuth Heads assure that both sides of a tape are played with extended frequency response. Non-NFB and Non-Switching Class A Amplification substantially reduce distortion. And a special Denon circuit eliminates the interference that often occurs when an amplifier is mounted in the trunk.

that most car stereos seemed to have been designed by people who look the bus to work. Well, Denon's designers definitely drive to the office. The DCR-7600's controls fall into logically related groups: Tape functions along the bottom left and to the left of the display and tape slot, tuner [illegible] below the display and along the right edge of the

In terms of sheer sound quality, Denon car audio fully lives up to the standards set by Denon record production, Denon pro studio recorders and

THE DENON DCA-3500 INCLUDES FRONT AND REAR STEREO AMPS, AN ELECTRONIC CROSSOVER AND A SUBWOOFER AMP—WITH ROOM LEFT OVER FOR LUGGAGE.

"...its human engineering is about the best I have yet run across. Learning how to use it takes less than a minute."

Audio's Ivan Berger on the DCR-7600

Denon home high fidelity. Which means, no matter what you drive, you've finally found car stereo as good as your car.

DENON

DESIGN INTEGRITY

Clipping and quote reprinted with permission from *Audio*.

Denon's most important components. The Denon Dealers.

In addition to creating advanced audio equipment, Denon insists on advanced audio dealers. Only at these authorized dealers will you be sure to find Denon equipment designed and manufactured for use in the U.S., protected by a Denon America warranty.

To make this list, each store had to demonstrate exceptional customer service, first-rate listening rooms, and outstanding expertise. While this concern for dealer service may seem obsessive, Denon wouldn't have it any other way.

ALABAMA

Birmingham: Lawrence Stereo (H), Radio Active (C) **Huntsville:** Sound Stage (C), Sound Distributors (H) **Mobile:** Fidler Hi Fi (H), Saad & Associates (C) **Montgomery:** The Record Shop (H)

ALASKA

Anchorage: Pyramid Audio (H) **Fairbanks:** Hoitt's Stereo (H) **Sitka:** Stereo North (H)

ARIZONA

Mesa: Federated Electronics (H), Hi-Fi Sales (HC) **Phoenix:** Audio Specialists (H), Federated Electronics (H), Kustom Kar (C) **Tucson:** Federated Electronics (H), Quality Auto Sound (C), Tucson Stereo (HC)

ARKANSAS

Batesville: Hi Fi House (H) **Fayetteville:** Stereo Buff (H) **Jonesboro:** Audio Visions (H) **Little Rock:** Arkansas Car Radio (C), Custom Audio (H) **Searcy:** Audio Express (C)

CALIFORNIA

Alameda: Autotronics (C) **Bakersfield:** Federated Electronics (H) **Anaheim:** Federated Electronics (H) **Berkeley:** DB Audio (H), Good Guys (HC), Uncle Ralph's (C) **Burbank:** Federated Electronics (H) **Canoga Park:** Federated Electronics (H) **Carlsbad:** Mad Jack's (HC) **Cerritos:** Federoted Electronics (H) **Citrus Heights:** Auto Radio Stereo (C), Good Guys (HC) **City of Commerce:** Federated Electronics (H) **Chatsworth:** Paris Audio (H) **Chico:** Sounds by Dave (H) **Chula Vista:** Mod Jock's (HC) **Clovis:** Federated Electronics (H) **Colma:** Federated Electronics (H) **Concord:** Good Guys (HC), Sound Distinction (H) **Corte Madera:** Good Guys (HC) **Costa Mesa:** Federated Electronics (H) **Culver City:** Audio Video City (H) **Daly City:** Good Guys (HC), Motor Music of San Francisco (C) **Dublin:** Motor Music of San Francisco (C) **El Cajon:** Federated Electronics (H) **El Toro:** Genesis Audio (H) **Escondido:** Federated Electronics (H), Mod Jack's (HC) **Eureka:** The Works (H) **Fair Oaks:** Pinkerton Audio Systems (H) **Fort Bragg:** Record Roost (H) **Foster City:** Phoenix Systems (H) **Fremont:** Home Express (H) **Fresno:** Boot's Camera Corporation (H), Federoted Electronics (H), Home Express (H) **Fullerton:** Federated Electronics (H)) **Hayward:** Good Guys (HC) **Haywood:** Home Express (H), Federoted Electronics (H) **Hollywood:** Federated Electronics (H) **Huntington Beach:** Federated Electronics (H) **Lafayette:** Creative Cor Stereo (C) **La Mesa:** Mod Jack's (HC) **La Puente:** Federated Electronics (H) **Larkspur:** Marin Auto Stereo & Alarm, Inc. (C) **Long Beach:** Federated Electronics (H) **Los Angeles:** Federated Electronics (H), Hollytron (H) **Mission Viejo:** Federated Electronics (H) **Modesto:** Federated Electronics (H), Poradyme (C) **Montclair:** Federated Electronics (H) **Monterey:** Monterey Stereo (H) **Morgan Hill:** Royal Sound (H) **National City:** Federated Electronics (H) **North Hollywood:** Sound Factor (H) **Oakland:** Cellular 2000 (C), Lakeview Auto Radio Inc. (C), Motor Music of San Francisco (C) **Oceanside:** Federated Electronics (H) **Pasadena:** GNP Loudspeakers (H) **Pinole:** Federated Electronics (H) **Redding:** Clydes Magnavox (H) **Redlands:** Federated Electronics (H) **Redondo Beach:** Axiom Engineering (H) **Riverside:** Federated Electronics (H) **Redwood City:** Alpine Specialties (C) **Sacramento:** Federated Electronics (H), Keith Yates Audio (H), Paradyme (C), World Electronics (H) **San Bruno:** Monney Electronics (C) **San Diego:** Breier Sound Center (H), Federated Electronics (H), Mad Jack's (HC) **San Dimas:** Federated Electronics (H) **San Francisco:** Custom Car Alarms (C), Good Guys (HC), Hormony Stereo (H), Mayburn's (HC), Sunset Car Audio (C), Stereo Store (H) **San Jose:** Good Guys (HC), Federated Electronics (H), LZ Premiums (H) **San Juan Capistrano:** Home Tech Stereo (H) **San Leandro:** Federated Electronics (H), MCM Audio System (C) **San Mateo:** Good Guys (HC), Mateo Hi Fi (H) **San Rafael:** City Car Radio (C), Marin Auto Stereo & Alarm, Inc. (C) **Santa Ana:** Federated Electronics (H) **San Bernardino:** Federated Electronics (H) **Santa Clara:** Federated Electronics (H) **Santa Cruz:** Water Street Stereo (H) **Santa Monica:** Shelly's Stereo (H) **Santa Rosa:** Good Guys (HC), M&W Electronics (HC), Sunset Car Audio (C) **Sherman Oaks:** JMA Audio Video (C) **Stockton:** Federated Electronics (H), Paradyme (C) **Sunnyvale:** Good Guys (HC), Sunnyvale Auto Stereo (C) **Temple City:** Federated Electronics (H) **Torrance:** Federated Electronics (H), Stereo Hi Fi Center (H) **Van Nuys:** Scan Audio Services (H) **Ventura:** Federated Electronics (H) **Westminster:** Audio Today (H), Federated Electronics (H)

COLORADO

Aspen: Main Music (HC) **Avon:** Mountain Music, Inc. (HC) **Boulder:** Listen Up (HC) **Breckenridge:** Jim's Alpine Camera, Inc.(H) **Colorado Springs:** C&S Audio (HC), The Sound Shop (H) **Denver:** Listen Up (HC) **Durango:** Durango Music (HC) **Fort Collins:** Audio Junction (H)

CONNECTICUT

Canton: Jo Di's (C) **Cromwell:** Cartunes (C) **Danbury:** Car Stereo Consultants (C), Tweeter, Etc. (H) **Enfield:** Jo Di's (C) **Fairfield:** Audio Design (H) **Greenwich:** Al Franklin's Music World (H), Auto Sound (C) **Groton:** Leiser Sound (H) **Hamden:** Stereo Station (C) **Hartford:** Al Franklin's Music World (H) **Manchester:** Jo Di's (C) **New Haven:** Audia Etc., Inc. (H) **New London:** Jo Di's (C) **North Haven:** Jo Di's (C) **Norwalk:** Audiotronics (H), Jo Di's (C) **Norwich:** Leiser Sound, Inc. (H) **Old Greenwich:** Audiocom (H) **Stamford:** Bob & Ray's Television (H) **Torrington:** Stereo King (C) **Waterbury:** Jo Di's (C) **Waterford:** Tweeter, Etc. (H) **West Hartford:** Jo Di's (C)

DELAWARE

Dover: Sound Studio (H) **Newark:** Sound Studio (H) **Wilmington:** Sound Studio (H)

DISTRICT OF COLUMBIA

Audio International (H)

FLORIDA

Altamonte Springs: Alltron Scientific (H) **Boca Raton:** Saund Advice (H), Sound Plus Wood (H) **Bradenton:** Stereo Roma (C) **Brandon:** Sterea Rama (C) **Clearwater:** Sound Advice (H), Stereo Ramo (C) **Coral Gables:** Sound Advice (H) **Coral Springs:** Creative Cor Sounds (C) **Daytona Beach:** Stereo Ramo (C), Stereotypes (H) **Fort Lauderdale:** Sound Advice (H), Speaker Worehouse (C) **Ft. Myers:** Avmar Electronics (C), Stereo Rama (C) **Ft. Walton Beach:** Audio Internationol (H), Fiddler Hi Fi (HC) **Gainesville:** Audio Visions (C), Sound Ideas Stereo (H) **Hialeah:** Sound Advice (H), Speaker Warehouse (C) **Hollywood:** Sound Advice (H), Speaker Worehouse (C) **Jacksonville:** Behrens Audio Lab (H), House of Stereo (H) **Kendall:** Sound Advice (H) **Lakeland:** The Sound Factory (HC) **Leesburg:** Knightwing Studio Sound (H) **Marathon:** Sound Source (H) **Merritt Island:** Island Audio Video (H) **Miami:** Aventura Car Stereo (C), Ritz Shop (H), Sedoris Electric (C) **North Miami Beach:** Sound Advice (H) **Pensacola:** Fiddler Hi Fi (HC) **Pinellas Park:** Stereo Rama (C) **Sarasota:** Sound Advice (H), Stereo Rama (C) **St. Petersburg:** Sound Advice (H) **Stuart:** Stuart Audio Video (HC) **Sunrise:** Sound Advice (H) **Tampa:** Sound Advice (H), Stereo Rama (C), The Consumer Center (H) **Tallahassee:** Sound Value (C), Stereo Soles (H) **West Palm Beach:** Sound Advice (H), Sound Performance/ Mobile Tel. (C) **Winter Park:** Sound Set (C)

GEORGIA

Athens: Hi Fi Buys (H) **Atlanta:** Cartunes Atlanta (C), Hi Fi Buys (H) **Augusta** Pro-Audio (C) **Buckhead:** Hi Fi Buys (H) **Cumberland Mall:** Hi Fi Buys (H) **Doraville:** Audio FX (C) **Gainesville:** Audio Dimensions (C) **Marietta:** Hi Fi Buys (H) **Martinez:** Southeastern Audio (C), The Stereo Shop (H) **Northland Festival:** Hi Fi Buys (H) **Perimeter Mall:** Hi Fi Buys (H) **Roswell:** Julians Audio (H) **Sandy Springs:** Hi Fi Buys (H) **Savannah:** Southland Sound (H). **Southlake Mall:** Hi Fi Buys (H) **St. Simons Island:** Saund Components (H) **Valdosta:** Stereo Connection (H)

HAWAII

Honolulu: Custom Car Stereo (C), Honolulu Audio Video (H), Sam Sung Electronics (C) **Wailuku:** Maui Audio Center (H)

IDAHO

Boise: Stereo Shoppe (HC) **Ketchum:** Infinite Audio & Video (H) **Lewiston:** Steiner Electronics (H) **Moscow:** Stereo Shoppe (HC) **Sandpoint:** Electracraft (HC)

ILLINOIS

Aurora: Sterea Systems (HC), United Audio Centers (HC) **Bloomingdale:** Audio Visions (H) **Chicago:** United Audio Centers (HC) **Charleston:** Uptown Audio (C) **Crystal Lake:** Northwest Audio Video (H) **Decatur:** Team Electronics #79 (H) **Deerfield:** United Audio Centers (HC) **Joilet:** Stereo Systems (HC) **Kankakee:** Barrett's Entertainment Center (H) **Lansing:** Audio Clinic (H) **Morton Grove:** United Audio Centers (HC) **Naperville:** Stereo Systems (HC) **Niles:** United Audio Centers (HC) **Peoria:** Electronics Diversified (H) **Rockford:** Absolute Audio (H) **Schaumburg:** United Audio Centers (HC) **Spring Valley:** Audio Labs (H) **Sterling:** Computer Corner (H) **Sidney:** August Systems (H) **Vernon Hills:** United Audio Centers (HC) **Westmont:** Sounds Deluxe (HC)

INDIANA

Anderson: Disc-O-Tech (C) **Carmel:** Sound Pro (H) **Evansville:** Dr. Dashboord (C) **Fort Wayne:** Classic Stereo (HC) **Indianapolis:** Dr. Dashboard (C), Ovation Audio (HC). Sound Productions (H) **Lafayette:** Pro Audio (HC) **Marion:** Classic Stereo (HC) **Muncie:** Classic Stereo (HC), Great Sounds (C) **South Bend:** Audio Specialists (H), Classic Stereo (HC) **Terre Haute:** The Audio Connection (H), Dr. Dashboard (C) **Vincennes:** Record Cellar Audio Video (HC)

IOWA

Carroll: Sound and Service (HC) **Coralville:** Spencer Sound (C) **Davenport:** Audio Odyssey (HC) **Des Moines:** Audio Labs (HC) **Dubuque:** The Audio Room (H) **Iowa City:** Audio Odyssey of Iowa City (H) **Marion:** The Audio Room (H) **Sioux City:** Audio Visions (C) Pflanz Electronics (HC) **Storm Lake:** Sound & Service (HC)

KANSAS

Lawrence: Kief's Gramophone (HC) **Leawood:** Audio Mart (HC) **Wichita:** Audia Visions (C), Custom Sound (H)

KENTUCKY

Bowling Green: Poston Electronics (H) **Lexington:** The Stereo Shoppe (HC) **Louisville:** Audio Video by Design (HC) **Murrey:** Long Run Video (H) **Paducah:** Long Run Video (H) **Owensboro:** Dr. Dashboard (C)

LOUISIANA

Baton Rouge: Mike's Automotive Audio (C), New Generation (HC), **Lafayette:** New Generation (HC), Rickey Smith Audio (C) **Lake Charles:** Classic Audio Systems (H) **Metairie:** Alterman Audio (H) **Monroe:** J's Sound Center (H), Southern Sound (C) **New Orleans:** Alterman Audio (H) **Shreveport:** Audio Fidelity (H)

MAINE

Freeport: The Great Northern Sound Company (H) **South Portland:** The Great Northern Sound Company (H) **Westbrook:** The Audio Lab & Soundship (C)

MARYLAND
Baltimore: Soundscapes (H) **Gaithersburg:** Montgomery Mobile Systems (C) **Laurel:** Audio Associates (C) **Tawson:** The Discerning Ear (H)

MASSACHUSETTS
Arlington: Audiosonics (C) **Auburn:** Leiser Sound (H) **Beverly:** Audio Design (H) **Boston:** Tweeter, Etc. (H) **Braintree:** Tweeter, Etc. (H) **Burlington:** Tweeter, Etc. (H) **Cambridge:** Tweeter, Etc. (H) **Chestnut Hill:** Tweeter, Etc. (H) **Danvers:** Tweeter, Etc. (H) **Dedham:** Tweeter, Etc. (H) **Framingham:** Natural Sound (H), Tweeter, Etc. **Hanaver:** Tweeter, Etc. (H) **Hyannis:** Tweeter, Etc. (H) **Littleton:** F.E.B. (H) **Lynn:** Sound Installations (C) **Pittsfield:** HBS Stereo Systems (H) **Seekonk:** Leiser Sound (H), Tweeter, Etc. **Shrewsbury:** Leiser Sound (H) **Waltham:** Waltham Camera (H) **Watertown:** Rich's Car Tunes (C)

MICHIGAN
Ann Arbor: House of Car Stereo (C), The Stereo Shappe (H) **Bad Axe:** Greve Systems (H) **Birmingham:** The Gramophone (HC) **Burton:** Stereo TV Village (HC) **Detroit:** Pecar Electronics (H) **East Lansing:** House of Car Stereo (C), Stereo Shoppe (H) **Flint:** Custom Auto Soundvan City (C) **Grand Rapids:** Classic Stereo (HC) **Kalamazoo:** Classic Stereo (HC) **Lansing:** House of Car Stereo (C), The Stereo Shoppe (HC) **Mt. Pleasant:** Dr. Goodear Audio Porlour (H) **Petoskey:** Puff's Home Centre (H) **Saginaw:** Court St. Listening Room (H), The Audio Shoppe (H) **Traverse City:** The Stereo Shoppe (HC)

MINNESOTA
Alexandria: Audio Concepts (H) **Bloomington:** Audio King (HC) **Brooklyn Center:** Audio King (HC) **Burnsville:** Audio King (HC) **Duluth:** Mel's TV/Audio (H) **Edina:** Audio King (HC) **Golden Valley:** Audio King (HC) **Mankato:** Audio King (HC) **Maplewood:** Audio King (HC) **Minneapolis:** Audio King (HC), Audio Perfection (H), Entertainment Design (H), Hi Fi Sound Electronics (HC) **Minnetonka:** Audia King (HC) **Rochester:** Audio King (HC) **Roseville:** Audio King (HC) **St. Cloud:** Exclusive Sound (H) **St. Louis Park:** Audio King (HC) **St. Paul:** Audio King (HC), In Concert (H) **Twin Cities:** Audio King (HC) **Winona:** Amalgamoted Audio (C)

MISSISSIPPI
Jackson: Cartunes Inc. of Jackson (C) **Ridgeland:** Ployers Audio Video (H) **Starkville:** Ideal Acoustics (HC) **Verona:** DECA Enterprises (C)

MISSOURI
Ballwin: Flip's Stereo (H) **Columbia:** D&M Sound (H) **Crestwood:** Flip's Stereo (H) **Jefferson City:** The Stereo Buff (HC) **Joplin:** The Stereo Buff (NC) **Ralla:** End of the Rainbow (H) **Springfield:** Stereo Buff (HC) **St. Louis:** Auto Exotic (C), Best Sound Co. (H), Sound Central (HC)

MONTANA
Bozeman: Thirsty Ear (HC) **Billings:** New Horizons Audio & Music (HC) **Helena:** The Stereo Shop (HC) **Great Falls:** Rocky Mountain Hi Fi (H) **Missoula:** Electronic Ports (H)

NEBRASKA
Kearney: Center Stage Audio Video (H) **Lincoln:** Stereo West (H) **Omaha:** Stereo West (H)

NEVADA
Las Vegas: Imports Audio (H) **Reno:** Stereotypes (H)

NEW HAMPSHIRE
Hanover: Camera Shop of Hanover (H) **Manchester:** Campus Hi Fi (H), Tweeter, Etc. (H) **Nashua:** Tweeter, Etc. (H) **Newington:** Tweeter, Etc. (H) **North Hampton:** The New Audiophile (C) **Rochester:** Campus Hi Fi (H) **South Nashua:** Tweeter, Etc. (H)

NEW JERSEY
Butler: Sound City (HC) **Cherry Hill:** Soundworks (HC) **East Brunswick:** Highway Audio (C) **Eatontown:** Hi Tech Stereo & Video (H) **Edison:** Zippo's Car Stereo (C) **Hasbrouck Heights:** Saddle Brook Stereo, Inc. (C) **Millburn:** Professional Audio Consultants (HC) **Montclair:** Perdue Radio (H) **Morristown:** Sight & Sound (H) **Neptune:** Auto Audio (C) **New Brunswick:** Hi Fi Haven (H) **Northfield:** Sound Inc. (HC) **Paramus:** Harvey Electronics (HC), Leonard Rodio of NJ (H), Perfection Plus (C) **Ridgefield:** Galaxy of Sound (C) **Ridgewood:** Motoring Images (C), The Sounding Board (H) **Scotch Plains:** Electronics in Motion (C) **Somerville:** Lork Electronics (C) **Springfield:** Kartunes, Inc. (C) **Toms River:** Rand's Camera & Hi Fi (HC) **Trenton:** Hal's Stereo (HC), Universal Stereo (C) **Union City:** A & D Auto Stereo Sound (C) **Upper Montclair:** CSA Audio Design (H) **West Caldwell:** Perdue Radio (H), Samm Sound (C) **Westfield:** Stuart's Audio (H) **West Hanover:** Cruisin' Music (C) **Woodbridge:** Woodbridge Stereo Center (H)

NEW MEXICO
Albuquerque: Hudson's Audio Center (HC) **Farmington:** Trio Arts Camera Shop (H) **Santa Fe:** The Candyman (HC)

NEW YORK
Batavia: Vinyl Jungle (H) **Bayport:** Classic Auto Sound (C) **Binghamton:** JSG Audio (H) **Boonville:** Adirondack Music (H) **Bronx:** Bronx Midtown Auto Radio (C) **Brooklyn:** Innovative Audio Products (H), Phil's Auto Radio (C) **Commack:** Sound Approach (HC) **Corning:** Chemung Electronics (H) **Eastchester:** Auto Concepts (C) **Elmira:** Chemung Electronics (H) **Fresh Meadows:** Sound Stage Audio (HC) **Geneva:** The Geneva Sound Shop (H) **Glens Falls:** Audio Genesis (H) **Hicksville:** Audio Exchange (HC), Designatrons Stereo Store (H), Stereo Headquarters, Ltd. Inc. (C) **Huntington:** A B Car Stereo (C) **Ithaca:** Chemung Electronics (H) **Jackson Heights:** Bruckner Auto Radio (C) **Latham:** Clark Music Co. (H) **Manhasset:** Autospec Mobile Electronics (C) **Merrick:** Performance Audio Video (H) **Mineola:** Autaspec (C) **Mt. Kisco:** Homestyle Appliance Inc. (C), The Sound Mill (H) **Nanuet:** Eardrum Stereo (H) **Newburgh:** Audio Expressions (H) **New York:** Borgers Audio Video (H), Bryce Appliance & Record Shop (H), Electronic Workshop (H), Grand Central Radio (H), Harmony House II (H), Harvey Electronics (HC), Park Avenue Audio (H), Sound Effects (C), Thalia Hi Fi (H) **Oceanside:** Absolute Auto Sound (C) **Port Jefferson:** Designatrons Stereo Store (H) **Rockville Centre:** Audio Command Systems (H) **Rochester:** JB Sound Systems (H) **Scarsdale:** The Listening Room (H) **Southampton:** Charos Custom Sound (HC) **Staten Island:** Clone Audio (HC) **Syracuse:** Clark Music (H), Gordon Electronics (HC) **Tonawanda:** Stereo Plus (H) **Watertown:** Happy Ear Stereo (H) **West Babylon:** High Tech Home Entertainment (HC) **White Plains:** Audio Experts (HC), Harvey Electronics (HC) **Whitesboro:** Adirondack Music (H) **Woodside:** K&K Electronics, Inc. (C), Leonord Radio (H)

NORTH CAROLINA
Ashville: Mr. Toad's (H) **Boone:** Highland Audio (H) **Burlington:** Audio Designs (H) **Charlotte:** Sound Systems (H) **Durham:** Audio Visions (H), Mobile Sound Authority (C) **Fayetteville:** Sound Systems (H) **Greensboro:** Sound Systems (H) **Greenville:** Todd's Stereo (H) **Hickory:** Dacia Electronics (H) **High Point:** Sound Source (H) **Jacksonville:** Onslow Audio (H) **Raleigh:** Audio Advice (H) **Wilmington:** Atlantic Audio (H) **Winston-Salem:** Custom Car Hi Fi (C)

NORTH DAKOTA
Bismarck: Eggers Audio (HC) **Dickinson:** Music Hut (H)

OHIO
Akron: Golden Gramophone (H), Northeast Appliance Co. (H) **Canton:** Audio Corner (H), Northeast Appliance Co. (H) **Cincinnati:** Sight in Sound (H) **Columbus:** Hammond Electronics (H), Progressive Audio (H) **Dublin:** Audio Encounters (H) **Elyria:** Northeast Appliance Co. (H) **Euclid:** Northeast Appliance Co. (H) **Fairlawn:** Northeast Applionce Co. (H) **Lima:** Classic Stereo (HC) **Lorain:** Grasso's Audio (H) **Maple Heights:** Northeast Appliance Co. (H) **Marietta:** Sound Room (H) **Mentor:** Northeast Appliance Co. (H) **Miamisburg:** Stereo Shawcase (H) **Middleburg Heights:** Northeast Appliance (H) **North Canton:** Hammond Electronics (H), Northeast Appliance Co. (H) **Toledo:** Audio Center (H), Jomieson's (H) **Youngstown:** Audio Arts (H) **Warrensville Heights:** Hoffman's House of Stereo (H) **Willoughby:** Auto Sound, Security & Accessories, Inc. (C)

OKLAHOMA
Lawton: Hi Fi Shop (H), Modern Method (C) **Oklahoma City:** Audio Dimensions (C) **Tulsa:** Audio Advice (C), Imperial Sound (H)

OREGON
Beaverton: Fred's Sound of Music (H) **Bend:** The Stereo Plant (H) **Eugene:** Stereo Loft (HC) **Gresham:** Fred's Sound of Music (H) **Medford:** Larsons Home Appliance (HC) **Portland:** Chuck's (C) **Portland:** Fred's Sound of Music (H) **Salem:** Focus Electronics (H), Sound Cache (C)

PENNSYLVANIA
Bethlehem: Canlen Audio (H) **Camp Hill:** Hi Fi House (H) **Ephrata:** Stereo Barn (H) **Erie:** P.J.'s Auto Sound (HC) **Fairless Hills:** Audiolab (H) **Hershey:** Stereo Barn (HC) **Greensburg:** Pat's Stereo Center (H) **Kingston:** The Summit Audio & Video (H) **Jenkintown:** Sassofras Audio (HC) **Lancaster:** Glicks Audio (H), Stereo Barn (HC) **Lewisburg:** M&M Stereo (H) **Natrona Heights:** Butch's Sound Shak (H) **Philadelphia:** David Mann (H), Nathan Muchnick (H) **Pittsburgh:** The Audio Gallery (H), Audio Junction (H) **State College:** High Fidelity House of State College (H) **Stroudsberg:** Auto Radio (C) **West Reading:** DS Audio (H) **White Hall:** Sassafras (HC)

RHODE ISLAND
Middletown: Soundings (C) **North Providence:** Eastern Discount (H) **Providence:** Tweeter, Etc. (H) **Warwick:** Tweeter, Etc. **Westerly:** Lesier Sound (H)

SOUTH CAROLINA
Charleston: International Hi Fi (H) **Columbia:** Audio Alternatives (HC) **Greenville:** Stereo Video Connections (H) **Spartanburg:** Road Music & More (C), Road Music (C) **Sumter:** OK Tire Stores of Sumter, Inc. (C)

SOUTH DAKOTA
Aberdeen: World Electronics (HC) **Sioux Falls:** Audio King (HC)

TENNESSEE
Chattanooga: College Hi Fi (H) **Jackson:** H & V Electronics (C) **Johnsan City:** Mr. Toad's (H) **Kingsport:** Mr. Toad's (H) **Knoxville:** Lindsey Ward (HC) **Memphis:** Opus 2 (HC) **Nashville:** Hi Fi Buys (HC), Safe & Sound Auto Stereo (C)

TEXAS
Abilene: Bunkleys Sound System (H) **Addison:** Ear Mark (C) **Amarillo:** The Soundroom of Southwestern Music (H) **Arlington:** Sound Idea (H) **Austin:** Audio Video (H), Hi Fidelity (H), Texas Radio (C) **Beaumont:** Beaumont Sound (H) **Brownsville:** La Frontera (C) **Bryan:** Sound Waves (C) **Cleburne:** Audiocomp Electronics (C) **College Station:** Sound Waves (C) **Corpus Christi:** Dyer Electronics (H) **El Paso:** Sound Quest (HC) **Ft. Worth:** Federated Electronics (H) **Dallas:** Federated Electronics (H), Preston Trails Audio (H) **Houston:** Custom Car Stereo (C), Enviro Tech Maintenance (C), Federated Electronics (H), Sheffield Audio (H) **Nacogodoches:** Spinet Music (H) **Laredo:** Audio Systems (H) **Longview:** Audio Techniques (H) **Lufkin:** Ellis Audio Video (H) **McAllen:** Showery Stereo, Inc. (C) **Odessa:** Harolds Electronics (H) **San Angelo:** Car Fonics (C) **San Antonio:** Bill Case Sound (H), Federated Electronics (H) **Waca:** Highland Camera (C) **Wichita Falls:** Hamilton-Bryan (H)

UTAH
Logan: Stokes Brothers (H) **Provo:** Auto Specialties (H) **Salt Lake City:** Audioworks (H)

VERMONT
Burlington: City Stereo (H) **Rutland:** Sound Directions (H)

VIRGINIA
Alexandria: Excalibur Audio & Video (H) **Bristol:** Mr. Toad's (H) **Charlottesville:** Stereotypes (H) **Fairfax:** Audio Associates (HC) **Fredericksburg:** Contemporary Sounds (H) **Newport News:** Sound Approach (H) **Richmond:** Audiotronics (HC), Gary's Enterprises (H) **Roanoke:** Audiotronics (HC) **Springfield:** Audio Associates (HC) **Virginia Beach:** Audio Connections (H) **Winchester:** Audio Associates (HC), Earfood (H)

WASHINGTON
Bellevue: Cartoys (C), Magnolia Hi Fi & Video (HC) **Bellingham:** QC Stereo (H) **Bremerton:** Evergreen Audio (H) **Chelan:** The Music Store (H) **Longview:** The Music Rack (H) **Lynnwood:** Magnolia Hi Fi & Video (HC) **Olympia:** Desco Electronics (H) **Renton:** Stereo First (H) **Richland:** Quicksilver Audio (HC) **Seattle:** Cartonics (C), Magnolia Hi Fi (HC) **Spokane:** Eclipse (C), Electracraft/Hals (HC), Steiner Electronics (H) **Tacoma:** Magnolia Hi Fi & Video (HC), Music Machine (C) **Wenatchee:** Wenatchee Audio/Video (H) **Yakima:** Stereo First by Bemis (HC)

WEST VIRGINIA
Charleston: Hi Fi Clinic (H) **Huntington:** Mack & Dave's (H) **Keyser:** Custom Components (H) **Princeton:** Sound Post Electronics (H) **Wheeling:** Look and Listen (H)

WISCONSIN
Appleton: American TV (HC), Sound World (H) **Eau Clair,** EME (H) **Green Bay:** Sound World (H) **LaCrosse:** Sound World (H) **Madison:** American TV of Madison (HC) **Menasha:** Audio Elite (H) **Milwaukee:** Audio Emporium (H) **Oak Creek:** American TV (HC) **Waukesha:** American TV (HC) **Wausau:** Sound World of Wausau (H)

WYOMING
Gillette: Murphy Sight (C) **Ranchester:** Serna's Speaker Service (C) **Sheridan:** Sheridan Sound Systems (C)

(H) = Home Audio Dealer
(C) = Car Audio Dealer
(HC) = Home and Car Audio Dealer

EDWARD TATNALL CANBY

PRESERVATION OF THE SPEAKIES

Illustration: Michael A. Donato

My excursion last month into the old question of what is music (and what isn't) has kept me thinking for another month on further implications, of a sort that are never very far from my mind. Sound—the basic subject matter of audio! We should pay more attention to the "audio" that is all around us, both live and reproduced, those sounds that are intended for practical purposes, and those that are purely accidental—or, should I say, incidental. It's all part of our new sonic history.

Incident or accident, many sounds just happen and then take on their own sonic life. Yes, life. They are very alive when your sensitive ears hear them! Take the excruciating squeal of a subway train rounding a too-sharp corner, for instance. Or the similar squeal of faulty automobile brakes. You can't call these sounds week-kneed. They stand up and hit you where it hurts. These and a billion more can be very potent in ways other than just the decibels. And thereby they are full of emotional impact for our human sensibilities, mostly unintended but sometimes on purpose.

That emotion can be nasty, painful, even sickening. Or, in different sonic areas, quite pleasurable, amusing, satisfying, even intriguing, making you ask, "What *is* that peculiar noise I'm hearing?" Like the strange accidental combination of a lawn mower and a passing helicopter that had me baffled, last summer, until the chopper went away and the mower stayed put. Or, of course, a new and strange visiting bird, its peculiar song unidentifiable. "What's *that*?" you ask. The last such, around my place, turned out to be a pileated woodpecker, big as a crow, black and white with red crest. Squawk, squawk, in a pine tree over my head, then YAK-YAK-YAK, very loud, as he flew away, to land in a heap in another pine tree. They are clumsy birds as you watch them.

You could say that these sounds, and plenty more, have audio potential. They are distinctive, they have an impact of one sort or another on people. They could become part of an audio message, even an entertainment—or perhaps a piece of music, a work of organized sound, to be reproduced on audio equipment. Certainly no more far-fetched than the factory noises "organized" by Edgard Varèse! And no more so, today, than the "music" of whales made into organized and playable compositions. Look in the Schwann catalog; you'll find the whale music, on records.

The phenomenon that provokes all these thoughts is sound recording. It remains, after more than a century, one of the more astonishing accomplishments in man's history. Was Napoleon a tenor or a bass? Did George Washington speak with a boom or a whine? Sketchy accounts may give an idea indirectly, but, like a picture, a recording is worth a thousand words. Did old man Caesar ever actually say *"Veni, vidi, vici"* ("I came, I saw, I conquered")? I, for one, would like to have heard him. Curious that in most Christian music, especially Lutheran music, the singing role of Christ is given to a bass. *Was he a bass?* The bass sound is not intended literally but simply represents dignity and quiet power in musical terms. In the same music, interestingly, the narrator of the story, when and if, is almost always a high tenor, as in the "St. Matthew Passion" and the "St. John Passion" by J. S. Bach. That would seem to be a practical thing, the tenor voice being more in the intelligible range of speech. A low bass, like a high soprano, has difficulty enunciating words, especially the vowels.

Before sound recording, there is, historically speaking, only an enormous silence. For centuries, millennia, millions of years. History, after all, is the entire remaining "record" of all those generations of man, back to the relatively recent times when writing was invented, and, much farther back, via artifacts, bones, the remains of buildings, tools, and the rest. We conventionally date modern history—the kind studied in the history departments of universities, as opposed to anthropology, paleontology, archaeology—from the time of the invention of writing. That's pretty arbitrary, what with all sorts of glyphs and pictures, from the Babylonian and Egyptian to the Mayan. What's more, a lot of the "writing" is still undecipherable or at best of doubtful meaning. (*Editor's Note:* A lot of current writing, unfortunately, is also that way.—*E.P.*) Still, that is the dawn of history in official terms and in most people's minds.

Wrong! It shows how abysmally

Was Napoleon a tenor or a bass? Sketchy accounts may give an idea, but, like a picture, a recording is worth a thousand words.

short do we value the dimension of sound. Sound, audio when taken down and given our special treatment, is an enormously important part of human life. I suppose it isn't very useful to set the dawn of a more complete history, with sound, in Thomas Edison's day, but that is the case. Can you hear what I mean? A meager century of archaeological sound documents, and before that, thousands of centuries of total silence.

Remember the now-famous skull of a very ancient proto-young girl whom archaeologists named Lucy? If Lucy in fact lived some millions of years ago, what did her voice sound like? Much more important, *did she have a language?* We do not know because, literally, we have no record. We can only say that, by the shape of her bones, she might have spoken *something*. What? Imagine if we knew. Would *that* be history! On a more modest scale, we do not really know how Queen Elizabeth I talked, though we have her language in terms of print. Yes, the scholars have done plenty of indirect sleuthing to figure out how those words were pronounced, but nobody on earth really knows, from first-hand (recorded) experience. All-silent sleuthing can give us clues, but no more than that. Not the sound itself. Not an absolute proof, only an indication.

"Blow, blow, thou winter *wind*; thou art not so *unkind* as man's ingratitude." How do you pronounce that? What did it sound like as Shakespeare put it down in so many letters? (Was it actually "blou"? Most Shakespeare spelling has been modernized over the years.)

These unanswered questions, and plenty of a great deal more importance, are the negative consequences of not having audio—not being able to preserve and collect the many sounds of civilization and its surroundings, over the entire span of human existence until just yesterday.

The existence and recordability of a thing like language encourages us to do something more with that language than we've done before. When it became possible to record words—not in sound, but visibly in writing—all the facts (and supposed facts) of history were put down by the ancient historians, and very soon also there was

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We're in the middle of a great sonic revolution, but we don't listen well at all. Who can blame us? This is a noisy age.

"art"—words for organized entertainment, repeatable, whether serious or humorous. All these things appeared quickly, though we are told that the earliest Near East writings on clay were almost entirely routine accounts for business. How dull. It couldn't last. That clay *had potential*. The Mayans, on this side of the world, did a lot more, if somewhat later: Elaborate accounts of kings and gods and generally awesome pomp and grandeur. Also that well-known, reliable calendar, which kept in step with nature more precisely than the European one then current, if I have it right.

I am just trying to put an enormous framework around our audio, to get it into a global focus. We are bigger than we think, not in dollars but in the sum of human civilization from 1877 on. We have a totality of tools that preserve an enormous area of life—good, bad, or indifferent—which has been slipping into eternity, vanishing, for the entire existence of this planet prior to 1877.

Therefore, I say, we are in the middle of the greatest sonic revolution in man's existence. *Of course* we should be aware of all sounds. Of course we should listen to all the sounds around us. You never know when one of these will become crucial in a day's audio work or an evening's home listening.

We don't listen well at all, and you can't really blame us. This is the noisiest environment in thousands of years, and we have to adapt, physically. We screen things out; we get so we don't listen. And yet, we also get so we can't manage without noise, constant sonics all the time. We go out and manufacture extra noise in the form of music, mostly very loud but also insidiously soft, and this noise never stops at all for most of us, day in and day out.

We are deathly afraid of that which brings out our most acute ear sensitivity, silence. Down in the mini- and micro-decibels, we are good; we can hear right to the threshold of Brownian movement, the sounds of basic particles in motion. Nature wisely stopped there, or we would be drowned in white noise. But do we use this acuity? Not often.

This has happened so fast! People born back in the age of occasional silence, a few decades ago, are profoundly distressed by the never-ceasing sound. It gets at you, into your very sense of living in a real world. This is not the world many of us were conditioned for. But it is for younger people. And that is dangerous. They are losing the best virtue of one of our two crucial senses, not merely the ears themselves but *the use of them*. As the Bible might say, they listen and they hear not.

Please, then, listen to small sounds, listen to *all* sounds. And experience the cleansing, healing effect of *silence*—maybe a whole minute at a time. What a message for an audio man!

Bass vs. Space

It's an old dilemma: To tolerate those large, room-dominating loudspeakers for the sake of true bass? Or sacrifice bass for the sake of more living space?

The classic solution to this problem—a solution that allows even efficiency-dwellers ample bass *and* space—is the satellite/subwoofer speaker system. Simply put, the mid-range and high frequencies are delegated to a pair of small satellite loudspeakers, placed for optimum stereo imaging. The bass is handled by a single large subwoofer unit, which can be hidden virtually anywhere in a room. (How? Frequencies under 100 hz are nondirectional; the ears can't tell where they're coming from. So one subwoofer suffices.)

The most common kind of satellite/subwoofer system is "passive" (externally powered), such as the Canton Plus C.

Active Advantages

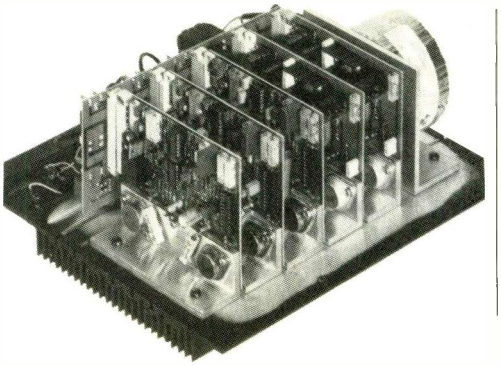
The Canton Plus Beta subwoofer looks much like the Plus C, but does the job quite differently. That's because it's "active" (internally powered).

Canton's Plus Beta active subwoofer.

Don't have a preamp? No problem, your receiver can drive the Plus Beta too. The amplified power from your receiver is dropped down to preamp line level and the Plus Beta amplifies this signal through its own three amplifiers.

Canton has a variety of satellites to choose from: minis, indoor/outdoor, ultra-thin speakers or bookshelf units.

Featured at right are the Plus S mini speakers. Like most Canton products, they are available in black, white or walnut.



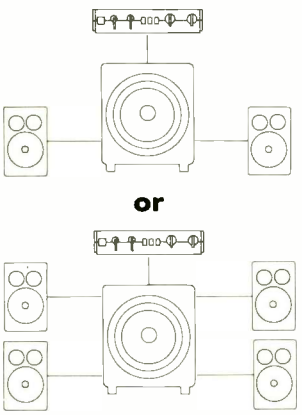
The Plus Beta contains three discrete power amps with digitally controlled active filters. They are frequency-driven and provide dynamic soft clipping for overload protection. The bass amplifier is rated at 100 watts RMS power; the satellite amps at 80 watts RMS per channel. THD is less than 0.01%.

Three advanced power amplifiers are built in, one custom-designed for the subwoofer and one each for the satellites. The active crossover network has three selectable crossover frequencies, allowing unparalleled flexibility in matching the Plus Beta with satellites. There is also an input sensitivity control and a bass level control.

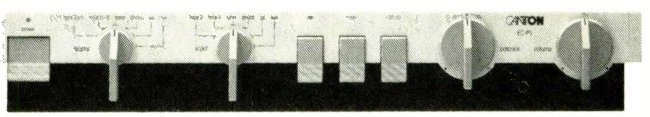
Consequently, the Plus Beta can be used with a wide variety of satellites. For example, Canton's affordable and very compact Plus S or the high-performance Karat 100. If desired, the Plus Beta can accommodate two pairs of satellites. By way of driving the Plus Beta, virtually any preamp or receiver will do, whether a high-end unit such as the Canton EC-P1 or a more modest design.

Where space is at a premium, but the awesome dynamic range of digital program sources can't be missed, there's no better option than an active subwoofer such as the Canton Plus Beta.

The Plus Beta's control panel allows adjustment of: crossover point, for perfect matching with any satellite loudspeakers; input sensitivity, to optimize preamp compatibility; and bass level control to adapt for room characteristics.



The Plus Beta can accommodate an extra pair of satellites, either in the same room or as extension speakers in another room.



A Plus Beta subwoofer/satellite system can be driven by any preamp, such as Canton's EC-P1.

Find out more about the entire Canton product line by visiting an Authorized Canton Dealer and picking up Canton's 1986/1987 40-page Loudspeaker Journal.

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KEN POHLMANN

THE SURGE TO KILL

Illustration: Steve Dinnino

I confess: I'm a guy who rides large-displacement motorcycles too fast for complete control. And yet I'm pretty careful when it comes to electronic equipment. Maybe it's because it seems so helpless when it expires suddenly at the cruel hands of fate. At any rate, electronic equipment (particularly digital audio gear) is vulnerable to both annoying and catastrophic power-line problems. Even if you don't have any respect for your own mortality, your stereo gear should have line spike and surge protection, with hash filters thrown in too.

Partly it's a question of probability. For example, lightning strikes can occur anywhere, but they tend to favor certain unlucky areas. (There is no truth to the rumor that South Florida became a high-risk area only after I moved here, a few years ago). One lightning discharge might measure a million amperes and several million volts, providing instantaneous power of a trillion watts. A direct hit isn't required for damage; a strike anywhere in a local utility network can cause a spike of up to 5,000 V, lasting 100 μS, to head right up your power cord.

The other odds which must be considered are man-made fluctuations in line voltage. For instance, spikes can occur when inductive loads are switched off; when a transformer or motor coil is de-energized, the collapsing magnetic field sends a voltage spike of perhaps 3,000 V, or more, back through the line. This spike in the circuit can affect other circuits as well; wiring capacitance can couple transients from one wire to another or from a wire to ground. A vacuum cleaner on one circuit may affect your CD player on another.

Other man-made line variations proliferate. Aside from blackouts and brownouts (5 to 15% voltage reduction), surges above nominal line voltage, and sags below it, can occur. Surges and sags are long-duration problems (as opposed to transients) stemming from load fluctuations in the network; their magnitude depends on the size of the load. The starting current of a motor, a refrigerator, or an air conditioner, for example, can cause a sag, manifested by a momentary dimming of lights. A sag might measure as a 20% reduction in line voltage, lasting hundreds of milliseconds. Surges typically are caused by a sudden decrease in utility demand, resulting in an over-voltage until the system can compensate. Both sags and surges might also occur as a result of a lightning strike as the system tries to cope. The farther away you are from a power plant or substation, the greater the chance of fluctuation.

What kinds of problems can occur from power-line fluctuations? Anything from flakiness to annihilation. Integrated circuits are thoroughly checked before leaving the fabrication plant, but a certain percentage inevitably appears at the low end of the reliability scale. A marginal chip may fail (perhaps much later, intermittently) when subjected to the stress of power-line fluctuations. Aging due to normal wear and tear is accelerated by over-voltage conditions caused by surges and spikes. More severe over-voltages damage power-supply components as well as chips. If there is no filter, or if there is some low-impedance path to ground, the surge or spike will use the device as its sink. A rectifier diode might fail while handling a fraction of its rated current, voltage-regulator ICs and transistors might blow while not even running warm—all thanks to surges or spikes.

Even a powered-down device can be critically damaged; the surge may arc across the power switch, applying high voltage to the device. A lightning strike may cause a common-mode voltage surge in which both power lines are raised to a high potential relative to earth. The high voltage may cause arcing across conductors and ground, destroying anything which happens to be between them. The result: Barbecue.

Unquestionably, lightning is potent stuff, but some simple measures can go a long way. Lightning rods are designed to provide an attraction point and current shunt. The rod itself is a sharp-pointed copper shaft connected by a copper cable to a copper-plated steel rod buried in the ground. When mounted at the highest point on a structure, the rod offers a zone of protection around it; larger structures require multiple rods. Because of the extreme voltages present in a lightning strike, flashover can carry high voltage to conductors 1 foot away. Furthermore, induced surges can spring up in any nearby conductors.

For increased protection against lightning strikes or any kind of power surge, transient suppression is required. Lightning arrestors such as

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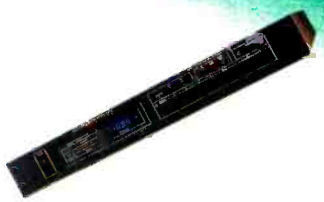

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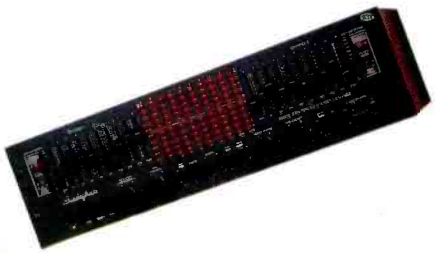

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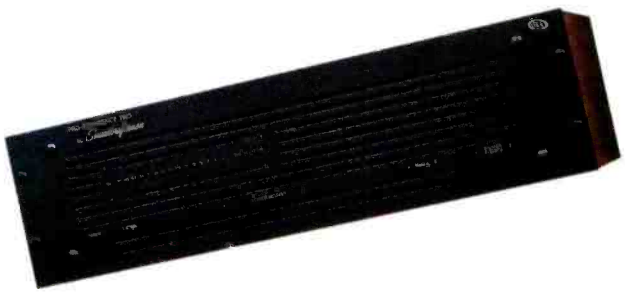

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Digital equipment, such as a CD player, is a prime source of electrical interference, FCC rules notwithstanding.

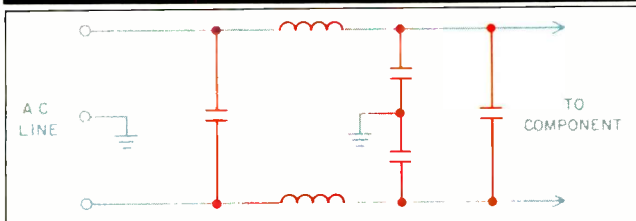

Fig. 1—A simple a.c. line interference filter.

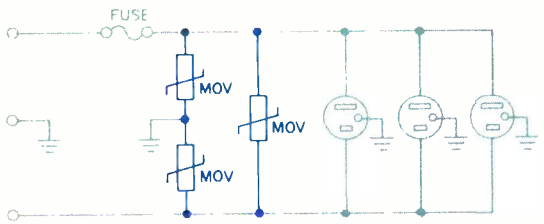

Fig. 2—Installation of MOVs in an a.c. outlet box.

zeners, thyristors, or varistors should be placed across the a.c. line and between a.c. lines and ground. A high-power zener network can be located across power-supply secondaries or between rectified outputs and ground. A heavy-duty solution to recurring problems is the installation of a constant-voltage transformer, which can minimize the effect of both surges and sags. Isolation transformers provide an ideal way to protect equipment from power fluctuation.

In addition to power surges, noise (often called hash) on the line can cause nonlethal yet annoying glitches. Sources of hash include motors, small electrical appliances, corroded light sockets and cords, fluorescent lights, SCR or triac dimmers, welders, X-ray machines, photocopying machines, d.c. switching power supplies, and internal combustion engines. We may classify the noise as radio frequency interference (r.f.i.), electromagnetic interference (EMI), or electromagnetic pulse (EMP).

Digital equipment itself (e.g., your CD player) is a prime source of electrical interference, FCC requirements notwithstanding. With system clock frequencies of 1 to 10 MHz, and the resulting harmonics, broad-band interference up to 54 MHz (channel 2) or beyond can be anticipated. Digital gates open and close at high speed—a rate equal to r.f.i.; that confusion between normal digital signals and generated noise can cause internal errors as well as errors in surrounding equipment. Ironically, not only is digital equipment a prime culprit, it is also more susceptible to noise than ordinary appliances.

A simple AM radio can be used for EMI testing; tune it to the loudest noise and then wander around looking for sources. Not only will digital equipment radiate noise, but connecting cables are culprits as well. An a.c. cord can radiate noise (especially if it's long and ungrounded).

Low-pass filters are effective against both transient and noise problems; they allow 60 Hz to be passed whereas high frequencies are attenuated. This is accomplished by a high series input impedance and a low shunt impedance to ground. A parallel capacitor or series coil is the simplest example; veteran digital designers are well familiar with the 0.01-μF capacitor placed between the power buses and ground to suppress switching transients. More typically in protection devices, L, T, or pi sections are employed; although the filter should be installed at the point where the line enters the equipment's casing, it is usually inserted at the power receptacle. An example of an r.f.i./EMI filter is shown in Fig. 1.

Hash filters can be installed in the device under attack. However, a more enlightened approach counterattacks by eliminating hash at the source. Any defective wiring should be replaced, filters should be put on noisy tools or equipment, all covers and shields should be securely fastened, and grounding rules should be scrupulously followed to minimize interference. A list of rules for r.f.i./EMI protection includes the following: Enclose sources and receivers within a shield, filter all incoming and outgoing leads, use shielded coaxial cable for high frequencies and twisted leads for lower frequencies, use single-point grounding, eliminate ground loops, and keep signal-sensitive leads short.

In addition to filters, crowbar circuits and voltage clampers can be used to suppress transients. Crowbars use a thyristor or spark gap to divert transients. It is critical to ensure that the protection device can operate quickly enough to catch spikes; SCRs and triacs, for example, are often too slow. A metal oxide varistor (MOV) is a voltage-clamping device; it operates in a way similar to that of a back-biased zener diode. Below the threshold voltage the MOV is an open circuit; above the threshold it conducts and thus absorbs the transient, dissipating it as heat. An MOV can respond to a transient in a few nanoseconds, with peak current capacities up to 50,000 amperes with a wide variety of operating voltages.

In terms of bang for the buck, the MOV is perhaps the most effective insurance you can buy. It guards against high-energy power-line transients and can be installed in existing power strips. For example, the General Electric V130LA10A MOV will clamp to 340 V at 50 amperes in 35 nS; it is available from Radio Shack. Three of them should fit neatly inside a power strip, wired between the hot, neutral, and ground wires as shown in Fig. 2. An MOV does not guard against hash; a separate line filter must be employed.

When specifying power-protection devices, you must determine how many output watts your application requires. Add up the ampere ratings of the equipment to be protected on a line, multiply by the voltage (120 V), and throw in some headroom; the resulting figure is an approximation of the wattage required to operate the devices and the rating required of the protection device. A good protection device should offer fast response to repeated voltage spikes and high-frequency filtering for incoming and outgoing noise.

Line protection—you can pay a little for it now, or you can pay a lot for it later.

'Before we could make our speakers better, we had to invent a better speaker test.'

—Laurie Fincham, DIRECTOR OF KEF RESEARCH AND DEVELOPMENT

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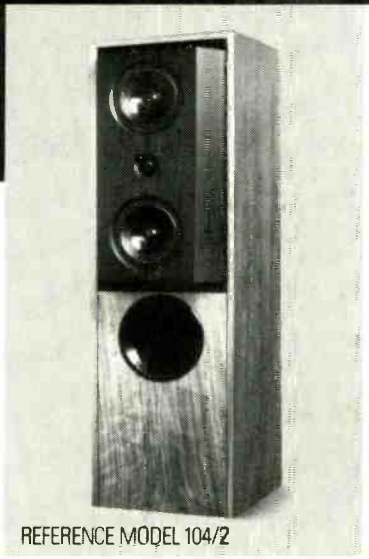

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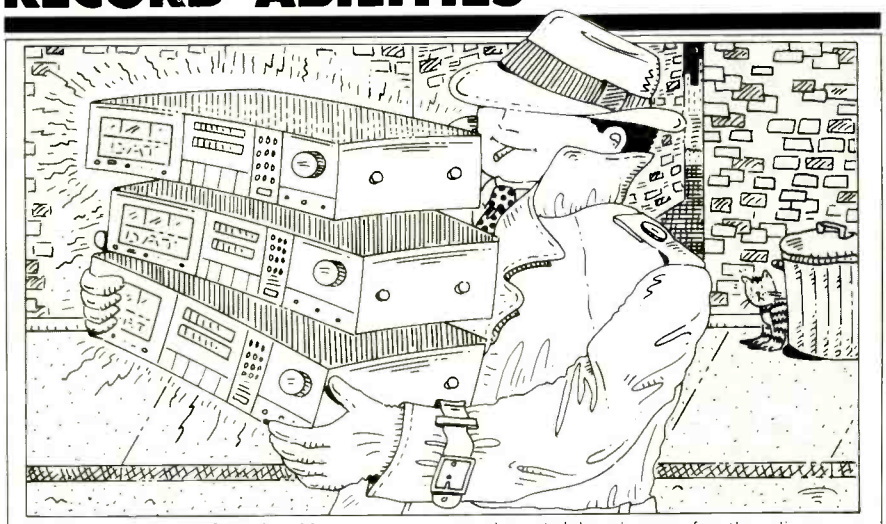

Illustration: Teresa Anderko

Get 'em Before They're Hot

While Congress makes up its mind about the future U.S. status of home digital recorders, at present they're perfectly legal—and what's more, they're more or less (though mainly less) available.

There are currently two types of digital media: R-DAT and video-based systems. If you have a VCR, you can get an EIAJ-Standard PCM converter that will allow the VCR to record digital sound in either a 14- or 16-bit format, though without any accompanying video. Toshiba's new DX-900 VCR has such a converter built in, for the 14-bit EIAJ format only. Some 8-mm VCRs record PCM audio along with their video, but 8-mm PCM uses only 8 bits (with analog compression) and a sampling rate of only 32 kHz, which seriously limits the fidelity.

A few U.S. dealers have begun importing R-DAT tapes and recorders on their own. So far, I've seen ads from Audio Gallery in Santa Monica, Cal. and Sterling International in Princeton, N.J. I wouldn't be surprised to hear of more.

Eventually, CD player/recorders will come out of the labs and into the stores, to compete with DAT recorders. Assuming equal recording quality, how will the two compare?

Part of this comparison is time-dependent. If both CD and DAT recorders were available today, CD would have a clear edge in compatibility with existing hardware. If you could buy a CD recorder now, you'd have no problem finding car and portable players for the discs you made. If you bought a DAT recorder, you'd have nowhere else to play your tapes (as yet). However, DAT is getting to the market first. It's been on sale almost a year in Japan, should be available in Europe when you read this, and may even make it into the U.S. if Congress doesn't hamstring it. If DAT has a long enough lead time before recordable CD arrives, and if it drops in price enough to become popular, much of CD's market edge would disappear.

When it comes to durability, each medium can withstand some kinds of abuse better than the other. The DAT shell, with its automatic lid, protects the tape against dirt and dust and against fingerprints on the recorded surface. But DATs will eventually wear out with normal play, while CDs won't. (So far, no one knows how many plays a specific tape will withstand without signal deterioration; judging from the kind of progress made in videocassettes, which use similar rotating-head technology, R-DAT cassettes should be good for at least 100 plays and possibly well over 300.)

As to convenience, the R-DAT fits most pockets better than the CD does, and the R-DAT box is definitely easier to open, especially with one hand. The Compact Disc offers faster track-to-track access, but for music applications I don't think that's quite as important. (Interactive CD systems will be another story.) All in all, as far as convenience goes, chalk one up for DAT.

Something to Flip Over

Pull a component out of your stereo system, and lean over the top to look at the connections on its back panel.

What do you see? A bunch of jacks, each labelled (from your viewpoint) upside down. I've always taken that for granted (cursing it all the while), but now I wonder why I accepted it so meekly. A rear view of the British-made Audio Development AD 062 mixer, in the Italian magazine *Audio Review*, showed its designations (even the company logo!) upside down—or rightside up, to those bending over it. Now that's a professional feature I'd like to see on home hi-fi!

On the other hand, there are those whose systems can be pulled out from the wall, allowing the rear panels to be viewed normally. Perhaps jack designations should be printed both rightside up and upside down, to cover both possibilities. Or would it be simpler to print them sideways? That way, no one would have to reorient himself more than 90° to read which jack is which.

(*Editor's Note:* And why isn't the back panel sloped at 45°, with a top shorter than the bottom? Or you could even have the jack field arranged vertically; the usual on-the-back array is like trying to look into one's navel.—*E.P.*)

Historic Circles

A year or so ago, General Electric purchased RCA. That had a nice, historic ring to it, since RCA had begun as something of a spin-off from GE, and since GE's early-Deco New York office building, decorated with lightning bolts and other symbols of electronics, originally was RCA's.

The recent sale of the GE/RCA consumer electronics business to Thomson SA of France has an historical angle too. Back in the 1950s, GE was a major name in component high fidelity, making preamps, cartridges and tonearms. Though GE itself is not getting back into that business, one of its stable mates in the Thomson empire, Dual, has been in it for years. And another stable mate, Telefunken, was one of the pioneers in early tape recording.

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'For decades, loudspeaker design was a matter of random trial and error. Engineers had no systematic means of identifying and correcting development problems.

'At KEF, computerised testing and computer-aided design have changed all that. For example, KEF's computerised modal analysis enables me to pin-point troublesome cabinet vibrations. And it helps me determine the most effective countermeasures.

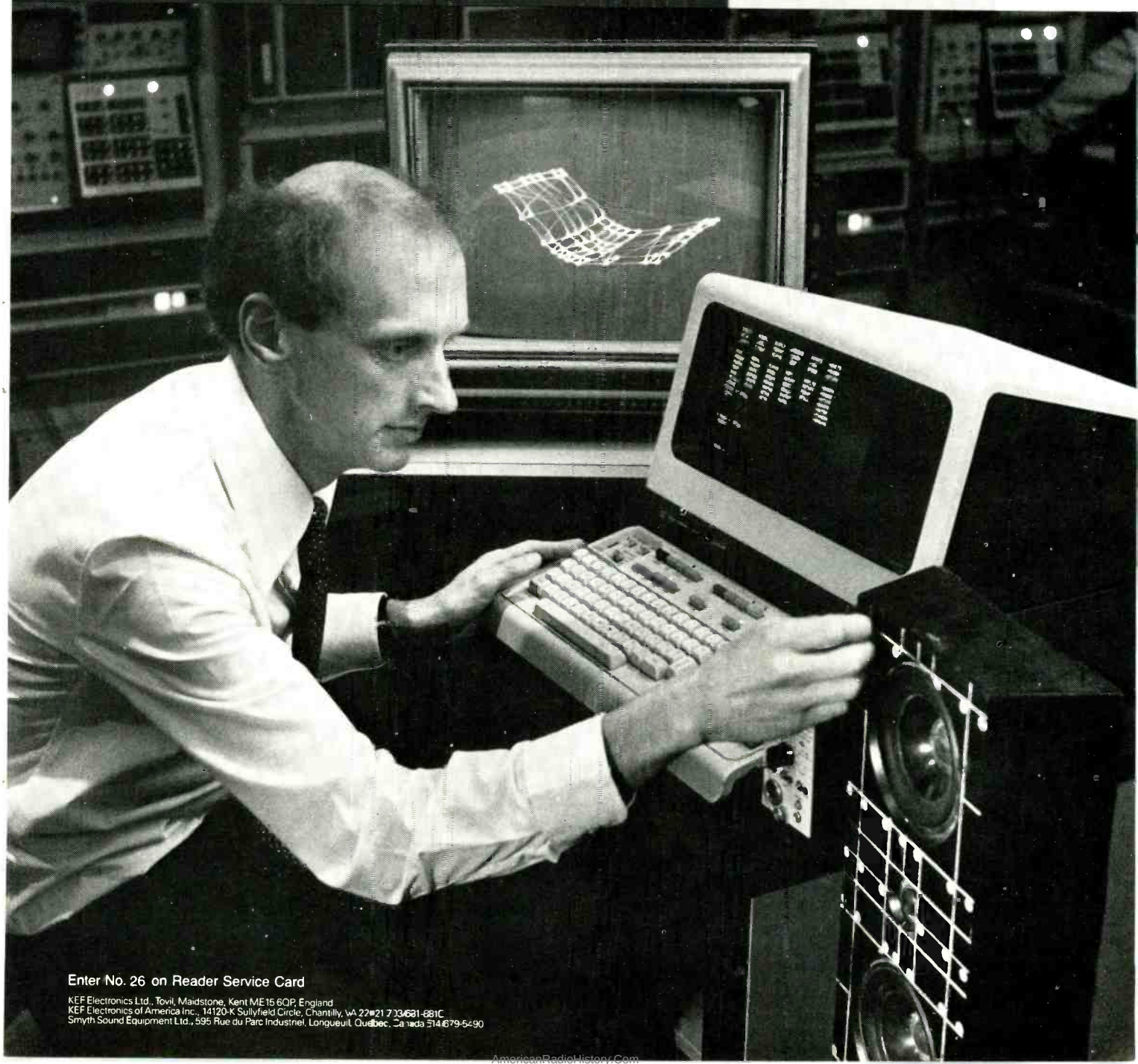
'While computers will never take the place of innovative engineering, they do enable us to examine and perfect loudspeaker performance as never before.'

KEF
The Speaker Engineers

MODEL C40

'By the time we build the final prototype in wood, we've already "built" dozens on computer.'

— Tim Barton, KEF SENIOR RESEARCH ENGINEER



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IVAN BERGER

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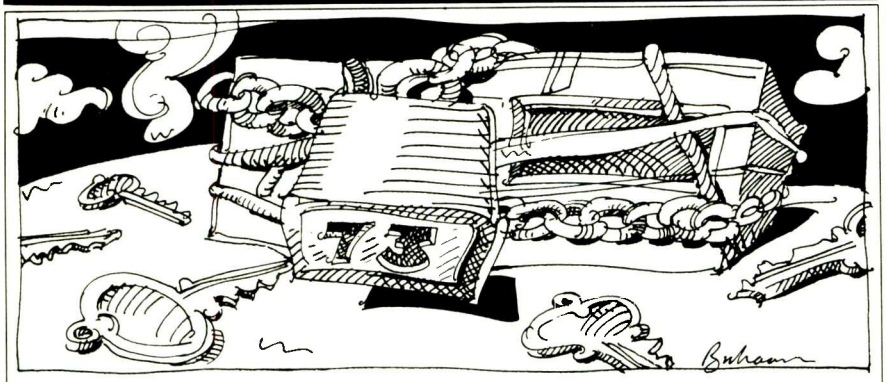

Illustration: Yvonne Buchanan

Code Alert

When cut off from their power sources, car stereos go dead. A stereo with secret-code protection will still play dead after the power is reconnected, until the proper code is entered via its station buttons. This renders the unit useless to a thief who removes it from the car, but it can also render it useless to you if the power is cut off due to a fuse failure or while a mechanic is working on the car's electrical system. If you remember the code or have it written down, no sweat; if you don't, you'll have to get the code from the radio's maker or, if you set the code yourself, ship the radio back to the maker for repair. Practically every auto mechanic I know has run into this problem.

So keep your code number where you can find it easily—but not in the car, where a thief might also find it. If your stereo's factory-set code was not revealed to you when you bought the unit, write to the manufacturer (with proof of purchase) right away, so you'll have the number if you need it. If your stereo lets you make up your own code, pick one that's easy to remember but hard for thieves to guess. One two-car family I know codes each stereo to the other car's license plates; another family uses the digits that both children's Social Security numbers have in common.

Some manufacturers take things out of your control. For example, the Becker stereos sold with Mercedes-Benz cars can't be restarted by their owners after power interruptions. Instead, the car must be taken back to a Mercedes dealer or the stereo must be pulled from the dash and shipped (with $16 and the chassis number of the car) to Becker North America in Saddle River, N.J.

Four Will Get You Seven

A few years back, when I asked someone from Delco why their radios had only four station preset buttons, he explained that market research showed that four memories were all most people needed. So when I reported on a Delco-GM/Bose system in the December 1986 issue of *Audio*, I assumed that its four-button Delco head unit had only four station memories per band.

Not so. A week after that story had gone irrevocably to press, I met a Delco engineer who told me that the radio actually has seven memories per band. The three extra memories are accessed by pressing two adjacent buttons—which amounts to pressing the cracks between the pairs of buttons. The owner's manual doesn't mention this, but word is getting out to Delco owners anyway. As soon as the December issue reached subscribers, I started hearing from owners of GM cars who use all seven memories. ("Don't tell GM," said one owner. "They'll take it away if they find out.")

Meanwhile, Carver's Model Nine has a system that's similar, but with 15 memories (eight buttons plus seven cracks); it *is* mentioned in Carver's instruction book. Chrysler has some four-button head units with eight memories per band, but you access the extra memories differently: Pressing any button once calls up the first station; pressing it again calls up the second station.

Month of Misfortunes

July was a bad month in the car stereo department, at least as far as my car was concerned. My problems started when I got a couple of bright blue car-stereo carry bags to use when taking my removable head unit and Compact Disc player from the car. Ironically, that helped me to lose my CD unit.

It happened when someone else drove the car one day, with my head unit plugged into the dash and my CD player tucked beneath the seat. On leaving the car, the driver dutifully unplugged the head unit and took it upstairs in one bag but left the other bag in plain view on the seat. *Aha!* said some passerby, *where there's a bag, there's a stereo!*, and it was gone.

The last time my stereo was stolen, again someone else had been driving. In that case, my friend left packages sitting on the seat; they were big enough to be seen from a block away. He also parked the car in a lot where there was no attendant, few passersby, and meters that showed which cars' owners would likely be away for quite a while. Although the packages probably drew the thief's attention, all he or she took was the stereo—probably because the doors couldn't be unlocked, and the packages would not fit through the car's windows.

The day after my more recent theft, my wife and I set out for Boston. On the way up, we noticed a hydrogen sulfide smell. "Bad gas," said a mechanic we consulted. "Run the car till it's nearly empty, then refill with a good brand and add some Dri-Gas." The car got up to Boston fine, but when we tried to restart it on the way home, the starter just clicked, though the battery read about 13 V. We rolled downhill to start it and went on our merry way until the car stopped dead on the highway, halfway home, all systems dead and steam pouring from the battery. The smell was from the battery fluid boiling, caused by failure of the voltage regulator. The high voltage had also killed the starter motor, and the voltage spike when the car expired killed the head unit, several amplifiers, and even the retractable-antenna motor.

Artistry in Sound

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Integra Series

DX-530 • DX-330 DX-230 • DX-130 • DX-C600

OPTO-COUPLING

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An Enlightening Experience. Listen to Onkyo's New Line of CD Players with Opto-Coupling*.

The technology behind the great sound of CD is optical technology, but there's no reason to limit it to the laser pickup. Onkyo realized that something more was needed to obtain the best possible sound from compact disc, so they invented Opto-Coupling. It separates the CD player's digital and analog blocks of circuitry electrically to eliminate DSI (digital signal interference) and bring you CD sound free of digital pulse noise. Just as important as what happens to the digital data signal midway between the laser pickup and the output terminals, however, is the integrity of its source — the laser pickup itself. Onkyo's special vibration damping system helps prevent tracking errors and the inevitable deterioration in signal quality that occurs when the error correction circuitry must operate excessively.

This introduction to Onkyo's new CD player lineup ends, as it began, with light — infrared light, that is. All of Onkyo's CD players (with the exception of the DX-130) include remote control units for extra convenience. In addition, the displays have been upgraded to give you more information in an even easier-to-read format.

In the dark about which CD player is for you? Just audition one of these brilliant performers. You're sure to be enlightened.

Light Bridges the Gap between Digital and Analog

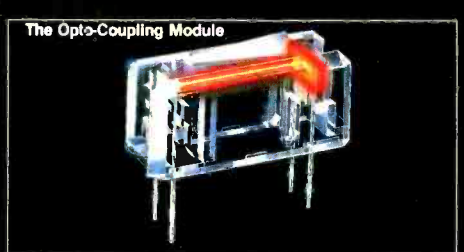
Onkyo's Opto-Coupling* with the Exclusive Opto-Coupling Module

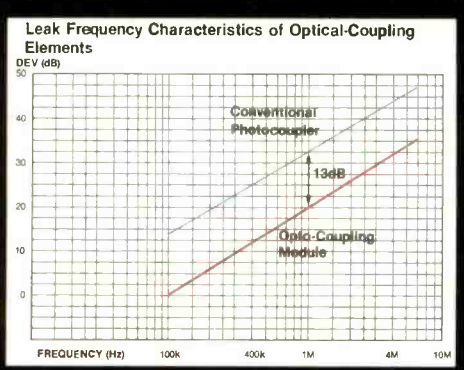
All CD players contain both digital and analog blocks of circuitry. If stray digital pulses from the digital circuit block find their way into the analog block, however, they can interfere with the music signal and cause your CDs to sound edgy and unnatural. Opto-Coupling keeps digital pulse noise out of the analog circuitry by electrically isolating the digital block.

The music signal must nevertheless be transferred to the analog section somehow, and this is where the "opto" of Opto-Coupling comes in. Beams of light, not electricity, transmit the necessary signals via a "bridge" composed of photocouplers and Onkyo's revolutionary "Opto-Coupling Modules." These modules, an Onkyo exclusive, each use an 11mm strand of optical fiber to link the emitting and receiving photodiodes. This design reduces high-frequency signal leakage by approximately 13dB compared with conventional photocouplers. Since there is no electrical contact at all between the digital and analog blocks, DSI (digital signal interference) doesn't even have a chance to develop. The resulting sound is clear and lifelike, without the harshness sometimes associated with the CD format.

Ladder-Network Type Integra Linear Converter

Conventional integrated D/A conversion systems require a quartz oscillator — yet another possible source of extraneous pulse noise. Onkyo overcame this problem by eliminating its root: the quartz oscillator in the analog block. The ladder-network type D/A converter in the DX-530 and DX-330 was developed specially for systems like Onkyo's which employ serial optical transmission. This "Integra Linear Converter" doesn't need a quartz oscillator in the analog circuit block in order to operate, so it generates no pulse noise.



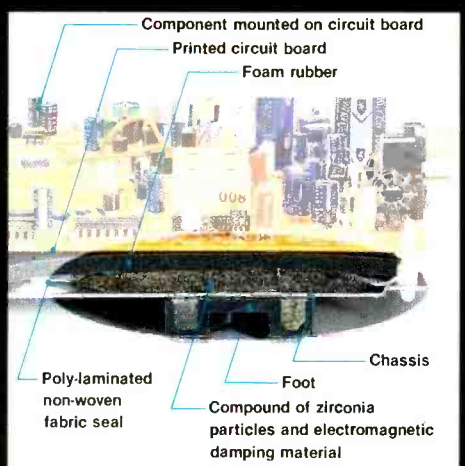


Light that Never Wavers

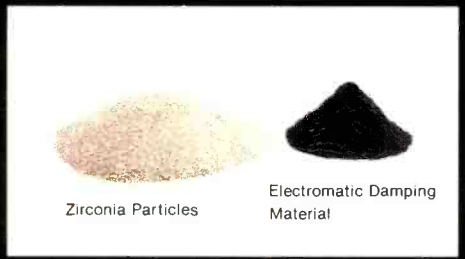
Special Vibration Damping

While any CD player's correction circuitry can protect you from data read errors so that you aren't exposed to the constant clicks and pops that plague analog records, it can't fully make up for the absence of the correct signals. The result is that you lose some of the detail you would have been able to hear if the correction circuitry had not had to operate in the first place. Clearly, the less correction needed, the better.

Onkyo's IFS (Isolated Floating Suspension) system separates the disc drive section from the chassis and suspends it on springs and four rings made of special vibration-absorbing material. The cover, which is the part of the unit with the largest surface area, is also specially damped by a protective layer of mica particles, bitumen and resin which kill vibrations by converting them into heat energy and thereby stop outside vibrations from being transmitted to any sensitive systems. Finally, the underside of the analog block's printed circuit board is protected by a specially designed insulation packet containing a compound consisting of zirconia particles (a new, high-tech material) and electromagnetic damping material. In addition to fighting vibrations in the same way as the cover's protective layer, it also absorbs stray electromagnetic flux from the components mounted on the circuit board — another possible cause of interference and distortion.



Insulation packet containing a compound consisting of zirconia particles and electromagnetic damping material (Packets are triple-sealed against leakage.)



Light Controls All Major Functions

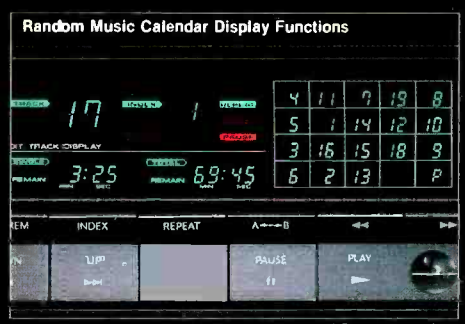
Infrared Remote Puts You in Full Command of The World's Only Random Music Calendar.

Onkyo's light connection extends as far as your listening chair: all our CD players with Opto-Coupling come complete with infrared remote controls that give you full mastery over all major functions. The DX-530's remote control even lets you adjust the volume of the output signal. In addition, the displays have been upgraded to make it even easier to keep track of what's going on. Onkyo felt that the standard indications of current track, playing time, etc. weren't enough. So they set out to make their new displays even easier to read and even more informative.

Random Music Calendar

The Random Music Calendar Display is another Onkyo innovation. Unlike some "fixed digit" displays that simply show the numbers of the tracks in memory, the Music Calendar shows you the track numbers in their playing order. It can display up to 19 track numbers at once. As soon as one track finishes, it vanishes and the following tracks each move up one notch. Best of all, the Random Music Calendar works in all play modes: normal play, memory play and even random (shuffle) memory play.

In addition to the Random Calendar, the DX-530's display also shows the number of the track in play, index number, sequential memory indication (a track's position in the memory sequence) and elapsed/remaining time for both the track in play and the disc (or memory play sequence).



*Patent pending

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Capriccio recorded its DATs via the real-time, multi-recorder route, but new technology from Sony should change all that.

September's column I passed along erroneous information to the effect that DAT tape is cobalt-doped ferric oxide. It is, in fact, metal-particle tape.)

Let us assume you're one of those audiophiles on the cutting edge and that you have bought a DAT recorder. All CDs have a copy-prohibit subcode flag, and the DAT won't record at 44.1 kHz, so you can't do digital-to-digital dubbing. However, you can feed an analog signal from your CD player into your DAT recorder; the DAT machine will convert it back to digital and record at 48 kHz. Are copies made in this way acceptable? I'd like to meet the golden-eared person who can positively detect a difference between direct-digital and digital/analog/digital!

Everything has a beginning. Back in 1958, a chap named Sidney Frey jumped the gun and issued his now-infamous *Dukes of Dixieland* stereo disc when there were literally no stereo 45°/45° phono cartridges available to play it. Of course, his actions stampeded the record industry into the era of the stereo disc, well before its planned introduction. Capriccio, an enterprising small label that has been importing musically interesting and sonically excellent digitally recorded CDs from East Germany, is apparently the first company to offer prerecorded DAT cassettes of classical music in the U.S. Essentially, Capriccio's DAT cassettes contain the same music that is on their CDs, and the technical people at Capriccio are doing the job properly. They play the digital masters on a Sony 1610 recorder at a 44.1-kHz sampling rate and feed the output into a sampling-rate converter. The converter then feeds a 48-kHz signal into the digital inputs of a bank of 24 Technics SV-D1000 R-DAT recorders. The copies are made on a one-to-one, real-time basis—which is tedious and cumbersome yet justifies the $28 price of each cassette.

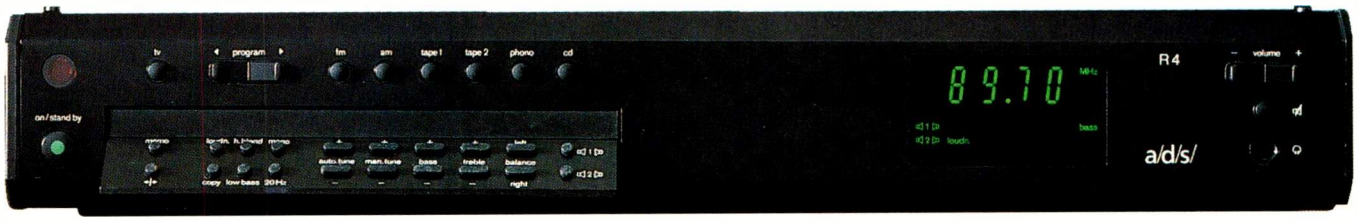
I can attest to the fact that Capriccio's DAT cassettes are of superb quality. At present, they include: Sir Neville Marriner and the Radio Symphony Orchestra of Stuttgart in performances of Schumann's "Symphony No. 1," "Manfred Overture," and "Overture, Scherzo and Finale, Op. 52" (Capriccio DAT 99-063); Japanese mezzo-soprano Mitsuko Shirai singing Mozart lieder in three languages (99-098); Max Pommer and the New Bach Collegium Musicum of Leipzig in a program of Bach, Handel, Pachelbel, and Haydn (99-046); Gustav Kuhn and the Staatskapelle Orchestra of Dresden performing Weber overtures (99-052); trumpeter Ludwig Güttler and the New Bach Collegium Musicum in a program of Bach trumpet works (99-039); and the New Bach Collegium Musicum performing three of Bach's "Brandenburg Concertos" (99-042).

Capriccio certainly deserves commendation for issuing these well-processed cassettes. This is obviously not a money-making project, so all the more reason to commend the company for their pioneering efforts in the DAT format. Capriccio expects to have some 40 DAT cassette titles available by the time you read this. (Capriccio Records is located at 2008 Cotner Ave., Los Angeles, Cal. 90025.)

Tom Jung, the brilliant recording engineer who makes state-of-the-art all-digital CDs for his Digital Music Products (DMP) label, has also been doing experimental recording, with a Sony DTC-1000ES DAT recorder. He was kind enough to send me a DAT cassette of his latest production, *Braziliana*, with Brazilian composer/pianist Manfredo Fest. Fest wrote 13 original pieces for this album, all very tuneful and with much of the rhythmic beat and vitality of the Brazilian musical idiom. With Fest on piano, accompanied by synthesizers and assorted percussion, Tom has provided the group with the immaculately clean, dynamically exciting sound that has become his trademark. My DAT copy was made directly from a Mitsubishi X-80 digital recorder, and the sensational sound I heard should be available soon on CD. Tom was mulling around the idea of producing DAT prerecorded cassettes via the multi-recorder real-time route, but a new development will probably change all that:

As we go to press, Sony has just announced the availability of a high-speed DAT contact-printing processor and has set up a new subsidiary, Magnescale, for this system. The same Sony 1630 mastering system used for CD production feeds a digital signal into a "mirror-mother" recorder. The running master tape this yields is sym-

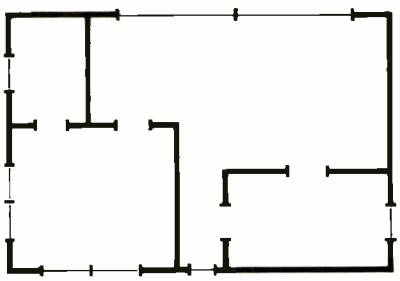
There are two tests for of a system.



As you know, a/d/s/ began life as a speaker company. But it was only a matter of time before our interest in accurate musical reproduction led us to think seriously about the electronic portion of a sound system.

As you can plainly see, the R4's displays are extremely legible and easy-to-read from anywhere within a wide viewing angle. The unit provides you with full information about its operating status, so you know what you're doing and not flying blind.

What we wondered was whether we could improve upon that which was available at the time. The results appeared first in this country in 1983.



The R4 gives you true multi-room capabilities, while the RC1 provides the means to control the system no matter what room you're in.

Lean, spare and understated, the Atelier Series was an articulation of our belief that high-grade electronic components needn't look like laboratory instruments. Nor require an engineering degree to coax into operation. Nor surrender to the indignities of planned obsolescence.

That philosophy today finds its expression in the Atelier R4 and its perfectly matched family of components.

A new class of component, as a look under the hood will attest.

At first glance, the R4 may appear to be a receiver. And it's true that the unit functionally incorporates the classic elements of that category of product. But beyond the impressive amplifier, pre-amplifier and tuner sections, the R4 bears about as much resemblance to a receiver as a BMW 735 does to a motor scooter. A look inside will illustrate the point.

We draw your attention first to what you'd least expect to find in a high fidelity product—a computer. Specifically, a microprocessor designed by a/d/s/ to provide a level of functionality never available before. For example, you can program the R4 to automatically turn on any combination of sources within your Atelier system for listening and recording, whether you're at home or off on an extended vacation.

When you <u>are</u> at home, you'll appreciate the fact that the R4 can give you access to any source from any room in your house—

The R4. Its slim, spare design gives little hint of the technological sophistication and sonic power that reside inside.

all by remote control. And when we say control, we mean control. With the RC1, you can control the nuances of every remote-ready Atelier component in your system—the compact disk player, the cassette deck, the tuner, even Atelier components which have yet to leave the drawingboards at a/d/s/.

If you're a computer buff, you'll be pleased to know you have the option of controlling Atelier functions by connecting your pc to the RS-232 port in the R4.

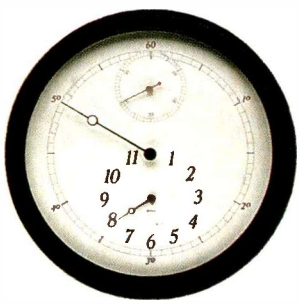
With the RC1 remote control unit, you can control every important function of every remote-ready Atelier component. You can do it standing up, sitting down or lying on your back. It issues more than 200 different commands.

the electronic heart Music and time.

Pertinent to the subject of control is the large scale integrated chip that's embedded within the R4's control circuit. This chip makes it possible for you to control volume, bass and treble settings in precise, digital increments—channel to channel, and with none of the variation in levels that are typical of "twirl-knob" systems.

The sonic purity is uncommon because the design is uncommon.

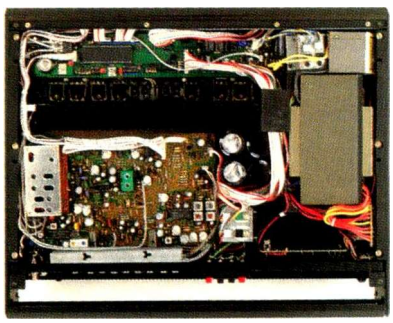
The R4's preamp signal paths are unusually noise free. That's because all circuits have been painstakingly protected from stray radiation by ample amounts of shielding—one of just many steps we've taken to preserve the extremely low distortion of the amplification stages.



As audio purists, we also feel compelled to tell you that the R4's microprocessor exists entirely outside the path of the audio signal. In other words, it keeps to itself, which is as it should be.

The FM portion of the R4 is as impressive as everything else about the unit. Finetuning is done in small, digital increments, which results in superb signal acquisition—the best possible, in fact—and eliminates distortion and "fuzzy" reception. Working down the signal chain, we come to the IF amps. Their bandwidth has been carefully designed to yield exceptional selectivity. Finally, stereo decoding is, in a word, impeccable. The result: optimum stereo separation.

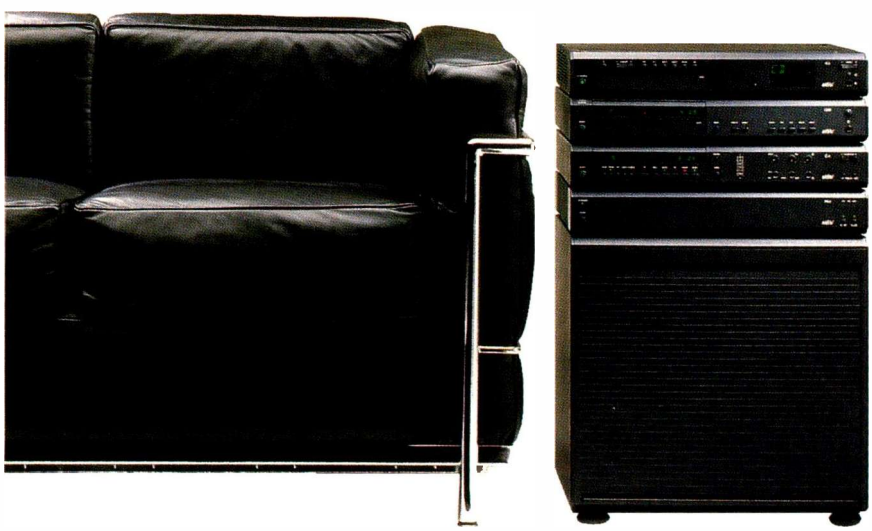
As for the prodigious amount of power the R4 produces for its size, that was accomplished thanks to our use of a proprietary rail-switching technology that automatically and instantaneously increases power for high-energy music transients—well beyond its rated 75 watts per channel.



A glimpse inside reveals how carefully thought-out the R4 is. No space is wasted. Electronic circuitry, heat sinks, transformers, etc., are all contained within a box that stands only 2¾" high.

When you need more power, we have more amplifier. Our PA4 amp provides 150 watts per channel, and nearly double that amount when bridged. Whether you use one or two PA4's in tandem with the R4, operation remains completely automatic. Moreover, you don't surrender any of your remote control capabilities—a fact that nicely differentiates Atelier from its competitors.

One final point deserves to be repeated. When we entered the electronics arena in 1983, our stated goal was to produce superb audio equipment that never became outdated. The R4 is the product of that vision, and it won't.



The Atelier system of electronic components. From top to bottom, the R4, the CD4 compact disk player, the C4 cassette deck and the PA4 power amp. That's even an Atelier storage module they're sitting on.

a/d/s/

Test them for yourself.

Shimek & Co.	Anchorage	AK
Great Alaska Sound	Anchorage	AK
Alaska Audio/Video	Juneau	AK
New Lawrence Stereo	Birmingham	AL
Sound Distributors	Huntsville	AL
Sound Advice	Mobile	AL
Leisure Electronics Inc.	Little Rock	AR
Casa Moore Stereo	Bakersfield	CA
Contact Stereo	Beverly Hills	CA
Sound Center	All Stores	CA
Kustom Hi Fi	Burlingame	CA
Paris Audio	All Stores	CA
Serra Stereo	All Stores	CA
Pacific Coast Audio-Video	Corona Del Mar	CA
Audio Video City	Culver City	CA
Genesis Audio, Inc	El Toro	CA
North County Stereo	Encinitas	CA
Sound Factor	All Stores	CA
The Record Roost	Ft. Bragg	CA
Radio Lab	Glendale	CA
House of Audio	Goleta	CA
Mad Jack's	All Stores	CA
Audio Concepts	All Stores	CA
Bel-Air Camera & Hi Fi	Los Angeles	CA
Henry Radio	Los Angeles	CA
World of Sound	All Stores	CA
Newport Audio	Newport Beach	CA
Stereo By Design	North Hollywood	CA
Fidelity Sound	Orange	CA
Desert Stereo	Palm Desert	CA
Western Audio Imports	Palo Alto	CA
Paradyme Consumer Electronics	Sacramento	CA
Stereo Showcase	All Stores	CA
Burdick Sales Co.	All Stores	CA
Hermary's	San Carlos	CA
Breier Sound Center	San Diego	CA
Stereo Plus	San Francisco	CA
Century Stereo	All Stores	CA
Gluskin's Camera Corner	Stockton	CA
Soundtrack	All Stores	CO
Main Street Music	Aspen	CO
The Sound Shop	Colorado Springs	CO
Soundings	Denver	CO
Gramaphone Audio	Durango	CO
Players Guitars & Stereos	Frisco	CO
U.S. Tech	Ft. Collins	CO
Yampa Valley Sound Co., Inc	Steamboat Springs	CO
Carston Stereo	Danbury	CT
Audio Design	Fairfield	CT
The Stereo Shop Inc.	Hartford	CT
Take 5 Audio	New Haven	CT
The Stereo Lab Inc.	New London	CT
Audiotronics	Norwalk	CT
Audiocom	Old Greenwich	CT
Tweeter Etc	Waterford	CT
Audio Spectrum, Inc	Altamonte Springs	FL
Sound Plus Wood, Inc.	Boca Raton	FL
Kuban's	Bradenton	FL
Rising Sounds, Inc.	Clearwater	FL
Audio Insight, Inc.	Fort Lauderdale	FL
Audio Tech Inc.	Jacksonville	FL
Audio Trend, Inc.	Melbourne	FL
Stereo By Design, Inc	Miami	FL
World Electronics Dist., Inc.	Miami	FL
House of High Fidelity	Naples	FL
Fox Audio, Inc	Stuart	FL
The Sound Center	Tallahasse	FL
Sensuous Sound Systems	Tampa	FL
Consumer Center	Tampa	FL
TV & Audio Center	Tequesta	FL
The Audiohouse	Vero Beach	FL
Electronic Connection	W. Palm Beach	FL
Stereo Designs, Inc.	Atlanta	GA
Macy's	Atlanta	GA
Audio Warehouse	Savannah	GA
Southland Sound	Savannah	GA
Hilo Audio, Inc	Hilo	HI
Chroma Electronics	Honolulu	HI
Comfort ACR Inc.	Honolulu	HI
Electronic Station	Honolulu	HI
Honolulu Audio Video Co., Inc	Honolulu	HI
Sound Specialties of Kona	Kailua-Kona	HI
Spencer Sound Systems	Coralville	IA
Golden Ears Audio Video	Fairfield	IA
Electronics Cave	Iowa City	IA
Jamison's Music West	Nampa	ID
Team Electronics	Algonquin	IL
Columbia Audio/Video	All Stores	IL
Good Vibes Sound	Champaign	IL
Audio Enterprises, Inc.	Chicago Hts.	IL
JR Lloyd	Decatur	IL
Audio Consultants, Inc	All Stores	IL
The King's Stereo	Springfield	IL
Alan Audio, Inc	Bloomington	IN
Soundpro	Carmel	IN
Good Vibes Sound	All Stores	IN
Audio Specialists	South Bend	IN
Stereo Crafters	Terre Haute	IN
Kief's Gramophone Shop	Lawrence	KS
The Sound Shop	Manhattan	KS
SOHO Electric Co.	Overland Park	KS
The Stereo Shoppe	Lexington	KY
Art Colley's Audio Specialties	Baton Rouge	LA
Wilson Audio	New Orleans	LA
Trolley Stereo	Belmont	MA
Tweeter Etc.	All Stores	MA
Sound Trak Audio	Brockton	MA
Natural Sound, Inc	Framingham	MA
The Music Store, Inc.	Greenfield	MA
Tripod Audio Inc.	Northampton	MA
New England Car & Home Stereo	Springfield	MA
Spaceways Sound	All Stores	MD
Hunt Audio & Associates	All Stores	MD
Audio Associates	All Stores	MD
Gramophone, Ltd.	Lutherville	MD
Audio Associates	Rockville	MD
The Great Northern Sound Co.	S. Portland	ME
Hi Fi Buys	All Stores	MI
Gramophone Co., Inc.	Birmingham	MI
Pecar Electronics	Detroit	MI
Audio Concepts, Inc.	Grand Rapids	MI
Kurtz Music & Sound, Inc.	All Stores	MI
Audio King	All Stores	MN
Hi Fi Sound Electronics	Minneapolis	MN
Audio Group	Minneapolis	MN
In Concert!	St. Paul	MN
The Sound Room	Chesterfield	MO
Best Sound Company	St. Louis	MO
Sound Advice	Gulfport	MS
Ideal Acoustics	Starkville	MS
Avitel-Bozeman	Bozeman	MT
Sound Systems, Inc.	All Stores	NC
Soundhaus	All Stores	NC
Dacia Audio/Video	Hickory	NC
Electronics Marketing, Inc.	Grand Forks	ND
Tweeter Etc.	All Stores	NH
Soundworks	Cherry Hill	NJ
Atlantic Stereo	E. Brunswick	NJ
Hi Tech Stereo & Video	Eatontown	NJ
Ultratech By House of Audio	Little Falls	NJ
Sound Incorporated	Northfield	NJ
Leonard Radio, Inc.	Paramus	NJ
Rand's Camera & HiFi, Inc.	Toms River	NJ
Hal's Stereo Sound Center	Trenton	NJ
Samm Sound Distributors	West Caldwell	NJ
Hudson's Audio Center, Inc.	Albuquerque	NM
Trend Tech	Farmington	NM
Music World	Hobbs	NM
The Sound Room	Las Cruces	NM
Import Audio	Las Vegas	NV
Sound Experience	Las Vegas	NV
Audio Authority	Reno	NV
Vinyl Jungle, Inc.	Batavia	NY
Adirondack Music, Inc	Boonville	NY
Video International, Inc.	Brooklyn	NY
Sound Approach	Commack	NY
Sound Stage Audio	All Stores	NY
Rabson's	All Stores	NY
Longplayer Stereo	Goshen	NY
Auto Sound Systems, Inc.	All Stores	NY
Rosner Custom Sound	Long Island City	NY
Performance Audio Video, Ltd.	Merrick	NY
The Sound Mill, Inc.	Mt. Kisco	NY
Borger's Audio/Video	New York	NY
Cosmophonic Sound Inc.	New York	NY
Grand Central Radio	New York	NY
Leonard Radio, Inc.	New York	NY
Park Avenue Audio, Inc.	New York	NY
Stereo Exchange	New York	NY
Square Deal Radio & TV, Inc.	Patchogue	NY
J.B. Sound Systems, Inc	Rochester	NY
Audio Command Systems, Inc.	Rockville Center	NY
Sound Concepts, Inc	Roslyn	NY
Le Sounde	Saratoga Springs	NY
Gordon Electronics	All Stores	NY
Stereo Plus	Tonawanda	NY
Sound Odyssey Inc.	Wappinger Falls	NY
Front Row Sound	White Plains	NY
Adirondack Music, Inc.	Whitesboro	NY
Leonard Radio, Inc.	Woodside	NY
Audio Craft Co., Inc.	All Stores	OH
Stereo Lab	All Stores	OH
Carlin Audio	Kettering	OH
Audio Tech	Lawton	OK
Gramophone Audio & Car Systems	Norman	OK
Contemporary Sounds	Oklahoma City	OK
Chelsea Audio Video	All Stores	OR
The Stereo Plant	Bend	OR
Oregon Typewriter & Recorder	Eugene	OR
Lutz Enterprises	The Dalles	OR
Canlen Audio, Inc	Bethlehem	PA
Sassafrass Records & Audio	All Stores	PA
The Audio Den	Erie	PA
Listening Post, Inc.	All Stores	PA
The Music Box	Harrisburg	PA
Summit Audio	Kingston	PA
Glick's Audio, Inc.	Lancaster	PA
David Mann Audio	Philadelphia	PA
Soundworks	Springfield	PA
Hi Fi House of State College	State College	PA
DS Audio, Inc.	West Reading	PA
Soundings	Middletown	RI
Audio Warehouse	Charleston	SC
Upstairs Audio	All Stores	SC
Southland Sound	Hilton Head	SC
Audio King	Sioux Falls	SD
Hi Fi House, Inc.	Knoxville	TN
Lindsey Ward, Inc.	Knoxville	TN
Modern Music Inc.	Memphis	TN
New Wave Electronics	Memphis	TN
Audio Systems, Inc.	Nashville	TN
Don's Hi-Fidelity, Inc.	Amarillo	TX
High Fidelity Inc.	Austin	TX
Brock Audio, Inc.	Beaumont	TX
Marvin Electronics Co.	Fort Worth	TX
Home Entertainment, Inc.	Houston	TX
Audio Systems, Inc.	Laredo	TX
Hi-Fidelity of Lubbock	Lubbock	TX
San Antonio Audio Concepts	San Antonio	TX
Bjorn's Stereo Designs	San Antonio	TX
Road Sounds #1, Inc.	Temple	TX
Audio Tech	Wichita Falls	TX
Lynn's Audio & Video	Logan	UT
Audioworks Inc.	Salt Lake City	UT
Arrow Audio	St. George	UT
Audio Associates	All Stores	VA
Stereo Types	Charlottesville	VA
Contemporary Sounds	Fredericksburg	VA
Sound Approach, Inc.	Newport News	VA
Audiotronics, Inc.	Richmond	VA
Ear Food Find Audio	Winchester	VA
City Stereo	Burlington	VT
Sound Directions	Rutland	VT
Magnolia Hi Fi	All Stores	WA
Stereocraft	All Stores	WA
Huppins Hi Fi and Photo	Spokane	WA
Paulson's Inc.	Tacoma	WA
EME Audio Systems	Eau Claire	WI
Hi Fi Heaven, Inc.	Green Bay	WI
Sound World	LaCrosse	WI
Happy Medium, Inc.	Madison	WI
Audio Elite	Menasha	WI
Flanner & Hafsoos Music Ltd.	Milwaukee	WI
Murphy Sight & Sound	Gillette	WY
The New Music Box	Laramie	WY
Bay Bloor Radio	Toronto	Canada

For more information about the audio components described on the preceding pages, we invite you to phone us, toll-free, at 1-800-345-8112. (In PA, the number is 1-800-662-2444.) We'll be happy to send you a White Paper on the new a/d/s/ speakers, Atelier literature or both.

Analog and Digital Systems, Inc.
One Progress Way
Wilmington, MA 01887

a/d/s/

Consider this: I reduced 22 pounds of open-reel tape to only a few ounces on a digital audio cassette.

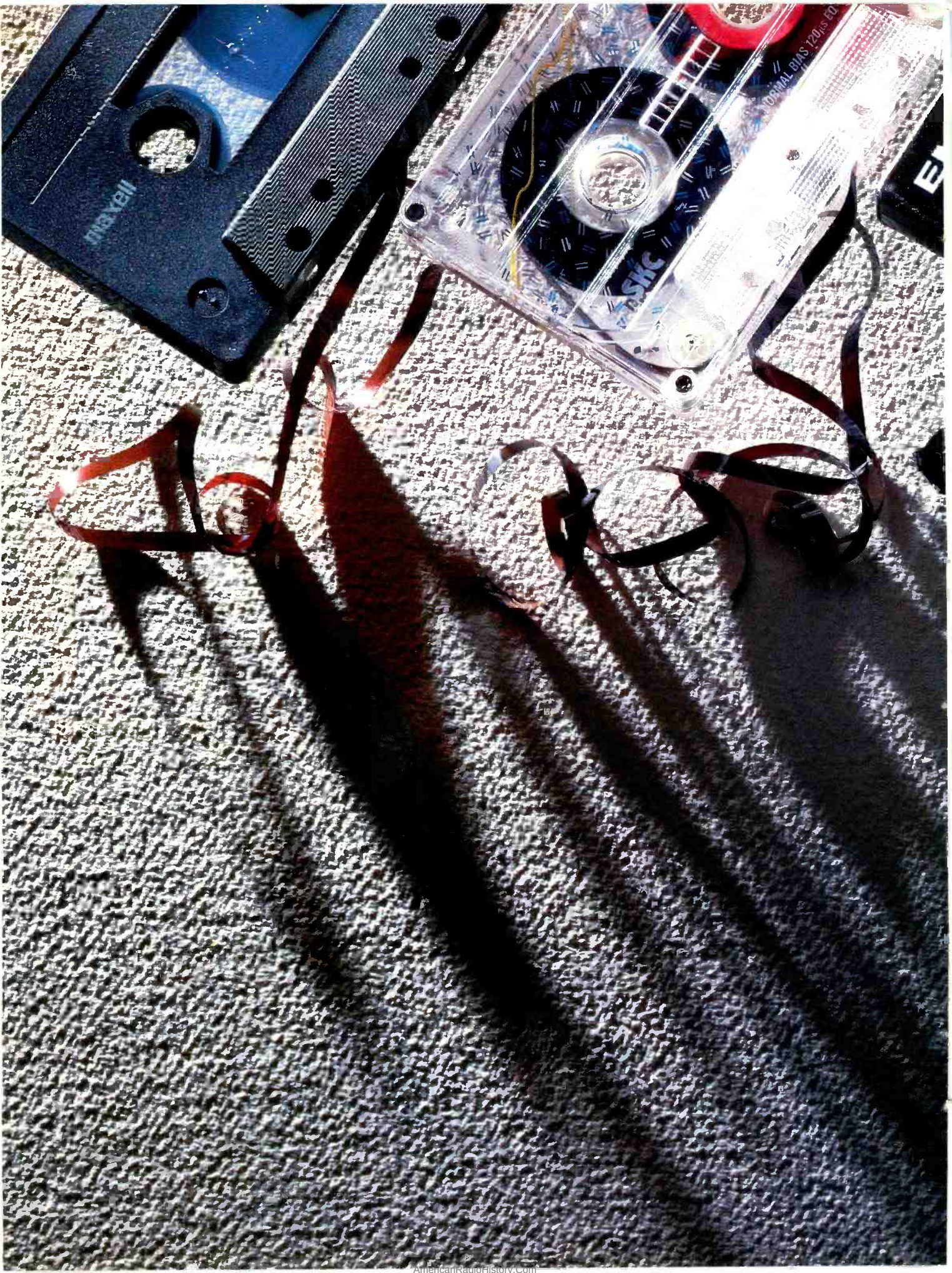
metrically contact-printed at high speed to DAT coated with high-coercivity barium ferrite. The system contact-prints at a 327-to-1 ratio; thus, an 80-minute DAT cassette can be duplicated in 15 seconds! The system operates at a 44.1-kHz sampling rate with 16-bit quantization. The price of the High Speed DAT Software Print System is $600,000, and deliveries are expected within several months. The advent of this printing system makes prerecorded DAT cassettes economically feasible. Because barium ferrite is not as expensive as metal-particle tape and because so little is used in a DAT cassette, it is conceivable that the price of prerecorded DAT cassettes will be on a par with CDs.

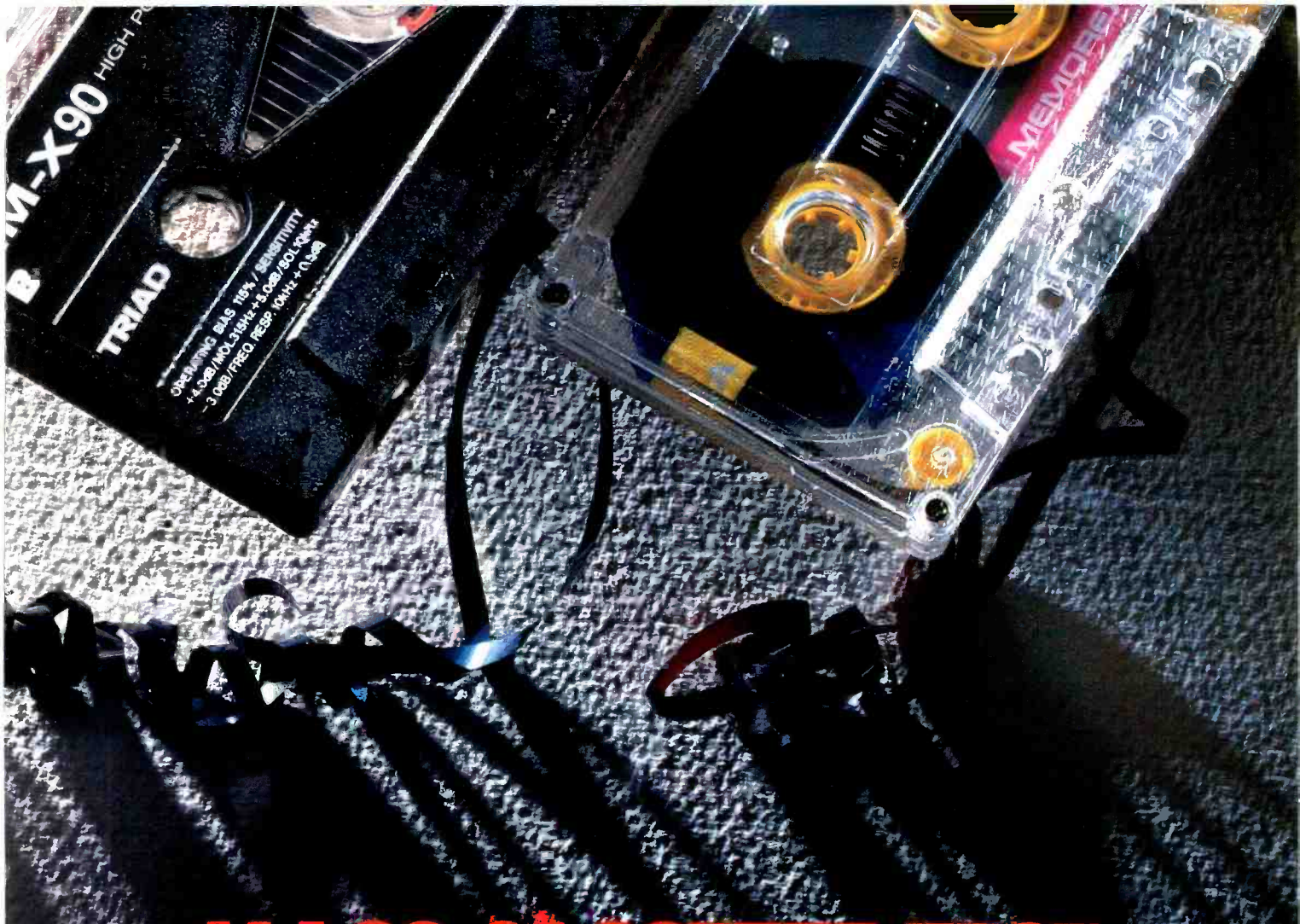
I have made many digital recordings with the Sony PCM-F1 processor in tandem with a semi-professional VHS VCR, the JVC HR-6400U. This is a pretty good combination, but in respect to error correction and freedom from dropouts, a DAT recorder is clearly superior. I must say I am tremendously impressed with the Sony DTC-1000ES recorder. It is certainly user friendly, and performance is outstanding. This DAT machine has a wonderfully precise and easy-to-use program-numbering and identification system; "Start ID" and number subcodes can be automatically "written" while you record. It is also possible to "write" or change program code numbers manually during playback.

Consider this: I played back some 15-ips, 10½-inch open-reel copies of my Everest masters on a big, console-mounted Ampex ATR-100 and transferred them to the Sony DAT recorder. Incredibly, I was able to record the Shostakovich "Symphony No. 6," Stravinsky's "Ebony Concerto" and "Symphony in Three Movements," Copland's "Appalachian Spring," Gould's "Spirituals for Orchestra," and Vaughan Williams' "Overture, The Wasps," on *one* D-120 DAT cassette. Twenty-two pounds of open-reel tape reduced to a few ounces! Furthermore, now that the music is in the form of digital pulses, it will be immune to the ravages of print-through. Physically, the narrow digital tapes should be less subject to tape cupping, which affects open-reel tape, and DAT's modern base and binder should be less prone to plasticizer dry-out than my old tapes are. Of course, as I recorded my music, ID subcodes were also written. After all the years of "hunt and search" for specific sections on open-reel tape, what a pleasure it was to access program 13 with the remote control of the Sony DAT recorder and, with a few quiet whirs and clicks, arrive precisely at the beginning of "Appalachian Spring"! With its bar-graph indicators, recording levels are easy to set on the Sony DAT recorder; one needs only to remember to keep the highest peaks just below the 0-dB point. As revealed by an A/B comparision between open-reel tape and DAT, the sonic fidelity of the transfer was, to my ears, absolutely perfect.

While I was listening to some of the Capriccio DAT cassettes, I did A/B comparisons with their equivalent CDs played on a Sony CDP-705ESD. The tapes were indistinguishable from the CDs. Since the Capriccio DAT cassettes do not have copy-inhibit subcode flags, I was able to make flawless digital-to-digital DAT copies from the Sony machine to another excellent DAT recorder, the Technics SV-D1000.

Admittedly, a DAT recorder may only have limited utility for many people. Ideally, the most useful embodiment would be a "dockable" automotive DAT recorder—that is, a removable dash-mounted unit which could be taken into the home to record customized DAT programs and then "docked" in the dashboard mother unit. However, I can state very strongly that even at this early stage of development, DAT is a thoroughly researched concept, and the engineering seems to be practical and reliable. The digital recording performance is as good as I have heard from professional digital recorders. Given a good digital microphone mixer, master-quality results are certainly achievable.





MASS CASSETTE TEST: WE REVIEW 35 NEW TAPES

HOWARD A. ROBERTSON

In June 1986, we published a "Cassette Test Update" covering 49 tapes. This follow-up survey covers 35 new or modified formulations: Seven from Denon, two from Fuji, three from Maxell, five from Memorex (made by Memtek Products), four from SKC, seven from Sony, four from TDK, and three from Triad. The manufacturers' descriptions of their new tapes are quoted or cited below. It is probable that, in a number of cases, tapes were changed in ways that were not mentioned in the limited literature which accompanied the samples I received.

The Denon tapes are DX1, DX3, and DX4 (Type I); HD6, HD7, and HD8 (Type II) and HD-M (Type IV). Their names have remained the same but their formulations have improved, and they have new shells and packaging. The exception is HD-M, which has been updated in minor ways but will be subject to the same major changes in the near future.

The Fuji tapes are FF-I Super (Type I) and FR-II Super (Type II); FR-II remains in the product line. FR-I Super offers Fuji's exclusive coating technology and cobalt-modified Fine Beridox magnetic particles. FR-II Super uses Super-Fine Beridox particles. Fuji states the two formulations have reduced bias and modulation noise.

The Maxell tapes are XLI-S (Type I), XLII-S (Type II), and MX (Type IV)—the same names as before. Maxell states that the new SS-PA (Super-Silent Phase-Accuracy) cassette mechanism "effectively reduces modulation noise, tape running noise and mechanical handling noise." The shell is precision-made out of a resonance-damping material, and it uses S-TA (Silent Tri-Arch) slip sheets with a "special coating treatment." Other features are the BF (Best Fit) pressure pad, two-piece QL (Quin-Lok) hubs for perfect circularity and smooth running, and SS (Super Smoothing) guide rollers to minimize vibration and reduce tension irregularities. The XLI-S and XLII-S formulations use new Superfine Epitaxial particles and new coating technology. The MX tape uses a new SSP (Super Stabilized Pure) particle with unprecedentedly small size and high resistance to oxidation. All of the tapes use a new binding treatment for increased durability and toughness.

The Memorex tapes are dBS and MRX I (Type I) and HB II, HBX II, and CDX II (Type II). Note that there is no

Photograph: Robert Lewis

Many of the latest cassette shells incorporate features designed to reduce resonance, vibration, and modulation noise.

Memorex Type IV tape. The manufacturer's position is that many decks are not really suited to such tapes, delivering high distortion with Type IV because of limited bias current and inadequate head designs. The dBS tape is a new entry, said to offer "performance and value." Its clear plastic shell has a "finely engineered mechanism" for smooth running. MRX I and HB II also have clear shells. The MRX I formulation uses ferric oxide, while HB II uses crystal ferrite. HBX II has "superior sensitivity to deliver greater 'sound presence.' " CDX II is claimed to have better-than-metal performance, but at the Type II bias setting; it is said to push MOL limits to new highs.

The tapes from SKC are GX and AX (Type I), QX (Type II), and ZX (Type IV). These are the first audio tapes from this major South Korean manufacturer to carry their own brand. All of the formulations come in the C-46 length, and the GX is also available as a C-120. GX uses a special ferric oxide for high output and offers "full dynamic range with excellent signal-to-noise ratio." The AX and QX tapes have wide-window, high-precision shells. The AX has an "exclusive particle formulation for superior fidelity," and the QX has a "superior high-bias tape formulation and ultra-high density tape finish" to provide extended high-frequency response. The SKC ZX metal tape has a "precision cassette shell for superior alignment and greater guidance accuracy." It is said to have specially treated pure iron particles for extended frequency response.

The Sony tapes are HF and HF-S (Type I); UX, UX-S, UX-ES, and UX-PRO (Type II), and Metal-ES (Type IV). In this case, the names for the Type I and Type IV tapes remain unchanged, but the Type II formulation names are new, replacing UCX and UCX-S. In their literature, Sony presents the new Type I and IV formulations as having higher sensitivity and greater high-frequency output than the previous versions. The manufacturer describes the particles for UX, UX-S, UX-ES, and UX-PRO as Micro-Fine Uniaxial, Super-Fine Super Uniaxial, Ultra-Fine Power Uniaxial, and Ultra-Fine High-Power Uniaxial, respectively.

Sony states that the rigidity and high precision of its latest shell design help reduce modulation noise and vibration in HF-S and all of its new Type II cassettes. The UX-PRO shell has unique ceramic tape guides for further improvements in this area, to gain "unexcelled sound purity." Metal-ES has a newly designed three-plate, high-precision shell for added rigidity and lowered vibration. This tape has ultra-fine Extralloy particles "in unique double-coating magnetic layers for reduced noise and expanded performance."

The four TDK tapes are AD-S (Type I), SA-XG (Type II), and MA-X and MA-XG (Type IV). AD-S has the same formulation as AD but uses a high-tech, see-through cassette design. The new shell has high rigidity and is made from a vibration-damping plastic to control resonances. SA-XG is said to be engineered to deliver the lowest bias noise and the finest audio performance available from a Type II tape. The MA-X metal-particle tape uses a newly developed two-layer plastic mechanism and an improved Finavinx formulation. The mechanism is constructed with special dual-layer shell halves for reduced resonance and superior tape-to-head contact. The shell halves are designed specifically for best tape transportability, and the plastic used increases the shell's rigidity. The shells have new slipsheets to ensure smooth tape travel and accurate winding while reducing flutter and transport noise. Other features include mono-molded hubs for improved surface smoothness and precise circularity, a new dual-spring pressure pad, and seamless guide rollers.

The new SA-XG and MA-XG tapes are the same magnetically as SA-X (introduced earlier) and MA-X, respectively. They use, however, the new three-layer RS-II cassette-shell mechanism with a die-cast metal-alloy frame. The high-performance mechanism "virtually eliminates sympathetic vibration and provides optimum precision in tape travel." The mechanism uses four ultra-precise guide pins to suppress the generation of modulation noise for "the purest, clearest sound."

The Triad tapes are F-X (Type I), EM-X (Type II), and MG-X (Type IV). All three are housed in Triad's Delta transport mechanism, which features a unique slip pad with a hub-tensioning device. The manufacturer claims that extended headroom, wide dynamic range, and high signal-to-noise ratio make all three formulations "ideal" for the "digital medium." Triad gives credit to the "unique cobalt saturation method" used for F-X, the technologically advanced process making the metal particles for the Type II EM-X, and the "near perfect" uniformity of size and composition of the MG-X particles.

TEST METHODS

The manufacturers supplied three samples of each formulation evaluated. I examined the packaging and unwrapped the samples, noting any pull-tag instructions. Every sample was fast-wound once in each direction before any other tests.

I used a Nakamichi CR-7A deck for the great majority of the record/playback tests; I also used a Nakamichi 582 recorder for some tests. Bias and sensitivity figures were measured relative to the IEC Type I, II, and IV reference tapes. A meter, in its relative-dB mode, measured bias at an internal point in the 582 deck. The 582's calibration tone was the source for measuring sensitivity in dB.

For other tests, the automatic calibration function of the CR-7A set the bias and the alignment of the playback head to the record head. I made swept-sinusoid plots at Dolby level (200 nWb/m at 400 Hz). The −3 dB points at the high-frequency end were measured at the same level. Let me emphasize here that although there are references to Dolby level, no tests were run with any noise reduction.

Maximum output levels (MOLs) were measured at 100 and 400 Hz and at 1, 2.5, 6, 10, and 15 kHz. I have changed the test frequencies I've used in the past. Chiefly, this was done to add 15 kHz, as recent examination of CD output spectra has shown that they can have significant energy up to about this frequency. Some other frequencies were then changed to provide more even spacing up to 15 kHz.

All MOLs were measured with a distortion limit of 3%. For the three lowest frequencies, the limit was 3% HDL_3 (third-harmonic distortion). For the four highest frequencies, the limit was 3% TTIM (twin-tone IM) distortion, using the two tones 400 Hz above and 400 Hz below the stated test frequency. In

TABLE I—MEASURED DATA

	Tape	Maximum Output Level (dB, re: 400-Hz Dolby Level) HDL$_3$ = 3% 100	400	1k	TTIM = 3% 2.5k	10k	15k	S/N Ratio (dBA)	Response At −3 dB For 0-dB Level (kHz)	Mod. Noise (dB)	Bias (dB)	Sens. (dB)
TYPE I	Denon DX1	+4.4	+4.3	+4.3	+0.5	−8.4	−14.8	57.3	9.7	−45.4	+0.3	−1.1
	Denon DX3	+8.0	+7.9	+6.8	+2.4	−7.2	−14.0	59.6	10.3	−45.7	+0.2	+0.8
	Denon DX4	+8.7	+7.9	+6.6	+2.3	−7.0	−13.5	59.1	10.5	−46.3	0.0	+1.0
	Fuji FR-I Super	+7.2	+7.9	+7.4	+1.9	−6.5	−13.4	60.1	10.2	−48.7	+0.9	+0.2
	Maxell XLI-S	+6.6	+6.3	+4.8	−0.5	−9.8	−15.4	59.4	10.0	−45.2	+0.6	+0.9
	Memorex dBS	+4.3	+3.8	+3.1	−0.1	−8.6	−15.4	55.8	10.2	−47.2	−0.2	−0.4
	Memorex MRX I	+5.9	+5.5	+4.7	+0.2	−8.6	−15.0	57.5	10.3	−44.4	0.0	0.0
	SKC GX	+4.8	+5.1	+4.9	+0.2	−8.0	−14.9	55.5	9.9	−48.2	+0.2	−0.3
	SKC AX	+6.1	+5.8	+4.9	+1.7	−8.1	−13.9	56.8	10.5	−45.5	+0.3	−0.2
	Sony HF	+3.5	+3.9	+4.7	+0.7	−8.3	−15.1	54.2	10.3	−48.3	+0.2	−1.0
	Sony HF-S	+6.1	+6.4	+6.4	+1.2	−7.2	−14.4	58.6	11.0	−48.2	+0.4	+0.5
	TDK AD-S	+6.2	+6.4	+6.2	+1.4	−6.8	−14.2	59.9	10.7	−45.0	+0.6	+0.2
	Triad F-X	+7.4	+7.3	+6.8	+1.7	−7.1	−14.0	60.3	10.5	−48.6	+0.9	+0.3
TYPE II	Denon HD6	+4.7	+5.0	+4.2	−2.2	−9.7	−14.6	61.8	9.3	−50.9	+0.7	+1.9
	Denon HD7	+5.1	+5.4	+4.5	−2.3	−9.7	−14.6	62.1	9.0	−50.7	+0.7	+2.0
	Denon HD8	+4.7	+5.0	+4.4	−2.2	−9.6	−14.4	61.8	9.6	−50.3	+0.7	+2.0
	Fuji FR-II Super	+5.5	+5.0	+4.2	−1.7	−8.8	−14.0	61.5	9.9	−50.8	+0.2	+1.6
	Maxell XLII-S	+4.6	+4.4	+2.5	−5.0	−11.5	−15.2	61.7	7.1	−49.4	+1.1	+1.6
	Memorex HB II	+3.0	+3.2	+2.4	−2.7	−9.5	−14.8	59.4	9.6	−42.7	+0.2	+0.8
	Memorex HBX II	+4.1	+4.2	+3.6	−2.2	−9.5	−14.4	59.7	10.1	−47.6	+0.3	+1.9
	Memorex CDX II	+4.2	+4.9	+4.3	−1.2	−8.4	−14.6	58.9	12.1	−45.2	+1.8	+3.5
	SKC QX	+1.6	+1.5	+0.9	−3.9	−10.4	−15.1	56.5	9.2	−51.0	+0.3	+1.2
	Sony UX	+4.0	+4.0	+3.1	−3.1	−10.0	−15.4	59.6	9.4	−48.6	+0.2	+1.5
	Sony UX-S	+4.8	+5.0	+4.1	−2.4	−9.5	−15.2	59.5	9.8	−51.7	+0.8	+1.9
	Sony UX-ES	+6.3	+6.4	+5.9	−1.1	−8.6	−14.8	62.0	10.6	−52.2	+1.2	+1.6
	Sony UX-PRO	+6.4	+6.7	+6.1	−1.0	−8.2	−14.1	62.5	10.5	−52.4	+1.4	+1.4
	TDK SA-XG	+4.5	+4.6	+3.1	−4.4	−11.3	−14.4	62.9	7.1	−49.7	+1.0	+2.6
	Triad EM-X	+4.0	+4.0	+3.0	−1.7	−6.7	−10.2	58.5	12.1	−47.4	+1.6	+2.8
TYPE IV	Denon HD-M	+5.4	+5.3	+4.3	−1.2	−6.8	−9.9	62.2	12.8	−43.8	−0.2	+0.4
	Maxell MX	+6.6	+7.2	+6.4	+0.2	−5.8	−10.3	63.7	13.1	−52.3	+0.7	0.0
	SKC ZX	+8.1	+8.2	+7.6	+1.1	−5.1	−9.7	62.3	13.4	−51.8	+0.4	+1.0
	Sony Metal-ES	+11.3	+11.9	+9.3	+1.6	−5.4	−9.5	68.0	13.7	−53.5	+1.6	+2.3
	TDK MA-X	+8.1	+8.6	+8.2	+1.2	−5.0	−9.9	64.1	13.5	−51.4	+0.8	+0.6
	TDK MA-XG	+8.0	+8.5	+8.3	+1.4	−4.9	−9.9	64.5	13.7	−52.7	+0.9	+0.3
	Triad MG-X	+6.9	+7.0	+6.2	+0.9	−5.5	−9.8	61.0	13.0	−49.2	−0.1	+0.5

the accompanying graphs of performance versus frequency, the MOL measurements were used to plot the dashed curves.

Signal-to-noise ratio was measured as the difference between the signal level that caused 3% distortion at 400 Hz and tape noise measured with IEC A-weighting. A 3-kHz tone was recorded and played back to assess flutter. Once again, I remind readers that the results are just general indications: The deck has a considerable effect on the exact flutter measurement with any tape. The same 3-kHz tone was used to test for dropouts and to determine the degree of level stability at this moderately high frequency. I measured modulation noise with a high-level 1-kHz test tone which was phase-cancelled and filtered out in the playback so that only noise would remain. This noise was then band-limited to the range from 500 to 1,500 Hz and passed to a meter. The meter was referenced to the playback level of the 1-kHz test tone without the filtering and cancellation.

USE TESTS

It was easy to remove the wrap on all samples. As a group, the Sony samples were the easiest to unwrap, followed closely by those from Fuji and TDK, with the Maxell and Triad samples close behind them. The Denon

Reading the MOL curves for the tape you prefer can help you judge the proper level settings to use when recording.

pull tabs were a little hard to start but worked very well after that. Some of the Memorex tabs were easy to find and pull; some were not. The SKC tabs were not marked, and some were hard to find and pull.

All of the samples were quiet during fast winding, except for a couple of the Memorex HB II and SKC GX samples. Maxell XLII-S and TDK MA-X were the quietest of all, with the Fuji and Triad samples not far behind.

Most of the cassettes offer tactile clues for telling side A from side B. This is very helpful for those with vision problems or for situations in which visual inspection would be difficult, such as while driving a car. Most of the Denon tapes have raised "A" and "B" markings on the appropriate sides, but these letters were not easy to pick out by feel. The "A" and "B" on Denon's HD8 shells, however, are incised rather than raised, in an arty typeface that was easy to feel.

I congratulate Fuji for including "A" and "B" in Braille on their shell halves. (The dot patterns can be decoded by the sighted as well as the blind.) I hope other manufacturers follow Fuji's lead.

The Maxell cassettes have a single raised dot at the left for side A and a double dot in the same place for side B. The Memorex HBX II and CDX II shells have raised letters, but they were difficult to decipher. The other tapes in the line have printed letters, impossible to detect by feel. It was possible to pick out the "A" (raised) or "B" (incised) on the SKC GX cassette, but the other tapes in the SKC line had no tactile clues.

The Sony cassettes have a raised "A" on the left, while the "B," in the same relative position, is slightly incised. This makes for easy selection by touch. Little arrows point to the location of the erase-prevention tabs for the side in use.

TDK's AD-S and MA-X shells use dots on the right side (one dot for "A" and two for "B"). These tapes also have raised letters, "A" and "B," which I could sense correctly with a fingertip. The TDK MA-XG shells offer no tactile clues as to which side is being touched. The snap-out erase-prevention tabs on this tape can be snapped back in again—a handy feature.

Triad tapes have no raised letters to provide tactile clues as to which side is which. However, the triangular view windows, which point in different directions according to which side is up, do make it easy to select the side you want by looking.

All of the cassettes (Denon's DX1 excepted) are supplied with pressure-sensitive labels, but there are some differences. Most of the Denon tapes have fairly wide labels for the two sides, plus narrow labels that can be placed on the long edge of the shell. This certainly is helpful when tapes are stored with their spines showing. The HD8 side labels are fairly narrow, but there are also little "No." labels that fit into an indented square at the right end of each side of the shell. The Fuji labels are reasonably wide, and stick-on numbers are supplied for easy encoding if desired. The Maxell labels are a good size but have many fine lines which might be more confusing than helpful to some users.

The Memorex labels are rather narrow, and their shiny surfaces would be hard to write on except with a ball point pen. Most of the SKC labels are slightly narrow, but it was easy to write on them. Most of the Sony labels are quite narrow, although the labels for HF tape are wide and easy to use.

The TDK labels are wide, which is good, but I needed a ball point to mark the shiny MA-XG labels. Because of the triangular shape of the Triad view windows, their shells do not take full-width labels. The small labels supplied don't leave much room for writing information, and they are gray, which reduces legibility.

MEASUREMENTS

Most of my previous tape surveys have presented data obtained only with a Nakamichi 582 deck and supporting instrumentation. In this survey, as I've said, the majority of the data was secured with a Nakamichi CR-7A deck, using its automatic calibration feature. There was no doubt about the convenience of its automation, but I did wonder how the results obtained with it, particularly the MOL figures, would compare to those I had obtained with the 582 in previous tests. In a detailed comparison, I found that, on the average, 100-Hz MOL readings were 0.7 dB higher with the CR-7A than with the 582, 400-Hz MOL readings were 0.1 dB lower, and 1-kHz MOL readings were 0.8 dB higher. There was, however, little difference between the higher-frequency MOLs (re: 3% TTIM) obtained from the two decks, and relative performance for all tapes was the same regardless of the deck used. However, I got more consistent results in rechecks with the CR-7A, which was therefore used as the source for all MOL data. The 582 was used to check puzzling results.

In my previous surveys, I have presented a table of data to summarize results. Such tables show a lot of detail, but they are difficult to use when making comparisons or absolute judgments. After toying with various forms of bar graphs and pie charts, I have arrived at a combination which I hope meets the goals of accuracy *and* visual effectiveness: The table of Measured Data, graphs of performance versus frequency, and pie charts.

For the pie charts, I have selected six parameters to be shown for each tape: 0-dB response (the −3 dB point at Dolby level), low-frequency MOL (at 400 Hz), modulation noise, "consistency," high-frequency MOL (at 10 kHz), and S/N ratio. All are self-explanatory except for "consistency," a catch-all term covering eight parameters. These are: 10-kHz skew consistency between the tape's two directions of travel, consistency of bias requirements and sensitivity with the IEC Standards, consistency of bias requirements and sensitivity among samples, consistency of playback level at 3 kHz throughout a sample, maximum occasional dropout, and flutter (speed consistency). All are measured in dB, with the exception of flutter; it is ranked as 0 for low, 1 for average, and 2 for high. A perfect "consistency" score would be zero, and I arbitrarily set 20 as the worst possible result.

I have some question whether offset from IEC reference bias and sensitivity should be considered a deviation from perfection. I have therefore weighted my scale so that each 1-dB offset from IEC Standards would reduce a tape's total performance rating by only 1%.

The angles of the pie segments were selected to correspond to the importance of the parameter. I allotted 75° each for 400-Hz MOL and 0-dB re-

sponse; 60° each for S/N ratio, 10-kHz MOL, and consistency, and 30° for modulation noise. In each segment, the area filled in from the center shows how that formulation's performance compared to the worst (0%) and best (100%) results that I have ever measured. The overall performance figure is the sum of the six percentages, weighted according to their respective contributions and using the same weighting as in the pie-chart diagrams.

The actual figures for each parameter are indicated on the pie charts. The figures for low-frequency and high-frequency MOL and for modulation noise are in dB. The figures for S/N are in dBA, and those for 0-dB response are in kHz. Consistency, as mentioned before, is just a number ranking between 0 (perfect) and 20 (worst ever).

The MOL curves, shown on the 0-dB swept-frequency plots, can be used to derive MOL figures for the frequencies not covered by the pie charts. There is a good correlation between the 400-Hz MOL and the other low-frequency MOLs shown in Table I, and between the 10-kHz MOL and the other high-frequency MOLs. MOL varies only slightly between tapes of the same type, but greater variations exist between tape types. Note that distortion at the 0-dB level is less than 3% wherever the solid curve is below the dashed curve and is more than 3% wherever the situation is reversed. The MOL curve is of particular help, therefore, in judging the necessary limits in recording levels relative to the high-frequency energy in the music.

My comments on each of the tapes are arranged alphabetically by manufacturer within each tape type. Most of these tapes showed good consistency, and so no details will be given for this performance category unless something about a given tape is particularly good—or bad.

TYPE I TAPES

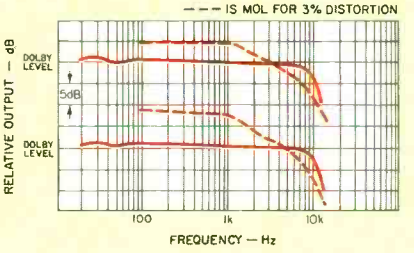
Type I tapes can have fairly high MOLs across the band. However, they have neither high MOLs at the highest frequencies nor really extended response at 0 dB, though they are usually better than Type II tapes in these respects. The best-performing Type I tapes, with 400-Hz MOLs of +6 dB or more, match the S/N ratios of many Type II tapes. The Type I overall ratings do not go much beyond 60% at this time because their performance (except for consistency) cannot match that of Type IV tapes.

Denon DX1: Its overall performance rating (46%) indicates that DX1 would be best used for noncritical purposes.

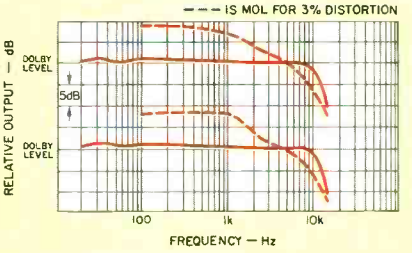
Denon DX3: This formulation is a considerable improvement over DX1. It is a well-balanced tape, giving good results for all parameters. Its 60% performance rating is one of the best for Type I tapes, equal or superior to that for most of the Type II tapes in this survey.

Denon DX4: This tape's 61% perfor-

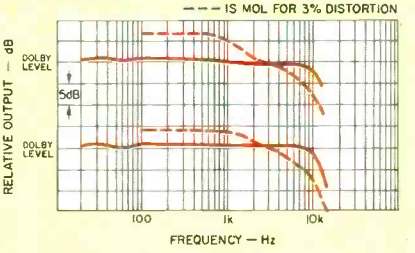
Denon DX1 (top) and DX3



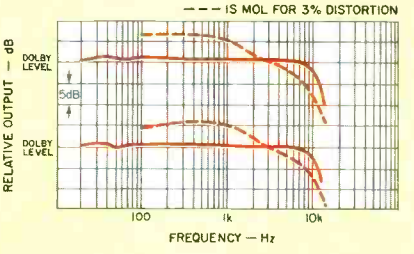
Denon DX4 (top) and Fuji FR-I Super



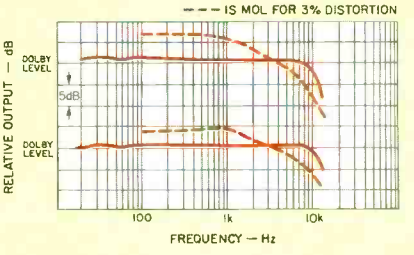
Maxell XLI-S (top) and Memorex dBS



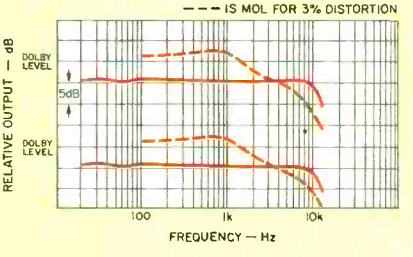
Memorex MRX I (top) and SKC GX



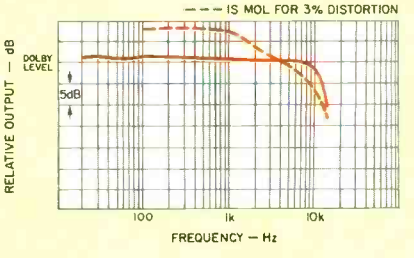
SKC AX (top) and Sony HF



Sony HF-S (top) and TDK AD-S

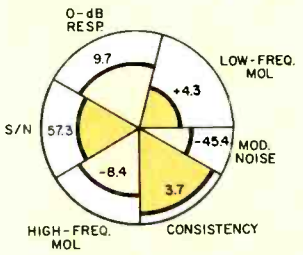


Triad F-X



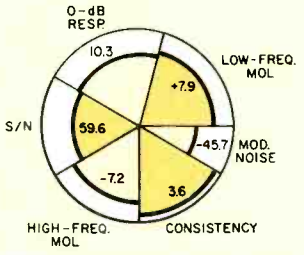
TYPE I

Denon DX1



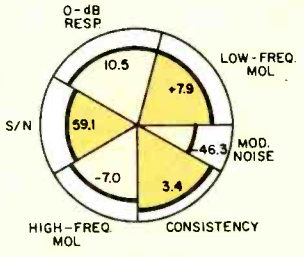
OVERALL PERFORMANCE: 46%

Denon DX3



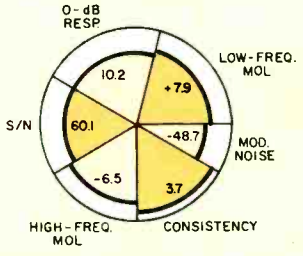
OVERALL PERFORMANCE: 60%

Denon DX4



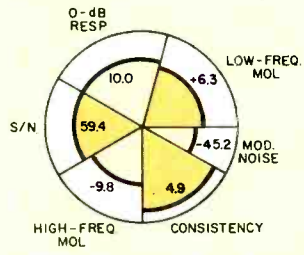
OVERALL PERFORMANCE: 61%

Fuji FR-I Super



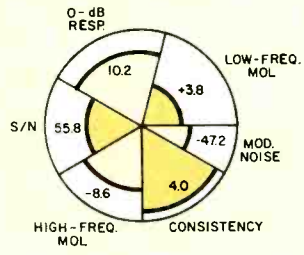
OVERALL PERFORMANCE: 62%

Maxell XLI-S



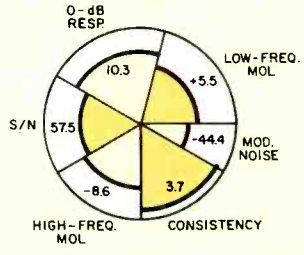
OVERALL PERFORMANCE: 50%

Memorex dBS



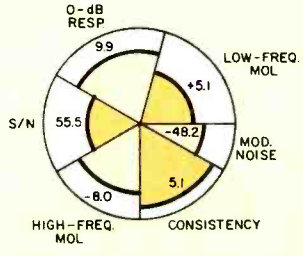
OVERALL PERFORMANCE: 45%

Memorex MRX I



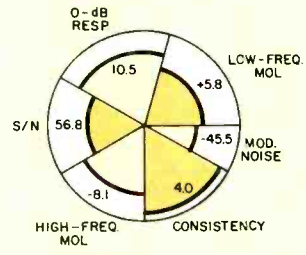
OVERALL PERFORMANCE: 50%

SKC GX



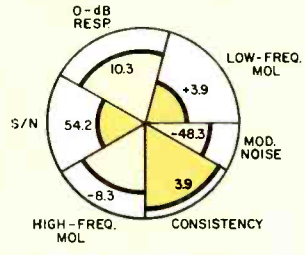
OVERALL PERFORMANCE: 48%

SKC AX



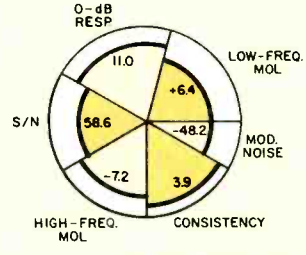
OVERALL PERFORMANCE: 51%

Sony HF



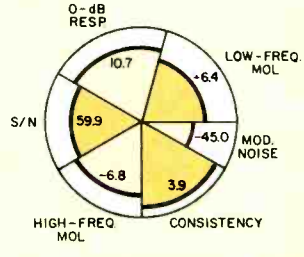
OVERALL PERFORMANCE: 46%

Sony HF-S



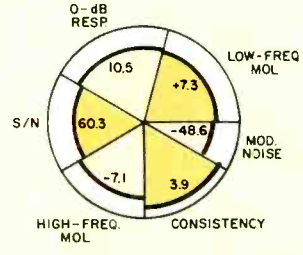
OVERALL PERFORMANCE: 58%

TDK AD-S



OVERALL PERFORMANCE: 58%

Triad F-X



OVERALL PERFORMANCE: 61%

mance rating earns it a tie for second place among the Type I formulations and puts it just above the best Type II. It is little different from DX3, as shown by its 1% performance advantage.

Fuji FR-I Super: Low modulation noise, a high S/N ratio, and a good 10-kHz MOL combine to give this formulation the highest rating of any Type I tape: 62%. This figure is better than that for any of the Type IIs and close to one of the Type IV tapes.

Maxell XLI-S: This formulation was a bit of a disappointment, with low MOLs and high modulation noise. Consistency was poorer than for most tapes because of high bias and sensitivity, measurable skew, 3-kHz level wandering, and dropouts. Overall: 50%.

Memorex dBS: Poor performance in most parameters gave this tape the lowest Type I rating (45%) in this survey. It was, however, still superior to a number of Type IIs.

Memorex MRX I: With the exception of modulation noise, this formulation is a worthwhile improvement over dBS. Its 50% rating is not *that* impressive, but it is better than a number of Type IIs.

SKC GX: This tape had low modulation

Most Type II tapes have higher S/N ratios than Type I formulations, but they also have poorer 0-dB responses.

noise, but its signal-to-noise ratio was poor. Irregular sensitivity and high skew contributed to poor consistency. Overall: 48%.

SKC AX: Except for its modulation noise and 10-kHz MOL, AX *is* better than GX. Overall: 51%.

Sony HF: This is actually one of the lower scoring Type I tapes in the survey, mostly because of poor 400-Hz MOL and a low signal-to-noise ratio. The modulation noise is fairly low, but the overall rating is just 46%.

Sony HF-S: A considerable improvement over HF, it has a well-balanced collection of performances in each parameter. This is one of the better Type I tapes and is superior to most Type IIs. Overall: 58%.

TDK AD-S: This formulation has good balance in performance among all of the test parameters, except that its modulation noise is on the high side. Its overall rating of 58% makes it one of the better Type I tapes and superior to most Type IIs.

Triad F-X: Offering good, well-matched results for all the parameters, it achieved an overall rating of 61%. It tied for second among Type I tapes and is just above the best Type II in the survey.

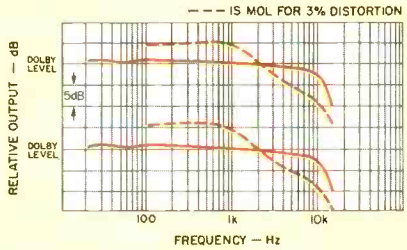
TYPE II TAPES

Most Type II tapes have low MOLs at the higher frequencies, but they usually have higher S/N ratios than Type I formulations. Most Type II tapes also have poorer 0-dB responses than do Type I tapes. The fundamental reasons for all three characteristics are these: The greater record equalization used with Type II tapes increases the high-frequency saturation, and the complementary equalization used in playback results in greater reduction of tape noise than with Type I tapes. The Type II overall ratings go no higher than 60% at this time, mostly because of low MOLs.

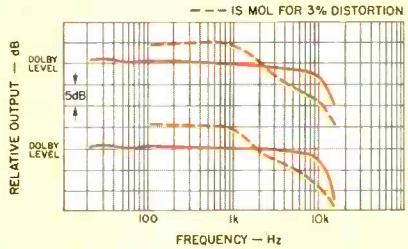
Denon HD6: This formulation is average, as Type II tapes go. The modulation noise was low and the S/N ratio high. Consistency was poor because of high bias and sensitivity offsets and higher-than-average skew and drop-outs. Overall: 49%.

TYPE II

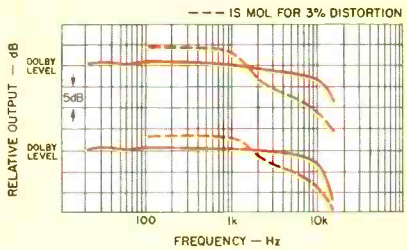
Denon HD6 (top) and HD7



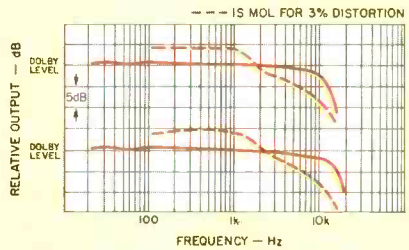
Denon HD8 (top) and Fuji FR-II Super



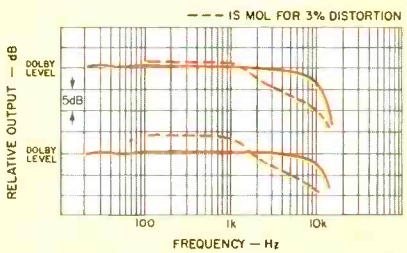
Maxell XLII-S (top) and Memorex HB II



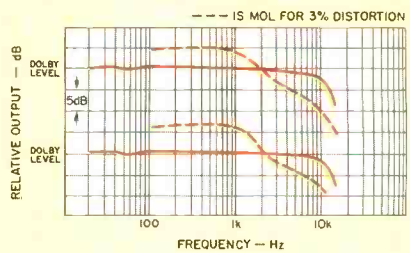
Memorex HBX II (top) and CDX II



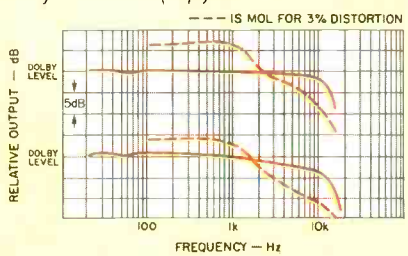
SKC QX (top) and Sony UX



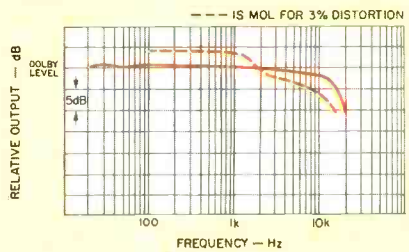
Sony UX-S (top) and UX-ES



Sony UX-PRO (top) and TDK SA-XG

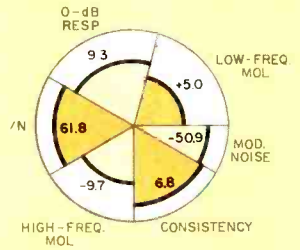


Triad EM-X



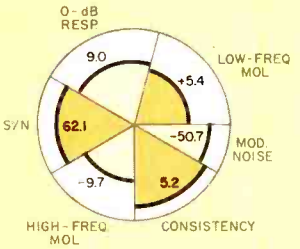
TYPE II

Denon HD6



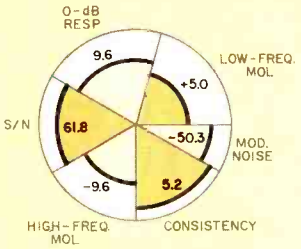
OVERALL PERFORMANCE: 49%

Denon HD7



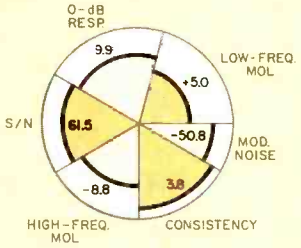
OVERALL PERFORMANCE: 50%

Denon HD8



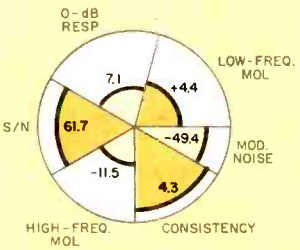
OVERALL PERFORMANCE: 51%

Fuji FR-II Super



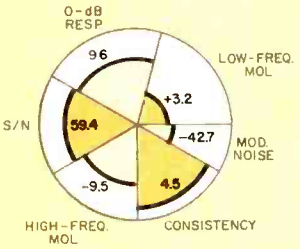
OVERALL PERFORMANCE: 54%

Maxell XLII-S



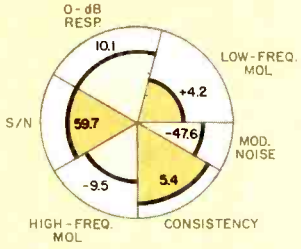
OVERALL PERFORMANCE: 40%

Memorex HB II



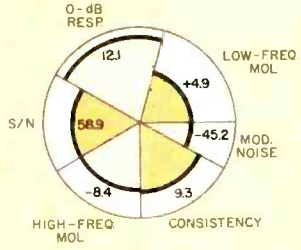
OVERALL PERFORMANCE: 42%

Memorex HBX II



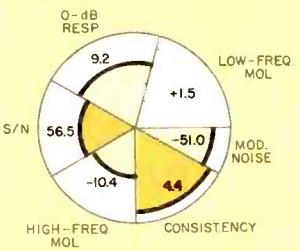
OVERALL PERFORMANCE: 47%

Memorex CDX II



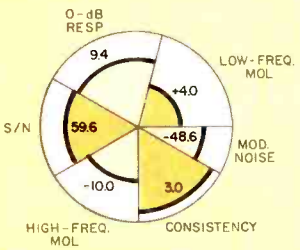
OVERALL PERFORMANCE: 51%

SKC QX



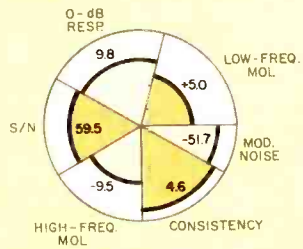
OVERALL PERFORMANCE: 38%

Sony UX



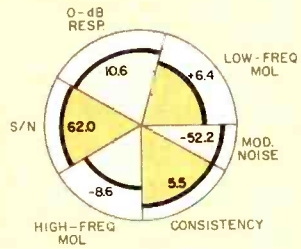
OVERALL PERFORMANCE: 46%

Sony UX-S



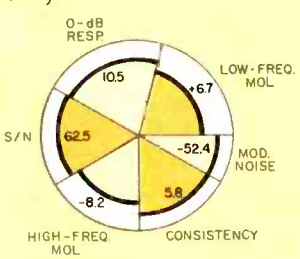
OVERALL PERFORMANCE: 51%

Sony UX-ES



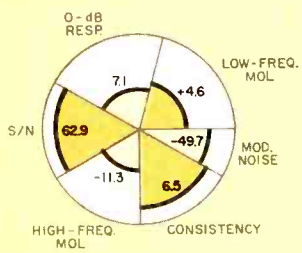
OVERALL PERFORMANCE: 59%

Sony UX-PRO



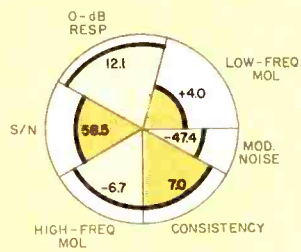
OVERALL PERFORMANCE: 60%

TDK SA-XG



OVERALL PERFORMANCE: 41%

Triad EM-X



OVERALL PERFORMANCE: 54%

The best overall performers were Type IV tapes, with advantages that are especially useful when taping from CDs.

Denon HD7: This tape's performance is quite similar to that of HD6. In three parameters it is slightly better, and in two others it is a bit worse. Up slightly overall from HD6, to 50%.

Denon HD8: This formulation is very much like the other two Denon Type II tapes. It is a bit above the Type II average, with an overall rating of 51%.

Fuji FR-II Super: Each parameter measured higher than the Type II average, winning it one of the better ratings in this survey. 54%.

Maxell XLII-S: The results for this tape were puzzling, in that it did not demonstrate expected improvements over earlier versions. Even after rechecking, however, its low 400-Hz and 10-kHz MOLs and its restricted 0-dB response could not be denied. With an overall rating of 40%, it is next to last in performance among the Type II tapes.

Memorex HB II: This formulation's poor 400-Hz MOL and its high modulation noise were balanced out, to some extent, by a reasonable 0-dB response. Overall: 42%.

Memorex HBX II: Improvements over HB II in four parameters were most welcome. The poorer consistency of HBX II was primarily due to greater offsets from IEC bias and sensitivity. Overall: 47%.

Memorex CDX II: A further improvement in performance is achieved by this Memorex formulation: There is a worthwhile extension in 0-dB response along with desirable increases in the MOLs. On the negative side, its consistency rating is the poorest among all the tapes in this survey (primarily because of high bias and sensitivity), and its modulation noise is among the highest. Overall: 51%.

SKC QX: This formulation had bottom-limit 400-Hz MOL and a poor signal-to-noise ratio. Relatively low modulation noise wasn't worth much in this case. Overall it rated 38%, the lowest figure in this survey.

Sony UX: As Sony's bottom-position Type II tape, UX is a bit weak in its 400-Hz and 10-kHz MOLs, but it is balanced quite well otherwise. The consistency was one of the best, with low flutter, excellent 3-kHz output stability, and very little in the way of dropouts. Overall: 46%.

Sony UX-S: This formulation was not all that different from UX, but the higher MOLs of UX-S are of definite value, and its more extended 0-dB response and lower modulation noise don't hurt. Consistency was poorer because of increased bias and sensitivity. Overall, it rated 51%.

Sony UX-ES: In moving up one more position in this manufacturer's Type II tapes, all parameters were improved with the exception of consistency, which was slightly poorer. Once again, higher bias and sensitivity were the culprits. The overall rating is 59%, making this the second-best Type II tape.

Sony UX-PRO: In general, this tape was similar in performance to UX-ES, but the PRO version had a slightly greater S/N ratio, and its MOLs were a bit higher. UX-PRO also provided outstanding 3-kHz stability, but the consistency rating was poorer because of the slightly higher bias and skew. Overall: 60%, the best of the Type IIs.

TDK SA-XG: The signal-to-noise ratio of this tape is the best of the Type IIs, but this cannot compensate for the low MOLs and the restricted 0-dB response. Overall: 41%, one of the poorer Type II tapes.

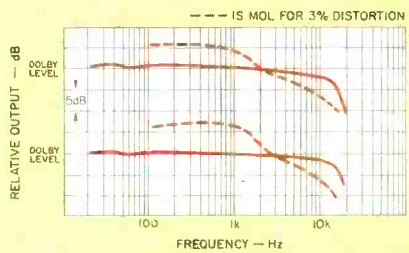
Triad EM-X: The 400-Hz MOL and the S/N ratio of this formulation are disappointing, but its 0-dB response is tied for best among Type IIs, and its 10-kHz MOL *is* the best. Overall: 54%, one of the better Type II tapes.

TYPE IV TAPES

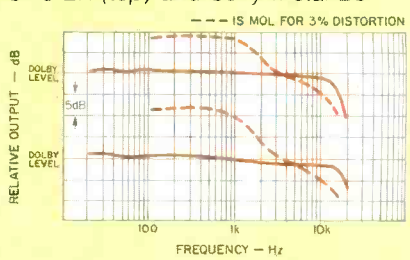
The better metal-particle Type IV tapes stand as the best performers overall, primarily because of their very high MOLs and reduced high-frequency saturation (which yields greater response extension at 0 dB). There has also been a general and slow reduction in the tape noise of Type IV cassettes since they first appeared. With the proliferation of CDs as sources, both at home and via broadcast, the performance at the high-frequency end has become even more signifi-

TYPE IV

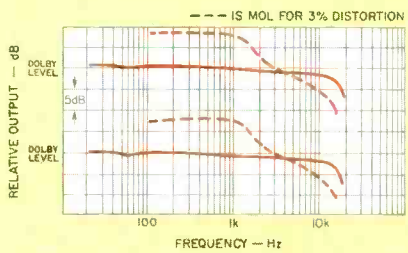
Denon HD-M (top) and Maxell MX



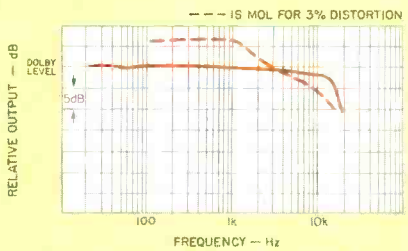
SKC ZX (top) and Sony Metal-ES



TDK MA-X (top) and MA-XG

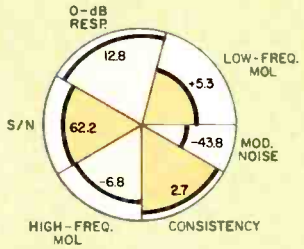


Triad MG-X



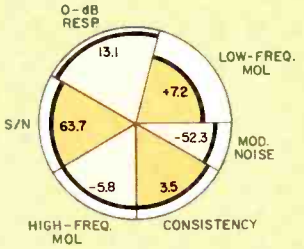
TYPE IV

Denon HD-M



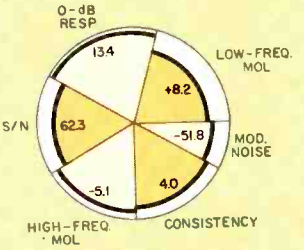
OVERALL PERFORMANCE: 64%

Maxell MX



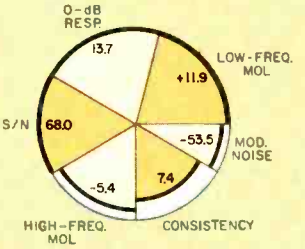
OVERALL PERFORMANCE: 75%

SKC ZX



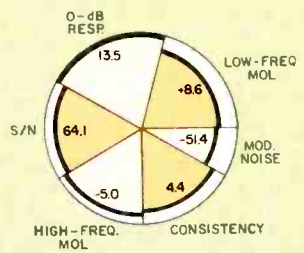
OVERALL PERFORMANCE: 77%

Sony Metal-ES



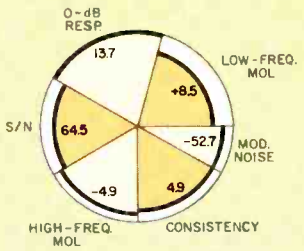
OVERALL PERFORMANCE: 88%

TDK MA-X



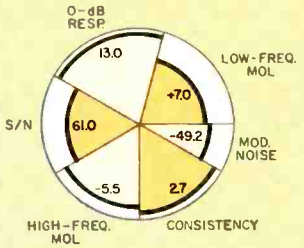
OVERALL PERFORMANCE: 80%

TDK MA-XG



OVERALL PERFORMANCE: 81%

Triad MG-X



OVERALL PERFORMANCE: 71%

cant. Thus, metal-particle tapes have become even more interesting to the serious recordist. The Type IV tapes approach 90% overall performance.

Denon HD-M: As the pie chart for this tape illustrates so clearly, an increase in the 400-Hz MOL and a reduction in modulation noise would bring the scores for these parameters closer to this formulation's other very good scores. Overall: 64%.

Maxell MX: This tape demonstrates further that the Type IV formulations are the source of the highest performance ratings. The 400-Hz MOL is just slightly low compared to a number of other metal tapes. Overall: 75%.

SKC ZX: With its first metal tape, SKC has hit the mark quite well. All of the results are very good, with no weak areas. The excellent 10-kHz MOL is certainly worthy of note. Overall: 77%.

Sony Metal-ES: This tape had the highest 400-Hz MOL and the highest signal-to-noise ratio, both by sizable margins. It also had the lowest modulation noise, and the 0-dB response was tied for best. Bias and sensitivity offsets were the most significant factors contributing to its relatively poor consistency rating. This formulation, with an overall rating of 88%, stands as the best-performing of any type evaluated to date.

TDK MA-X: With high MOLs, extended 0-dB response, high signal-to-noise ratio, and good consistency, this is certainly a very good metal tape. Overall: 80%, third best of all tapes tested.

TDK MA-XG: As this tape uses the same actual formulation as MA-X, I should have found the same performance—and I did, pretty much. The XG version's slightly better 0-dB response, S/N ratio, and modulation noise outweighed its slightly poorer 400-Hz MOL and consistency. The discrepancies all fall well within meter-reading error limits. Overall: 81%, making it second best of all these tapes.

Triad MG-X: This is a very good performer, in general. However, its 400-Hz MOL was low for a Type IV tape, and its S/N ratio was the lowest for the metal tapes in this survey. Consistency was among the best, with zero skew and low flutter both worthy of mention. Overall: 71%.

FURTHER CHECKS

When I selected the six parameters and chose all of the various modifying factors, I expected that the Type IV tapes would show the highest ratings. I did think that the Tape II tapes might edge out the Type I tapes, primarily because of their higher signal-to-noise ratios. The fact of the matter is that the average overall performance figure was 53% for Type I and 49% for Type II. This is not a big difference, to be sure, particularly when we think about the 76% average for Type IV tapes. The Type I tapes were superior to the Type IIs in 400-Hz MOL, 0-dB response, 10-kHz MOL, and consistency. The Type IIs were superior to the Type I tapes in signal-to-noise ratio and modulation noise. As noted above, many of these differences are due to the different equalization curves used with the two types. The Type IVs were superior to both in all parameters, with the exception that Type I tapes were very slightly more consistent. For the next survey, perhaps I will have to change the weighting of the various

I had expected Type II to edge out Type I because of higher S/Ns. In fact, the average Type I performance was a bit better.

parameters or add another parameter, but I will have to learn more before doing so.

I decided that a broad-band pink-noise record/playback compression test would have value in proving the importance of some of the parameters. The pink noise was band-limited to the range from 20 Hz to 20 kHz, and a negative shelf of about 5 dB was put in from 5 to 20 kHz to make it more music-like. For a flat display on the ⅓-octave RTA, a complementary positive shelf was put in after playback. I call this modified pink noise "PN/Music III." For my tests, I used a dual attenuator whose second section had been wired backwards so that attenuation would decrease in one section while increasing in the other. The noise was fed through the first attenuator section into the recorder, and playback was fed to the RTA via the second section. Because of the reverse connection, the total attenuation of both sections remained constant for all settings, so the signal level to the RTA remained the same at all times *except* for the effects of any compression. Buffering amplifiers were used to maintain required impedance matches for exact and equal steps of the two sections.

Figure 1 shows the results of the compression test. The level of the noise was adjusted for a 0-dB indication on an rms meter that had been calibrated to 400-Hz Dolby-level playback. The attenuator was operated in 1-dB steps over the range from −15 to +5 dB. Because of the differences between peak and rms indications, the CR-7A's peak-responding meters indicated close to "+10" at the noise level which corresponded to 0 dB on the rms meter, and the CR-7A's meters went off-scale at the +5 dB maximum level.

Three formulations were tried, one of each tape type. As is shown in the figure, the Type I and II tapes had some roll-off at the highest frequencies, even at −15 dB. The vertical spread of each trace shows the compression in each ⅓-octave band. There is normally some spread in the lowest bands because of the statistical character of the random noise. It is easy to see that the Type I tape has less compression than the Type II across the entire band, and that they both show more compression at the higher frequencies. The Type IV tape is quite superior to the other two tapes across the entire band, with relatively little additional spreading at the highest frequencies.

One thing this exercise demonstrates clearly is that maximum recording or meter levels are different for one tape than for another. The limits are lower for Type II tapes than they are for Type I tapes, in general, but the question of which tape to use for what music is more complex than is suggested

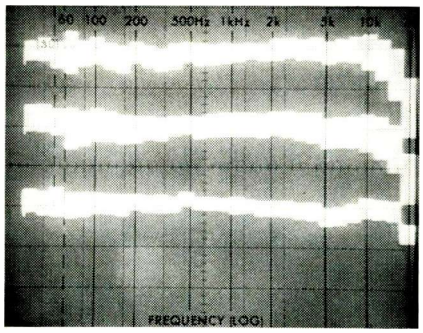


Fig. 1—Compression vs. level and frequency for high-quality Type I (top), Type II (middle), and Type IV (bottom) cassettes, over the range from −15 to +5 dB rms re: Dolby level. Thickness of traces in each ⅓-octave band shows the degree of compression (except in the bass, where statistical noise increases the spread); the trace for a perfect tape would be a thin, straight line (see text). Input signal was PN/Music III, band-limited from 20 Hz to 20 kHz. Vertical scale: 5 dB/div.

by this relatively simple test. In my next survey, I will do more testing of how tapes perform in the recording of music. The desirability of the IEC bias and sensitivity references for the consistency rating will also be reviewed.

FINAL THOUGHTS

Since my previous survey, Sony Metal-ES has become even better. A caveat here, however, is that with the relatively high bias and sensitivity (re: IEC) of this formulation, it will not perform at its best unless the recordist adjusts his deck to match it.

This is also true of the other tapes whose bias and sensitivity figures are offset from the IEC Standards, especially when this discrepancy is large enough to adversely affect the consistency rating. The rule applies to tapes with extra-low or extra-high bias and/or sensitivity ratings; however, high-performance tapes are usually on the high side of the IEC bias or sensitivity specifications.

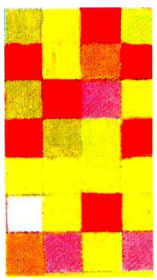
This facet is particularly important, of course, when the user employs Dolby noise reduction. Dolby NR can track accurately only when levels are matched exactly to the Dolby encoder and decoder. Level errors cause deviations in playback frequency response because the decoder makes the wrong "correction." Frequency response errors caused by poor bias matching generate level errors, which usually cause further response deviations. As a general rule, the recordist should not use a tape having extra-high bias and/or sensitivity (re: IEC) with Dolby NR *unless* the deck can be matched to it.

Digital audio tape is no longer a distant possibility. R-DAT decks have appeared in Japan, and their pricing history is expected to follow that of CD players. They have also been announced in Europe. Many factors, as yet unpredictable, will affect what happens to DAT in the United States market. Among them, of course, are the questions as to whether R-DAT decks will be required by law to include anti-copy chips and whether record companies will carve a notch from their products' frequency response to trigger such chips into action. My own studies of many CDs' spectra have shown that there is as much music energy in the area of the anti-copy notch as in the equivalent areas around it. Is this energy not, then, just as important as the energy that the notch would not affect? Let us all hope that no foolish decision is made to remove some of the music that we have been trying so hard to capture and reproduce accurately.

In the meantime, the recordist has many formulations to choose from for whatever purpose and for whatever form of cassette recorder. I hope that the pie charts presented here—as well as the text discussions—will facilitate making rapid comparisons when selecting a tape.

Do CDs Sound Different?

JOHN EARGLE



Nothing is wrong with digital; it's just that analog's nonlinearities were carried over to it.

When stereo LPs mastered from digital sources appeared in the late '70s, they were not met with complete enthusiasm. Many audiophiles raised their eyebrows, complaining of edginess and "lack of ambience." A few years later when the CD appeared, everyone was impressed by its low noise floor and unquestionable bass response, but many of the same audiophiles still found fault with digital recording. Again, the major complaint was edginess, even more so than with the digitally mastered LPs.

It has only been in recent years that most major record companies have altered their recording techniques in order to produce better CDs, and just about everybody would agree that recent discs sound far better than the early ones. Of course, CD players have become better too, and that is also a substantial reason for the overall improvement in sound.

Many people would like to think that recording techniques *had* to change in order for CDs to sound their best—and that there is something inherently wrong with the digital technology which forced these changes to be made. I would like to put forth the opposite notion—that there has been something inherently wrong with analog techniques all these years, which required recording methods to be adapted to them. While avoiding the digital/analog controversy per se, I think it can be shown that there are enough nonlinearities in analog recording techniques to have profoundly shaped the medium by these inherent characteristics.

Analog Nonlinearities

Consider state-of-the-art analog tape recording at 15 ips without noise reduction. Assuming one is using the best tape available and recorders with adequate electrical headroom, we observe the typical situation shown in Fig. 1. These curves indicate response roll-off of high frequencies at high recording levels. The actual amount of roll-off is dependent on the kind of tape that is used, the equalization curves that are chosen, and the reference modulation level.

Are such high levels reached in normal recording operations? The clear answer is yes. Even when a recording engineer is ostensibly operating his equipment at safe levels, there can be such signals present as that shown in Fig. 2. This trumpet waveform illustrates the high ratio of peak-to-average signal value which can exist in music. The important thing here is that such a signal, even if produced as a steady-state tone, can register on a standard VU meter as being no greater than zero level, while in actuality, peak levels some 13 dB higher are reaching the tape. Since the spike in the waveform is obviously high frequency in nature, it is clear that it will be partially rolled off through the recording process. Now, if the recording engineer allows his VU meters to register 3 or 4 dB above reference level—and this is not uncommon—then we are really into high-frequency roll-off!

We probably will not hear this roll-off; more to the point, we probably will hear no distortion due to the nonlinear action of the tape. The mechanism at work here is high-frequency self-erasure, and it has functioned over the years as an inadvertent but often benevolent audio signal conditioner. In general, the roll-off due to self-erasure produces master tapes which transfer easily to the master lacquer disc used in record production, since potentially troublesome high frequencies are attenuated by the process.

Disc recording and playback operations use complementary frequency pre-emphasis and de-emphasis, and

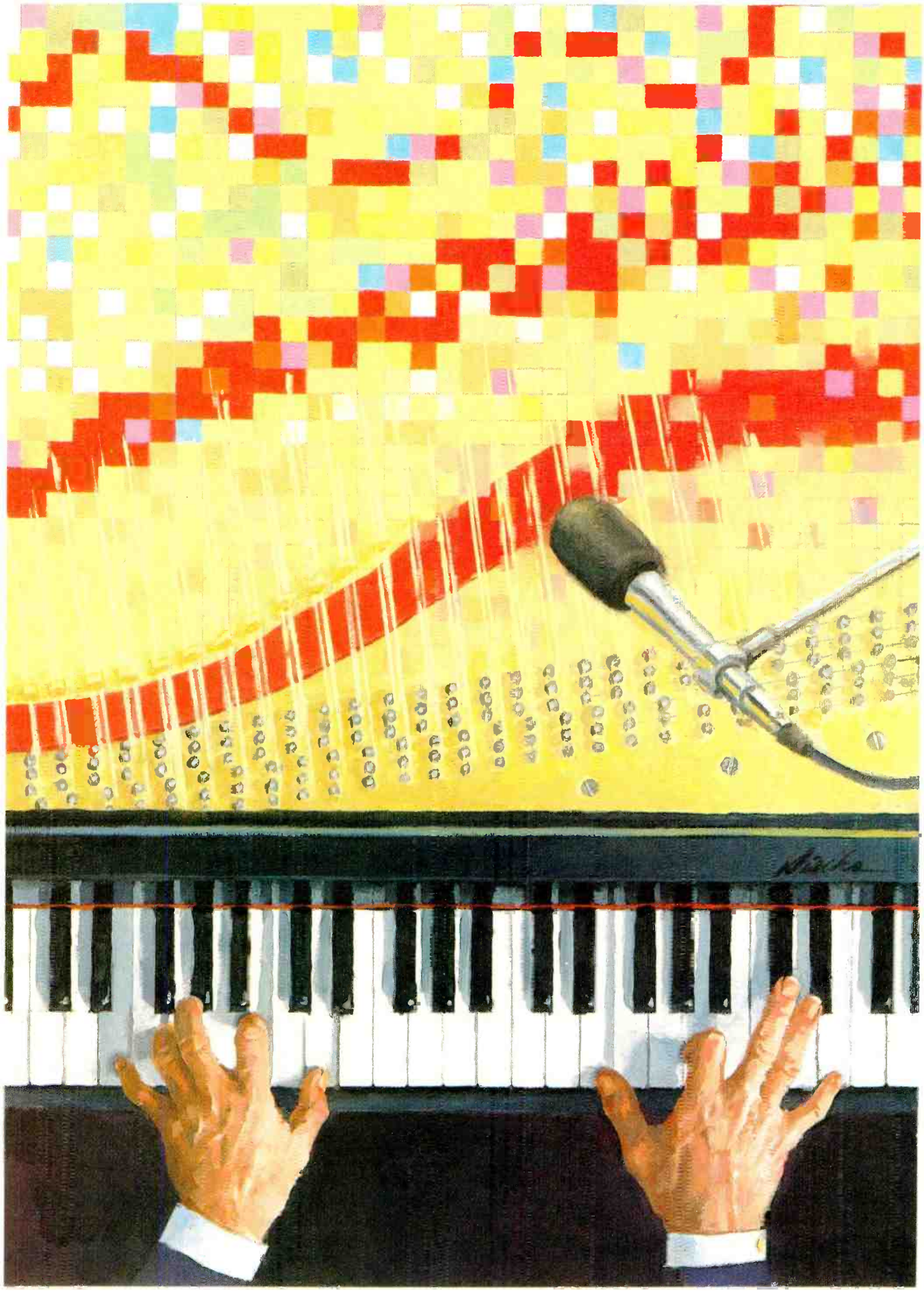


Illustration: David Dircks

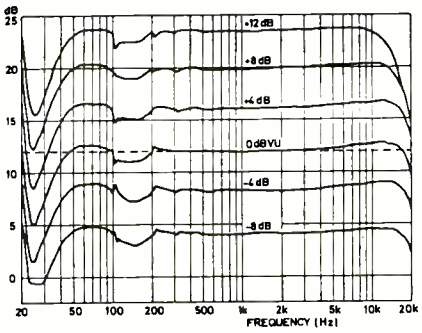


Fig 1—Analog-tape output curves for six recording levels. Note how high-frequency roll-off above 8 kHz increases with recording level. Recordings were made at 15 ips; kink in curves between 100 and 200 Hz is an artifact of the measuring system. (Data taken from John Borwick, Sound Recording Practice, Oxford University Press, London, 1976, pg. 119.)

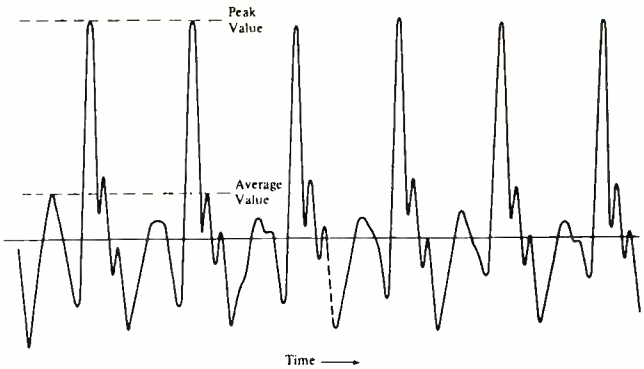


Fig. 2—Trumpet waveform (about 400 Hz), with peak-to-average ratio of 13 dB. Signals like this are common in pop-music recordings in which microphones are placed close to instruments. (From John Eargle, Handbook of Recording Engineering, Van Nostrand Reinhold, New York, 1986, pg. 124.)

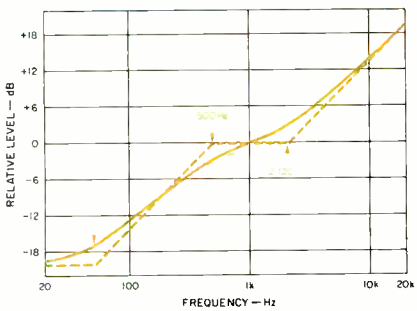


Fig 3—The RIAA pre-emphasis curve used in disc recording to conserve modulation space at low frequencies and raise high frequencies above the inherent disc noise. A complementary de-emphasis curve is used in playback to restore flat response.

the range from lowest to highest frequencies is 34 dB. What this means in practice is that the disc cutting process is very sensitive to the amount of high frequencies present in the program source.

The disc recording pre-emphasis curve, shown in Fig. 3, has a considerable effect on playback nonlinearities. These are shown in Fig. 4, and the curves have been normalized to the outer diameter of the disc. It can be seen that at inner diameters, where music is often loudest, there is substantial roll-off of high frequencies. These losses appear to be additive; that is, the losses shown for the vinyl pressing are the sum of the losses engendered in the cutting process (shown in the curve for the metal mother) and those due to deformation of the vinyl material itself.

Corrective Feedback Around the Creative Loop

Over the years, research and development engineers in the recording industry have addressed the problems caused by both tape and disc nonlinearities and taken certain corrective measures. The first measure was the easiest to implement: The use of brighter microphones in the studio itself. This produced a brighter master tape, and if still more brightness was needed, then additional high-frequency program boost could be added during the transfer from the master tape to the master lacquer. In some cases, another interim master tape would be made, the so-called "EQ-ed" master, and it would be used for subsequent disc transfer. At each step, an engineer and/or producer made an equalization decision based on playing back a reference lacquer or possibly a test pressing. In some cases, additional high-frequency boost was added simply on the basis that the pressing operation itself would result in slight diminution of high-frequency response, due to the polishing of some of the metal matrix parts used in replication. These cumulative steps amounted to corrective feedback around the entire engineering, manufacturing, and playback loop, as shown in Fig 5.

The overall procedure became so ingrained in the industry that every new step in the process was at first suspect—even if it audibly improved any part of the chain—because it upset some delicate balance. The first of these improvements was Dolby A noise reduction, which was introduced in the mid-'60s. With noise reduction, recording on tape could be carried out at lower levels, thus producing less high-frequency self-erasure. While everybody agreed that these tapes sounded better in terms of noise, not everyone agreed that the overall high-level spectrum was quite what it had been before or that it produced the record which everyone expected.

Enter Digital Recording

By its very nature, digital recording exhibits flat power bandwidth. By this I mean that it can record all frequencies in its pass-band at full level. There is no roll-off of high frequencies, even at maximum recording level.

If we simply replace the analog tape recorder with a digital recorder, we have taken one set of nonlinearities out of the overall loop. Since the "correction" for these nonlinearities probably still exists somewhere in the chain, we have upset our delicate balance somewhat.

This is what happened in the late '70s, when digital recorders were first introduced to the industry. The "correction," now out of place, was the bright microphoning to which engineers had become partial. In fact, the

current demand for truly smooth microphones dates from this period. In particular, many of the engineers who first espoused digital recording, sought out super-flat instrumentation microphones to use instead of the peaky studio models that were standard at the time.

When the CD finally hit the market, there was a wild rush to get product out. The major record companies went back to their "EQ-ed" tapes (since these were the ones which had received artists' final approvals) and directly transferred them to digital master tapes, which were used to make CDs. Then all hell broke loose. Much of the resulting sound was terribly bright and harsh, and we can easily see why. The tapes used to create the CDs were primarily intended for LP cutting and had built into them all the corrections needed for that process. Of course, not all analog master tapes were that bad, and not all companies had a history of heavy post-processing of their recorded material. However, one need look no further than the earliest CD reviews in *Audio* to appreciate the enormity of the problem.

In relatively few years, we have seen the industry rethink the entire recording process. One great boon here has been the return to direct-to-stereo classical recording by most companies, due to the high cost of multi-channel digital recording. When one records directly to stereo, there is little that can be fixed later. The balances must be correct at the outset—and they must be arrived at quickly. This constraint has led to the use of fewer microphones; we now find superb classical orchestral recordings being made with as few as three.

Whether three or 12 microphones are used is not the main point, however. What is important is the quality of the microphone, and today there are superb models, in all pickup patterns, that have remarkably flat response and extremely low self-noise. This means they can be used a bit farther away from the orchestra with no loss of detail or signal-to-noise ratio. Likewise, today's better mixing consoles have improved input characteristics and low distortion throughout.

Digital recorders themselves have improved remarkably in recent years, notably in the areas of input and output filtering and linearity of the conversion processes. The complete recording chain now used by many companies in producing classical CDs has become a very simple one, and operational procedures used to ensure signal integrity are straightforward. Most important, the numerical data which ends up on the CD is, except for changes introduced in the editing process, virtually the same as what is committed to digital tape at the recording session.

To many engineers involved with digital recording, the simplicity of the overall chain has made it possible to return to the basic stereo techniques that we have all read about over the years. Figure 6 shows a typical stereo digital recording chain in which the signal remains in the digital domain from the recorder until it is played back by the listener.

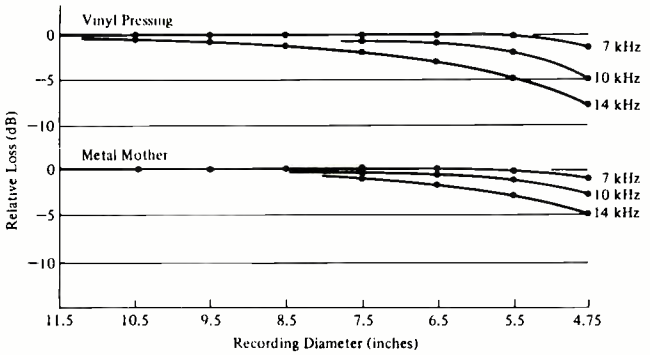


Fig. 4—Change in disc high-frequency response from outer to inner grooves. Signals were recorded at 15 dB below 1-kHz reference velocity of 5.5 cm/S, using RIAA pre-emphasis and de-emphasis curves; playback measurements were made with an elliptical stylus having a horizontal scanning radius of about 0.0002 inch. (From John Eargle, "Performance Characteristics of the Commercial Stereo Disc," Journal of the Audio Engineering Society, Vol. 17, No. 4, 1969.)

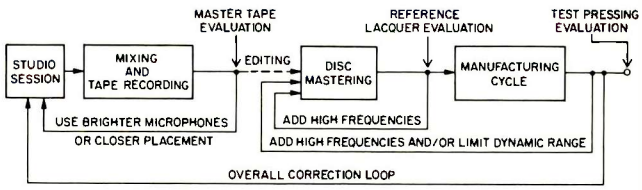


Fig. 5—Corrective feedback processes performed by recording engineers in LP recording and manufacture.

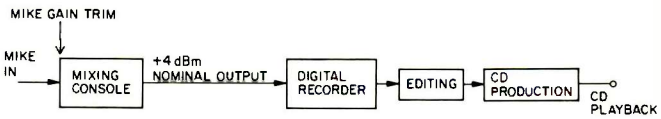


Fig. 6—The digital recording chain. In a normal setup, levels are adjusted for equal headroom, usually 20 dB, in the mixing console's output and the digital recorder. Microphones that can handle the anticipated peak acoustical signals are chosen, and the console input stages are trimmed to safely contain the microphone output. As long as the digital peak input meters do not exceed zero, no distorted signals will reach the tape. Original peak signal levels are then carried through the editing process and onto the Compact Disc for playback in the home.

Final Remarks

Nothing that has been said here should be construed as "anti-analog." There are many beautiful analog recordings in all our collections which will always be enjoyed. Also, of course, analog technology is improving—witness the advent of Dolby SR (Spectral Recording) and Direct Metal Mastering of LPs. What I have stressed in this article is that the two media do not easily mesh together, unless great care is taken.

Photograph: ©1987, Robert Lewis

THE AUDIO INTERVIEW

ALLEN TOUSSAINT

Crescent City Classic

TED FOX

New Orleans has been dubbed the Crescent City, and for music it has been a fertile crescent indeed, at least since the Jazz Age. Born there in 1938, Allen Toussaint began making music almost as soon as he began toddling down the streets of Gert Town. He was playing piano professionally, writing, arranging, and producing while still a teen-ager. At 22 he was already in creative control of the important New Orleans R&B label, Minit. There he produced, arranged, and wrote many now-classic R&B hits for Ernie K-Doe, Irma Thomas, Aaron Neville, Lee Dorsey, and others.

Toussaint has written more than 600 songs, most of which he also produced, including: "Working in the Coal Mine," "Mother-in-Law," "Fortune Teller," "Lipstick Traces," "I Like It Like That," "Java," and "Whipped Cream" (the Herb Alpert tune that became the Dating Game *theme). He has also released a half-dozen solo albums, including the classic* Southern Nights, *the title tune of which was a huge hit for Glen Campbell.*

In 1973, Toussaint and partner Marshall Sehorn opened Sea-Saint Studios, and a flood of top artists from around the world descended upon New Orleans to work under Toussaint's guidance and benevolent spirit. There he recorded the likes of Paul McCartney and Wings, Joe Cocker, Robert Palmer, and The Pointer Sisters, who had a smash with their cover of his "Yes We Can Can." Recently he served as musical director and on-stage performer for the well-received off-Broadway play Staggerlee. *In many ways, Toussaint is both the father and favorite son of the New Orleans sound.* T.F.

Your first work as a studio musician was on a Fats Domino record. It seems kind of strange for a piano player to begin as a session musician for another pianist. Did you play parts that he otherwise would have played?

Right. At some time I may have considered that my first, but I think Dr. John, who was Mac Rebennack at that time, and I played on some things maybe even a little earlier. But my first major move in the studio was playing at the Fats Domino sessions with Dave Bartholomew.

How did that come about?

Dave Bartholomew saw me playing at the Dew Drop, which was the popular nightclub in New Orleans then—the "who's who" always came through there. I would play exactly like the record, be it Ray Charles, Fats Domino, or anyone else. I played precisely like the record because I thought that's the way it should be done.

You were a teen-ager.

Oh, yes. And Dave heard me playing there and told me to come down to his office the next day. I did go down, and he asked me to play some things. I knew Fats Domino's entire repertoire, everything that he had recorded, and most other things that were on the air at the time. Fats wasn't in town, so Dave had me come into the studio and play on a couple songs: "I Want You to Know," and "Little School Girl," and a third one that I don't recall. We were [recording on] two tracks at that time, so we could put the music down and then put Fats' voice on it when he returned. It was a wonderful thing for me.

You also worked for a brief while as a touring road musician with Earl King and with Shirley and Lee. How did you like the experience of working on the road with a band?

Marvelous. I didn't tour straight through with Earl King. He would do spot jobs and come back on the same

> Guys and girls would get together at my parents' house and jam all day long, and I would write songs so we could have fun.

FATS DOMINO

night or the next day or two. With Shirley and Lee I stayed out almost a year straight, and that was just great. We toured the whole country.

But you didn't remain a touring road musician for long. What changed your mind about pursuing that as a career?

Well, Shirley and Lee came back in and stayed in for quite some time. Of course, I got really busy playing on sessions back in New Orleans. I got another great opportunity when the bass player with Shirley and Lee, whose name was Roland Cook, was going to record with Danny Kessler, who was a travelling talent scout or producer. The word "producer" wasn't used yet. Roland Cook was the leader of the band that I was playing with. While making the record, Roland needed another song. So I wrote him a song to do, and I played on the session, and Danny Kessler heard me. He really liked what he heard as far as the piano was concerned, and he came to me when the session was over and asked if I could prepare something to record within a week or two. I said, "Oh, yes, I'd love to." He said, "How about an album?" I said yes.

An album in a week or two?

Oh, yes.

Isn't that kind of short notice?

No way! He could have had it that hour.

So you'd been thinking about this?

No, I never thought about it.

You were that quick? You could put an album together that fast?

Oh, yeah. That was all I did. That was my whole life. I used to spend time playing with a group of guys in my neighborhood. We'd spend the whole day in the front room of my parents' house, just playing and writing songs.

In the studio, Red Tower—Alvin Tower, a baritone player who played on all of Little Richard's sessions, Fats Domino's sessions—he was sort of in charge of the session musicians. Danny put Red in charge of seeing that my record happened. So Red got together with me in the studio.

Was "Java," the song that Al Hirt later had a hit with, one of the pieces you wrote for that album?

Yes. In a couple of weeks we went in and recorded the album. It was called *The Wild Sound of New Orleans*. They spelled my name "Tousan." He thought Toussaint was a little too serious, it would give deejays a hard time.

Shortly after your album debut, you started moving behind the scenes, arranging and producing. Did you feel you would rather do that than be a performer?

Well, I hadn't thought of myself as a performer, ever. I thought of myself as a pianist, one who could write songs and liked to write and arrange. I loved to arrange and get those wonderful sounds that were available to get. Guys and girls would get together in the front room of my parents' house and we would have a jam session all day long. I would write songs just so we could sing and have fun. I'd write what we felt like doing at that time. So to go into the studio [as an arranger/songwriter/producer] was the same thing I was doing anyway.

How did you work in the studio in those days? Would you bring the band members together before the session to work with them on the arrangements?

Oh, never, never. We never had the band before a session. But I had the singers available all the time. We'd work out background vocals in the front room of my parents' house, and get all of the vocal things down very well. Then I'd write out the songs for the band. We'd have the same general musicians all the time. I'd pass out the music in the studio and we'd go through it. We'd do four songs in three hours. The music was simple. It was never anything very complex.

You worked with Paul Simon on the arrangements of Rhymin' Simon. ***That must have worked quite differently.***

Not really. They had the basic tracks already down; I came to New York with the horn parts written out. I gave the musicians the music, we went over it a couple of times, and we did it.

Even though this wasn't your material, your songs?

Right. Later on I began to arrange some things that I hadn't written, like for Peter Yarrow. Also, for Labelle, much of the arranging that I did was on songs that I hadn't written; Nona Hendryx is a great writer, which is always a blessing. Early on, most of the songs that we were recording were songs that I had written. We were always starting from scratch, and I just happened to have been the writer of the day for us. I would have gladly just arranged. But we always needed songs so . . . . It was just so easy to write a song.

But was it equally satisfying to arrange a good song that someone else had written?

Oh, yeah, over half the job was done. They'd already found a good plot, a

Photograph: Michael Ochs Archives, Venice, Cal.

If a song didn't come out well, I'd throw it in the wastebasket. I was so in a hurry to get to the next one that it didn't matter.

ERNIE K-DOE

good melody, good song, good changes. Arranging was much easier. I don't think you have to be a musician to be a good arranger.

Don't you have to know how to transpose to a different key and all that?

Yes, if you're going to be one who goes that far. Like, I do the whole thing, transpose and whatever is necessary. I decide which instrument will get the best warmth and best color, the best vibes. But you can dictate what you want to someone who knows how to transpose, because transposition is just a mechanical device that's used. Some people write in the concert key all the time, so they never transpose. Then the one who copies the music knows the rules of transposition, and they transpose it for whichever instrument you need. That seems like a very lazy way to arrange, but some people do it that way.

Let's talk a little more about songwriting. When you, especially in the early days, were writing for this group of artists you worked with—Ernie K-Doe, Irma Thomas, Lee Dorsey, and so forth—would you always write a song for a particular artist? Did you always have someone in mind when you were writing?

Every time. Even songs that never got recorded were written with someone in mind at the time. It was very comfortable that way, and it seemed like the best route to take. To hear their voice right in front of you there, to see how they were and who they were and how they walked and just their general demeanor, was always a great help and inspiration. I always regretted that there were not many artists writing their own songs at that time. Ernie K-Doe began writing some pieces. He always did like his own material very much. Much of his material, however, consisted of gospel songs that he changed the words to. And as much as I've liked gospel all my life, I didn't like doing that. It seemed like treading on grounds that shouldn't have been tread on. To take something like "Amazing Grace" and make it something like "Amazing Beat," I never liked doing that. I don't mind taking a secular song and changing the words and making it gospel, though.

The story goes that K-Doe literally retrieved "Mother-in-Law" from the wastebasket. Is that true?

The reason that was said is because I threw songs in the trash can every day. The guy that retrieved most of the songs from the wastebasket was Willie Harper, who sang background on "Mother-in-Law," and "Working in the Coal Mine," and almost everything that I was doing. I'd write these songs, and if it didn't come out very well the first time, well, I just balled it up quickly so I wouldn't think about it. Sometimes the rest of the group there in the front room would be a little bit saddened by it—not to the point of tears, or anything—but a little saddened by it because they thought, "Oh, that wasn't bad at all, that was a pretty nice song." But I was so in a hurry to get to the next one that it didn't matter. But Willie would get the song out of the wastebasket and take a look at it anyway while I was writing another. I'd tell him, "Willie, leave that alone." Sometimes he'd keep it, though. Two or three weeks later he would show me these balled up pieces of paper, these songs that I still wouldn't record. But "Mother-in-Law" . . . . You know, I must think about that . . . . I kind of liked the way "Mother-in-Law" went. It was based on a six melody, and Ernie wasn't singing the six, and that was the most important thing for the artist, to base it on a six, because I thought in this case it was a pretty color for the song. I've always liked that six mood. But Ernie K-Doe was so sort of wild in a way, in a wonderful way, for stage and singing, and that [six melody] didn't mean the same thing to him as it did to me. So he was just improvising. I remember almost getting a little angry . . .

. . . and tossing the song into the wastebasket.

That is the way it happened. I had written another song the night before, called "Tain't It the Truth." I dreamed that song. It was one of those that you dream and you hear it and you just get up right then and write it. I had "Tain't It the Truth," and I kind of liked it, and I knew I had it to work with and didn't need "Mother-in-Law."

Now, you had publishing on all these songs, right?

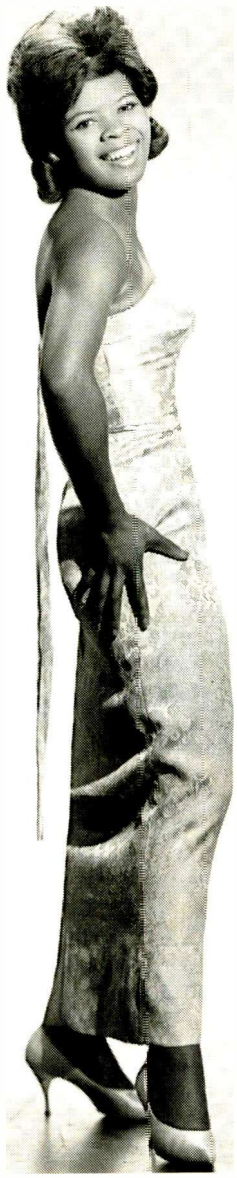
Oh, no, I wasn't thinking publishing at that time.

So what happened?

What happened is what I think should have happened—a publishing company had to publish it. Who knew how to publish? I knew nothing of that. If I'd had my own publishing company at the time, it might have been great for the moment, but nothing later.

You think the songs wouldn't have gotten pushed as much if you'd had your own publishing company?

Photograph: Frank Driggs Collection



IRMA THOMAS

I don't regret not having the publishing rights to the songs I wrote. Who knew about publishing? I got whatever writers get, and that was fine with me.

Well, the first time around they might have, but not the second or third time around. Also, you had to be really involved in those days to know how to collect your money. Now, during those days I was with Minit Records, which was distributed by Imperial. Thus, the business was handled by Joe Banashak and Larry McKinley, who owned Minit. The publishing was handled by Post Music and Travers Music. I guess they had their own reasons why one song would go to Post and one to Travers. I got whatever writers get, and that was fine with me. Even to this day, I don't regret not having the publishing, because I was with a publishing company. They published, and I wrote and arranged. I was comfortable with that arrangement, and I lived and learned.

Let's talk about some of the other great songs you wrote and produced. How about Lee Dorsey's "Ya Ya"?

Yeah, well, I'm glad you mentioned "Ya Ya," because sometimes there is a misconception about that record. By the time "Ya Ya" came along, I was already with Minit Records, but "Ya Ya" was not to be a Minit production. Now, whatever company I was with, I was totally married to. Marshall Sehorn was handling Lee Dorsey at the time, and he was an officer of Fury Records. He knew my work. He came to me and asked if I would put "Ya Ya" together for him, even though he knew I wouldn't go in the studio with him because I was with Minit. So we got together in the front room and I arranged "Ya Ya." They got Harold Baptiste to go in the studio with it, and that worked out very well.

How about "Working in the Coal Mine"? Someone asked me if you really had worked in one.

I half believe I did [laughter]. I don't know why the song said "working in the coal mine," but I remember writing it in a back room on St. Phillip Street, because that's where we had a piano. By then I had begun working with Marshall Sehorn as a partner. I had dissolved my affiliation with Minit. While writing for Lee Dorsey, I knew we were going to record in the next few days, so I needed songs. I could write for Lee Dorsey all day, with that kind of voice. In fact, while I was writing the song I was trying to hurry and get through it because I heard another one coming. And "working in the coal mine" came to mind. It was very, very fast, almost too fast to pronounce.

Did you have the title line first, or did you have the rhythm or melody in your head first?

The melody. The words "working in the coal mine, going down, down, down" came with the melody. The tempo was very fast, like this. [He snaps his fingers rapidly.] That was ridiculous, of course, but that's how it felt. For a while in the back room I was doing it like that, because to carry on I had to submit myself to how it was coming. It felt really exciting when it came through fast like that, like one of those really heavy, sanctified kinds of rhythms. And then I slowed it down. Of course, when I slowed it down, I began to hear what I thought it should be. Because it was too fast to comprehend. If we'd left it that fast, one could have done nothing to it. You'd get tired of tapping your foot after the first verse. I put two verses in it. That was a session that didn't really work.

Why didn't it come off?

I didn't care for the way some of the music came off. We didn't get through the second part of it as gracefully as I thought we should. But we had other songs that I liked on that same recording session.

How often did you have to release records that you weren't totally satisfied with as a producer?

Too many times, at an early age. But saying I "had to release" something isn't really it; it was more that, once I was through with my part of it, others would say, "Oh, it's not as bad as he thinks." What happened with "Working in the Coal Mine" is that Marshall Sehorn took it after everything was over, and did an edit job on it which made it all work. I thought that was really fine. I had so much [material] coming at that time, so what if something didn't work? Do something else.

Your "Ruler of My Heart," which Irma Thomas recorded, was such a great song. What happened with Otis Redding's "Pain in My Heart," which was obviously a direct copy?

Otis Redding did hear "Ruler of My Heart" and liked it a lot, and he said "pain in my heart," and he followed through with the next line having to do with that. Then everything else was the same, the melody and the changes and everything. It's just that he changed the line. And he didn't give credit. That was one of those cases where one would take a song and . . . . When I heard it, I knew that had hap-

Photographs: Michael Ochs Archives, Venice, Cal.

pened, but I didn't know one could do something about it. Banashak didn't rest two minutes when he heard that. He immediately went after it and got it back. I loved Otis' "Pain in My Heart" because I like anything Otis did, and I was sort of proud that he did that, you know. It was nice that he liked something I did well enough to do that. I hadn't considered whether it was honest or dishonest, or whether something should be done about it.

Did the two of you ever talk about it?

Oh, never. I didn't get to know him very well. I did meet him in his dressing room. He wasn't very big yet, but it was really good to see him.

So there's no hard feelings on your part.

No way.

Did it cut Irma's song out from under her?

No, it came out at a different time, so she got whatever could come out of hers, and he got whatever could come out of his.

Let's talk about some of the many songs you did with R&B artists that went on to be covered by pop or rock artists. For instance, Benny Spellman's "Fortune Teller," which The Rolling Stones covered. How did you feel about The Stones' version?

I love The Stones. I love what they give to the audience and to the world. Just dynamic. But I've never heard [their version of] that song before. I'm going to look it up. I would like to hear it now, but in those days I was just so busy.

How about "I Like It Like That"? It was a big hit for The Dave Clark Five, though it was originally done with Chris Kenner.

In fact, Chris wrote most of that song. I added to what he wrote, and I added so much to it, Banashak just couldn't let it go by [without a credit for me]. I did that a lot on songs that I didn't get credit for. I would add verses here and there and I just figured that was what I was supposed to do to make it work. My main function was to get a recording out of what was brought in. When it was a song that I didn't write, I was always glad to receive it, even though it didn't happen an awful lot. But in Chris Kenner's case, he would have a lot of wishbones and grivenes around, and we would make a chicken out of it [laughter].

How do you feel about having your songs covered by rock artists?

I love that. For one thing, I love the idea that someone likes it well enough to do it. Even the early Otis thing, even though there was an attempt to shift the credit around. I love the different versions of the songs that I've written. It means someone else went through all of the arranging, and they had to live with it a bit. That's kind of nice. I really like that. And I especially like when they do their own versions. Some songs that I've written have been covered just as they were. Like, as much as I do like Herb Alpert's version of "Whipped Cream," which I wrote for The Stokes, he did it exactly as the record was. Except Herb Alpert had such a wonderful way of handling the trumpet, with the dips on the end melodies, and the double trumpet—I love that. Also, when someone does the piece exactly as we did it, it means that they not only liked the song, they even liked the way we did it. That's quite a boost for the writer.

LEE DORSEY

Do you have a favorite cover of a tune of yours that was not arranged as you did it?

One time, riding in the car on the way from Texas, when I was getting out of the Army [in the mid-'60s], I heard "Java" being done by a large orchestra. They modulated two or three times and had many different instruments with different colors doing it, and it was just a grand "hooray" feeling. The deejay did not say who it was after he played it. Maybe he said it before, when no one was interested.

We just touched on The Stokes. That was an all-instrumental group of yours, and as you mentioned, "Whipped Cream" was one of their songs. You formed The Stokes when you were in the army in '63 in Texas, right? How did that come about, and why did you decide to go with an all-instrumental group?

We had a vocalist on stage, but not on the record. The group consisted of a trumpet, a tenor, sometimes a trombone, a bass, drums, and piano. We had a vocalist called Spike. The trombone player, Ron Inzell, was my immediate superior. I was in the soldiers' chorus, you see, and he was the chorus director. We gigged around some nearby towns right off-post. I wrote lots and lots of instrumental songs. I always did like writing those instrumental-type pieces like "Java," and having this band, now, it gave me a chance to continue doing that. They loved to play all the time. Most of the

> My function was to get a recording out of what was brought in. If it was a song that I didn't compose myself, I was glad to receive it.

original stuff that we would do were instrumental pieces. It seemed, though, that in clubs, whenever it would be a vocal song, people wanted to hear what was on the air, rather than new material. So the vocal songs that we did were usually radio songs—"Since I Fell for You," whatever was on the air at the time. It was a dancing audience, an audience out to have fun. It didn't mean that they were unintellectual, it just meant that concentration and taking on something new was not the call of the hour. They liked the familiar, I think. So that's why I didn't write many vocal songs to do in a club. But the instrumentals, of course, that's just a lot of foot-tapping, and you don't have to put your intellect to work too hard to decipher what the meaning of an instrumental song is. You just get up and boogie.

That continued with your involvement later on as a producer for The Meters, another largely instrumental group.

Yeah. But I didn't instigate that as much as The Meters did themselves. I certainly wanted The Meters to be who they wanted to be. The Meters were mostly a percussion group—not percussion instruments, but they played percussively. Everything they played was very heavily syncopated, and everyone played very percussively, to the max. I gave them carte blanche to do whatever they would like, because they were a co-op group, even though I knew that there was a leader. They felt co-op, but Art Neville *was* the leader, and the reason why whatever worked really worked. That was very obvious to anyone on the side, whether The Meters knew it or not. Art Neville always has been able to put together magic. He was a magic man. And The Meters was the result of one of Art Neville's concoctions. They were very strong as musicians. They could come together, and whoever started out the song knew that he could count on the others doing something that was going to be nice. A lot of it was put together that way. Their songs were a conglomeration of firecrackers going off here, and pops there, explosions here. It was just fire.

What is your job as producer?

My job as producer is to get the best out of whoever is the call of the day. How do we get *this*—whatever "this" is—to *them*—meaning the audience. In the case of The Meters, that meant, for me, not doing all that I do with other people, which I would rather do. But I felt very comfortable in letting The Meters do what they would do. I don't mind saying it's harder to do that than it is to take full responsibility, because as you hear things you always would rather do this or that. But producing is a very touchy situation. It's diplomacy all the way, and it takes quite a while to come to terms with that. Sometimes an artist may just feel, "I need to do some really wonderful stuff that I have in me." Most times, there's a way of guiding that in your direction. But you have to allow that to happen. Because bruises are terrible. They can last too long, they can bend the creative spirit . . . . The next thing someone does may be just totally wonderful.

You and Marshall Sehorn, in your various operations in New Orleans, had a lot of local and regional success throughout the '60s, but not too many of those songs really hit nationally, did they? Did that disappoint you?

Even though we were having fun, I must admit that yes, I would rather that they did go national. I began to understand later on that it took more than song after song after song. It took building an artist's career. And there was no one doing that. That wasn't my fault, even if I knew that it needed to be done. It wasn't what I do or could do. I must admit that [my] early companies, even before Marshall Sehorn—with Minit and Instant and Alon—those companies were about the next record, recording the next record, and collecting whatever royalties that came. That was it. Then "let's go on to the next record," and to the next. They never had the slightest notion of building an artist's career. I don't know whether they just didn't know how, or if they just were satisfied with the royalties that would come. But the only way that you can become a nationally renowned artist is that someone has to be building your career.

And is that a function of the record company or the individual management?

Record companies can pull that together. A manager of course can, but in our area we weren't in touch with that caliber of management. And the company that we were with, Minit Records, didn't know that it would be to its benefit to see that that happened. In fact, there were a couple of artists that had managers in New Orleans, but the managers were of the same mentality. Whatever came to them would be sufficient, I guess. They just didn't know how to approach the nation.

What about you and your partner Marshall Sehorn?

Ah . . . I don't think we got into that

THE POINTER SISTERS

Photograph: Michael Ochs Archives, Venice, Cal.

> Bruising an artist is terrible; it can last too long and bend the creative spirit. That's why producing requires diplomacy.

I began to understand success takes more than song after song. It requires building an artist's career, and nobody was doing that.

LABELLE

either. For one thing, we couldn't be managers, especially myself. As far as building artists' careers, that's been a problem . . . . The Neville Brothers, I think, have overcome that. A group called The Dirty Dozen Brass Band has overcome that.

Why did you, in the early '70s, decide to resume work as a solo artist performing your own material?

By request of other folk. I never decided that. Others would say, "Oh yes, you should, you should." I think Steve Terrell was the first one who encouraged me, enough to do an album for Scepter as a vocalist. That had been the farthest thing from my mind. I would sing songs to the artists—to Irma [Thomas], to Aaron [Neville], to K-Doe, whoever was around—but I never thought of singing on a recording myself. Steve Terrell instigated that.

Were you satisfied with those albums, Toussaint *and* From a Whisper to a Scream*?*

Of course not. No way. Vocally I just didn't accept the fact that I had my own sound. Now, even though I don't think of myself as some great, grand singer among fine singers, at least it's my own signature, and I understand that, and I thank God for that.

Let's talk about the Southern Nights *LP. That album almost seemed to me like your* Sgt. Pepper. *It was a real concept record.*

What a way to put it. I really tried to make it a good album. I felt dear about it. We also thought that we should make it . . . . Rather than just putting in a song and then a space, another song, another space, we thought of staying with the listener throughout. We tried to stay in touch throughout the album, from beginning to end. We really cared.

Did you consciously try to link the songs?

Sometimes. But much of that just happened. It all was written at the same time, so without even trying it appeared to be a concept.

Jerry Wexler produced your Motion *album. How did that come about, and what was it like working with Jerry?*

It was done through Warner, I think. Jerry called me and asked, "What about this?" I couldn't get over the fact that he would have considered it. I learned so much. Jerry is a real producer, and he's not a musician, which is wonderful. I saw him just put in who he figured was the best for a project and get it done. He was a general. I felt very important. Even though he didn't write songs, he was there working with me as an artist, and that was the first time that had happened to me. I felt unworthy, I must say that. But it was wonderful because the idea that this was Jerry Wexler, doing with me what he had done with Aretha Franklin and Ray Charles . . . . I was in good company. It was wonderful to look through the glass at Jerry Wexler right there, even though I already knew him enough to talk with him. It wasn't like I was meeting him for the first time.

In 1973, you and Marshall Sehorn opened Sea-Saint Studios. Why did you decide to open your own studio?

Because Cosimo Matassa's studio wasn't around anymore.

Jazz City Studio?

Yes. And before that, just "Cosimo's studio," whatever he called it [J&M]. If he had kept his studio until today we would never have opened. We were always very satisfied with Cosimo's studio, even though they never were finished. I don't recall his having a finished studio, ever. But it was wonderful. And we were always very satisfied, and I would be today, I think.

Sea-Saint signed a long-term production deal with Warner Bros. How did that come about?

Marshall has always been a go-getter. He didn't sit anywhere very long. And we were signing other acts. I think The Meters was one of them. Warner Bros. inquired about me as a solo artist. Marshall spoke with me about it and I said yes. Whatever I can do that will assist the company, I'm all for it.

Things really seemed to happen after Sea-Saint opened. You produced Labelle's "Lady Marmalade," and The Pointer Sisters covered your song "Yes We Can Can." Were you really trying to change your direction or did things just start happening?

Things just started happening. I wrote "Yes We Can Can" sometime before for Lee Dorsey. Later on it was covered by The Pointer Sisters, and they did a wonderful job. That was one of those very precious moments, when I heard what they did to "Yes We Can Can." I loved it dearly. "Lady Marmalade" I produced in the studio in New Orleans, and I did what I do with that. It was written by Bob Crewe and Kenny Nolan. Out of the songs we were sorting through, they had this album with that piece on it by someone. Labelle's manager said that the girls had heard this and liked it, and would I give it a listen to see if it could be a candidate. And when I heard it I thought, "Of course it can." I didn't know it would be the winner it turned out to be. It was a "why

THE METERS

> One could be based anywhere, but New Orleans is a garden I like a lot, and I'm one of the plants that belong there.

not?" type of song. Of course, we gave our own treatment to it, and the rest is history.

Tell me about working in your studio with Paul McCartney and Wings.

He spent a couple of months there, and it was delightful to have him down. He was one of the most professional producers I've ever seen. He knew exactly where he was going, and he knew when he had arrived. There aren't any ragged edges in his music that you just let happen. He's totally responsible and he knows when he's arrived at the magic. I just played on a couple of sides; he actually produced himself.

What do you think of McCartney as a songwriter?

One of the greatest of all times, of course, even before that time, and even now.

Did you ever consult? Did he ever ask your opinion on songs, or ask how you might go with a piece?

No, not at all. I don't mind saying one is sort of in awe of Paul. But he was wonderful to hear.

Were the national and international artists who came to Sea-Saint in the '70s looking for a New Orleans sound, and do you think that recording in a particular city can make a difference in the sound?

Yes, by all means. I don't expect to record New Orleans in New York. You can bring a New Orleans group to New York and record them, and you can record that New Orleans sound in another city. But when you go to a city without bringing your whole household of equipment there, yes, it definitely makes a difference. I think when companies send an artist to New Orleans, they want something that they think will signify New Orleans. Otherwise, you wouldn't leave metropolitan New York to go to New Orleans—the best of everything is in New York. But New Orleans is not in New York.

What do you get in New Orleans that you don't get here, then?

Gumbo [laughter]! Well, there's some subtleties that you get out of players in New Orleans that you can't get in New York, just because it's in New York. The musicians in New Orleans have an individuality that's influenced by the second-line parades, the Mardi Gras, the syncopated beat, things like that.

When you and Marshall first got together, I know he wanted to move the operation to New York, but you said no, New Orleans was your home. Would you ever feel comfortable leaving New Orleans as your base?

Oh, I wouldn't leave. Well, I guess one could be based anywhere, but I feel that New Orleans is a certain kind of garden that I like a lot, and I'm one of the plants that belong there.

New Orleans was once such an important recording center. Now, the music business seems to have largely passed it by. Why?

The lack of business folks. Well, let me put this right . . . . People came through and got what they wanted, and went back home. That was good for a few people who reaped benefits—the owners of studios and small companies. But major companies didn't move there and base themselves there and do business from there. Their headquarters were always somewhere else—New York, California, maybe Chicago. The few business folk who were involved then [in New Orleans] would have had to interest someone else in other categories of the business, and encourage them, and show them in black and white how something was worthy of their deepest consideration. They would have had to take it seriously. But the music business wasn't taken very seriously some years ago, especially in the smaller areas. Of course, in areas like New York, everywhere that's making money, it is taken very seriously. But the pace of New Orleans was slow.

In the early '80s things seemed to slow down for you and for Sea-Saint. Warner didn't renew its contract. Why did things slow down?

Well, the main thing about the contract with Warner is that I didn't live up to my end of it as I should have, putting albums out as I should have, on time. I wasn't interested in myself enough. So if there was a problem, that was the problem. Warner Bros. was wonderful to us. As far as being a recording artist, I just never took that seriously enough, so it slowed down to a standstill. Other things—again, out of the artists that we were recording, even in recent days, the building of careers has suffered, and artists just look for the next record. That was okay for an artist to do many years ago, but now it's too crowded out there to overlook any facet of the business. That part of it is still being overlooked. It suffers terribly these days, much more than it would have before.

What's going to be happening in New Orleans in the future? Will New Orleans always be a good music town for recording?

It has peaks and valleys, I've noticed over the years, and we're on our way out of a lengthy valley, I might say. And it looks good.

Photograph: Michael Ochs Archives, Venice, Cal.

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1

VELODYNE ULD-15 POWERED SUBWOOFER

Manufacturer's Specifications

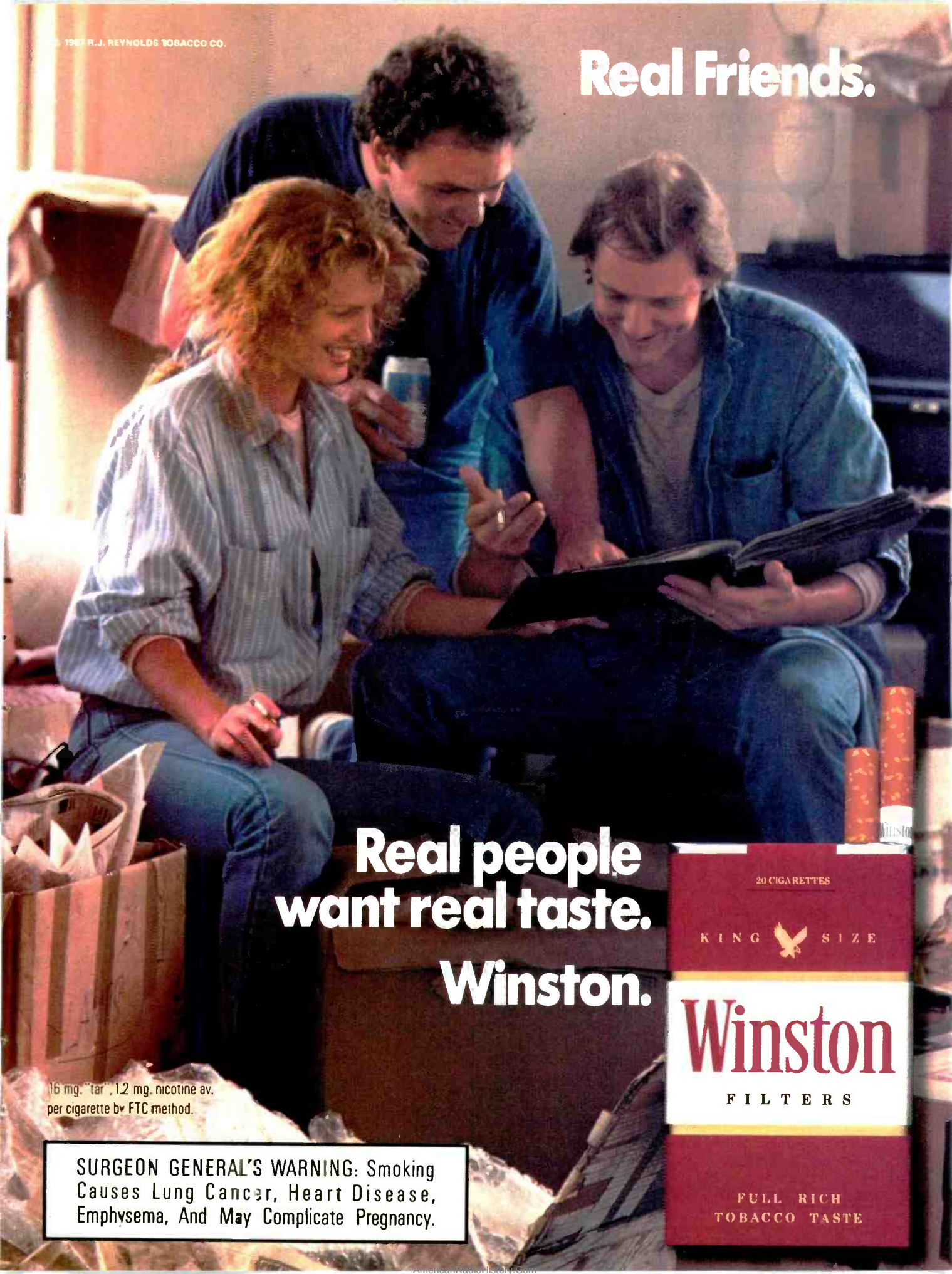
System Type: Sealed-box woofer with separate feedback-controlled power amp and electronic crossover.
Driver: 15-in. (38-cm) woofer with accelerometer and preamp.
Frequency Response: 20 Hz to selected crossover frequency, ±3 dB.
System Distortion: Less than 1.0% at half power, 20 to 85 Hz.
Amplifier Power: 350 watts.
Input Impedance: 20 kilohms.
Input Sensitivity: Variable, 300 mV or more for maximum output.
Crossover: Frequencies independently selectable for high pass (36 to 212 Hz) and low pass (58 to 193 Hz) via solder-in resistors installed by dealer. High-pass slope (6 or 12 dB/octave) set by dealer. Shipped set for 85-Hz, 12-dB/octave operation.
Dimensions: Speaker, 18¼ in. H × 22½ in. W × 17 in. D (46.4 cm × 57.2 cm × 43.2 cm); electronics, 3½ in. H × 17 in. W × 11 in. D (8.9 cm × 43.2 cm × 27.9 cm).
Weight: Speaker, 57 lbs. (25.9 kg); electronics, 19 lbs. (8.6 kg).
Price: $1,350.
Company Address: 1746 Junction Ave., San Jose, Cal. 95112.
For literature, circle No. 90

Photograph: ©1987, Bill Kouirinis

The Velodyne ULD-15 is a complete mono subwoofer system that will extend the response of stereo speakers to below 20 Hz with an unprecedented low level of distortion. The down-firing 15-inch woofer is housed in an attractive and amazingly small cabinet. The separate crossover/amplifier is housed in a rack-mount style chassis 3½ inches high. If you like clean, low bass from your audio system, this is a painless way to get it.

In addition to the 15-inch model tested, Velodyne makes two other servo or feedback woofers, an 18-inch model for $500 more than the ULD-15 and a 12-inch model for $500 less. They differ mainly in the sophistication of their electron-

Real Friends.



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Attention to details is crucial in the design of a complex system, and this is where Velodyne has done excellent homework.

ics and in their output capability. A single ULD-15 is a good choice because it is a match for anything found in live music short of cannon fire. All three models, however, boast distortion figures closer to those of amplifiers than those usually associated with speakers. Velodyne points out that woofer distortion is highly audible because, at low frequencies, hearing sensitivity is greater for the harmonics than for the fundamental.

Wide-bandwidth negative feedback is the key to the Velodyne's performance. Despite its name, negative feedback is very positive in its results. In non-electroacoustic form, it is very familiar: When we perform any physical activity, such as walking, we rely on our senses to constantly correct and refine our motions. This corrective action is a form of negative feedback. A negative feedback system consists of a power source that is controlled by both an input and a sensor from the output. Our body is the power source, the desire to walk down a path is our input, and sight is the primary sensor to keep us on the path.

An ordinary woofer receives a signal from the power amplifier and "woofs" only as accurately as its suspension and the voice-coil drive force allow. A negative-feedback woofer, however, senses its own output and uses this information to keep itself on the path dictated by the input. Negative feedback is a continuous process, correcting for every nuance of the input waveform.

The power amp is a woofer's power source, so it must be made part of any feedback system. In other words, negative feedback from the output sensor must be applied at the input of the power amp, thus enclosing it in the loop along with the woofer. The result is an amplifier/woofer system that can reduce distortion of an "open-loop" system by a factor of 10 or more.

Figure 1 is a block diagram of the Velodyne system, showing the active crossover filters, a limiter, and the components of the feedback system. The limiter is a gain-reduction device which operates only when the input signal is great enough to cause amplifier clipping or excessive cone excursion. In this feedback system, allowing either condition to occur could cause more than the usual amount of distortion. While it's clipping, the amplifier would be unable to respond to feedback and would lose track of the cone's position; due to feedback, excessive excursion would make the amplifier clip.

The purpose of the box labelled "Compensation" is to prevent the negative feedback from becoming positive at any frequency. With a phase shift of 180°, the feedback signal would begin adding to the input, quickly producing a full-power oscillation. This happens most readily at frequencies in the range above 1 kHz, where the coupling between woofer and sensor is affected by resonance and propagation delays. To prevent this, the compensation network gently attenuates high frequencies and, with them, high-frequency feedback. When the loop finally gets 180° out of phase, the signal is too far attenuated to produce positive feedback. This may seem complicated, but it's a technique that has been used in amplifiers since the 1930s.

The obvious way to sense the woofer's output would be to use a microphone. Unfortunately, the time it takes for the signal to propagate only a few inches through air would cause enough phase shift to require excessive compensation, resulting in reduced high-frequency feedback. The method chosen by Velodyne is to mount a piezoelectric accelerometer to the voice-coil form. This lightweight crystal pickup generates an electric charge proportional to its acceleration. An amplifier located on the speaker frame converts the tiny charge variation to a voltage which is fed back to the power amp's input.

Acceleration-sensitive pickup has one advantage. A flat frequency response for a small radiator (even a 15-inch cone is small in relation to the 11-foot wavelength of a 100-Hz tone) results from equal peak *acceleration* at all frequencies. You might think the cone would have to move the same *distance* at all frequencies for a flat response. Not so. It must increase its stroke to maintain output at low frequencies. If an acceleration pickup were not used, an additional conversion stage would have to be inserted in the feedback path to make the pickup acceleration-sensitive.

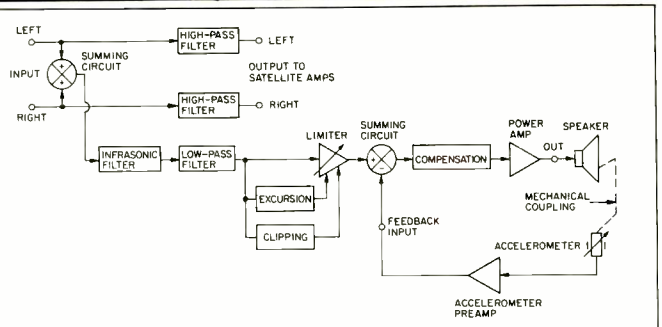

Fig. 1—Block diagram of the ULD-15 (see text).

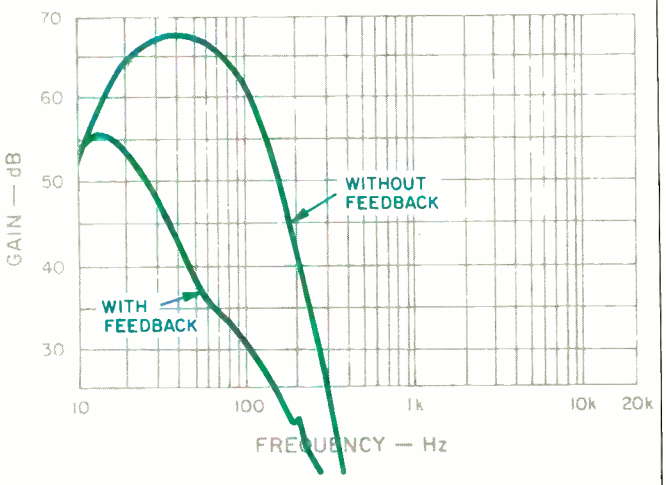

Fig. 2—Amplifier frequency response, measured from left input to speaker terminals, with feedback loop both connected and opened. The difference between the curves shows the amount of feedback available for reducing distortion.

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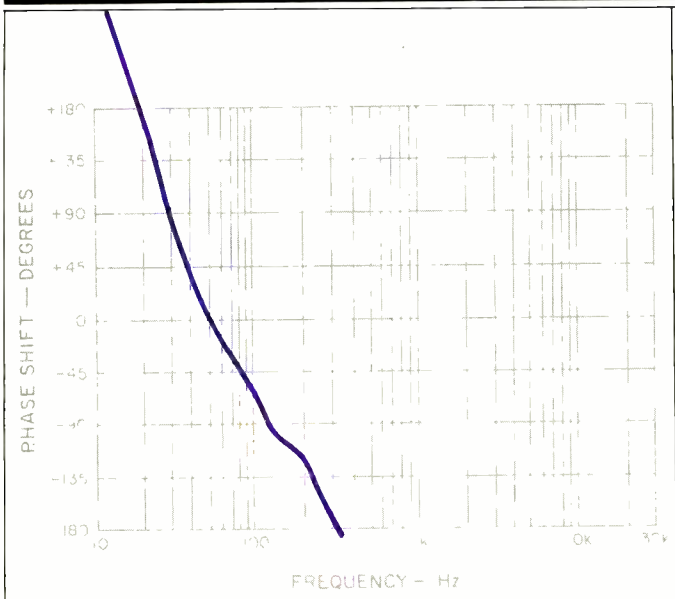

Fig. 5—Acoustic phase response for 193-Hz crossover, measured at 1 meter with speaker placed on floor.

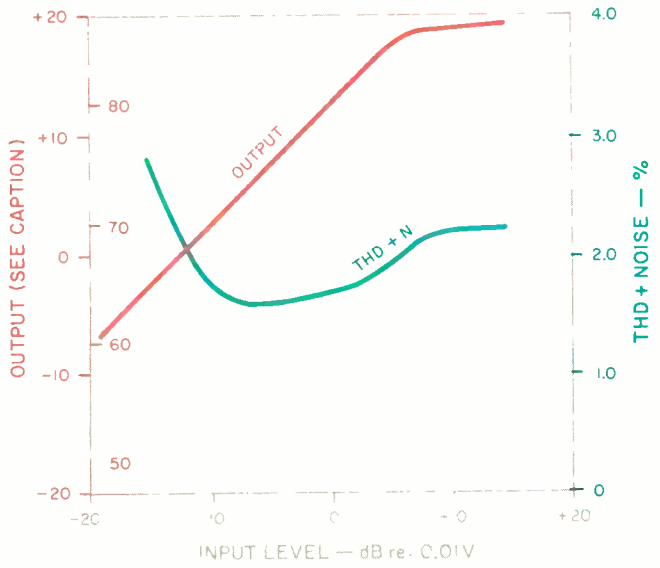

Fig. 6—Linearity, using 20-Hz signal, showing both output and THD + N vs. input voltage. Output curve shows both amplifier power (outer scale, in dB re: 1 watt) and acoustic output (inner scale, in dB SPL measured at 1 meter in half-space). Note flattening of both curves as limiter cuts in at high signal voltages. Apparent rise in THD + N at low levels is due to ambient noise (see text).

The sealed woofer box is finished on all sides in oiled walnut veneer. It is a sturdily built and rather attractive piece of furniture.

Measurements

The ULD-15 is an integrated electroacoustic system. It would normally be evaluated as a black box, from RCA-jack input to acoustic output. I decided to go a little further and poke around inside the loop. First I measured frequency response, with feedback, from the left input to the speaker terminals (Fig. 2). The speaker terminals are inside the loop, so this plot shows the amp output response that will produce the rated acoustic output range of 20 to 193 Hz. An increase in the amplifier output at low frequencies, to compensate for the small box, is evident.

Also plotted in Fig. 2 is response at the speaker terminals with the feedback cable unplugged. This curve results from the input signal passing through the crossover band-pass filter, the compensation filter, and the amplifier. (Refer back to Fig. 1, the block diagram, as necessary.) Note the difference between the two curves; it is a measure of the feedback available for reducing distortion and flattening response of the acoustic output. Note that from 30 to 200 Hz, there is at least 20 dB—and mostly more—of feedback. This translates to more than a 10-to-1 reduction in distortion over this range.

Let's look at what the two curves tell us about what is happening at 20 Hz. The 11 dB of feedback will correct the speaker's natural response roll-off quite closely, but what about the harmonics generated at 40, 60, 80, and 100 Hz? They fall in the range where an average of 30 dB of feedback is in effect; this results in a distortion reduction of 30 dB, or 32 to 1! This is not an exaggeration if the accelerometer is linear: If we start with 10% distortion in the driver, we end up with 0.32% for the system.

The power amp is designed specifically to drive the ULD-15 woofer/enclosure, and that would be its ideal test load. The trouble is that no woofer would be likely to survive continuous maximum-power testing. The woofer impedance was measured as 8.1 ohms at 20 Hz, rising to 45 ohms at the 48-Hz resonance and dropping to 7.7 ohms at 100 Hz. An 8-ohm load resistor was chosen as a substitute load for power testing. A minimum of 392 watts, with distortion at around 0.3%, was recorded over the range from 20 to 100 Hz. This betters the power spec handily. Remember, the distortion observed here is really of no concern—once the driver is reconnected, the amp will be inside the loop and subject to distortion reduction by the speaker feedback.

Conventional measurements showed an input impedance of 24 kilohms or more. The crossover's line outputs clipped at 7.5 V, with 0.2% THD + N. Distortion at the standard output level of 2.0 V was 0.064% maximum, from 20 Hz to 20 kHz. Gain through the high-pass section was unity unless the level control switch was set to "Master," in which case gain was variable to 21 dB.

Figure 3 plots some of the high-pass filter curves available. The 12-dB/octave slopes are reasonably accurate in frequency, but they sag more at cutoff than the 3 dB of the common Butterworth designs. This response shape is intended to help the subwoofer blend well with typical speak-

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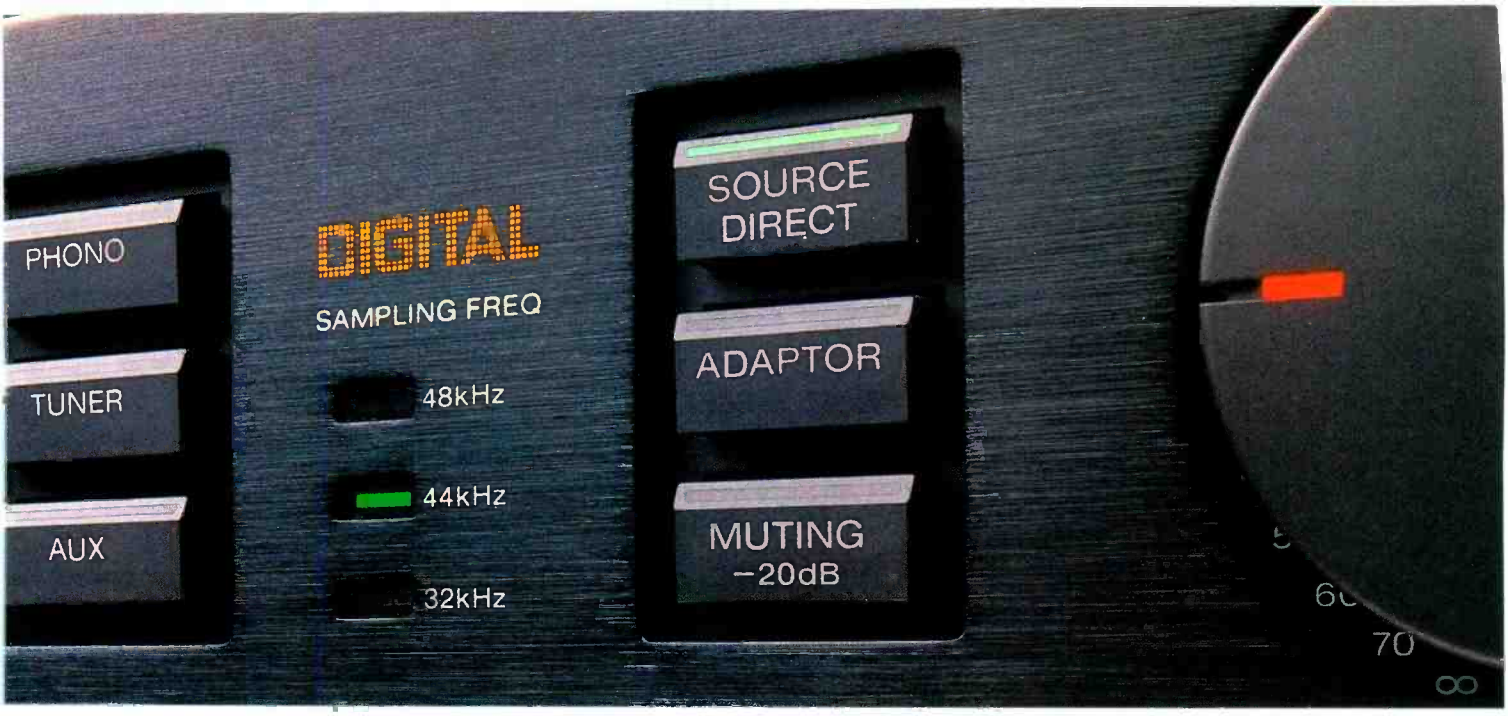

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The limiter reduces gain only at frequencies and amplitudes where cone excursion would otherwise become excessive.

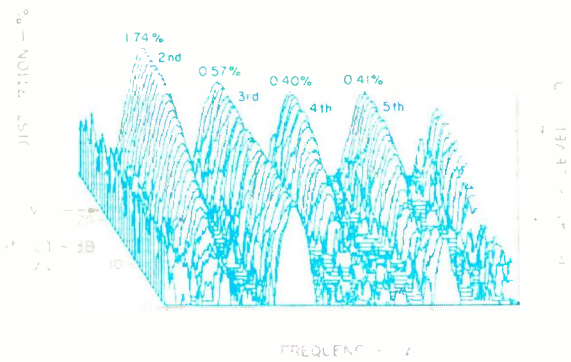

Fig. 7—Harmonic distortion for the musical tone E_1 (41.2 Hz).

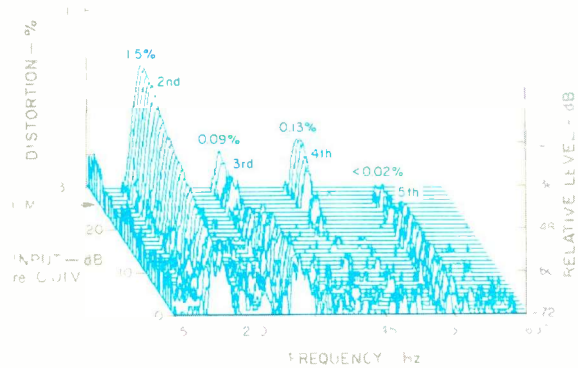

Fig. 8—Harmonic distortion for the musical tone A_2 (110 Hz).

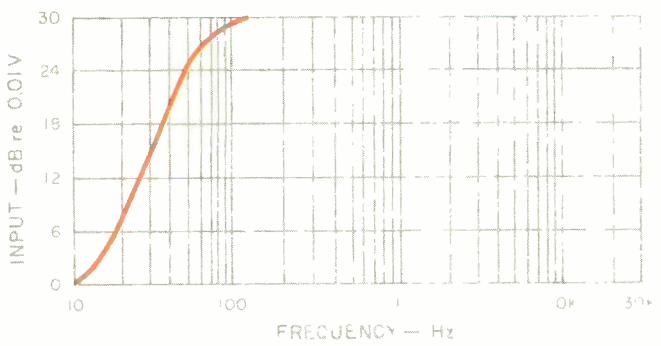

Fig. 9—Limiter action. Input voltage needed to cause a given level of compression varies with frequency to limit cone excursion (see text). Shown here: Voltage vs. frequency for 1-dB compression.

ers which have underdamped response at cutoff. For those speakers which are not underdamped, setting the high-pass section at a lower frequency might be just right.

My first acoustic output measurement was of frequency response (Fig. 4). For the test, I placed the ULD-15 on the floor, the condition for which the down-firing woofer is designed. This differs from my usual anechoic measurements, mainly in that it increases acoustic output by 6 dB for all frequencies in the ULD-15's range. Curves are shown for both the crossover's minimum (58-Hz) and maximum (193-Hz) low-pass filter settings. Their shapes are determined almost entirely by the response of the infrasonic and low-pass filters preceding the amplifier/woofer feedback system. The response of these filters, and of the high-pass filters in the crossover, is chosen by Velodyne to give the best blend between the ULD-15 and the upper-range speakers in use.

Phase response of the acoustic output is plotted in Fig. 5 for the 193-Hz low-pass setting. The phase shift is very much like what one would measure from a simple electronic circuit having the same frequency response as the ULD-15. This means the ULD-15 is a minimum-phase device and will interface predictably with its companion speakers.

Two plots are given in Fig. 6. The output curve (relating to the left-hand scales) shows how the amplifier and the acoustic outputs track increases in 20-Hz input only up to the point where the limiter kicks in. The limiter reduces gain to prevent excessive cone excursion at the frequencies and amplitudes where it predicts this problem will occur. (The limiter's prediction was right. I observed over ½ inch of peak-to-peak excursion at the point where it kicked in.) The THD + N curve is for the acoustic signal. Note that distortion holds at a constant 2.2% after the limiter is activated. The apparent increase in THD + N at very low levels is not an increase in THD but is really a measure of background noise in my lab; the mike was picking up ambient sound as well as true distortion products.

Figure 7 shows a "3-D" plot of the harmonics of a 41.2-Hz signal. This frequency is the lowest note of a normally tuned string bass. Even with feedback, the usual distortion components are all there—but notice their values: There is less than one-tenth as much distortion as one usually finds in speakers. Furthermore, the upper harmonics, which are at more easily audible frequencies than the lower ones, have the lowest amplitude of all. (The point at which the limiter begins to hold the output steady is indicated on the scale for input level.)

The "3-D" plot of the harmonics of a 110-Hz signal (Fig. 8) is just as remarkable. Only the second harmonic is worth noting. The absence of upper harmonics is a testimony to the wide bandwidth over which the ULD-15's feedback is effective.

If input drive is continuously increased, there will be a point, for any speaker, where the output cannot increase proportionally. This compression can take two forms. The first, waveform compression, squashes the shape of the sine wave and generates harmonics. In speakers, this is often a result of overexcursion. The other type is envelope compression, where the waveform remains sinusoidal (and thus does not sound distorted) but fails to increase in

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The quality, if not the magnitude, of Velodyne's achievement is up there with Dolby noise reduction and the Compact Disc.

amplitude. Voice-coil heating and restricted vent airflow are common causes of envelope compression. Compression results in most speakers from both forms of distortion.

For the ULD-15, virtually all of the compression is of the envelope type and is produced by the predictive limiter. Figure 9 shows how this limiting action varies with frequency and input voltage for a given degree of power compression. The lowest frequencies require the greatest cone excursions, so they activate the limiter at a lower level. The audible effect of this compression is not distortion or bottoming, but rather a thinning out of the low bass as volume is raised to high levels. An important point is that Velodyne's limiter only allows use of the driver's full *clean* capability.

Use and Listening Tests

Blending a subwoofer with a satellite system can be thought of as either a problem or an opportunity, depending on one's point of view. The problem is that separating the signal can lead to a discontinuity of sound in the crossover range. The opportunity is that a separate subwoofer affords wider options for dealing with room acoustics. I see subwoofers from the opportunity side.

The satellites can be fairly small full-range speakers that allow placement for best imaging without regard to the best bass response. The subwoofer, on the other hand, can be placed wherever it yields the best bass, with almost no effect on imaging. The subwoofer level control effectively becomes a broad equalizer that helps compensate for room modes and losses through walls. Often, as is the case with the Velodyne, crossover points can be shifted to match the low-frequency capability of whatever speakers are used as satellites with the ULD-15. And because the low- and high-pass points are independently selectable, they can be overlapped or underlapped to deal with dips or peaks in the room's acoustic response at the crossover point. Also, flipping the subwoofer's polarity may improve results. The idea is not to try assembling a system that will be perfect in an anechoic chamber, but to tune the system to an imperfect room.

What kind of equipment is needed to find optimal subwoofer settings? Instruments can speed things along, but I always end up making final adjustments by ear using music. An excellent piece, recommended to me by Ivan Berger, is "You Look Good to Me" by the Oscar Peterson Trio on *We Get Requests* (Verve CD 810 047-2). I believe trial and error, guided by careful listening, is the best way to set up a satellite/subwoofer system.

First, one should find the best positions for the satellites, then place the subwoofer between them, if possible. The crossover frequency should be set as low as possible, considering the bass capability of the satellites. Moving the subwoofer to different locations in the room will enhance and suppress different room modes—try for a balance. If a peak or dip in the crossover range is suspected, change the polarity, the frequency, or the overlap.

I followed this procedure in my listening room, using Magnepan MG-IIIa speakers as satellites. Interfacing a subwoofer with bipolar panel speakers such as these is considered by many to be very difficult or impossible. (Magnepan suggests using the MG-IVa, which has additional bass panels, if one requires more low-frequency output.) I ended up with a virtually seamless blend by placing the subwoofer between the satellites and against the wall behind them. The crossover was set for 85 Hz, high pass, to the Magnepans and 100 Hz, low pass, to the Velodyne. Polarity reversal was required.

The sound of the combined system retained all of the clarity and depth of image that properly set-up Magnepans are known for, and it added a previously unheard octave of low bass. Loudness capability, I would estimate, was increased by 4 dB. Gone was the feeling of strain I used to hear from my system at high signal levels. Although my 1,200-watt amplifiers were approaching clip level by the time I sensed this strain, I am sure its absence was due to the fact that the Velodyne's crossover had relieved my panel speakers of having to handle bass below 85 Hz. Deep bass from drums and organ pedals sounded precise and open rather than overly tight. Perhaps this subwoofer blends so well with satellites because there are no buzzing harmonics to call attention to it.

I can't say I've never heard a subwoofer that equals this one, but I've never heard a comparable one that measured less than 15 cubic feet. Still, I have minor quibbles or, more properly, observations about the ULD-15. On loud rock, the absence of distortion in this speaker may be responsible for reduced "punch" and "attack." Perhaps most rock is mixed on, and intended for, lesser speakers. Also, there was a bit of a "thud" tonality on many instruments, perhaps traceable to the rising low end of the ULD-15. Velodyne claims this is intentional and designed to compensate for roll-offs in the recording chain. I'm not sure I want my woofer to speculate on this matter, but if any excessive bass is heard, it can be removed by repositioning the woofer or by cutting the bass control a tiny bit. Asking for extremely low bass at high levels can activate the "keep it clean" limiter, thus altering spectral balance between subwoofer and satellites. If this is a problem, the solution is simple: Buy a second ULD-15.

The Velodyne subwoofer is one of those rare components I can recommend to almost anyone. A system based on the right two-way satellites and a ULD-15, plus a receiver and CD player, can cost as little as $2,100 and still knock your socks off if you set it up carefully. The next step is to use some of the more expensive "mini-monitor" speakers with the Velodyne. Although any expensive speaker's bass may be improved with the ULD-15, large panel speakers such as those from Magnepan or Quad generally benefit most.

The Velodyne subwoofer is the most interesting product I have reviewed to date. When asked about 20-Hz bass response and distortion, audiophiles traditionally mumble something about "no musical information below such and such" and change the subject. The craftsmen who built church organs in centuries past did not agree with this opinion, and they provided pipes with output down to 16 Hz. Velodyne recognized the problem of reproducing low bass and engineered a solution. This feat required multi-disciplinary ability, intuition, craftsmanship, organization of priorities, and common sense. I rank the quality, if not the magnitude, of this small California company's achievement up there with Dolby noise reduction and the Compact Disc.

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2

SUMO POLARIS AMPLIFIER

Manufacturer's Specifications

Power Output: 100 watts per channel into 8-ohm loads, 175 watts per channel into 4-ohm loads.

THD at Rated Output: Less than 0.05% into 8 ohms, less than 0.1% into 4 ohms, both from 20 Hz to 20 kHz.

SMPTE IM: 0.05% from 0.25 watt to full power.

Rise-Time: 2 μS.

Input Impedance: 47 kilohms.

Damping Factor: 500 minimum.

Dimensions: 19 in. W × 5¼ in. H × 8¾ in. D (48 cm × 13 cm × 22 cm).

Weight: 24 lbs. (10.9 kg).

Price: $649.

Company Address: 21300 Superior St., Chatsworth, Cal. 91311.

For literature, circle No. 91

The Polaris power amplifier is a relatively new product from Sumo. It differs from their other power amps in that it uses MOS-FET output devices instead of bipolars, and the output circuit topology is half-bridge instead of full-bridge. It is also fully discrete.

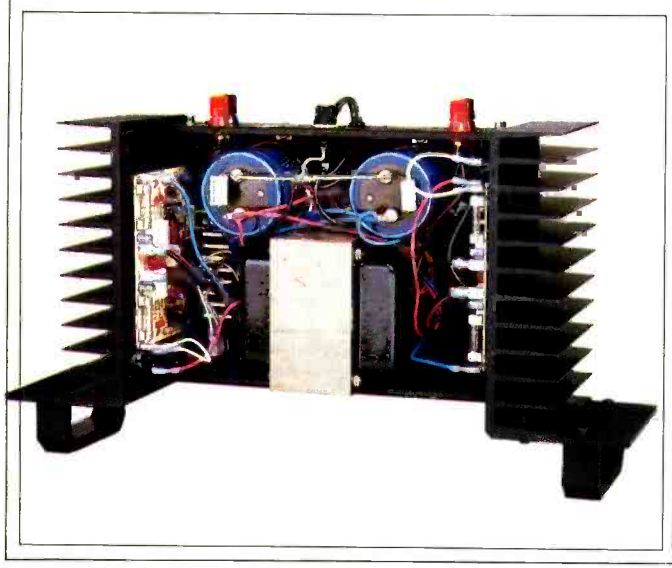
Physically, the construction is quite simple; the Polaris consists of two U-shaped pieces, one forming the bottom chassis and the other being a removable top cover. The side pieces of the enclosure are extruded aluminum heat-sinks upon which are mounted the plastic MOS-FET output devices, the amplifier circuit boards, and the thermal cutout switches. Mounted in the bottom chassis are two 15,000-μF, 80-V filter capacitors, a full-wave rectifier bridge, and a good-sized power transformer. The transformer is made with EI laminations, and it has a copper strap and a magnetic shield around the core.

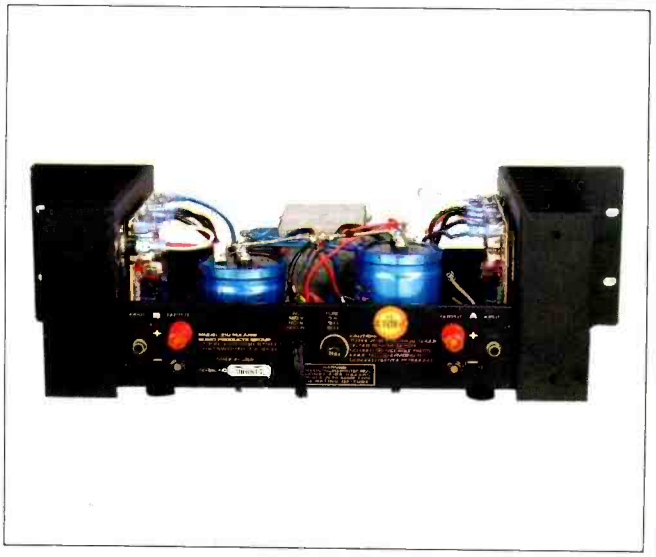
On the rear panel are two signal-input RCA jacks, two pairs of five-way binding posts for speaker connection, a line fuse, and the power cord. The front panel has an illuminated, rocker-type power switch.

The Polaris comes with a removable rack-mounting kit. This consists of two pieces of $^{3}/_{16}$-inch black-anodized aluminum (with handles) which are bolted to the front fins of the heat-sinks.

Circuit Description

Topologically, the Polaris' overall circuit design is similar to that of a number of other fully complementary solid-state power amplifiers. The signal is coupled, via a 2-μF film capacitor and a 1-kilohm series resistor, to the noninverting side of the input stage. A shunt resistance, consisting of two 100-kilohm resistors in parallel on the transistor side of the 2-μF capacitor and a 1-megohm resistor on the signal input side of the 2-μF cap, sets the input impedance at about 47 kilohms. A 200-pF shunt capacitor in conjunction with the 1-kilohm series resistor forms a first-order, low-pass ultrasonic filter with a cutoff frequency of about 800 kHz. The 2-μF/50-kilohm time constant yields a first-order, high-pass filter that is 3 dB down at 1.6 Hz.





The active circuitry starts with a dual-differential complementary input stage using bipolar NPN and PNP transistors. Constant-current sources for the emitter pairs use a two-transistor circuit, with the thermal compensation and temperature-tracking voltage reference and compensation developed by a diode-connected transistor. (This discrete circuit is similar to the current-turnaround and constant-current sources built into some IC op-amps.) Emitter feedback in this input stage is significant, as the values of the emitter resistors are about 10% as great as those of the collector resistors.

The inverting outputs of the first stage are direct-coupled to the inputs of a complementary predriver/voltage-amplifier stage made up of discrete bipolar transistors. Such an arrangement consists of an emitter-follower driving a common-emitter amplifier. The emitter resistors of both devices in this stage return to the decoupled 60-V supply rail, which is also connected to the collector resistors of the input stage. This second stage has a high input impedance which does not load the preceding input stage. It also has relatively high speed, as the common-emitter amplifier is driven from the low output impedance of the emitter-follower.

The outputs of this predriver stage are the collectors of the common-emitter amplifiers; they are tied together through a bias-spreading network and drive a complementary emitter-follower driver stage. Output of this driver stage directly drives the gates of the MOS-FET output devices through small-value isolating resistors. The output stage is configured as a complementary source follower, with two devices in parallel for each half cycle.

The aforementioned bias-spreading network is an active circuit that reduces distortion in the output stage by linearizing the transconductance of the output devices. Since it is a proprietary circuit, details are not appropriate for discussion here.

The overall feedback loop is d.c. coupled from the amplifier output to the inverting input of the input stage. Feedback divider ratio would set the closed-loop gain at a theoretical 22.4× or 27 dB. Since the amount of overall negative

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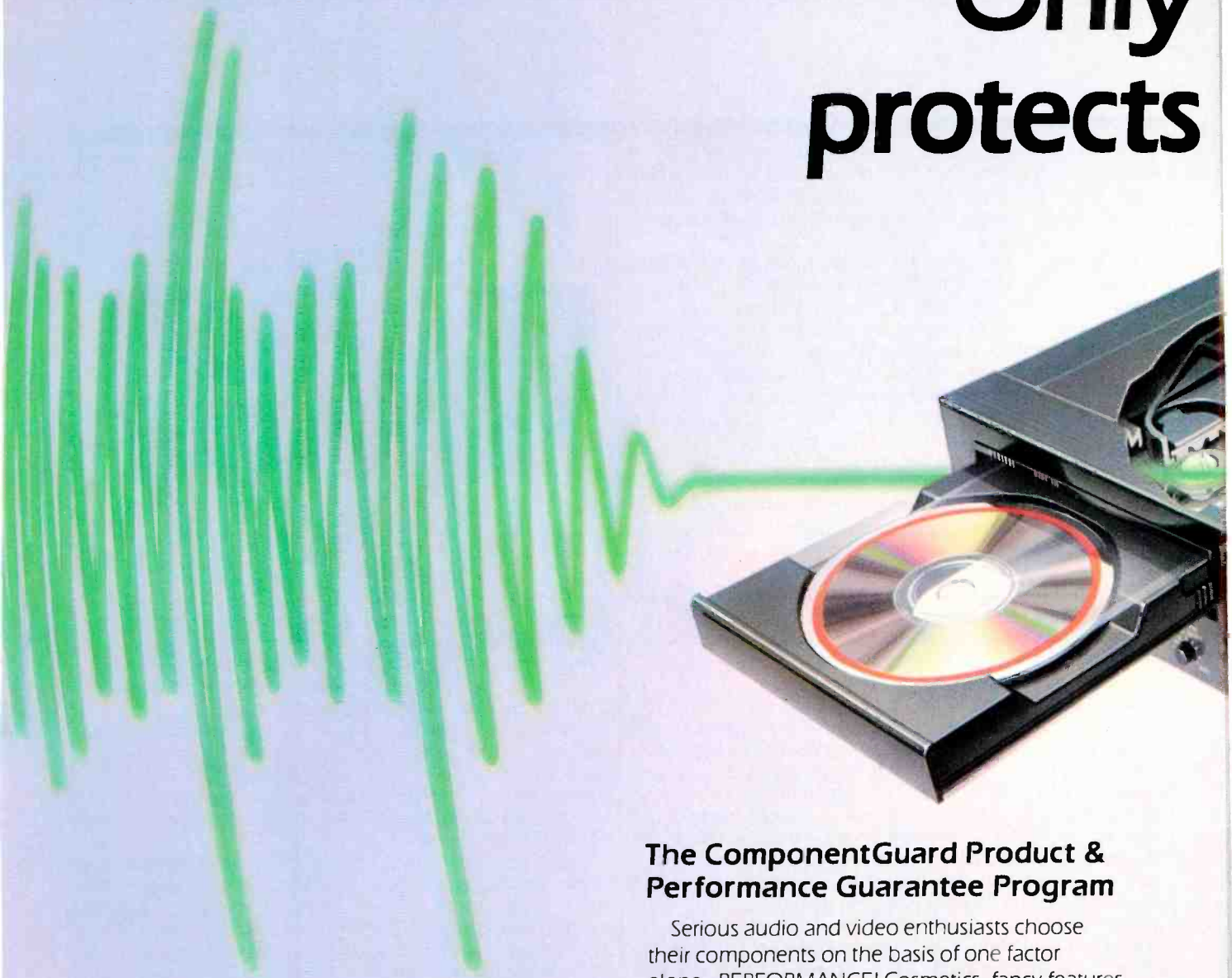

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I found myself listening to music with this amp a lot. Its listenability and modest price earn it a high recommendation.

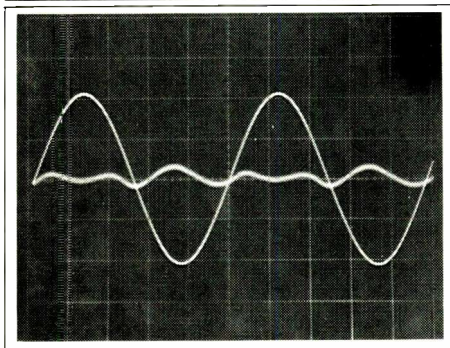


Fig. 3—THD at 1 kHz for 10 watts output into 8-ohm load. Large trace is output signal; small trace is distortion residue after subtracting input frequency.

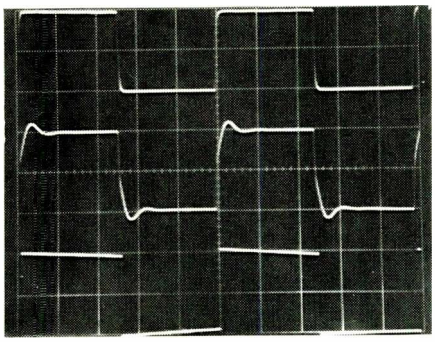


Fig. 4—Square-wave response for 10 kHz into 8-ohm load (top), 10 kHz into 8 ohms paralleled by 2 μF (middle), and 40 Hz into 8 ohms (bottom). Scales: Vertical, 5 V/cm; horizontal, 20 μS/cm (top and middle), 5 mS/cm (bottom).

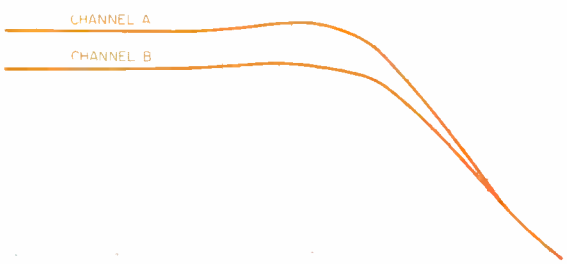


Fig. 5—Damping factor vs. frequency with 8-ohm load.

channel into 8 ohms and 144 watts per channel into 4 ohms, resulting in clipping headroom of −0.36 and −0.85 dB.

The reason for this slight power loss is that the saturation resistance in MOS-FET output devices increases with temperature. This is a result of the devices' negative temperature coefficient—the very same characteristic which makes them thermally stable without bias circuit compensation, and which keeps them from having secondary breakdown as bipolars do. I'm sure this reduction in clipping power at elevated temperatures occurs in other power amps that use MOS-FET output devices. The impact of this phenomenon is probably minimal in most music-reproduction use. The average temperature of the heat-sinks during music listening is nearer to idling temperature than to the elevated temperatures caused by one-third power sine-wave testing.

Square-wave performance is shown in Fig. 4. The top trace is for a 10-kHz signal and an 8-ohm load, the middle trace is for 10 kHz into 8 ohms paralleled by 2 μF, and the bottom trace is for 40 Hz into 8 ohms. Rise- and fall-times for ±5 V at 10 kHz into 8 ohms were 1.2 μS. At 100 watts into 8 ohms, rise- and fall-times lengthened to 1.5 μS, with a small glitch showing up near the positive peak. One-watt frequency response into 8 ohms was down 0.2 dB at 10 Hz and down 3 dB at 240 kHz.

Crosstalk was found to be more than 75 dB down from 20 Hz to 20 kHz. It rose at both frequency extremes from about 100 dB down at 1 kHz.

Damping factor as a function of frequency is shown in Fig. 5. As is frequently the case, the two channels differ slightly in their output impedance and, hence, their damping factors. Further, damping factor decreases as output impedance rises above 1 kHz, due to the presence in this design of an output-buffering inductor paralleled by a resistor in series with the amplifier output.

The A-weighted IHF signal-to-noise ratio (re: 1 watt output) was −90 dB in channel A and −91 dB in channel B.

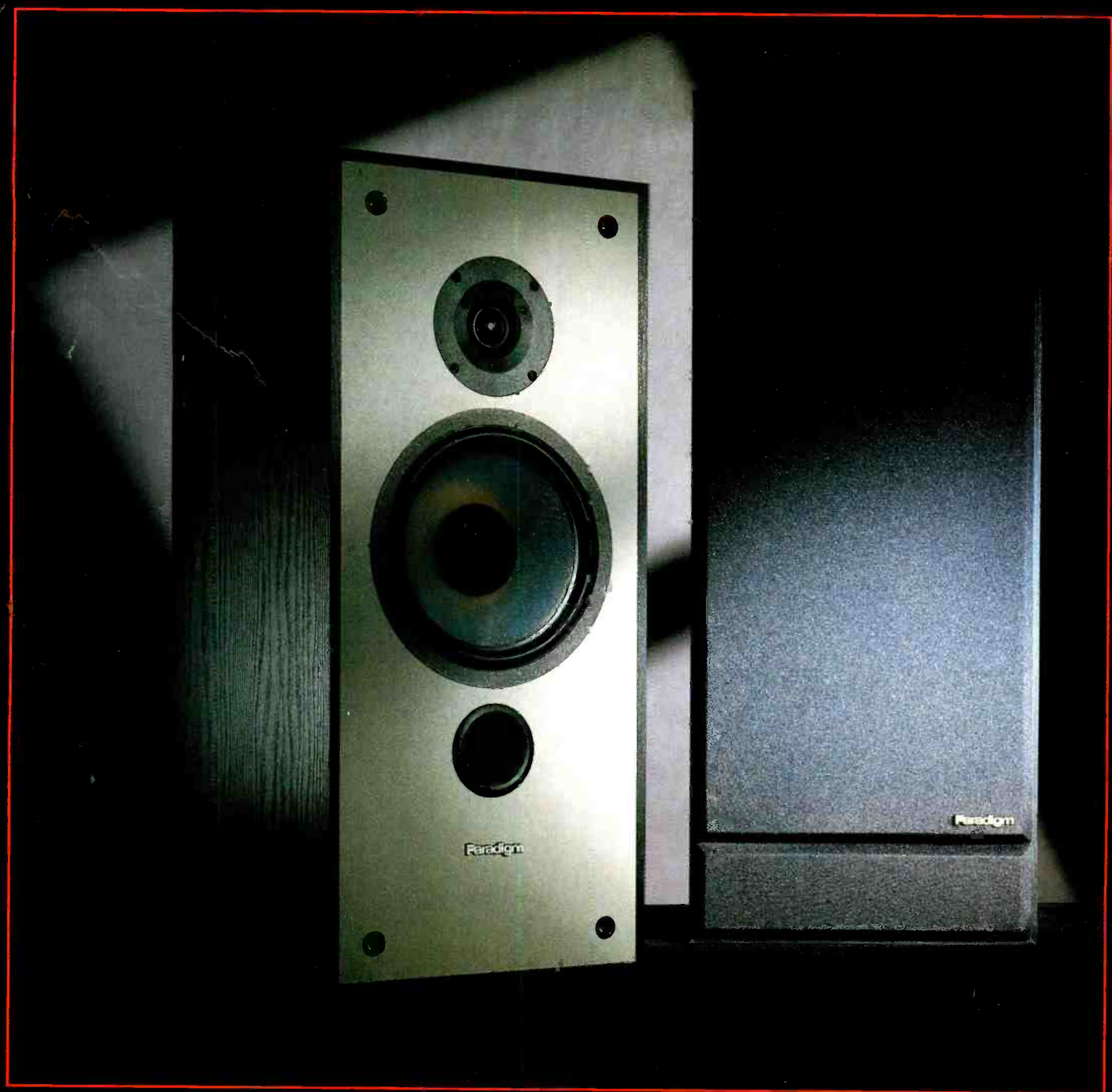
Use and Listening Tests

Equipment used to evaluate the Sumo Polaris included an Oracle turntable with a Well Tempered Arm and a Koetsu Black Gold Line cartridge, California Audio Labs Tempest CD player, Audio Research SP-11 and Klyne SK-5A preamps, and Siefert Research Magnum III speakers. Other amps used were Marantz Model 9s, my custom-built, 100-watt/channel triode units, and a McLaren 702.

Generally speaking, the sound of the Polaris was musically satisfying, with good tonal balance, space, and dimension. The bass was a little on the lean and dry side, the midrange was open, and high frequencies were detailed, with relatively low irritation. Subjective power delivery of this amp was good; it played most material as loud as—or louder than—I wanted to hear it. I found myself listening to music with this amp a lot, although whenever I changed over to one of the tube power amps, I generally preferred the overall sound with the tube amps. I found that the Polaris needs a couple of hours of warm-up to sound best, so I left it on all the time during the period that I was auditioning it.

Summing up, I find the Polaris a very listenable amp. Considering its very modest price, I give it a high recommendation. *Bascom H. King*

....remarkable!



par.a.digm [par'adim] *noun: serving as an example or model of how something should be done.*

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A bias-spreading network of Sumo's design reduces output-stage distortion by linearizing the output devices' transconductance.

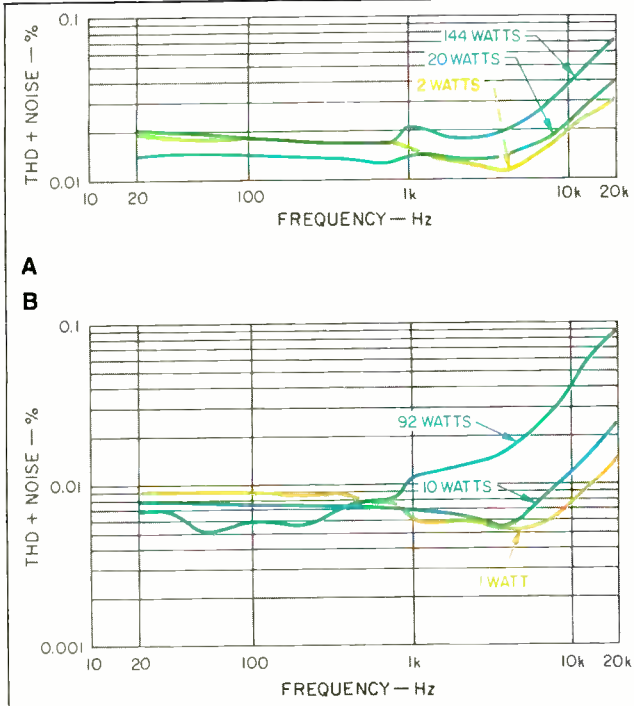

Fig. 1—THD + N vs. frequency for 4-ohm (A) and 8-ohm (B) loads.

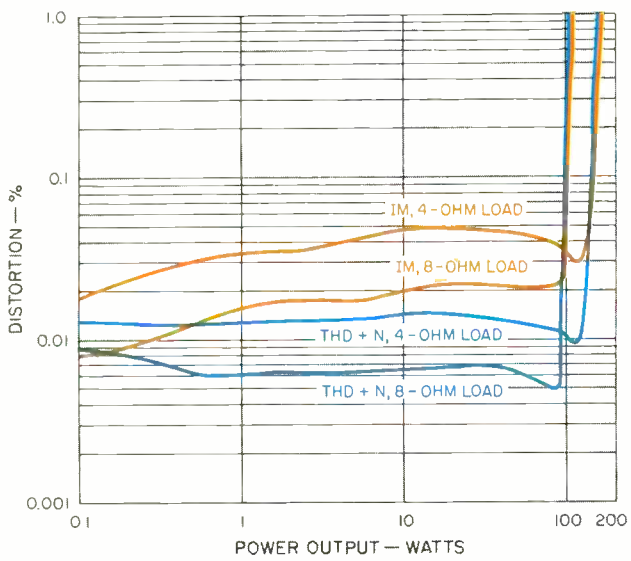

Fig. 2—THD + N at 1 kHz, and SMPTE IM, both vs. power output.

feedback is relatively low (some 27 loss in the input network, the actual out to be 26.4 dB.

An inverting integrator servo utilizing the d.c. output of the amplifier and drives one of the 100-kilohm resistors which are in noninverting input of the input stage. This res ic reduction of d.c. offset at the amplifier c values and creates another low-frequency roll-o the 1.6-Hz roll-off of the input coupling network.

Internal 4-ampere fuses mounted on the am boards are in series with the power-supply tes output stage. These fuses, along with the a.c. constitute the Polaris' protection scheme.

Measurements

For the measurements on the Polaris, I enlisted t James Bongiorno, founder of GAS and Sumo. (Jim involved in the design of the Polaris; it was develop he sold Sumo.)

The unit was first run for 1 hour at one-third of rated (33.3 watts per channel) into 8-ohm loads. The hea got quite hot to the touch but not enough to excee thermal-cutoff threshold and cause shut-off.

Voltage gain with 8-ohm loads was measured and f to be 20.9× or 26.4 dB for both channels. The Polaris input sensitivity for 1 watt output into 8-ohm loads turned to be 137 mV.

Total harmonic distortion plus noise is shown in Fig. 1 a function of power and frequency for 4- and 8-ohm loac Shown in Fig. 2 is 1-kHz THD + N (with a measureme bandwidth from 400 Hz to 80 kHz) and SMPTE-IM distortior both versus power output and load. Figure 3 shows typica harmonic-distortion content for 10 watts output at 1 kHz with an 8-ohm load. The dominant harmonics here are the second and third.

Using the manufacturer's power specs of 100 watts per channel into 8-ohm loads and 175 watts per channel into 4 ohms, IHF dynamic headroom was 2.28 dB (169 watts) into 8-ohm loads and 2.34 dB (300 watts) into 4-ohm loads. With the standard tone burst that is used to determine IHF dynamic headroom, peak current output into a 1-ohm load was ±14 amperes, with the negative half-cycle giving out or clipping first.

I have always defined the onset of clipping as the point where it becomes visible when I observe the waveform on a 'scope. Distortion at that point, where one begins to see the onset of peak-flattening on the waveform, typically ranges from the high tenths of 1% to several percent. Jim Bongiorno defines the onset of clipping as the point where distortion spikes start to occur on the signal peaks in the THD residue after the input signal has been subtracted from the output.

With the Polaris at idling temperature, power at visual onset of clipping measured 106 watts into 8 ohms and 164 watts into 4 ohms, giving clipping headroom figures of 0.25 and −0.28 dB, respectively, referenced to the manufacturer's power specifications. At elevated temperatures, such as those that would be produced by the standard warm-up for power tests, clipping power measured 92 watts per

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3

LINN BASIK LVX TONEARM AND K9 CARTRIDGE

Manufacturer's Specifications

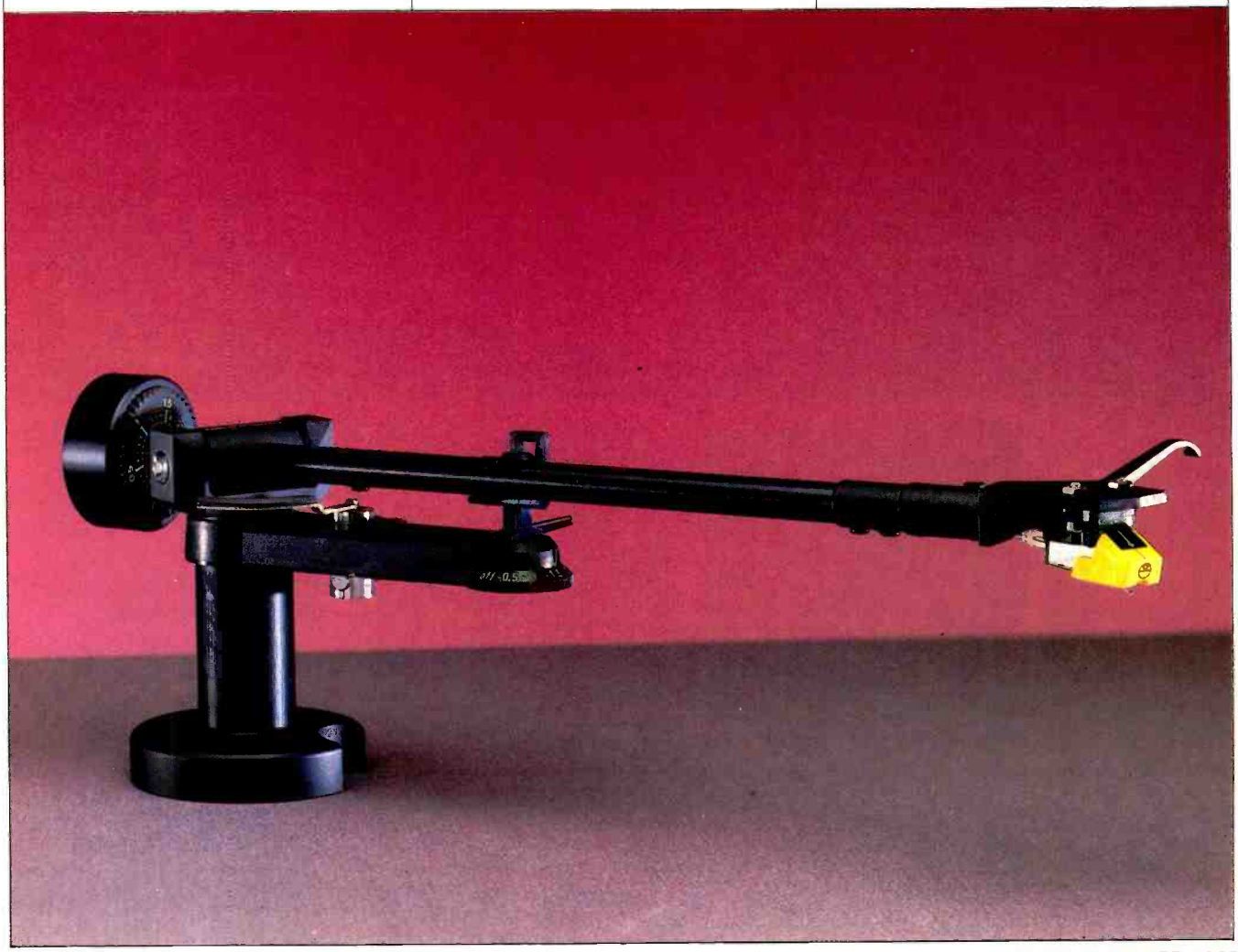
Tonearm

Type: Pivoted, static-balance, with removable headshell.
Bearing Friction: Less than 50 mg, lateral or horizontal.
Effective Mass: Approximately 10 grams (varies with tracking force).
Tracking-Force Adjustment Range: 0 to 3 grams.
Cartridge Weight Range: 2 to 10 grams.
Pivot-to-Stylus Distance: 9 in. (22.9 cm).
Stylus Overhang: 1/16 in. (18 mm).
Effective Length: 8 5/16 in. (21.1 cm).
Price: $220; extra headshell, $24.

Cartridge

Type: Moving magnet.
Frequency Response: 20 Hz to 20 kHz, ±2 dB.
Separation: Greater than 25 dB at 1 kHz.
Channel Balance: Within 2 dB at 1 kHz.
Recommended Tracking Force: 1.7 grams (at 20° C).
Recommended Load: 47 kilohms.
Tracking Angle: 20°.
Price: $185; replacement stylus, $111.

Company Address: c/o Audiophile Systems, 8709 Castle Park Dr., Indianapolis, Ind. 46256.
For literature, circle No. 92



When Linn Products of Scotland decided to introduce the Axis turntable with a lower price than their LP-12 Sondek, they also decided to make it available as a complete, self-contained package with a tonearm and cartridge. The tonearm reviewed here is the Basik LVX and the cartridge is the K9, which are also available separately for mounting on other turntables. The Basik LVX was completely specified by Linn and is made for them by a Japanese manufacturer which supplies tonearms to other companies. The K9 cartridge is a moving-magnet type which was designed by Linn and is also made in Japan.

The Linn Basik tonearm is very well finished and has an excellent feel. Tapping the tonearm near the headshell produces a "thwock," while the sound is more like "tank" when the arm is tapped near the pivot. The feel of the tonearm is very good, with extremely low friction in both the lateral and vertical planes. I couldn't feel any play in the bearings when I held the pivot steady with one hand and tried to force movement of the armtube with my other hand. The tonearm is finished in matte and satin black, with some chrome highlights provided by the arm-lift lever and the pivot screws. The calibration markings are in white and are very easy to read, even in dim lighting. My overall impression of the LVX arm was very favorable.

The user-replaceable stylus of the K9 cartridge is bright yellow, and it comes with a clear plastic protective cover that is easy to use. I recommend that you put it over the stylus assembly after each use, even though a locking device on the arm rest holds the tonearm very securely. The headshell is removable, but its locking screw gives it almost the integrity of a solid headshell built into the arm.

If you buy the Linn Axis turntable complete with the Basik LVX, the arm will already be mounted, but if you buy the Basik LVX to mount on another turntable, you will find that the tonearm mounting is fairly easy and straightforward. The tonearm base requires a central hole about ¾ inch in diameter, plus three smaller holes to clear the hex bolts which fasten the base to the turntable platform or tonearm mounting board. The tonearm pillar slides up and down in the arm base to allow adjustment for different turntable heights. After the vertical tracking angle has been adjusted, a large hex screw in the arm base can be tightened to hold the arm pillar securely in place.

The arm rest is on the end of a platform which is cantilevered out from the arm pillar. This black plastic arm rest has a very good armtube locking device which I found quite easy to use. Located right under the arm rest is the anti-skating or sidethrust adjustment dial. This dial is marked in grams so it can be set to correspond to the vertical tracking force. The dial turns approximately 240°; it is marked from 0 to 3.5 grams but actually turns past 3.5 to about 4.0 grams. Below "0" is an "Off" setting, and I could hear a very distinct click as I turned the dial back and forth between the two positions.

Though setting the sidethrust dial to correspond to the vertical tracking force is a good compromise, I have found that the best way to set sidethrust is by listening to music. The correct adjustment is achieved when the sound of a good stereo record is stable during high-level passages. If

MEASURED DATA

Basik LVX Tonearm

Pivot-to-Stylus Distance: 9.0 in. (22.9 cm).
Pivot-to-Rear-of-Arm Distance: 2.0 in. (5.1 cm).
Overall Height Adjustment: 1.88 in. (4.8 cm).
Tracking-Force Adjustment: 0 to 3 grams.
Tracking-Force Calibration: Within 0.1 gram.
Cartridge Weight Range: 2 to 10 grams.
Counterweights: One (140.8 grams).
Counterweight Mounting: Plastic sleeve with rubber ring.
Sidethrust Correction: Calibrated knob on arm-rest platform.
Pivot Damping: None.
Lifting Device: Damped lever plus finger-lift on headshell.
Headshell Offset: 23.5°.
Overhang Adjustment: Slots in headshell.
Bearing Alignment: Excellent.
Bearing Friction: Moderately low.
Bearing Type: Jewelled pivot (vertical), ball race (horizontal).
Lead Torque: Negligible.
Arm-Lead Capacitance: Left, 126 pF; right, 120 pF.
Arm-Lead Resistance: Left, 1.0 ohm; right, 1.3 ohms.
External Lead Length: 39.4 in. (1.0 meter).
Structural Resonances: 750, 1,400, 3,150, and 5,650 Hz.
Base Mounting: Single hole for pillar.

K9 Cartridge

Coil Inductance: Left, 400 mH; right, 400 mH.
Coil Resistance: Left, 429 ohms; right, 435 ohms.
Output Voltage: Left, 0.72 mV/cm; right, 0.68 mV/cm.
Tracking Force: 1.7 grams recommended; 1.7 grams used.
Cartridge Mass: 6.1 grams.
Microphony: Moderate.
Hum Rejection: Excellent.
High-Frequency Resonance: 23.8 kHz.
Rise-Time: 27 µS.
Low-Frequency Resonance: 8.0 Hz (in Basik LVX tonearm).
Low-Frequency Q: 5.7 (in Basik LVX tonearm).
Recommended Load Resistance: 47 kilohms.
Recommended Load Capacitance: 250 pF or less.

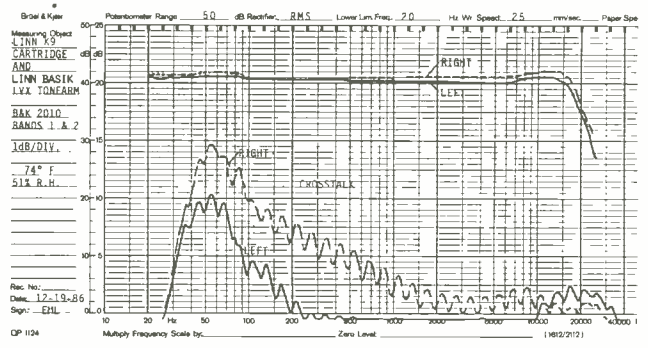


Fig. 1—Frequency response and crosstalk, K9 cartridge in Basik LVX arm, using B & K 2010 test record.

The Basik LVX tonearm is well finished and has a very good feel. Reading its calibrations is easy, and so is mounting it.

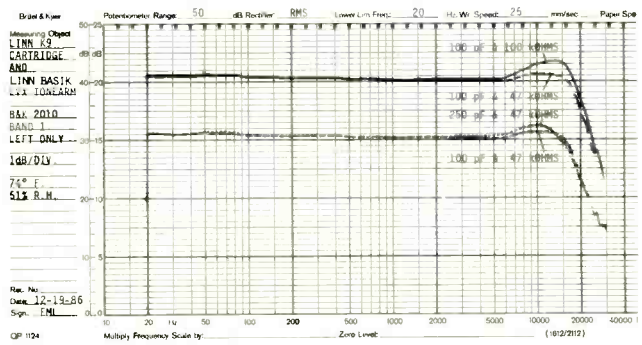


Fig. 2—Frequency response for different values of input impedance and capacitance.

there is too much or too little sidethrust correction, the dynamic tracking force will be different in each channel. Of course, the whole problem of achieving the proper compensation for the effects of sidethrust is complicated by the fact that it is influenced by such things as groove diameter, rotational velocity, and dynamic level. The calibrated sidethrust settings of the LVX serve as a good compromise for most listeners and as a good starting point for fussier ones.

The vertical tracking force is set by rotating the counterweight in a spiral groove at the rear of the tonearm. The counterweight is first set to balance the mass of the cartridge. Then, while holding the counterweight in one hand so it cannot turn, one rotates the dial with the other hand until the dial's "0" calibration is opposite a line on the top of the armtube. The tracking force is then adjusted by rotating the counterweight until the desired number is opposite this line. The dial is clearly marked in white, with major calibrations in 0.5-gram steps and lines at 0.1-gram increments.

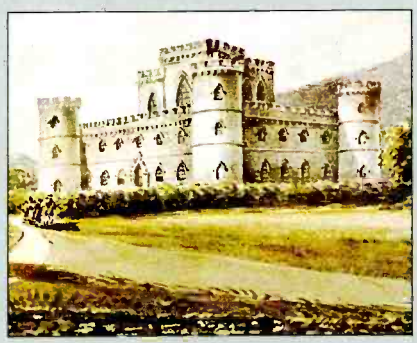
BACKGROUND REPORT

Last fall I travelled to Scotland to visit the facilities of Linn Products Ltd. and to meet the people behind the products. I was accompanied by Gene Pitts, the Editor of *Audio*, and Gary Warzin of Audiophile Systems, the importers of Linn equipment into the U.S. Upon arrival at Prestwick Airport, we were met by Alan Gibb, Linn's export sales manager. The next morning we headed for the Linn factory in Castlemilk, a suburb of Glasgow.

After an exciting ride on the wrong side of the road, Alan pulled up in front of a group of low buildings across from a cow pasture. (I never did find the castle!) All of the buildings are part of Linn Products except for one, in the middle, which is Castle Precision Engineering. This is the company where Ivor Tiefenbrun, the managing director of Linn, once worked for his father and where the dream of Linn began.

We toured the production area where the mechanical parts of the Sondek and Axis turntables are machined, treated, polished, and fitted together. I must admit that I was impressed. I also had a good feeling when Alan showed us what everyone at Linn considered to be their highest precision piece of manufacturing equipment, a CNC (computer numerical controlled) machine made in Elmira, N.Y., which is not far from my home town of Rochester. I reciprocated by teaching the Scots how to pronounce "Elmira."

We also toured the engineering department and met Bill Miller, the main analog design engineer, who was working on a p.c. board layout with a CAD (computer aided design) system running on an IBM PC-AT computer. We were then shown Linn's



large DEC computer system and the very high-performance Intergraph CAD system that is tied to a similar system in the offices of the London architectural firm which designed the new Linn factory. In addition to the heavy investment in computer equipment, Linn has made a serious commitment to software, including not only the writing of application-specific programs but the development of high-level language they call "linngo."

It might come as a surprise, to those who see Linn's position as "anti-digital," that much of the company's latest engineering efforts have gone into digital hardware design. But they have directed their work into areas where they feel digital is best suited, such as the control and switching circuits in their LK1 preamplifier. This digital design work is being carried out mainly by Neil Gibson. The mechanical design and packaging of Linn equipment, including the LK1 and the LK2 power amplifier, are being done by product designer Andy Park. These products have cast faceplates and look great. (We heard the LK1 and LK2 the next day during extended listening sessions, and they sound very good too!) That evening Gene, Gary, and I went to a dinner meeting with Ivor, Alan, and Neil Gaydon, and we had some good discussions about the Linn philosophy, which has certainly stirred up much interest in the past 10 or 12 years. This proved to be only the beginning of our discussions!

The next day we went to see the new Linn facility, nearby and still under construction at the time of our visit. The main building, encompassing about 30,000 square feet, houses the main offices and the engineering and production facilities; it is connected to a smaller building of about 9,500 square feet which is used to store inventory vertically to a height of

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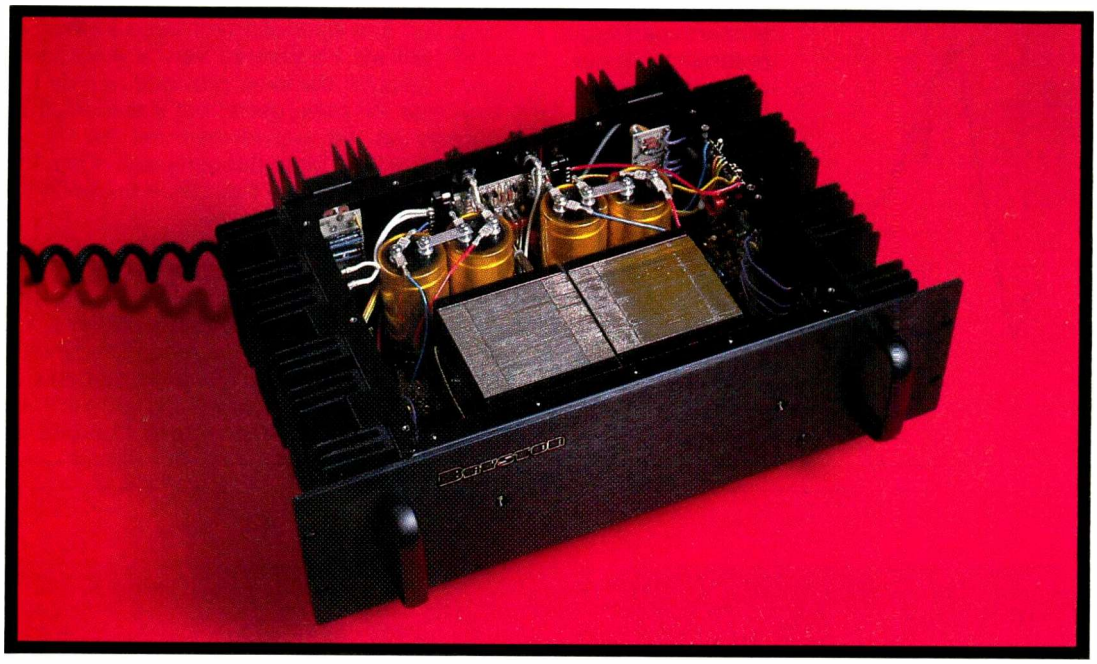

Bryston design philosophy incorporates three general concepts.
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2. Long term reliability
3. Product integrity

MUSICAL ACCURACY

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

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

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

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

Each of the various steps or stages in every Bryston amplifier, from the input section to the output section, without exception, are designed to optimize the musical experience.

STANDARDS OF RELIABILITY

We consider this criterion to be exceedingly important. We have applied techniques and materials in our everyday construction of electronic equipment more typically utilized in the military and aerospace industries.

The power transistors used in all Bryston amplifiers are 100% tested for safe operating area, both before and after installation in the circuit. They are then taken to a "burn-in" table when they are given a capacitor load, a square-wave input signal, and set at slightly under clipping for a period of 100 hours. During this time, the input signal is cycled three hours on to one hour off, to exert additional thermal stress.

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

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

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A locking screw holds the removable headshell firmly in place, so extraneous mechanical energy will travel out of the system.

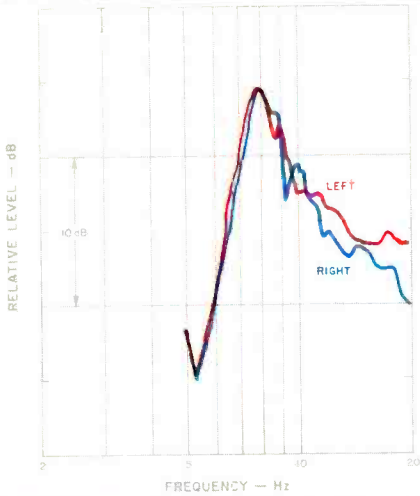

Fig. 3—Low-frequency tonearm/cartridge resonance peaks at 8.0 Hz with a Q of 5.7.

The Basik LVX tonearm has a very effective and easy-to-use lifting and lowering device. After the arm is placed over a record, the arm lever can be moved forward quickly; the tonearm itself will be lowered very slowly due to the high amount of viscous damping provided. It may be a little on the slow side for some users, but it ensures that when the stylus engages the groove there will be no tendency to bounce around, as often happens with some lowering devices. The headshell also includes a finger-lift for the more dextrous or impatient user.

The headshell is removable, but as I mentioned earlier, it is held firmly in place by a locking screw. This ensures a solid connection between the headshell and the armtube, thus allowing extraneous mechanical energy (caused by the interaction of the stylus and the record) to be removed from the system. With such a solid connection, this energy can be effectively transmitted down the armtube and through the bearings to the arm pillar, where it can be absorbed in

about 40 feet. The parts and assemblies are stored as "kits" and are moved in and out by pallet-picking cranes mounted on guided vehicles. These are controlled by a computer system which directs them to the correct positions. The computer is also programmed to keep track of the inventory. (Incidentally, the man responsible for computers at Linn is Jerry Ubysz, a hi-fi enthusiast with a flair for making computers do what he wants them to do.)

The manufacturing philosophy at Linn is in line not only with "just in time" concepts but with Linn's commitment to building things in batches. This means that workers move to different jobs constantly, which reduces the tendency toward boredom or complacency. Alan told me that, when he joined Linn, he spent his first months learning and performing every job in the plant. How about that—a salesman who has actually built parts of the product and assembled it before he is allowed to sell it!

After our tour of the new buildings, we returned to the Castlemilk factory and were ushered into a large listening room. There were two couches in the middle, a pair of Linn loudspeakers up front, and some equipment on a side wall at the back. Linn makes a number of different models of loudspeaker, but they believe only one pair should be in the listening room at a time. The loudspeakers were new, experimental models with electronic time-delay crossovers. Martin Dalgleish, Linn's technical director, gave a summary of the direction that Linn is taking in its product development. Bill Miller, Neil Gibson, and Andy Park discussed aspects of the new electronic designs and were very open in their replies when I asked about circuitry and even specific parts they were using.

Then we auditioned the Axis turntable, comparing it to a competitive turntable and to the Linn Sondek LP-12, using the self-same tonearm/cartridge combination on each. We checked the absolute polarity of each system to make sure they were the same. We auditioned several combinations of tonearm and cartridge with the turntables, including the Basik LVX and K9. Everyone at Linn initially had qualms about bringing out the Axis turntable because they feared the difference between it and the Sondek LP-12 would be difficult to hear. However, apparently there have been enough improvements in the LP-12 so that, while the Axis may be as good as the original LP-12, the difference is easy to hear when the new models are compared. Gene Pitts and I could hear the difference immediately; it isn't subtle! We also compared the Sondek LP-12/Ittok LV II/Asak combination to the Axis and the difference was even greater, with the Sondek retrieving the subtle inner details of the music from the record grooves with greater accuracy. We even listened to a master lacquer which had been cut on the Linn mastering lathe just minutes earlier, and it was a revelation to hear the detail being retrieved with such clarity. The fact that they can cut such master discs and compare them to the master tapes is very helpful to Linn engineers in designing disc-reproducing equipment. The recording lathe is a Scully with a Linn-designed drive system and control electronics. A Linn-designed disc equalizer and power amplifier drives the cutting head.

The trip to Scotland wasn't all technical and musical, and I was able to see many interesting sights. I even took a boat trip up to the Campbell castle at Inveraray. On the way, I listened to American submarine radio traffic as the subs practiced maneuvers in the lochs. The most fun for me were the dinner conversations with Ivor Tiefenbrun, who was able to discuss the philosophy of music reproduction with insight and humor, and the historical information I received from him and Alan Gibb. Despite all of this, I still use the comments from my listening panel when I report on turntables, and they hadn't come along!—*E.M.L.*

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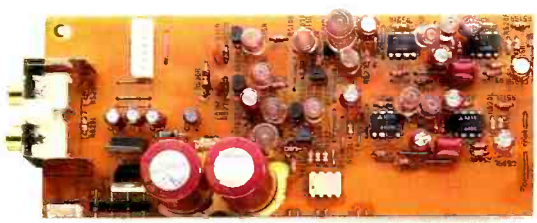

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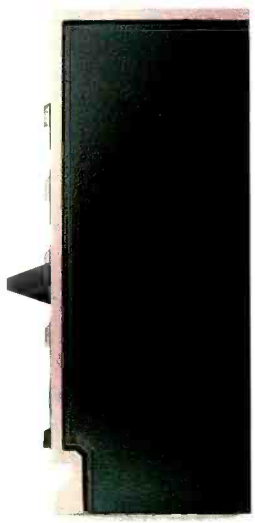

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How did all these innovations happen to come from Kyocera, and not some household name? Perhaps because Kyocera's knowledge of digital circuitry comes from years of building computers for some of the best-known names in electronics. Perhaps because Kyocera is a world leader in Fine Ceramics, the technology used to house circuitry in aerospace and other advanced applications. Or perhaps because some top-rated CD players from other brands were actually made by Kyocera.

Now Kyocera has four world-beating Compact Disc Players, ranging in suggested retail price from $350 to the $800 model DA-710CX shown here. Each boasts technology so advanced, it's a preview of what the competition will be selling in 1989. After all, history does repeat itself.

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The response curve shows a roll-off above 15 kHz, but listeners made no adverse comments that could be related to this.

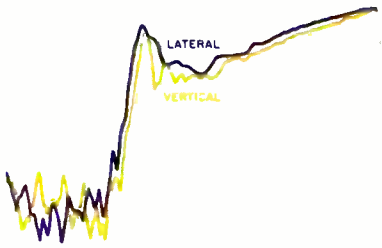

Fig. 4—Response to vertical and horizontal modulation from 2 to 100 Hz (slow sweep). Note the similarity between the curves (see text).

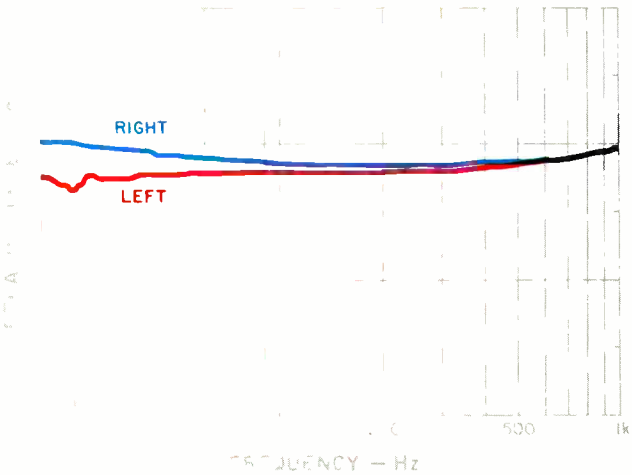

Fig. 5—Slow sweep from 20 Hz to 1 kHz. Note absence of "glitches" (see text).

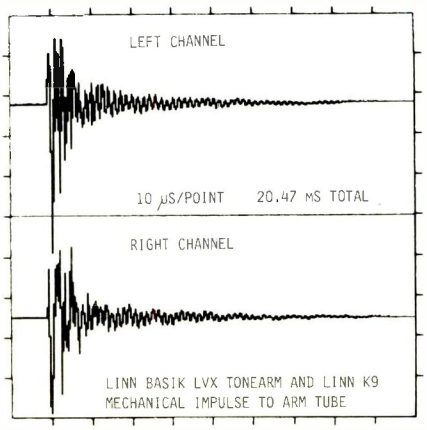

Fig. 6—Output vs. time of arm/cartridge when mechanical impulse was applied to armtube, with arm on rest but not clamped.

the tonearm mounting board. If such energy is not removed, it can cause undesirable delayed energy to be reflected back to the stylus, where it is mixed back in with the desired groove information. This can cause blurring or smearing of the sound as well as possible colorations due to addition and cancellation effects. These latter effects, known as "combing" or "comb filtering," can cause a false sense of stereo. Some stereo synthesizers use just such a "combing" to produce their effects. Part of the sense of spaciousness reported by other tonearm reviewers can also be attributed to this effect. The clue to this is that, while they hear a sense of spaciousness, they also report that they find it difficult to localize images precisely. The solid connections provided by the LVX's headshell-locking system and by the headshell's very snug fitting are very effective in reducing the above-mentioned problem.

The headshell has a set of slots that allow the cartridge to be mounted with the correct amount of stylus-to-spindle overhang. First, the tonearm is positioned so that the stylus is in line with the tonearm pivot and the center spindle of the turntable. The cartridge can then be moved back and forth in the headshell until the stylus is positioned beyond the center spindle by a specified distance, which compensates for the tracking error present in any pivoted tonearm. An added touch is that the nuts, which are to be placed on the top of the headshell, are kept from turning by little ledges on each side of the slots. I liked the fact that the mounting screws are the Allen-head type rather than the usual slotted type, and therefore they can be tightened easily with a hex wrench.

Measurements and Listening Tests

I will try again, as I have in past reports, to correlate the subjective comments made by members of a listening panel with technical measurements of the tonearm and cartridge combination. The technical measurements are made in advance of the listening evaluations so I can make certain that everything is adjusted correctly and working properly.

Not every measurement is easy to correlate directly with subjective impressions, but they each play an important part in assessing the quality of the system, at least in a general way. For example, although a roll-off above 15 kHz is visible in the amplitude-versus-frequency response curve of this arm/cartridge combination (Fig. 1), the listening panel made no adverse comments that could be directly related to it. The Reference Standard loudspeakers used during the listening sessions have a response which extends flat to 24 kHz on-axis and which is down only 6 dB at 45° off-axis at 20 kHz, so I don't think they have any limitations which would mask this measured roll-off. The B & K 2010 test record extends to 45 kHz (albeit with a slight roll-off above 20 kHz), so the measurement is relatively accurate. While I might have been tempted to make comments about the lack of high-end response because I saw the curves before I listened, the listening panel members had no such prior knowledge. Some of the things the panel did say about the sound of the Linn combination versus the reference combination were very interesting and could be correlated very indirectly with the response shown in Fig. 1. I'll say more about this as we move along.

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A compact disc player that is reading the disc correctly has one thing in common with a player that isn't.

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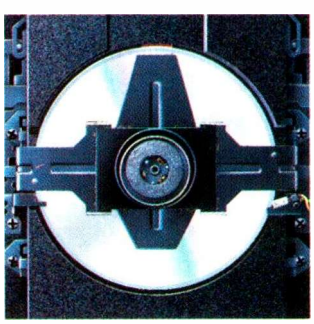
At the same time, our exclusive one-chip Large-Scale Integrated circuit keeps an eye on the disc's rotation speed and maintains digital error correction.

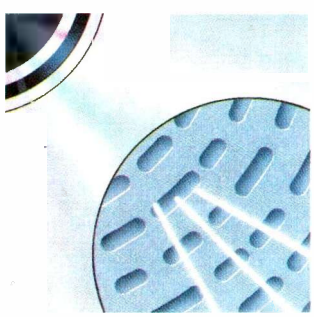
And parallel center disc clamping minimizes eccentric rotation.

In fact, Mitsubishi engineers have come up with ways to improve everything from the way the laser pickup transmits digital data, to a unique four-compartment chassis that isolates critical components from vibration and interference.

The result is a machine that can put your favorite band in your



This parallel clamp grips the center of the disc eliminating wobble for remarkably accurate playback.



Incredibly precise Mitsubishi three-beam tracking utilizes two sub-lasers which continuously monitor and correct the main laser's position.

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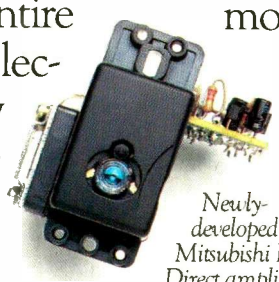

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The interchannel phase relationship is very good, and the listening panel's comments regarding image stability were favorable.

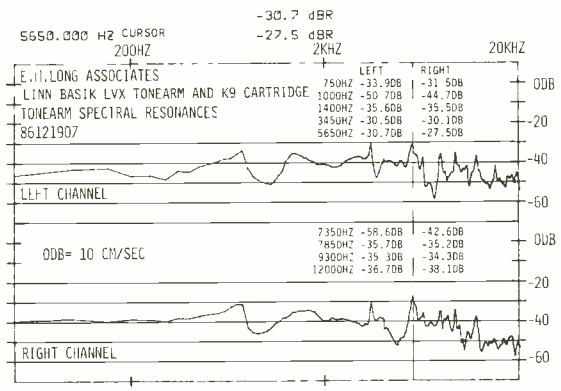

Fig. 7—Spectral output of arm/cartridge for mechanical impulses applied to armtube; traces shown are average of 16 impulses.

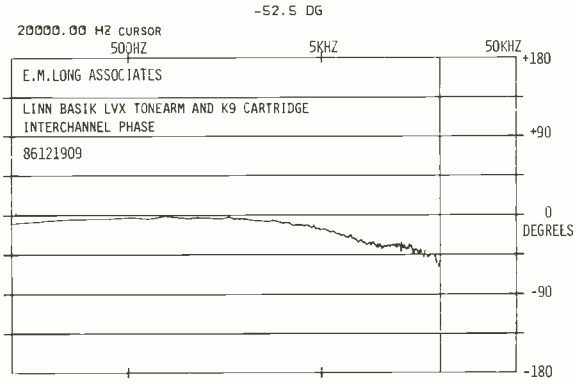

Fig. 9—Interchannel phase difference vs. frequency from B & K 2011, band 7, pink noise.

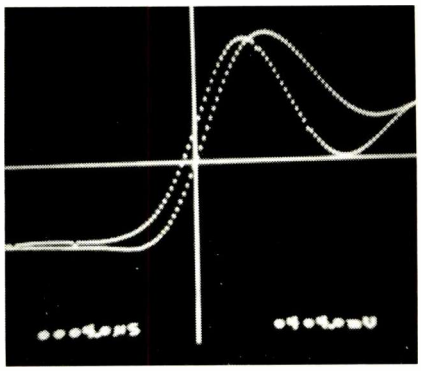

Fig. 10—Time delay between right and left channels. Right channel leads left by 4.0 μS.

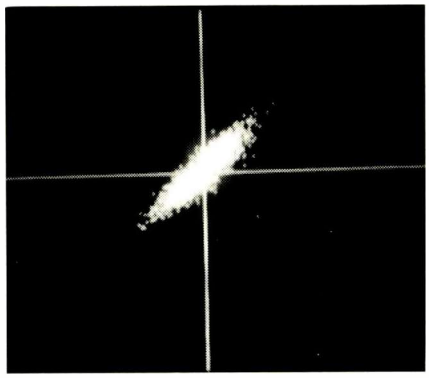

Fig. 8—Interchannel phase difference, using pink noise from B & K 2011, band 7.

Figure 1 also shows that, above 1.5 kHz, the output of the right channel was about 1 dB higher than the output of the left and that the crosstalk was also higher in the right channel. This was corrected by fussing a little with the azimuth of the stylus. I think it is important to see what can happen if the azimuth is not carefully adjusted.

Figure 2 shows the response of the K9 cartridge after the azimuth was adjusted. Since the K9 is a moving-magnet cartridge, the weight of the coils does not affect the moving mass. The coils are wound with a large number of turns; this increases the K9's output considerably over that of a moving-coil type, which must necessarily have many fewer turns. This does mean, however, that the inductance of the K9's coils is greater. The relatively large inductance of moving-magnet cartridges means that they are generally more susceptible to external loading by the preamplifier inputs. In the top set of curves, the solid curve shows the response of the K9 cartridge when the input resistance is raised to 100 kilohms; the dashed curve is for 47 kilohms. Both were run with 100 pF of input capacitance loading. The bottom set of curves shows the effect of changing the capacitance loading from 100 pF (dashed curve) to 250 pF (dotted curve). Notice how the increased capacitance raises the output at the peak but also lowers its frequency.

The low-frequency resonance of the tonearm/cartridge combination is shown in Fig. 3. The rise, similar in both channels, peaks at 8.0 Hz; its Q of 5.7 is on the high side. If a subwoofer is used, some care in positioning the turntable will probably be necessary to prevent low-frequency acoustic feedback. Figure 4 shows the lateral and vertical responses from 2 to 100 Hz and indicates that the mass and compliance are distributed fairly evenly in both planes. All of the listening panel members felt that the sound of drums and double bass was bigger and lower for the Linn combination than for the reference system. This is because the reference system has a very well-damped low-frequency resonance, and this was heard as "less" bass by the panel members.

Figure 5 shows the response of the Basik LVX tonearm and K9 cartridge to a slow sweep from 20 Hz to 1 kHz. The

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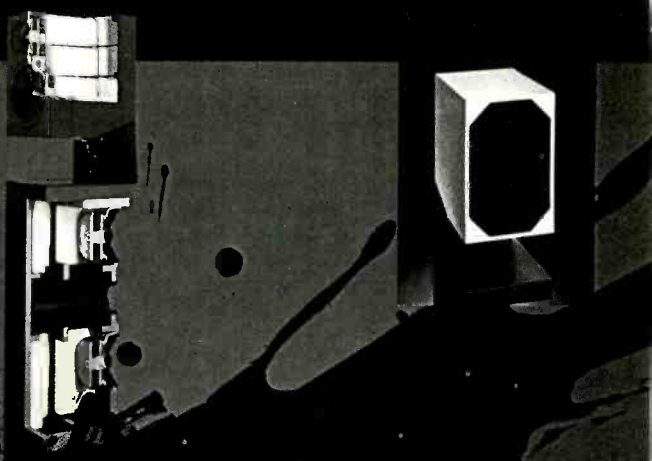

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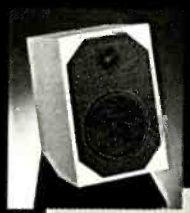

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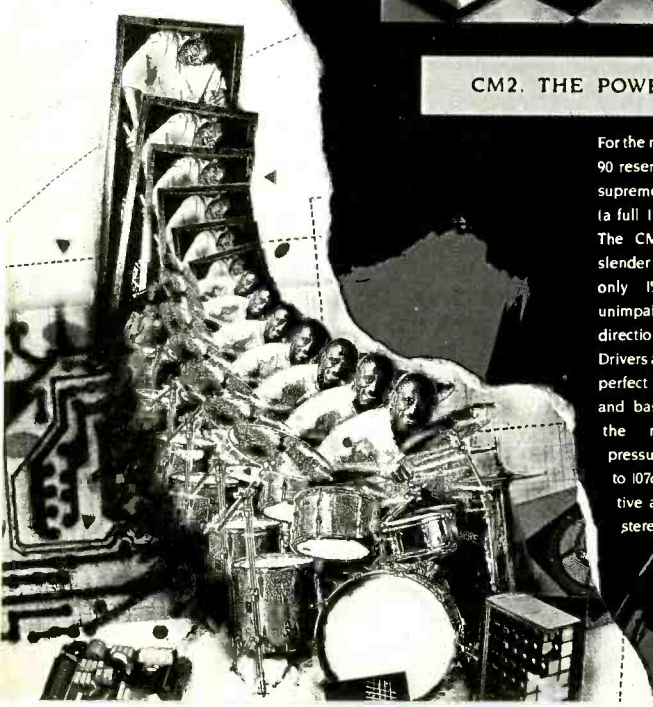

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No glitches showing in the slow-sweep test indicates that this combination is free of major resonances that would color the sound.

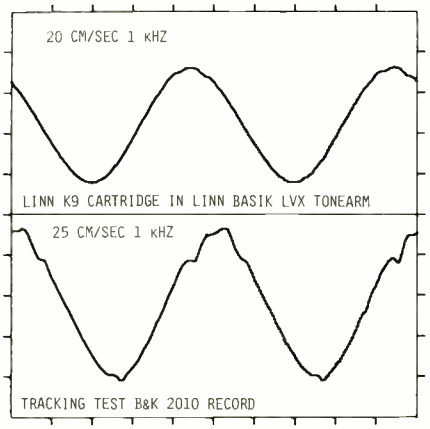

Fig. 11—Tracking test of K9 cartridge in Basik LVX arm shows very little jitter, which indicates good stability. The mistracking in the lower graph is with the highest level band of B & K 2010; the performance is quite good.

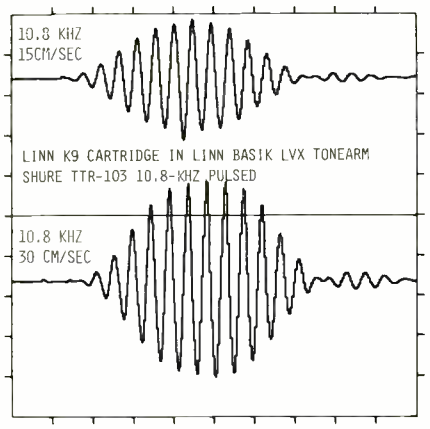

Fig. 13—Response to 10.8-kHz pulse, Shure TTR-103 test record.

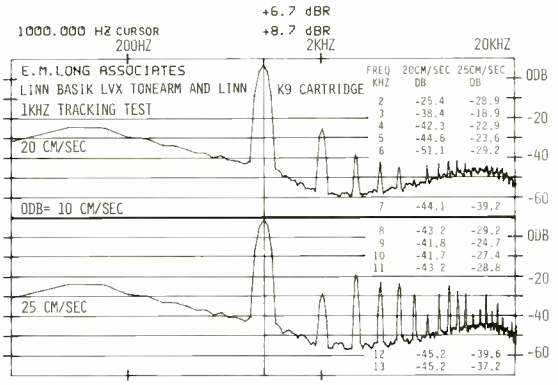

Fig. 12—Spectrum analysis of the cartridge output when reproducing the test tones of Fig. 11. The third harmonic (at the cursor position) is 0.56% for 20 cm/S and 4.2% for 25 cm/S. (Many cartridges cannot track the 25-cm/S band at all.)

absence of "glitches" in the response indicates that the combination is free of major resonances which would cause colorations in the sound. The listening panel's very favorable comments about voice reproduction with the Linn combination verify the absence of resonance problems; such problems usually affect the voice range most of all. I was curious to see if any resonances would appear if I didn't tighten the screw that holds the headshell in place. I plotted response curves for this condition, but the fit of the headshell to the armtube is so snug that it didn't change the shape of the curves at all.

Figures 6 and 7 show the output versus time and the frequency spectrum for a mechanical impulse applied to the Linn armtube. These data agree very well with some of the comments made by the listening panel. The mechanical energy produced by the stylus and entering the tonearm will tend to excite this sort of response. The relatively long decay of energy shown in Fig. 6 will tend to mask some of the subtle inner details of the music. As can be seen in Fig. 7, most of the energy is in the midrange, which will tend to add brightness to the music. Figure 7 also shows that there are a number of peaks in this range. Despite the apparent high-frequency roll-off shown in Fig. 1, the slow decay of this upper-midrange energy enhances the perceived high-end response. Comments about the "projection and clarity" of voice and the "brightness" and "sharp" quality of strings and brass seem to correlate well with this phenomenon.

Figure 8 shows the interchannel phase relationship; if it were perfect, we would see a straight 45° line. Here we don't, but the measurement is still very good. Figure 9 shows that the phase difference between the output of left and right channels is only 52.5° at 20 kHz, which means that the time differential is only 7.3 μS. The panel's comments regarding the Linn system's image stability were very favorable, with the reference system providing only slightly superior resolution. Figure 10 shows the time difference between channels when reproducing the 1-kHz square wave of the CBS STR-112 test record. In this case the right channel leads the left by only 4 μS, which is very good.

Figure 11 shows the output of the K9 cartridge when reproducing the two highest bands of the 1-kHz signal on the B & K 2010 test record. While the 25-cm/S signal appears distorted, it is very stable. Most cartridges I have tested will not track this band at all, and those that do show a very unstable and jittery waveform. The spectrum for these two levels is shown in Fig. 12. The upper trace, for the 20-

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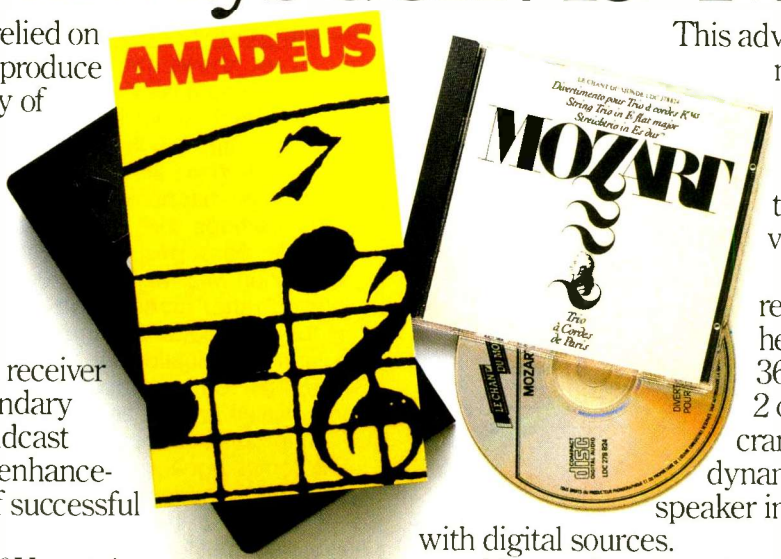
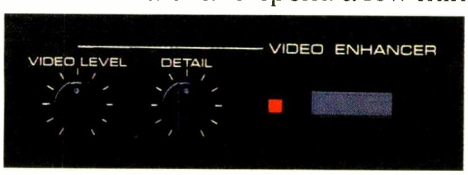


In fact, the RX-1100U contains so many exciting features, you might want to visit your authorized Yamaha dealer and spend a few minutes exploring them for yourself.



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Next, take the most musically demanding CD, crank open the 125 watt/channel* amplifier, and listen to what's missing.

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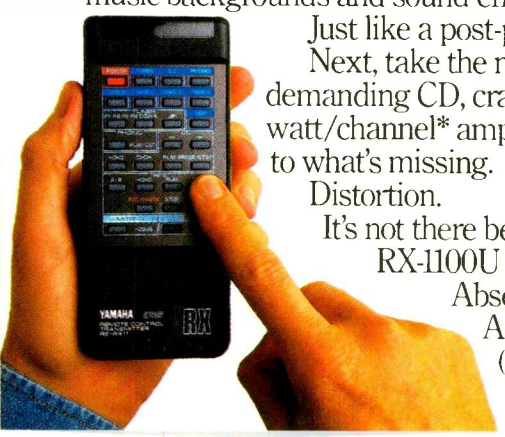
It's not there because the RX-1100U boasts our new Absolute Linear Amplification (ALA) circuitry.



This advanced amplifier technology injects a mirror image of the output distortion back into the input stage. The distortion component drops virtually to zero.

What's more, this receiver has plenty of headroom—up to 360 watts/channel into a 2 ohm load—so it's never cramped by the wider dynamic range and varying speaker impedances associated with digital sources.

Now, walk to the other side of the room, where you can appreciate the new RS interactive remote control to its fullest.

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Did the panel members like listening to music via this Linn tonearm/cartridge combination? Their answer was a definite yes.

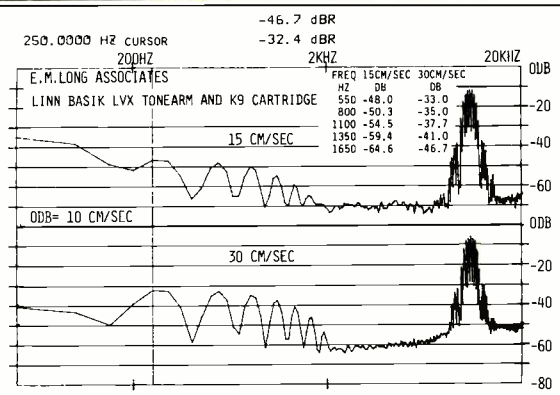

Fig. 14—Spectrum analysis of output from signals shown in Fig. 13. Distortion is 2.4% at 250 Hz for the 30-cm/S level (bottom trace).

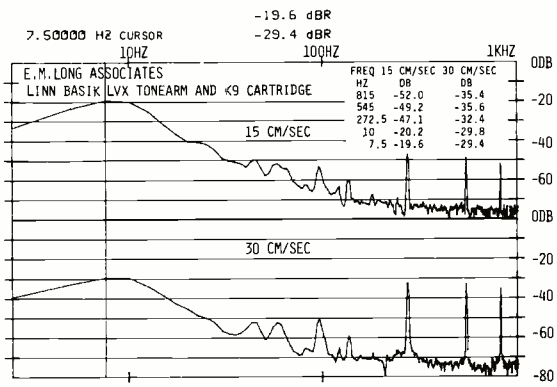

Fig. 15—Spectrum analysis of distortion products from signals shown in Fig. 13. Note that the frequency range shown runs only to 1 kHz and that the level at the arm/cartridge resonance drops when the signal level is raised (see text).

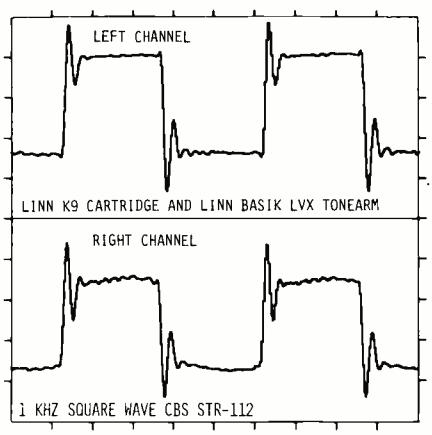

Fig. 16—Response to 1-kHz square wave, using CBS STR-112 test record.

cm/S level, shows the second, third, fourth, and fifth harmonics at progressively lower levels. This tends to produce a sound which could be called bright but not necessarily sharp or harsh. The increase in harmonics when switching from the 20- to the 25-cm/S band is greater for the odd than for the even harmonics, and this does result in a harsh sound. Perhaps this is why, when listening to high-level orchestral passages, the panel commented that the Linn combination was "dry" and "reedy" while the reference was "detailed" and "unrestrained."

Figure 13 shows the amplitude-versus-time response of the Linn combination for the 10.8-kHz tone burst on the Shure TTR-103 test record. At the 30-cm/S level, a little compression can be seen in the top of the waveform. The effects of this are shown in the spectrum of Fig. 14. Since the 30-cm/S signal is 6 dB higher in amplitude than the 15-cm/S signal, the lower frequency components should also be 6 dB higher in the lower trace. Instead, these components are about 15 dB higher, which means that distortion at these frequencies is increased. These overemphasized lower frequency components impart a "leaden" quality to bells and cymbals. Still, the Linn combination fared well when reproducing high-level, high-frequency sounds. The listening panel members indicated that they felt the performance of the reference system was only slightly better.

In past reports I had noticed that, at higher levels, the output at the lowest frequency shown in the tone-burst spectrum plot was less for the 30-cm/S test signal than for the 15-cm/S signal; I have now investigated this further. Figure 15 is a more detailed look at the spectrum below 1 kHz. The output at the tonearm/cartridge resonance is about 10 dB lower for the 30-cm/S signal than for the 15-cm/S signal. The only explanation I have for this seemingly incongruous result is that the energy from the stylus/groove interaction is being spread into the upper frequencies by what is called, in mechanics, a "forcing function." After all, the energy comes from the stylus-groove interaction, and if it is used to increase the output at other frequencies, then the energy available to excite the tonearm/cartridge resonance must necessarily be less. I would be interested in any other explanations that readers might have for this phenomenon.

Figure 16 shows the 1-kHz square-wave response of the Linn combination. This is typical for a cartridge which has a fast roll-off near the upper end of the audio spectrum. After you have seen a number of these plots and have compared them to the amplitude-versus-frequency response plots of the same cartridges, you can predict the frequency response fairly well using the square-wave data alone. Since some test reports on cartridges and CD players show square waves but not response curves, this can be a quick way to assess the high-frequency performance.

Conclusions

You should really draw your own conclusions about this arm and cartridge from the data and discussions contained in this report. But for those in a hurry, here is a fairly direct summation. I asked the panel members whether, if they owned the reference, they could also enjoy music as reproduced by the Linn Basik LVX tonearm and the K9 cartridge. The answer: Definitely *yes!* *Edward M. Long*

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

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4

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Manufacturer's Specifications

Gain at 1 kHz: MM phono, 36 dB; MC phono, 56 dB; CD, 20 dB.

THD at 1 kHz for 5 V Output: Phono, less than 0.0025%; CD, less than 0.003%.

Overload at 1 kHz for 0.2% THD: MM phono, more than 200 mV; MC phono, more than 25 mV; CD, more than 10 V.

Channel Separation at 1 kHz: Phono, greater than 80 dB; CD, greater than 80 dB; tuner, greater than 90 dB.

S/N: Phono, less than 80 dB, A-weighted, re: 0.5 mV.

Equivalent Input Noise: Phono, 0.2 μV; CD, 3 μV; tuner, 0.4 μV.

RIAA Accuracy: ±0.1 dB, 20 Hz to 20 kHz.

Overall Loop Feedback: Phono, 20 dB; line, 20 dB.

Maximum Output for 0.2% THD: More than 16 V.

Dimensions: 17.3 in. W × 3.5 in. H × 10.4 in. D (43.9 cm × 8.9 cm × 26.4 cm).

Weight: 13.2 lbs. (6 kg).

Price: $1,995.

Company Address: c/o Mel Schilling, Music & Sound Imports, 30 Snowflake Rd., Huntingdon Valley, Pa. 19006.

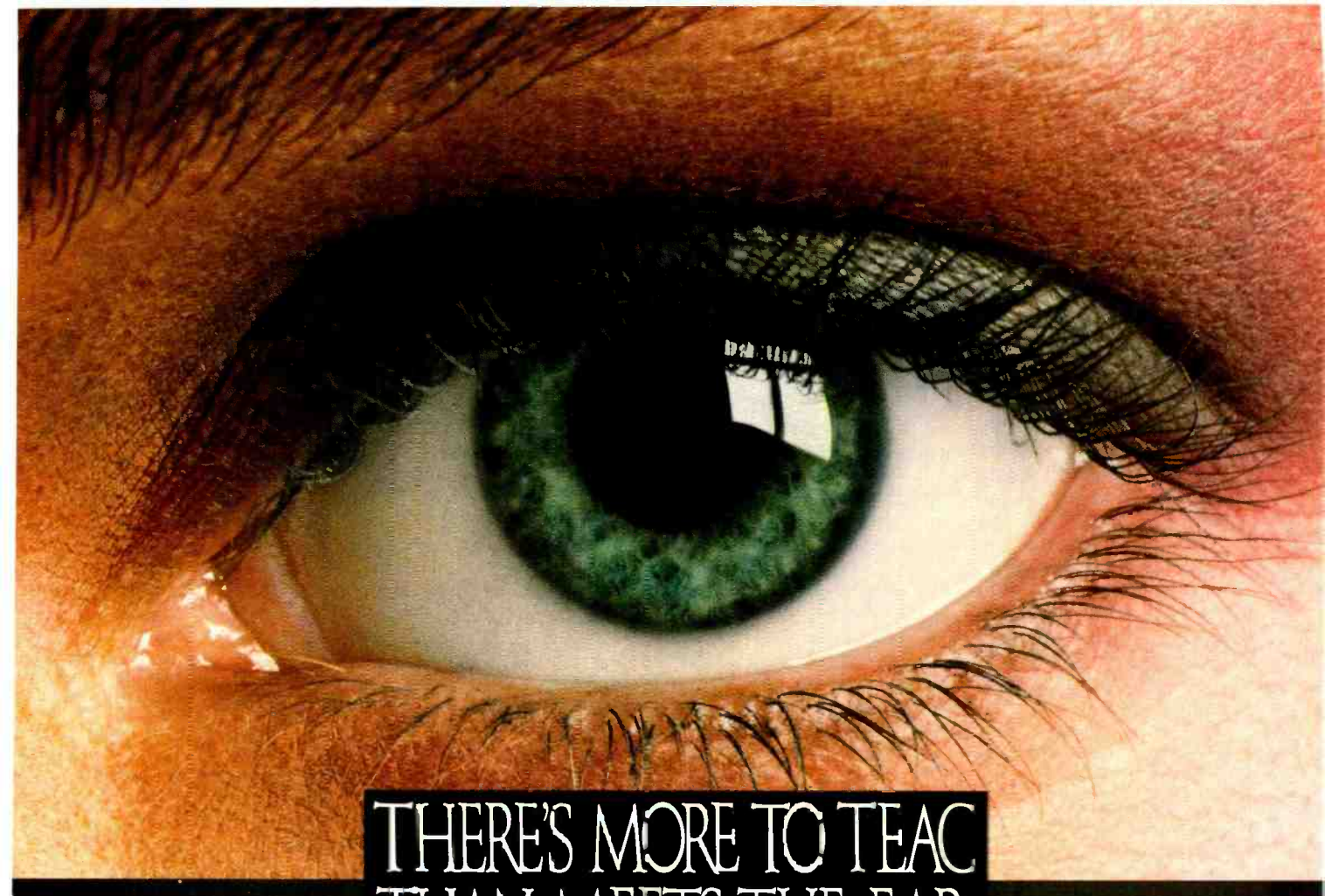
For literature, circle No. 93

The maker of this simple but elegant preamplifier, the Norwegian firm of Electrocompaniet, was founded in 1974. Originally, its purpose was to produce amplifiers based upon a design developed by Dr. Matti Otala, a well-known Finnish audio engineer and theoretician. Since then, the company's line has broadened to include audio amplification equipment that handles signals ranging from a few microvolts in amplitude to several hundred watts of power.

Much of the four-page owner's manual that accompanies the EC-1 is devoted to explaining the design philosophy behind the preamplifier. The designers conducted listening tests and concluded that conventional distortion, of the nonlinear type that occurs in the transfer function with respect to time, correlates closely with audible imperfections in amplifier performance. As we all know, one way to reduce measured distortion is to increase negative feedback, but the designers' listening tests showed that this was not the way to improve audible performance. They concluded that while negative feedback might reduce one obvious form of distortion, it can and does affect other important parameters. On the other hand, they found that amplifiers or preamplifiers completely devoid of negative feedback are also audibly deficient.

This dilemma was solved by Electrocompaniet in an unusual (though not totally original) way. Feedback is applied only locally, around individual stages, thus avoiding overall feedback from output to input stage. This concept, according to the designers, was further expanded to take care of phase and interface distortion between the EC-1's stages. The designers applied loop feedback around only those stages where such feedback resulted in audible improvements. Stability margins were also widened, since feedback no longer affected overall frequency response.

The RIAA equalization function is accomplished by a two-stage, all-passive network, using 1% metal film resistors and 1% polypropylene film capacitors. High-frequency roll-off components for the playback curve are placed as close as possible to the cartridge input to achieve a higher overload



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The EC-1's THD is only 0.0037% at 1 kHz. This is remarkably low, especially for a preamplifier with no overall loop feedback!

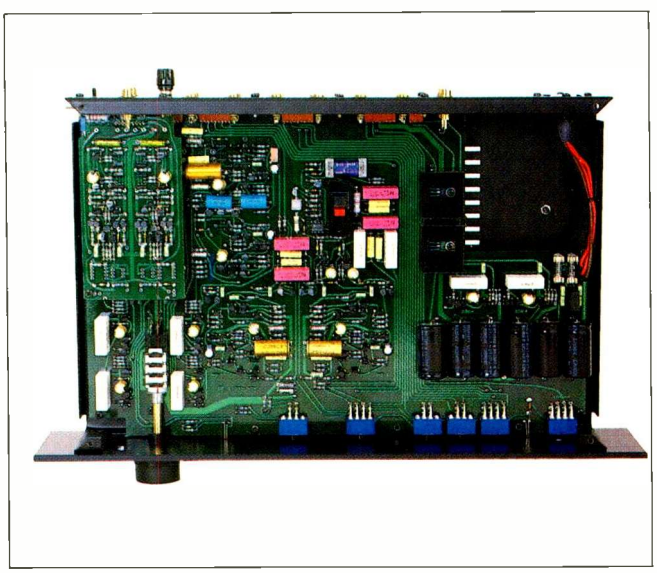
margin at the treble end of the spectrum. Low-frequency boost is handled by the second stage to achieve a better signal-to-noise ratio and improved overload characteristics at low frequencies.

All stages incorporate cascode circuitry, which helps to linearize the preamplifier at high frequencies. The power supply has separate regulators, with extended open-loop frequency response, for each stage and channel. The EC-1 I tested came with its power transformer in a separate cylindrical housing that was connected to the preamp by a cable about 40 inches long. This arrangement was to ensure that any hum fields generated by the transformer would have little effect on the preamplifier's audio circuits. The most recent version, the importer tells me, uses a special low-hum transformer mounted inside the unit.

Cartridge matching for moving-coil cartridges is handled by two resistors in each channel. To match the impedance of a given cartridge, you select one of four values for R1 from the seven pairs of precision resistors supplied, and insert it into a socket on the p.c. board (no soldering is required). Then you select one of three values for R2 to adjust gain to match the cartridge's impedance. (The lower the impedance of a moving-coil cartridge, the lower its output is likely to be.) The EC-1 comes with two pairs of resistors already mounted on the p.c. board and five more pairs in transparent bags that are stapled to the owner's manual. A diagram of the moving-coil pre-preamplifier stage is also supplied, showing the location of R1 and R2.

Control Layout

The only rotary controls on the face of the EC-1 are the concentrically mounted volume and balance knobs at the extreme right. When the volume control is rotated fully counterclockwise, much of the circuitry is turned off, but some critical circuits remain operative and ready for use without any warm-up time (assuming the power toggle switch at the left of the panel is switched on). A tiny red light near the volume control indicates that the preamp is in standby mode.



As you might guess, there are no tone-control circuits in the EC-1. All remaining controls are two- or three-position toggle switches. Included are a tape "Dubbing" switch (tape 1 to 2 or tape 2 to 1), a "Tape 1/Tape 2" selector switch, a "Source/Monitor" switch, an input selector switch (phono, tuner, or CD), and a three-position switch that selects full (0-dB) gain, −20 dB gain, or audio muting. The latter position cuts off output altogether; the 0 and −20 dB switch positions give a choice of normal gain settings so the user can pick the one that allows use of the main volume control's most linear region when listening at low levels.

The rear panel of the EC-1 is equipped with neatly arranged rows of gold-plated input and output jack pairs. The MM/MC selector switch is a toggle at the far left, adjacent to the phono input jacks. Just to the other side of these jacks is the ground terminal. The socket for the long power-transformer cord that was needed for the version I tested is at the right end of the rear panel, as far removed from the phono input stage as possible.

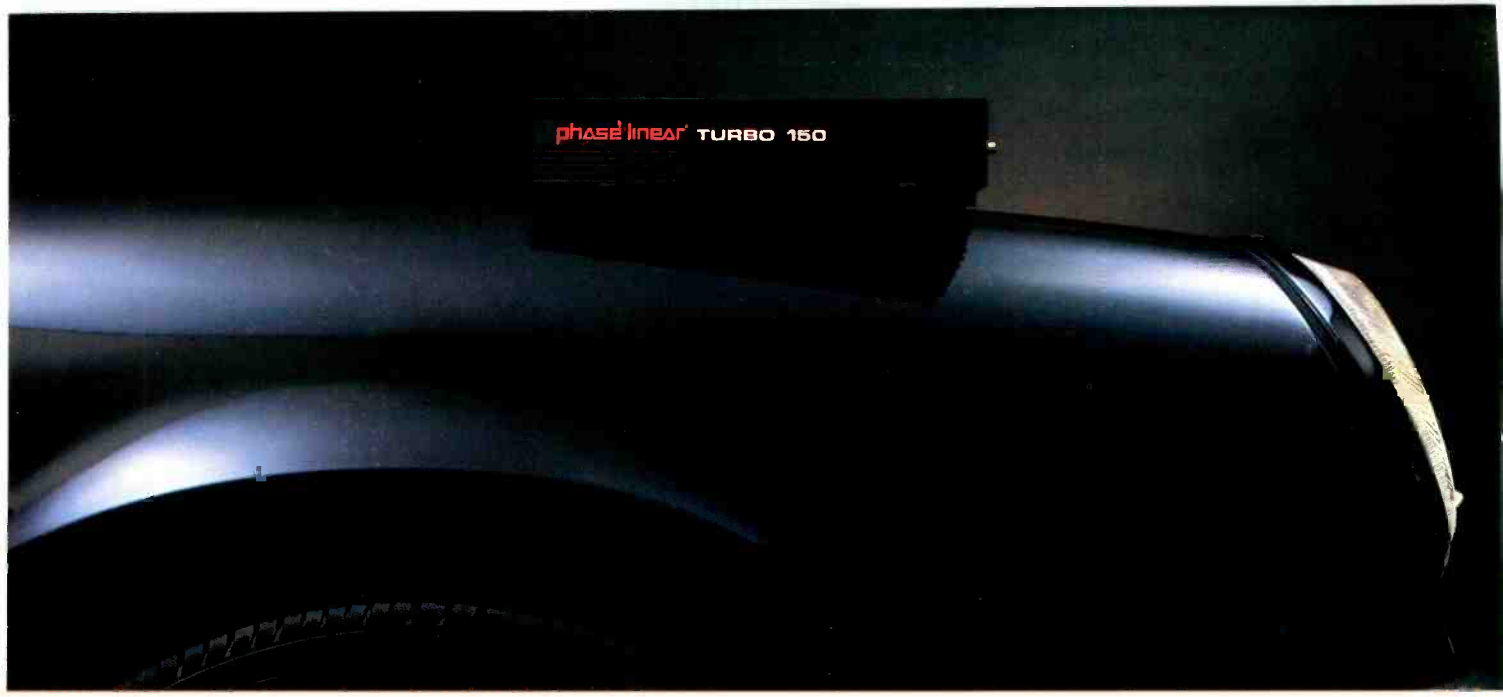
Measurements

Input sensitivity for the high-level inputs, referred to 0.5 V output, was 35 mV. The moving-magnet phono inputs required 0.83 mV for the same level of output. The moving-coil inputs required 80 μV of input to reach 0.5 V output with the volume control turned up fully—that is, once I had selected the proper values of R1 and R2 for the relatively high source impedance of my signal generator. (The resistors that were in place when I received the unit had been selected for the lower impedances typical of MC cartridges: with those resistors, I needed 0.4 mV from my generator to attain full output.)

Figure 1 shows how THD varied as a function of frequency for an output of 1 V, with overall gain via the high-level inputs set for approximately 10 dB. Considering the fact that there is no overall loop feedback in this preamplifier, the THD levels are quite remarkable—only 0.0037% at 1 kHz, for example! SMPTE-IM distortion for the same test conditions measured only 0.0067%. Maximum output obtainable from the preamp via the high-level inputs was 16.0 V before significant levels of distortion were evident. Phono input overload for the MM inputs measured 300 mV; for the MC inputs it measured close to 30 mV.

Perhaps the most impressive thing about this preamplifier is its moving-magnet phono signal-to-noise ratio. I measured S/N of 83 dB for a 5-mV input signal with the volume control set for an output of 0.5 V. When you consider the fact that the high-level input S/N measured 86 dB referred to 0.5 V input and unity gain, the result for the MM phono section is truly superb, among the best I have ever obtained for any preamplifier's phono stage. Figure 2A is an analysis of the MM phono S/N characteristics. Figure 2B shows the distribution of noise relative to 0.5 V output for the moving-coil phono inputs, with 0.5 mV of signal applied and the master volume control adjusted to provide the reference output. The RIAA equalization was accurate to within 0.15 dB.

One characteristic of a precision preamplifier/control unit that I feel is extremely important (but which is seldom measured) is volume-control tracking. Once the balance control is set for equal output from both channels with the



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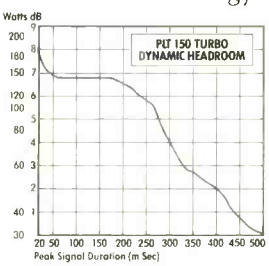

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Each one, built with rigid graphite cones, responds more quickly and accurately than paper cone models to intense fluctuations in peak performance music. And because they tend to "break up" less at higher volumes, you can blast away all day without the slightest hint of distortion.

So if you've been thinking of buying a car stereo amp, we suggest you try our new PLT 150 Turbo. It may not help the way your car drives. But with the right equipment, it will definitely get you going.

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Some LPs seemed to have new sparkle and a sheen I hadn't noticed before. The EC-1 may well have been the reason.

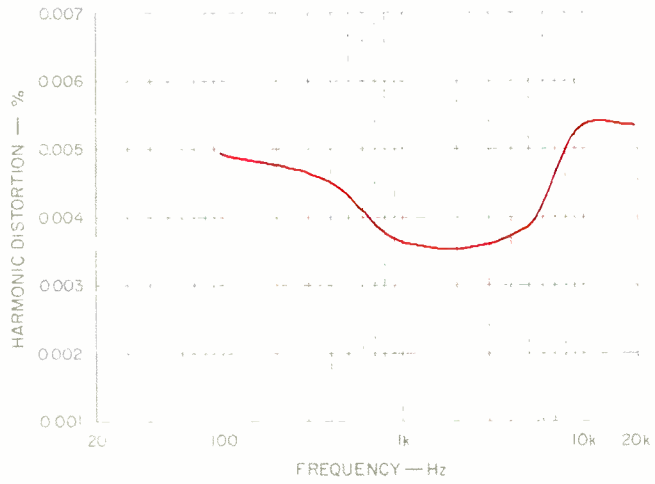

Fig. 1—THD vs. frequency, high-level inputs.

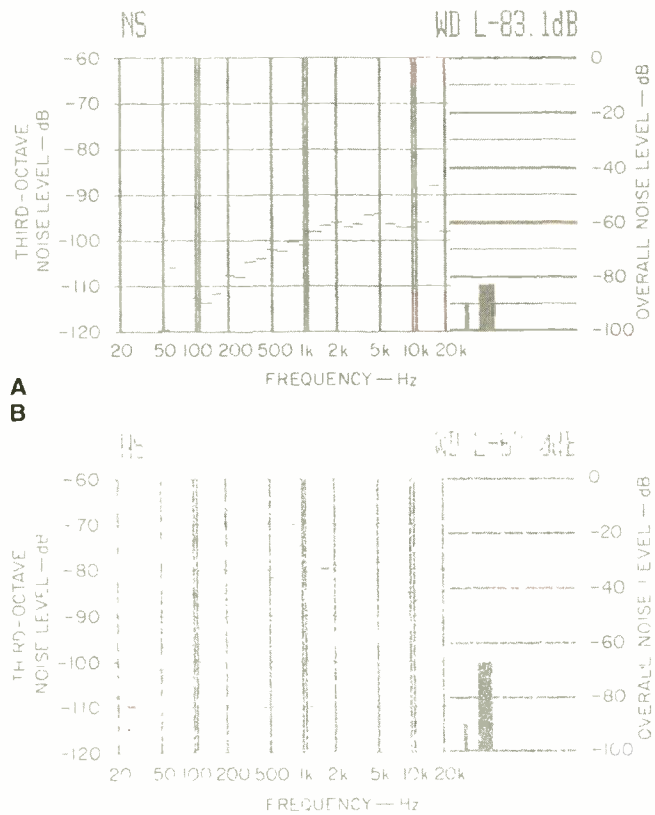

Fig. 2—S/N analysis, A-weighted, for moving-magnet (A) and moving-coil (B) phono inputs.

volume control set at its maximum position, balance should be maintained for a wide range of volume settings. In this regard, the EC-1 performed extremely well. I could not measure more than 0.2 dB of channel imbalance at any setting of the volume control from maximum to −60 dB.

Use and Listening Tests

I tried to select truly superb source material for my listening tests of this very expensive preamplifier. Aware that incremental improvements in sound quality as a function of price are asymptotic, I certainly didn't want any deficiencies in the source material to mask whatever minimal superiority I might hear from a preamp in this price class. (While I am not of the school that maintains that there is no difference in the sound of reasonably designed amplifiers and preamplifiers, neither do I expect to detect gross audible differences.)

The setup for these listening tests consisted of the preamplifier itself, a Forté Audio Model 1 power amplifier, a newly acquired Sony DTC-1000ES DAT recorder, and my reference CD player. Initially, the monitor loudspeakers used were KEF 105.2 units, which have long been standard fixtures in my listening room. Later, I substituted a pair of B & W Model 300 speakers, which have served as standbys when I want to judge components using somewhat less costly transducer systems. Finally, I used the same electronics but switched to a newly acquired pair of DCM Model 250 Time Windows, which are bipolar speaker systems.

CDs used in my tests included a Denon recording of Mozart's "Clarinet Quintet in A Major" (28C37-40, Japanese import) and several tracks from Telarc's latest sampler (Volume 4, CD-80004). Although stereo imaging and overall tonal response varied from one speaker system to the next (no great surprise), at least one characteristic was consistent regardless of the speakers used. That characteristic was an openness of sound, a lack of restricted or strained quality, which clearly distinguished the EC-1 preamplifier from lesser models.

I used the DAT machine to record live speech (my own voice and my wife's); in playback, the system described above reproduced the voice recordings with a clarity that surprised this home recording hobbyist.

The LPs used were fairly old but reliable discs (I haven't purchased an LP in some time now, for reasons known to all of us). A few of my favorites, Mobile Fidelity's Original Master recording of Holst's "The Planets" (MFSL 1-510) and Telarc's recording of Saint-Saëns' Symphony No. 3, the "Organ Symphony" (10051), seemed to have new sparkle and a sheen that I had not noticed previously. It's logically hard to attribute the improvement merely to the presence of the EC-1 in the signal path, but that may well have been the reason.

It is difficult to justify a price of nearly $2,000 for any preamplifier these days, especially since there are preamps and even integrated amplifiers whose sound quality might be indistinguishable from that of the Electrocompaniet EC-1 for most listeners, and barely distinguishable for a few keen-eared listeners. But, as we all know, to that keen-eared few, any audible improvement seems to be worth paying for, regardless of how much that improvement costs.

Leonard Feldman

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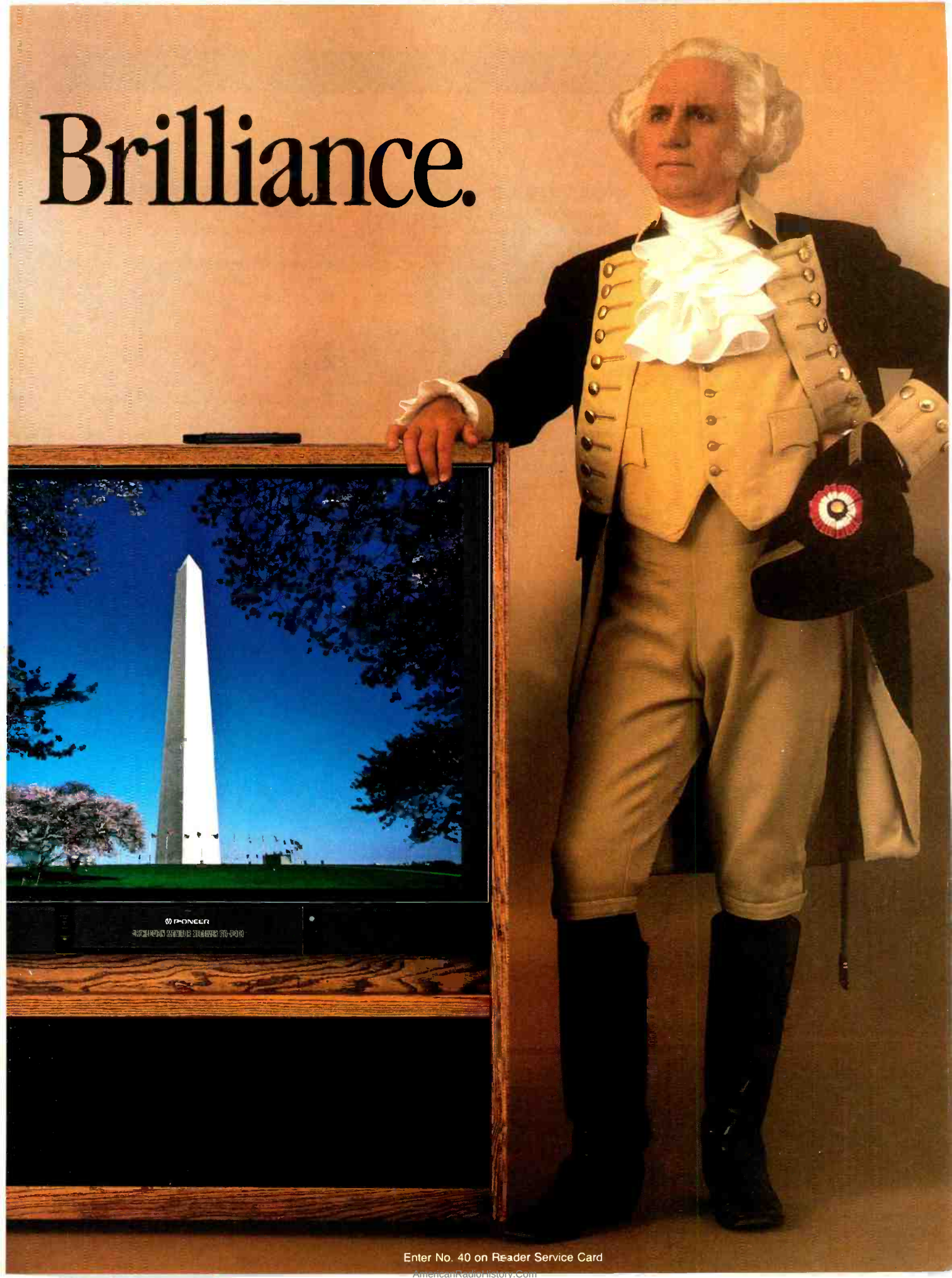

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5

HAFLER XL-280 AMPLIFIER

Manufacturer's Specifications

Power Output: 145 watts per channel, continuous, both channels driven into 8-ohm loads, 20 Hz to 20 kHz; 200 watts into 4 ohms, 20 Hz to 20 kHz; 400 watts, bridged mono, into 8 ohms.
Rated THD: 0.05% at 8 ohms; 0.1% at 4 ohms; 0.1%, bridged mono, at 8 ohms.
SMPTE IM: 0.04% from 1 watt to 145 watts at 8 ohms.
Phase Shift: Less than 0.25°, 20 Hz to 20 kHz.
Damping Factor: 300 re: 8 ohms.
Input Sensitivity: 1.6 V rms for 145 watts at 8 ohms.
Slew Rate: 75 V/μS (using 10-kHz, 60-V peak-to-peak square wave).
Rise-Time: 0.7 μS (10% to 90%, using 10-kHz, 60-V peak-to-peak square wave).
S/N Ratio: Greater than 100 dB.
Frequency Response: 10 Hz to 50 kHz, ±0.1 dB.
Power Consumption: 150 VA at idling; 1,200 VA maximum.
Dimensions: 17 in. W × 5⅛ in. H × 10½ in. D (43.2 cm × 13 cm × 26.7 cm).
Weight: 27 lbs. (12.3 kg).
Price: $600 assembled; $525 in kit form; XL-10 test unit, $50.
Company Address: 5910 Crescent Blvd., Pennsauken, N.J. 08109.
For literature, circle No. 94

David Hafler is one of audio's true pioneers. Like Avery Fisher, Herman H. Scott, Sidney Harman, and a few other outstanding innovators, he was seeking better sound reproduction back when audio was still the hobby of a limited few. Amazingly, Mr. Hafler and his engineers continue to innovate. Taking their cue from an often-stated goal of audio aficionados, they have come up with the XL-280, an amplifier that comes as close to being the proverbial "straight wire with gain" as any I have yet tested or listened to. Furthermore, Hafler has devised a simple but clever way of "tweaking" the amplifier so that it continues to act like a "straight wire with gain" even when it is driving real-world speaker loads instead of the resistive loads used in testing. In order to make this adjustment, it is necessary to use a small

Behind this equipment is the best thing

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We've just shown you the other side of our new D Series Components to expose an extraordinary breakthrough in digital sound reproduction.

For the first time ever, our engineers have utilized fiber optics in an external link between the D Series Compact Disc Player and the D Series Integrated Amplifier. In short, our fiber optic cable allows raw digital data to be transmitted to the amplifier in its purest possible form—light. And because light is totally impervious to outside interference, there's no line loss between the compact disc player and amplifier. None.

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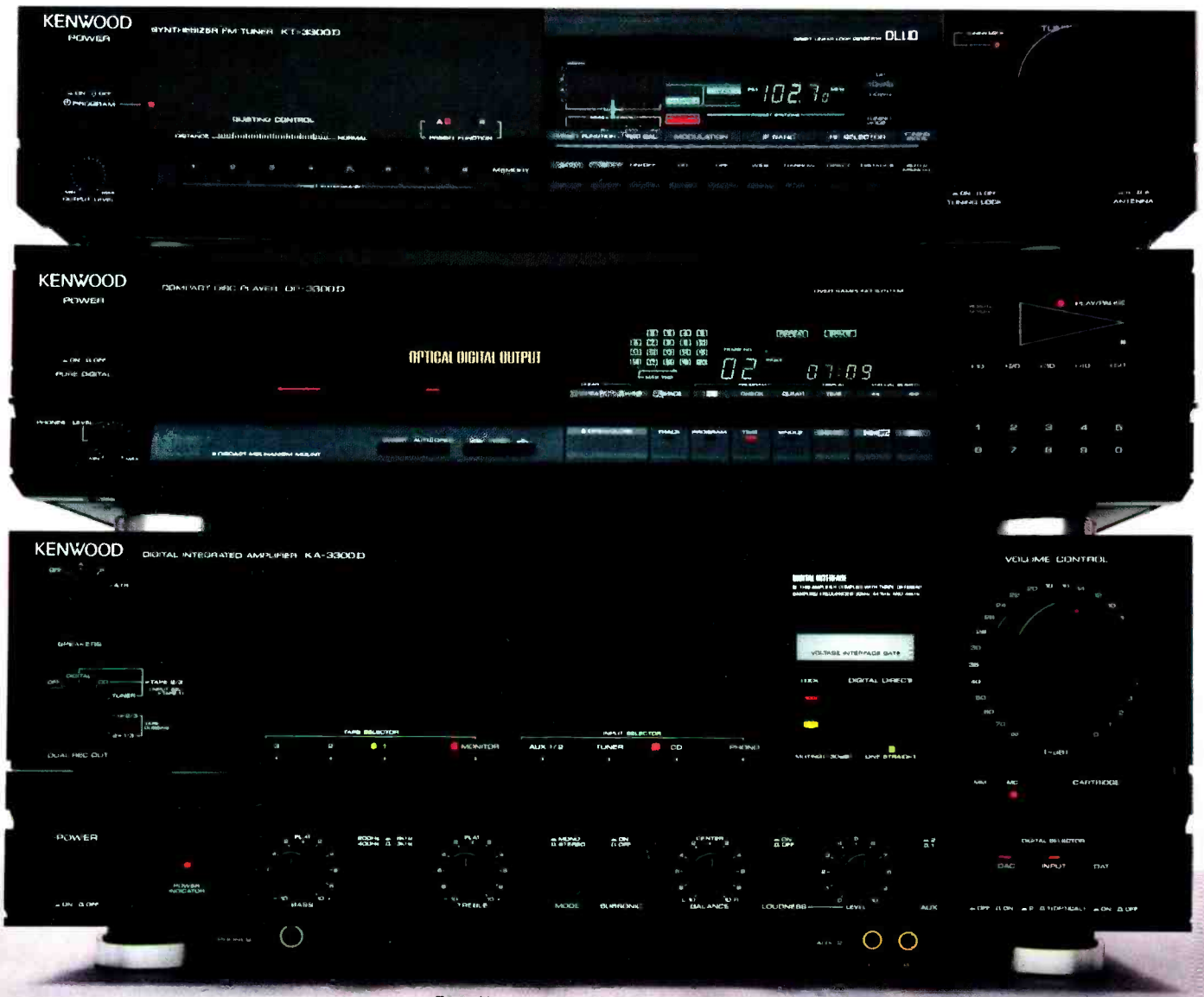

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g that's ever happened to digital sound.

to pure CD sound reproduction, our engineers could have quit while they were ahead. But that's not their style.

Instead they set out to develop an equally remarkable tuner. And they succeeded. The D Series Tuner incorporates a unique Pentacle Power Supply and 4-D Circuit. Together, these innovative features add up to FM reception that literally gives new meaning to the word clear.

If you're beginning to get the idea that our new D Series equipment is the best thing that's ever happened to digital sound, we suggest that you call 1-800-4-KENWOOD for the location of your nearest authorized dealer. Just tell them you've seen the light. And now you'd like to hear it.

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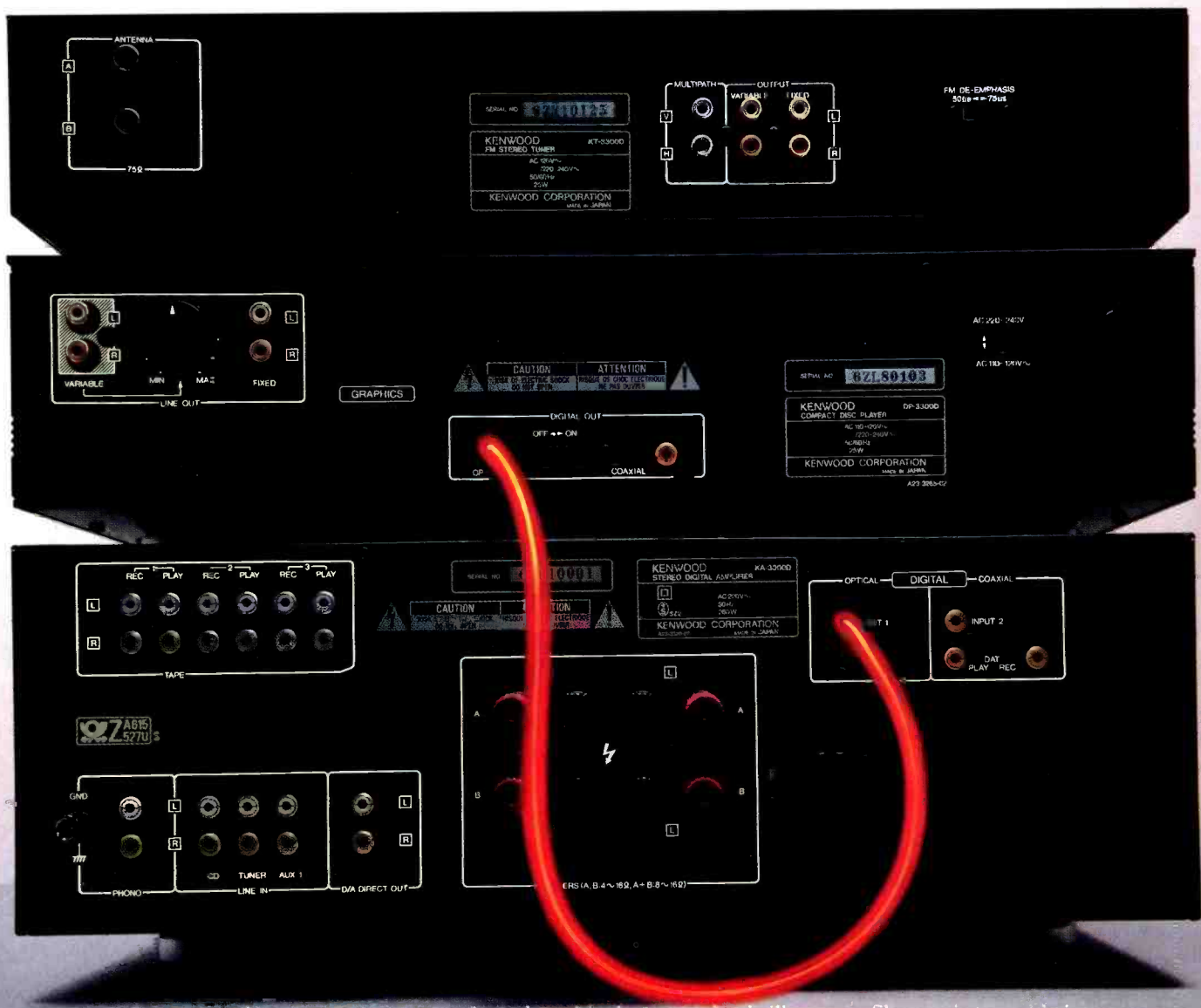


We removed the protective coating from the cable shown to clearly illustrate a fiber optic transmission.

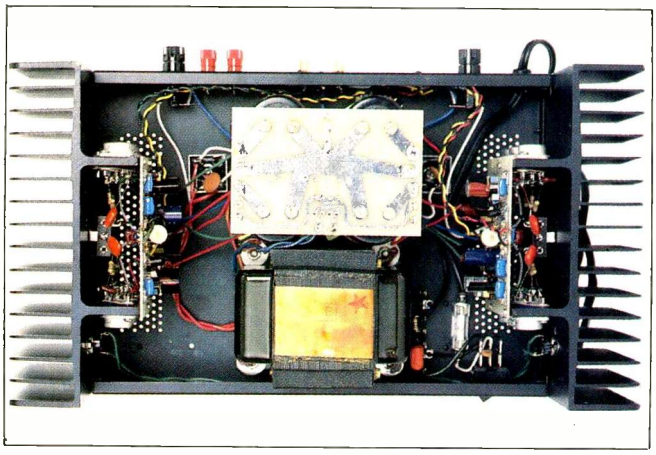
Hafler has a simple but clever way to "tweak" the XL-280 so it acts like a "straight wire with gain" even with real-world loads.

device that Hafler calls the XL-10. Since the adjustment need be performed only when the amplifier is first installed, you may not want to spend the extra $50 for it, so check with your Hafler dealer. He might very well lend you an XL-10. A readjustment would be necessary only if you changed loudspeakers, and even then, the amount of readjustment required might very well be minimal or even inconsequential.

The principle involved in using the XL-10 is easily understood by looking at the schematic of Fig. 1. One channel of the stereo amplifier to be adjusted is used as a driving amp, while the other channel is subjected to the test and adjustment procedure. First one sets a slide switch to position B and connects a suitable signal (such as interstation noise on an FM tuner, or even a music signal) to the input of the driving amplifier. Then volume is adjusted to a comfortable level as one listens through headphones or a monitor speaker. Next, the slide switch is moved to position D, and the coarse and fine controls are adjusted until a distinct null is achieved. In this switch setting, the direct signal from the driving amplifier is being subtracted from the same signal after it has been fed through the test amplifier channel. The purpose of the fine and coarse controls is to adjust the signal level to the input of the test amplifier so that an overall gain of unity is achieved. The deeper the "null" created as these controls are adjusted, the closer the amplifier under test is to being a "straight wire with gain." It does not matter if the driving amplifier alters the signal in any way, since the output of that driving amp is used to feed the speakers or phones directly and the same output is used to drive the amplifier under test.

In addition to the test for a null, it is possible to conduct a very accurate A/B comparison between the "straight wire" sound (the driving amp's direct output) and the sound of the test amplifier playing the same signal. To do this, you simply alternate between the A and B switch settings. (For a more complete discussion of this type of test, see "Nulling Out Amp Distortion" in the February 1987 issue.)

Since these tests measure how an amplifier operates with a specific load, the XL-280 has adjustments in each channel which "tweak" the amplifier to match whatever speaker loads are connected to it. Using these adjustments, you can make the test null so deep that you hear hardly any sound at all when the XL-10's switch is in its D position. I will have more to say about how this adjustment actually worked during my use and listening tests, but first let's take a look at the amplifier itself.



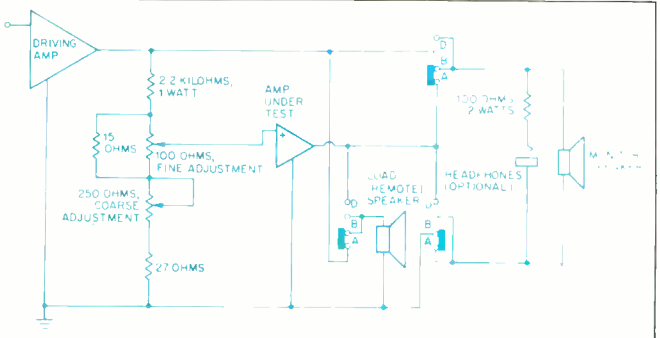


Fig. 1—Schematic of Hafler's XL-10 test fixture. Switch position A is for listening to the output of the test amplifier, position B for bypassing to hear the driving amp's direct ("straight wire") output, and position D for the differential null test. All switch sections are ganged. See text.

Control Layout and Circuit Highlights

A large, rocker-type power on/off switch at the lower right of the front panel is the amplifier's only control. An optional rack-mounting kit is available. On the rear apron, I found a mono/stereo bridging switch, gold-plated input jacks for each channel, five-way speaker-cable binding posts, and separate fuse-holders. As received, the fuses in the holders had a rating of only 2 amperes. A quick calculation revealed that these fuses would allow me to measure continuous power levels no higher than 32 watts into 8-ohm loads and no more than 16 watts into 4-ohm loads. The owner's manual points out that these fuses do pass the amplifier's full power on normal musical peaks while still protecting whatever speakers you might be using. However, the manual also indicates that, as far as the amplifier is concerned, one can substitute fuses rated at 7 amperes. Even under continuous-power tests, this would allow me to reach maximum power levels of 392 watts per channel into 8 ohms and close to 200 watts per channel into 4 ohms. I therefore made the substitutions for my bench tests.

The circuit of the XL-280 represents something of a departure from previous Hafler amplifiers. The input jacks feed four J-FETs in a double-differential push-pull cascoded input stage. The second stage current-mirrors the input. The usual input capacitor and output choke found on most amplifiers have been eliminated in this design to reduce phase shift at frequency extremes. The circuit is direct coupled throughout, and power-supply capacitors are bypassed. Completely separate power supplies beyond the common power transformer reduce interchannel interaction, and total power-supply capacitance amounts to over 31,000 μF. The output stage employs MOS-FET devices.

The Hafler XL-280 is a very clean-sounding amplifier, and the power it delivered was more than I'm ever likely to need.

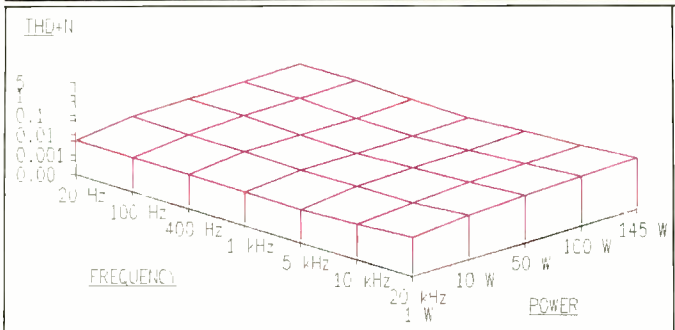


Fig. 2—THD + N vs. power and frequency, 8-ohm load. Note that THD scale is logarithmic.

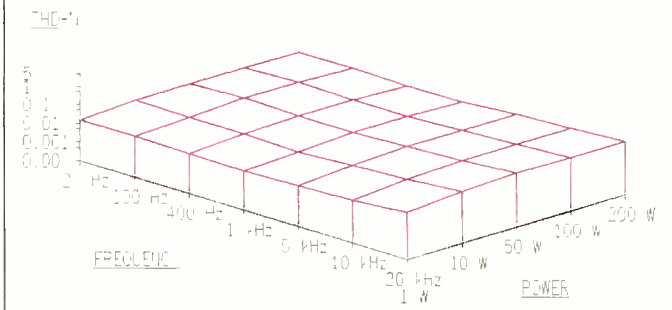


Fig. 3—Same as Fig. 2 but with 4-ohm load.

Measurements

Figure 2 shows how THD + N varied as a function of power output level and frequency when the amplifier was connected to 8-ohm loads. At the rated power level of 145 watts per channel, THD was only 0.0085% at mid-frequencies, 0.012% at 20 Hz, and 0.035% at 20 kHz. The 0.1% distortion level was not reached until the amp was delivering 174 watts at 1 kHz, 167 watts at 20 kHz, and 162 watts at 20 Hz. Dynamic headroom at 8 ohms was a bit more than 1.0 dB, while damping factor measured 111 at 50 Hz re: 8-ohm loads.

A complete set of measurements was also made with the amplifier connected to 4-ohm loads; THD + N versus frequency and power output level is shown in Fig. 3. At the rated output level of 200 watts per channel, THD measured 0.016% at 1 kHz, 0.057% at 20 kHz, and 0.017% at 20 Hz. The amplifier delivered 225 watts per channel at 20 Hz before THD rose to 0.1%; for the same distortion level, it delivered 252 watts per channel at mid-frequencies and 240 watts per channel at 20 kHz.

Dynamic headroom when driving 4-ohm loads measured more than 2.0 dB, which means that even considerably higher short-term power levels could be delivered during music reproduction. The SMPTE-IM distortion was 0.03% for the rated power level of 145 watts into 8-ohm loads and 0.063% for the rated 200 watts per channel into 4-ohm loads. The CCIF-IM distortion was only 0.0015% at rated power when driving 8-ohm loads, rising very slightly to 0.005% when 4-ohm loads were connected.

The XL-280 exhibited one of the widest bandwidths of any amplifier I have ever measured. Its frequency response extended from 5 Hz to 600 kHz for the −1 dB points and from 2 Hz to 650 kHz for the −3 dB roll-off points. Input sensitivity for 1 watt output was 125 mV. It was not possible to measure signal-to-noise ratio in strict accordance with the EIA/IHF amplifier measurement Standard since this amplifier does not have an input-level control. As an alternative, I measured S/N with respect to 1 watt output and read an A-weighted figure of 96 dB. Translated to rated output, this would correspond to an S/N of 117.6 dB.

Use and Listening Tests

The Hafler XL-280 is, first and foremost, a very clean-sounding amplifier. Power level delivered to my reference loudspeakers under actual listening conditions (4 ohms nominal impedance) was more than I was ever likely to need, even considering the fact that my reference speakers are fairly low in efficiency. I also connected the amplifier to three other sets of loudspeakers that were currently in my lab; in each case, the Hafler had no trouble driving them to more than adequate levels, and there were no problems caused by any of the speakers' impedance characteristics.

I had hoped that at least one of the speaker systems I used in my listening tests would require a drastically different setting of the internal "tweaking" controls. (These controls, by the way, are accessible from the top of the amplifier; one simply removes a couple of small plug buttons and uses a long screwdriver to make the adjustments.) The fact of the matter is that the setting which produced the most complete "null" when I connected Hafler's little XL-10 A/B/D switchbox to my reference speaker systems was pretty much the same as when the other speakers were connected. Furthermore, the musicality of the amplifier did not audibly change when I departed slightly from the ideal setting. Perhaps the speakers that I used did not present as great a problem to the amplifier as other models might have. It is entirely possible that, under some circumstances, an audible improvement might be detected when adjustments are made.

From my own point of view, I was more than pleased with the sound of the XL-280 even before I "tweaked" the internal potentiometers. The amplifier's construction and audible performance are fully consistent with what I have come to expect from David Hafler and his organization. I did not see the XL-280 in kit form. However, judging from other Hafler units offered as kits, I would guess that almost anyone who has used a soldering iron and the simplest of electronic hand tools would have no trouble assembling it and having it work perfectly the first time. Purchased fully assembled, the Hafler XL-280 is a real bargain. As a kit, it would be even more so! *Leonard Feldman*

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What separates the 401 system from other speakers? *Direct/Reflecting® speaker technology.* Taking their cue from a live performance, Direct/Reflecting® speakers deliver a precise combination of direct and reflected sound. The result is a sense of musical realism and impact usually experienced only during a live performance.

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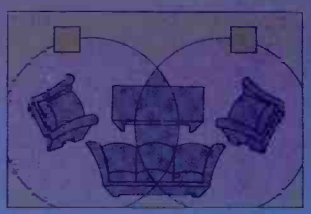
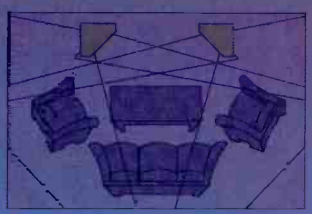


Since conventional speakers radiate primarily *direct* sound, stereo is heard in only part of the room.



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6

AUDIO-TECHNICA AT-9400 STEREO MICROPHONE

Manufacturer's Specifications

Type: Twin unidirectional electret condenser.

Frequency Response: 60 Hz to 17 kHz.

Impedance: 1.5 kilohms per channel.

Sensitivity: −53 dB re. 1 mW per 10 dynes/cm^2 (1 mW/Pa).

Connectors: Twin mini-phone plugs with ¼-in. plug adaptors.

Power Supply: Internal AA cell.

Accessory Supplied: Swivel mount with ⅝-in.-27 thread.

Dimensions: 8 7/16 in. L (21.4 cm); head, 2¼ in. W × 1½ in. H (5.7 cm × 3.8 cm); cord length, 9 ft., 10 in. (3 meters).

Weight: 7.1 oz. (201 grams).

Price: $49.95.

Company Address: 1221 Commerce St., Stow, Ohio 44224.

For literature, circle No. 95

The AT-9400 is a low-cost microphone intended for use with cassette tape recorders. It offers the convenience and economy of a single microphone for stereo recordings, and it is considerably more "high-tech" and complex than its low cost might imply.

A stereo microphone is most effectively used at a distance from a group of sound sources such as musical instruments, vocalists, or people speaking. The stereo spatial perspective adds realism to recordings of many events ranging from concerts to weddings. Sometimes, a stereo microphone is used to pick up a single source; in that case, to assure a stable center image, the mike must be placed a few feet away from the source. A stereo microphone is not appropriate for close-up vocal or instrumental use. Stereo mikes are primarily used for classical music, where the acoustics of the auditorium or studio, as well as natural spatial perspectives, are important. In commercial pop music recordings, multiple single-element microphones are used with large mixing consoles. In audiophile applications with no mixing board, the stereo microphone may be used out in front of live performances to capture the true spatial perspective of both pop and classical music.

The earliest stereo microphone configuration was an X-Y pair of figure-eight (velocity) microphones, invented by Blumlein in the 1930s. The AT-9400 consists of a pair of cardioid-pattern electret condenser elements with coincident horizontal axes (Fig. 1). Most professional stereo microphones have elements that are situated on a common vertical axis, but their horizontal axes may be up to 2 inches apart. I think the layout of the AT-9400 is good, because the elements are only about 1 inch apart, and the mike is easy to aim because of its axial pickup direction. The back of the capsule cage represents an acoustic obstacle behind the elements, and very detailed directional responses had to be measured to ascertain its effect.

A cardioid element has a pickup pattern about 120° wide, and an X-Y array of cardioids is usually angled at 90° to 120°. A wider angle gives a broader stereo image and more room ambience. The AT-9400's elements are angled 120° apart—a good choice for a fixed-angle stereo microphone for amateur use, since audiophiles using short cables and low stands may be likely to place the mike too close to the sources.

The elements of a stereo microphone each receive sounds from both left and right at the same time. Localization of a source is accomplished solely by the relative intensity of the reproduced sound from each channel of speakers or headphones. For example, a sound source on the microphone axis is attenuated 3 to 6 dB (depending on frequency) by the cardioid patterns of the elements. The reproduced image will be perceived centrally because of equal intensities in left and right channels. This is known as "intensity stereo."

A tape made using a stereo microphone can reproduce spatial perspectives very accurately, and this is true regardless of whether playback is via headphones or via speakers. Tapes made with spaced mikes do not reproduce such accurate images, but the imagery is more "colorful" or "spatial."

A wealth of information on electret microphones, stereo microphones, and stereo microphone arrays and perspectives, as well as an extensive bibliography, may be found in the July/August 1985 issue of the *Journal of the Audio Engineering Society*. Authors include myself, Streicher, Dooley, and Knoppow.

For best imagery, the AT-9400 should be positioned so that the sound sources lie mostly within the 120° angle subtended by the elements (Fig. 1). The reader may wisely observe that the useful pickup angle extends 60° to either side of this 120° angle. These two areas on the far left or far right may be thought of as reserved for pickup of reflected sound or room ambience. The microphone should always be oriented with the on/off switch facing up.

The casing of the AT-9400 is all plastic, appropriate to a low-cost microphone. The cable is short but highly flexible and of excellent quality. The connectors are of high quality. Two microphones were received for review, packed in lightweight cardboard boxes. Save for brief data printed on the boxes, no instructions were provided. I think the addition of

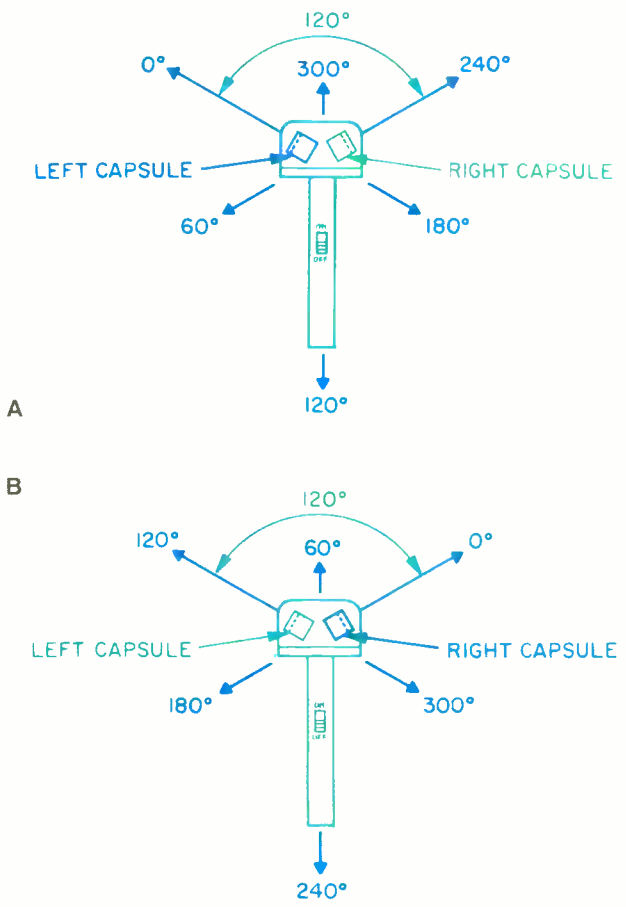

Fig. 1—Capsule layout of the AT-9400. The angles for the left capsule (A) correspond to the response curves shown in Figs. 3 and 5; angles for the right capsule (B) are for use with Figs. 4 and 6.

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Played through speakers or headphones, tapes made with a stereo mike can very accurately reproduce spatial perspectives.

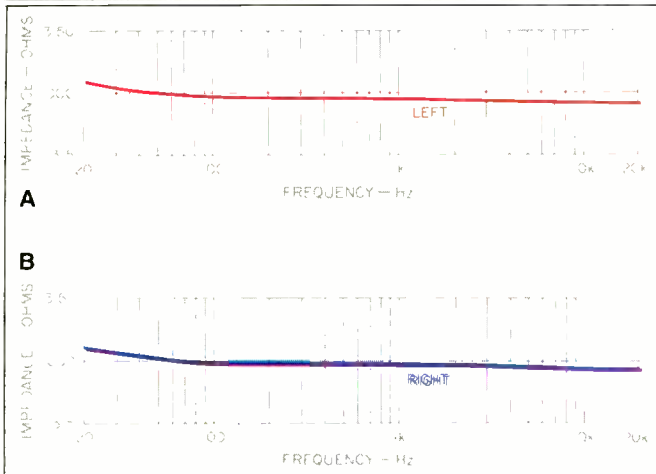

Fig. 2—Impedance of left (A) and right (B) capsules. The two curves are virtually identical, and impedance (920 ohms at 1 kHz) is lower than the rated 1.5 kilohms. Note that impedance scale is logarithmic.

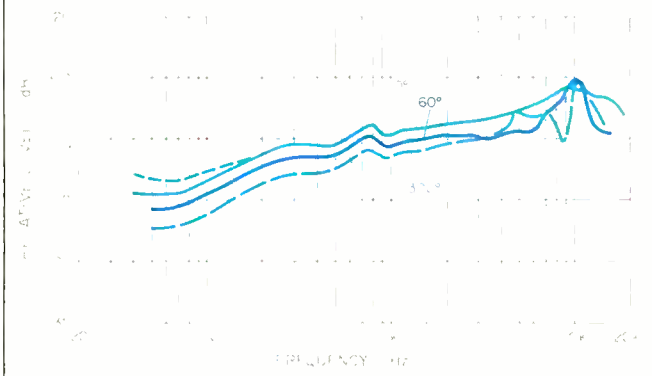

Fig. 3—Frequency response of left capsule within its 120° useful pickup angle. The 0° curve is on the capsule's axis, 300° is on the axis of the microphone handle, and 60° is for ambience pickup from the microphone's left. All responses were measured at 24 inches from the sound source except for the dashed portion of the 0° curve, which was measured at 12 inches. Reference level (0 dB) is −47 dBV/Pa.

a detailed instruction sheet would benefit the user and add little to the cost. The internal battery is easy to replace. The mikes were used from time to time over a six-month period, and the cells did not lose energy.

Measurements

The rated impedance of this mike is 1.5 kilohms per channel, which is quite high compared to the 150-ohm ratings typical of professional mikes. The actual measured value of 920 ohms per channel (Fig. 2) is considerably less than the rated value. (The same value was obtained for both samples.) An Aiwa F990 cassette recorder, which I use for concert recordings, has an actual input impedance of 10 kilohms, so it does not impose any significant loading on the AT-9400.

For frequency response tests, I used a 30-foot extension cable of the shielded, twisted-pair type normally used for mikes with balanced outputs. This was connected to an "unloaded" 150-ohm transformer-coupled input of a professional mike preamp, without hum, noise, or pickup of radio stations. I would not recommend using a longer extension on any mike with an unbalanced output.

The mikes were used for a concert recording prior to the lab tests, with excellent results. I was interested to find out why a mike costing only $25 per channel sounded so good. The frequency response tests were conducted with a 2-inch-diameter precision sound source.

Audio-Technica provided no clues to the orientation of the capsules inside the wire cage, but by placing a bright light behind the cage, I was able to measure a 120° included angle between the capsules. Normally, I measure microphones with cardioid patterns at 0°, 90°, and 180°. I look for a 6-dB reduction in output at 90° and a "null" (which I define as a reduction or cancellation of at least 15 dB) at 180°. However, since the angle between the capsules of the AT-9400 is not a multiple of 45°, I decided to measure at 60° increments of rotation of the microphone. To keep things consistent, these angles will be stated with respect to the respective capsules, as shown in Figs. 1A and 1B: 0° at the capsule axis and continuing counterclockwise to 60° at the capsule's left, 180° directly behind the capsule, and 300° (360° − 60°) at a point 60° to the capsule's right. Using this notation, sounds centered with respect to the microphone handle will be at 300° for the left capsule and 60° for the right.

The above test resulted in 12 response curves with the mike at 12 inches from the source and another dozen at 24 inches. (Bass boost due to proximity effect vanishes for a cardioid at 24 inches and beyond.) The capsule cage geometry is asymmetrical with respect to each capsule, so each capsule's 60° response curve is not the same as its 300° curve. This asymmetry required that each capsule be tested throughout 360° rotation. But how could this data best be displayed? Three curves per figure seemed best, for easy interpretation, so two graphs are presented to show the performance of each capsule. These are divided into two angular regions: The frontal area of useful pickup and the rear where sound is rejected.

Figures 3 and 4 show the frontal curves for each capsule. In recording, sound sources should lie in the 120° angle

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Axial (0°) curves show a rising but smooth response extending from 40 Hz to 19 kHz, a range that beats the published spec.

between capsules: pickup in this area is shown by the left capsule's 0° and 300° curves (Fig. 3) and the right capsule's 0° and 60° curves (Fig. 4). To examine the AT-9400's response to reverberant sound, look at the 60° curve for the left capsule and the 300° curve for the right.

The axial (0°) curves show a rising but smooth response from 40 Hz to 19 kHz, exceeding the specified 60 Hz to 17 kHz. The off-axis curves are similar but ragged above 4 kHz, due, no doubt, to grille and cage effects. This wide-ranging response is quite good for a low-cost mike and, in my opinion, well tailored for general-purpose use. In live recordings of pop music, where the mike is picking up mostly amplified sounds, the rising high-frequency response will improve the clarity of muddy vocals. Pop groups often play in small rooms where the bass becomes intense, and I think the bass roll-off will be an advantage in those situations. In classical recording, the mike may be good as-is for organ, but for orchestral recording some equalization might be best. The axial curves may be used as a guide to setting a graphic equalizer: aim for a flat response first. If the mike is poorly situated, you may find that its bass attenuation will reduce ambient noise and that its treble boost will add clarity. It might therefore be best to use no equalization in such problem situations.

Figures 5 and 6 show the responses in the region of rejection, towards the rear of the mike. I was pleasantly surprised to find that rejection approximating 15 dB is maintained at both 180° and 240° for each capsule. The latter is

IN THE STUDIO

The great thing about stereo microphones is their ability to capture true spatial relationships of sound sources while providing the listener with the ambience of the chosen recording space. Unfortunately, nearly all stereo mikes cost a fortune. And if you choose to use two matched mikes in a stereo configuration, your cost will still be very high. With a suggested retail price of $49.95, the Audio-Technica AT-9400 is very inexpensive.

I realize that Audio-Technica created the AT-9400 for different fields than the ones I usually work in—essentially rock, pop, and jazz. However, I felt that this mike could have some real uses other than those for which it had apparently been intended—recording conferences or family events, with portable tape decks or home decks.

I used the AT-9400 with sound-reinforcement systems as well as with professional and home recording setups. First I tried the mike with a choral group singing a cappella. Here I wanted to see how well the mike picked up its signal within a good stereo perspective, how well it rejected signals—and noise—from the sides and rear, and how well it rejected extraneous noise and unwanted room ambience. The condenser elements are angled far enough apart to capture a good stereo spread and space, but not so wide as to accept unwanted reverberation and noise from the rear. The mike did very well on all counts, picking up and transmitting the a cappella voices clearly and cleanly, and I was very pleased with the final recording.

While recording backup singers on a rock session, I found that if you use the AT-9400 as an ambient mike rather than as a primary mike (you would then mix the primary and two ambient signals together to get a blend), you need to turn up the mike gain fairly high. Unfortunately, this creates a noise (hiss) problem. If you pay special attention to miking distance and source levels, you won't have any problems.

Another drawback I encountered, when using the mike in a music club, is that the AT-9400 cannot be handled while being used to record. The one-piece plastic body is not shock-mounted or insulated to prevent handling noise. Any recording will need to be done with a stand or desk mount.

In addition to recording vocals, I also used the AT-9400 as an ambient mike for recording a small jazz group (watch those miking distances!), as well as to record electric guitar and synthesizer. When recording electric guitar, I placed the mike about 3 to 5 feet from the amp's speaker cabinet. This distance allowed for low noise while permitting stereo recording. (The optimum distance will vary according to amp level and miking effect desired, so experiment.) At medium levels, the mike signal was clean and punchy. Miking in stereo permits you to record two signals simultaneously; thus, you can equalize the two signals differently or process them with special effects individually. This all makes for a thicker, more powerful guitar sound. For those recording on personal 4-track cassette machines, this saves time and makes the recording sound stronger. At moderate guitar amp levels, the AT-9400 sent usable, undistorted signals to the tape machine, and that's exactly the kind of signal I wanted.

While recording synthesizers, I used the AT-9400 as an ambient mike. I fed the synth signal through speakers into the main recording room, where it was picked up by the AT-9400. I then combined this signal with the direct signal from the keyboard. Where string synthesizer voices are being used, this combination provides additional realism. I was happiest with the AT-9400 in this experiment. I wanted to capture greater ambience and realism on tape, and this stereo mike performed the job admirably.

The Audio-Technica AT-9400 one-point stereo microphone is a very useful tool for its intended use of recording family events and miking conferences, but it also is very good for home and small-studio music recordings. (Major studios will have other, much more expensive stereo mikes.) The AT-9400 brings another source of creativity to the musician and home recordist, and I am all for that. *Hector G. La Torre*

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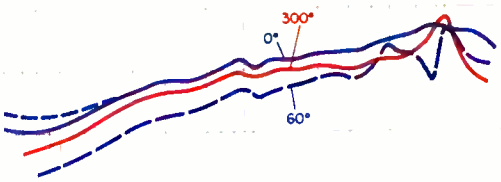


Fig. 4—Same as Fig. 3 but for the right capsule. The 0° curve is on the capsule's axis, 60° is on the axis of the microphone handle, and 300° is for ambience pickup from the microphone's right.

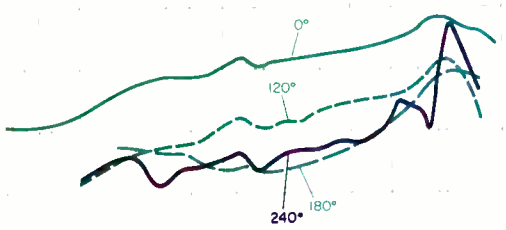


Fig. 5—Frequency response of the left capsule in the region of sound rejection. The 120° curve is to the rear of the microphone handle, 180° is directly behind the capsule, and 240° coincides with the axis of the right capsule. On-axis (0°) response is given for comparison.

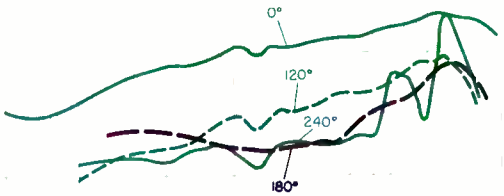


Fig. 6—Same as Fig. 5 but for the right capsule. Here, the 120° curve coincides with the axis of the left capsule, 240° is to the rear of the microphone handle, and 180° is directly behind the capsule.

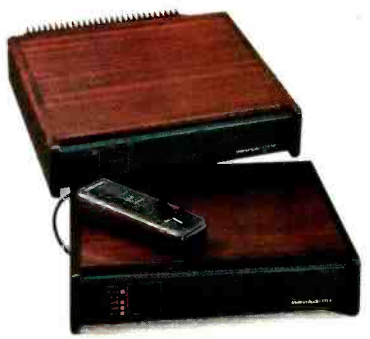
probably a benefit of the cage effect; the 120° and 240° curves, each taken at the same angle to the capsule's axis, do not match as they would for unobstructed capsules.

The rectangular cross-section of the cage means that responses in the vertical plane will not, in general, match those in the horizontal plane. Olson taught us many years ago that the poor treble response of a microphone with a long ribbon element in the vertical plane was not generally a problem, because sound sources commonly lie in a horizontal plane. (He didn't mention tall pipe organs and performances of Mahler's "Symphony of a Thousand.") Now we have shorter ribbons and diaphragms smaller than 1-inch diameter (the AT-9400 appears to have small-diameter capsules) which offer uniform response and directivity up to very high frequencies in any direction.

Only the left capsule of the AT-9400 was tested in the vertical plane (Fig. 7). Note that the angles are indicated with respect to the axis of the handle, midway between the two capsule axes, so that the "axial" (0°) curve of Fig. 7 should be identical to the 300° curve of Fig. 3. (It is close enough.) The "off-axis" curves of Fig. 7 are therefore farther off the capsule axis than indicated. Looking at the 0° and the 60° curves, it is seen that the response in the vertical plane is as good as in the horizontal plane. The rejection at 120° is poor, and this seems to have been traded for the extra rejection measured in the horizontal plane.

This test is relevant to the question of "what points straight ahead?" in X-Y coincident microphone arrays and in X-Y stereo microphony. The answer is that the capsules must have very good (high-frequency) response off-axis. Generally, this means the capsule must be no more than 12 to 16 mm in diameter, although very thin 25-mm capsules, such as the double-diaphragm units in the AKG C-422 stereo mike, have good response off-axis. Otherwise, sources in the center will sound muffled compared to those to the left and right. The 300° curve of Fig. 3 and the 60° curve of Fig. 4 show the response to a centered source, and these adequately match the 0° curves of those figures.

What happens when L and R are summed to form a center or monaural channel? To conduct this test, the sound source must transmit phase-coherent sound pressures to the two capsules. My 2-inch precision sound source can closely meet this requirement. Two identical preamps were used. Figure 8 shows that the L + R response is essentially the same as the L and R curves (300° and 60° off capsule axes), save for slightly greater amplitudes of dips and peaks. No deep nulls are seen up to 19 kHz. The capsules



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The Tandberg 3015A Compact Disc player has two notable distinctions. First, it is one of the best players I have ever heard, and I've surveyed more than 100 different models. Second, it is the first Philips-based 16-bit player that I have heard which really sounds better than the previous Philips 14-bit machines. Like most audiophile gear, the Tandberg 3015A is expensive, retailing at $1,895. It is, however, not only technically outstanding but sonically outstanding as well.

I have not encountered the Tandberg's impressive sound characteristics in any of the other new Philips-type 16-bit, four-times oversampling machines that I have listened to, in spite of the fact that the new Philips 16-bit process should produce better resolution, better imaging, better ambience, and smoother high frequencies with less edge. The shift from a 14- to a 16-bit process should increase signal resolution and improve dynamic range by 12 dB.

This shift also allows the manufacturer to remove the noise shaping used to give the earlier players a signal-to-noise ratio of 96 dB rather than the 84-dB ratio theoretically resulting from a 14-bit decoder. The four-times oversampling system, originally producing the equivalent of 16-bit resolution in 14-bit units, allows the new players to achieve S/Ns approaching those of 18-bit players without a noise-shaping device. Tandberg uses a third-order Bessel filter (−3 dB at 30 kHz) instead of a steep filter which presents potential phase problems.

The new Philips D/A chip provides a separate D/A converter for each channel in a single housing. This eliminates the temperature differences—and the resulting sound differences—that might occur with separate chips. It also allows the manufacturer to eliminate potential group-delay problems inherent in using one D/A converter for both channels.

Despite all this technical potential, the other Philips-type 16-bit machines I have heard all have annoying sound problems not present in the earlier 14-bit players. They have better resolution and better imaging, but they do not have better ambience, nor do they have smoother, less edgy high frequencies. In fact, they have a fatiguing upper midrange which becomes steadily more annoying with time, far too little depth, and a rather two-dimensional ambience which emphasizes left-to-right distinctions without giving a proper hall effect or a convincing placement of individual instruments or soloists. The other Philips-based 16-bit CD players have also seemed to be vaguely out of focus in low-level passages.

Even though these players measure better than their predecessors, I can't help disliking their sound. Given the choice, I would much rather hear music reproduced through a better-quality 14-bit machine such as the Sonographe than through a new 16-bit player such as the Magnavox CDB650 or the Mission PCM 7000.

The Tandberg 3015A, however, is proof that the problems lie in the execution and not in the technology per se. The Tandberg has the cleanest overall sound of any machine I have yet heard, rivalled only by the best samples of the Cambridge and the latest top-of-the-line Sony models. Its depth and ambience are excellent. In fact, it delivers far better sonics in every aspect of its sound stage and upper-octave performance than either the initial 14-bit version of the 3015A or any of the competing Philips-type 16-bit players I've heard to date.

The 3015A also has an audio section to rival that of any competing high-end machine. The analog stages are all direct coupled, and there are no series or coupling capacitors from the D/A converter to the output jacks. De-emphasis is done with a passive filter, and all negative feedback is eliminated without any significant increase in distortion. The 3015A also uses polypro-

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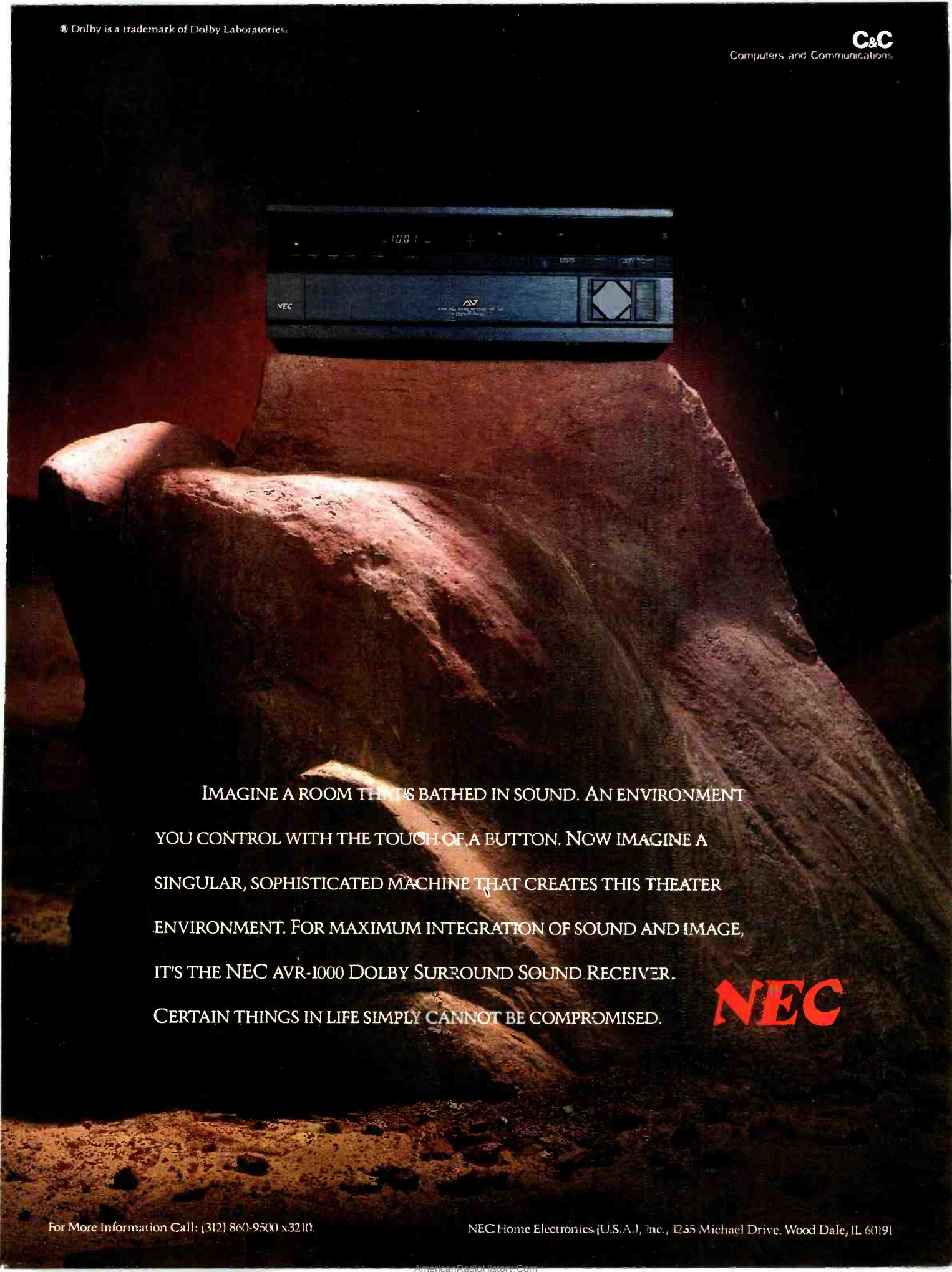

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pylene capacitors and high-precision metal resistors.

This attention to the analog stages pays off—just as it does in a good preamp. It may well explain the excellent overall sonic balance, including the deep, powerful bass, which is better controlled and more detailed than in the earlier 14-bit version of the 3015A. The bass and midrange are up to the quality of the highs and the sound stage.

> The 3015A, perhaps the best CD player available, is a tribute to Tandberg's skill in listening as well as in design.

Dynamics are also very good. In spite of their theoretical capabilities, many CD players seem to have trouble either with low-level passages or with sudden major shifts in volume or musical energy, when compared to records or master tape. The Tandberg is free of most such problems.

If I were to suggest improvements in the 3015A, they would involve adding a few of the best sonic features of the top-ranking competition. I'd want to add an upper octave that had not only the 3015A's detail, but the sweetness of the upper octaves in the California Audio Labs players. I'd want to add all the outstanding depth and instrumental placement of the Sonographe. I'd want to add the filtering or equalization adjustments that allow a player to match a given CD, such as those on the Cambridge. Finally, I'd like just a touch more openness, to match the sound that the PS Audio had.

Barring perfection, however, the Tandberg 3015A is clearly a leading candidate for the best CD player presently available. It is one of the most exciting and musical players, and it is a tribute to Tandberg's skill in listening as well as in design. Tandberg has long produced some of the best-sounding cassette decks and perhaps the best-sounding consumer version of an open-reel tape recorder. The 3015A is proof that this company is now emerging as a much broader-based high-end firm. *Anthony H. Cordesman*

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MOBILE FIDELITY'S LATEST

JOHN EARGLE

During the golden era of analog stereo LPs, Mobile Fidelity Sound Lab held a unique position in the record industry. Their approach was to license master tapes from main-line companies, lavish care on all stages of transfer and manufacture, and come up with superior pressings, which sold in the $16 range. High-quality, real-time cassettes also entered the picture, as did UHQR vinyl pressings, which carried that art to its limit.

With the advent of the CD, more and more record companies started to lavish tender loving care on their master tapes, and Mobile Fidelity's competitive position had to be redefined. Sixteen-dollar LPs became virtually obsolete overnight, inasmuch as the marketplace could support only one expensive medium, the CD.

While Mobile Fidelity continues to make high-quality product in all formats, it is the CD which is now in the commanding position. Not content to stay with conventional technology, the company has recently embraced a type of CD known as the Ultradisc, on which the metallizing step is carried out using gold instead of aluminum. A claimed advantage is that the gold surface is more uniform than aluminum, rendering the surface more evenly reflective and hence more error-free. This is a pretty tenuous claim, since the error-correction scheme used in the CD is so robust that even large burst errors can be corrected in stride with no audible effects. Another claimed advantage is the long-term stability of gold as compared to aluminum. We won't know this for several more years, lab tests notwithstanding.

In any event, the sample Ultradisc I received is stunning to look at, and it has program content to match. It is a jazz sampler (UDCD-JS1A) licensed from Cafe Records, with source material going as far back as the mid-'50s. There is beautiful playing by the likes of Zoot Sims, Charlie Barnet, Sarah Vaughan, Maynard Ferguson, Max Roach, and Shelly Manne, and most of the cuts show recording techniques that have stood the test of time.

More vintage jazz is contained in three CDs licensed from the BBC. Volume 1 is titled *New Orleans* (BBC CD 588), volume 2 is *Chicago* (BBC CD 589), and volume 3 is *New York* (BBC CD 590). The titles are largely self-explanatory; source material is mostly from the '20s and '30s. The transfers from old 78s have been carefully made, and the pseudo-stereo processing is pleasing enough. (Those who do not care for such embellishments can operate their preamps in mono mode and effectively recover the original sound.) Highly recommended for old-time jazz buffs.

For jazz diehards, there are two interesting documentary releases. Old rehearsal tapes of Billie Holiday, recorded in Las Vegas in the early '50s, give an interesting picture of the artist both in conversation and song (*Billie Holiday in Rehearsal*, MFCD 840). Max Roach and Clifford Brown are presented in pretty good mono sound from the bebop era of the early '50s. These performances have not been previously released, and the playing is first rate (*Daahoud*, MFCD 826).

Mobile Fidelity's reemergence is based not so much on technology as on marketing expertise. They have recently entered into an agreement with the Melodiya Record Company of the U.S.S.R., and they are currently issuing titles from that company's archives.

I received two items in the Melodiya series. The more interesting of these is a recording of Rachmaninoff's *Symphonic Dances for Large Orchestra, Op. 45* (MFCD 858). The performance is by the U.S.S.R. TV and Radio Large Symphony Orchestra, conducted by Vladimir Fedoseyev. Neither orchestra nor conductor is known to me, and the ensemble tends to make up in brio what it lacks in finesse. The recording is excellent; however, the total playing time of 35 minutes falls way short of expectations for a CD.

The other Melodiya release is a double CD set of *Popular Symphonic Pieces by Soviet Composers* (MFCD 2-862). The Bolshoi Theatre Orchestra is conducted here by Mark Ermler. The fare is largely taken from film and ballet scores by Prokofiev, Khachaturian, Shostakovich, Shchedrin, and others. Much of the music is spotty, and the playing, I am sorry to say, is pretty bad.

My recommendation to Mobile Fidelity is that they proceed with the best artists and the best repertoire guidance they can get in their relations with Melodiya. What is needed to make the project a success is selection of top-rate artists and music, of which there are plenty. Both Melodiya releases include notes in English and Russian.

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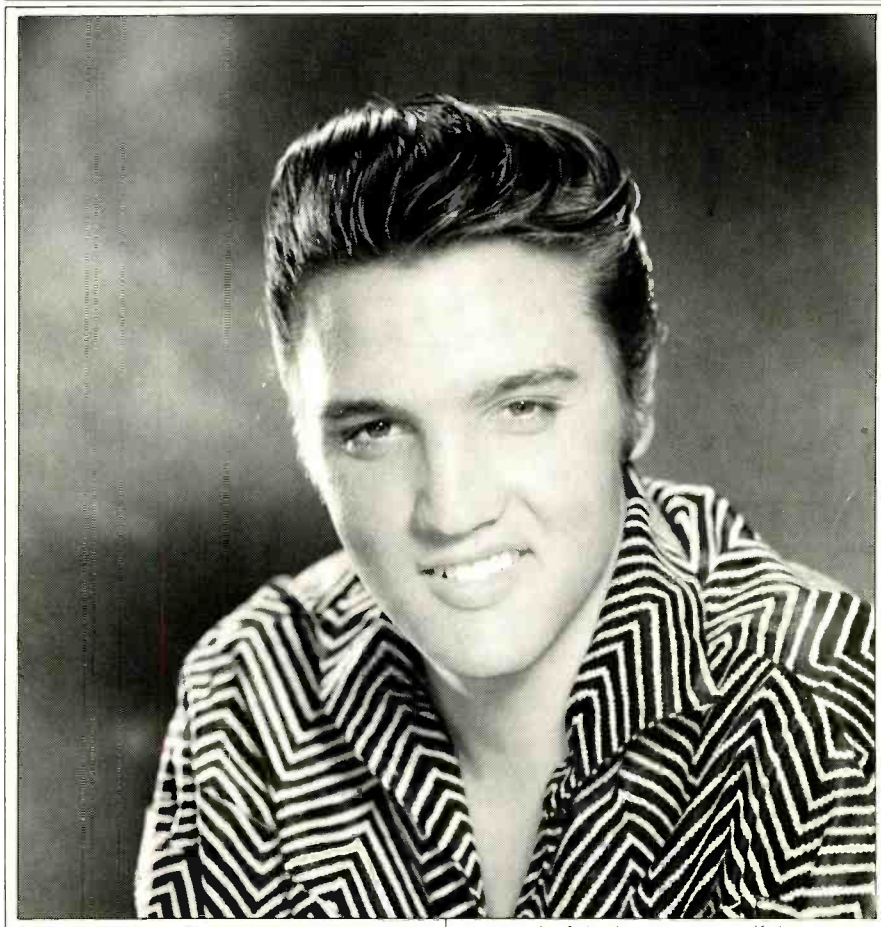

The Top 10 Hits: Elvis Presley
RCA 6363-2-R, two-disc set.

The Sun Sessions CD: Elvis Presley
RCA 6414-2-R.

The Memphis Record: Elvis Presley
RCA 6221-2-R.

With the 10th anniversary of Elvis Presley's death, RCA has released a new batch of Elvis repackages. This is something they have done time and time again. However, this bunch was put together especially with the CD in mind, and there is some swell stuff here, even if a lot of it is pretty familiar.

The Top 10 Hits is a double CD set of the 38 Elvis songs that reached *Billboard*'s Top 10. From 1956's "Heartbreak Hotel" to 1972's "Burning Love," this set is packed with gems. Hindsight may tell us that some of these songs are pretty dumb ("Bossa Nova Baby," to name one); however, what is really important is how bright Elvis' charisma still glows. And he was, undisputedly, a wonderful singer, even if he never wrote a song.

These songs have been heard millions of times, but they have never sounded better than in this digitally remastered collection. Annotation gives the recording date and highest chart position for each cut. One quibble: There should have been more listings of sidemen and studios; the information is readily available. Still, the super sound makes *The Top 10 Hits* especially valuable. (Incidentally, if you take your Elvis in smaller doses, there is an alternate, one-disc version of *The Top 10 Hits*, which includes only those songs that made it to number one. Not surprisingly, it's called *The Number One Hits*, RCA 6382-2-R.)

Two other releases capture Elvis at critical junctures of his career.

As everyone knows, it all began for the Big E with his Sun Records sessions of 1954 and 1955. These are all brought together on *The Sun Sessions CD*. Here we have the teenage Elvis Presley searching for a sound to call his own, in blues like "That's All Right Mama," "Milk Cow Blues Boogie," and "Mystery Train"; in country balladry like "Blue Moon" and "I Love You Because," and in such flat-out rockers as "Good Rockin' Tonight," "Baby Let's Play House," and the legendary, souped-up "Blue Moon of Kentucky." This is history in the making as Elvis, Scotty Moore, and Bill Black permanently alter the face of pop music.

This CD includes all the legendary master takes, 12 outtakes, and various alternate takes. These last are particularly fascinating because you can hear the creative process at work, complete with snippets of studio patter. The alternates of "Blue Moon of Kentucky" and "That's All Right" are good, but they clearly lack the fire of the versions that were released. The alternates document the changes that "I Love You Because" and "I'm Left, You're Right, She's Gone" went through on the way to being a finished product. Not as many alternate takes are included here as on the two-LP *Complete Sun Sessions* (a consequence of limiting this release to a single CD). But the meat is in the masters, and they are intact. Spiffed up with CD sound, *The Sun Sessions CD* is sensational, even if the outtakes and alternate takes are more for the fanatic than the casual fan.

By 1969 Elvis had hit hard times creatively. He hadn't had a Top 10 hit since 1965's "Crying in the Chapel," which actually was a 1960 recording. So he made the decision to return to Memphis to record again—the first time since the Sun days that he had recorded there. These sessions are documented in the 23 tracks of *The Memphis Record*.

Sure enough, Elvis sings here as if he has something to prove, on cuts that are deeper and darker than he had ever recorded before. Let's face it: "In the Ghetto," "Suspicious Minds," and "Only the Strong Survive" are a long way from "Hound Dog." He really cuts loose on such blues as Percy Mayfield's "Stranger in My Home Town" and "Long Black Limousine." The songs in these sessions demand maturity, and Elvis delivers, putting more pure heart into them than you can find in nearly all his other work. Even the band sounds especially

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I don't know about ECM's other discs, but these two are extremely dreamy, their pace ranging from adagio to a standstill.

charged up. It adds up to a 73-minute portrait of an artist on a mission. All of the LP *From Elvis in Memphis* is included, but there is more as well. *The Memphis Record* is a fascinating document, and I highly recommend it.

Master archivist Gregg Geller, who treats Elvis reissues with the respect his legacy is worthy of, deserves a lot of credit for assembling these collections. Alas, Geller has since left RCA, so these are likely to be the last Geller compilations we will see. Annotator Peter Guralnick also deserves credit for the super essays he wrote for the Sun and Memphis sets. They are great reading, and they make the sets they accompany that much more valuable.

Michael Tearson

Romances and Elegies for Viola and Piano. Kim Kashkashian, piano; Robert Levin, viola.
ECM 1316 (827 744-2).

Gavin Bryars: Three Viennese Dancers. Arditti String Quartet; Pascal Pongy, horn; Charles Fullbrook, percussion.
ECM 1323 (829 484-2).

ECM is a label based in Munich, but in the usual current fashion its product, both musically and technically, spreads from continent to continent. One of these "New Series" CDs, the *Romances and Elegies*, was recorded

Kim Kashkashian

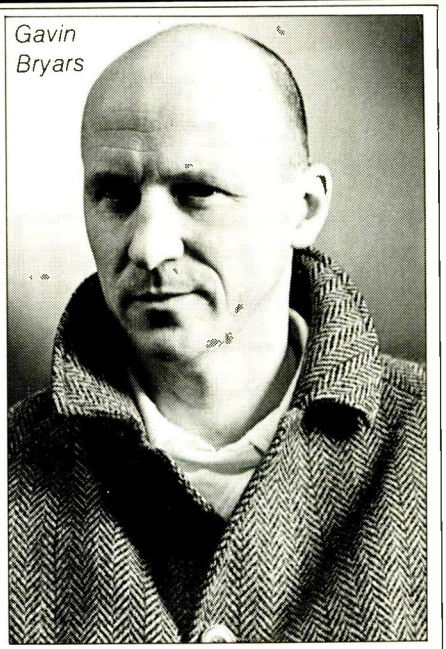
in New York by that familiar super-fi team, Marc Aubort and Joanna Nickrenz (of Elite Recordings); the other was done in the German home territory. Marc Aubort, if I am right, is one of the outstanding proponents of high-quality analog recording in these digital times. His disc is marked here as ADD—an analog original with digital mixing, editing and mastering. You may therefore take this viola/piano CD as an example of state-of-the-art analog, recorded only last year, well into the digital era.

As for the Bryars recording, it is marked clearly as AAD—an analog original and analog editing before the CD; however, just above the AAD symbol are the words "Digital Recording, February 1986." You figure it out for yourself.

I do not know whether ECM has other music which moves at a reasonable pace, but these two are the dreamiest recordings yet, ranging from adagio to a dead musical standstill.

I liked the viola recording, which in earlier days would have been called a recital, with all the music for one instrumental combination. I fear it is intended, on records, as a kind of mood music; it is better than that, in spite of the prevailing slowness and mostly dreamy quality. The composers range widely, beginning with Benjamin Britten (the biggest piece, and I think the best). Then there is Britten's soul-mate Vaughan Williams; it is surprising how closely the works of these two Englishmen mesh together when performed in sequence. Then it's on to Elliott Carter (a piece surprisingly mild, for him), Glasunow, an excellent bit of Liszt, Kodaly, and Henri Vieuxtemps. The latter's "Elegie," the only selection with a certain amount of terminal vivacity, brings the CD to an end (and maybe wakes you from your reveries). Robert Levin is not of the "cold in the nose" viola school of past generations; he plays smoothly and with grace, aside from a few high tones. Kashkashian plays the piano parts with a big sound, but it is kept discreetly just subservient to the viola, a very proper balance for this sort of music. (On stage it corresponds to a grand piano with the lid only partially opened.)

As for the *Three Viennese Dancers*, this is new music that comprises

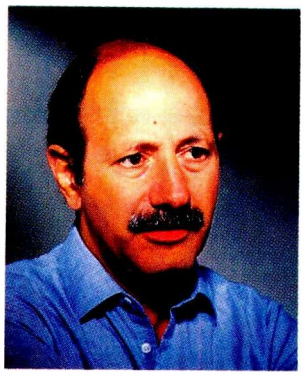


Gavin Bryars

French horn, an assortment of languidly played percussion, and a string quartet using RAAD instruments, which are said to combine the virtues of electric and acoustic violin. The title is symbolic, merely citing the presence of three famous dancers in Vienna on a certain night in 1906—there is no dance in this music. It is all slow, abysmally slow, *incredibly* slow, without the slightest relief of any impact. Hypnotic? You may well think so. As for me, I could only recall the very early days of tape music—"musique concrète"—those eerie, mournful, wailing sounds that came before synthesizers appeared, made out of "real" or concrete noises from such sources as factory machinery and reversed pianos, all done by simple hand-editing and copying. Another example, I marvel to see, of sounds that once were tape, and thus audio, now reappearing in the form of live music performed by real-time players.

I suppose we must always have, in a time of quick change, composers who industriously develop new techniques at the expense of real *musical* interest. The techniques here are fabulously advanced, as described by the composer himself. The content I found very slight, not trivial but with little to say. And at such a slowness! I longed for a minute of disco, right in the middle.

Edward Tatnall Canby



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Andy Petite, chief designer, Boston Acoustics

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"What we've accomplished is no trick. It's knowing what to do, then doing it.

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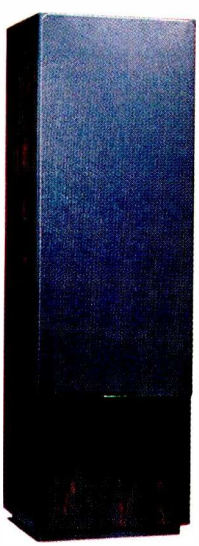

The 3-way T830 Tower System. It needs only 10 x 9¾″ of floor space, only 32″ in height. Suggested retail: $480 a pair.

Boston Acoustics

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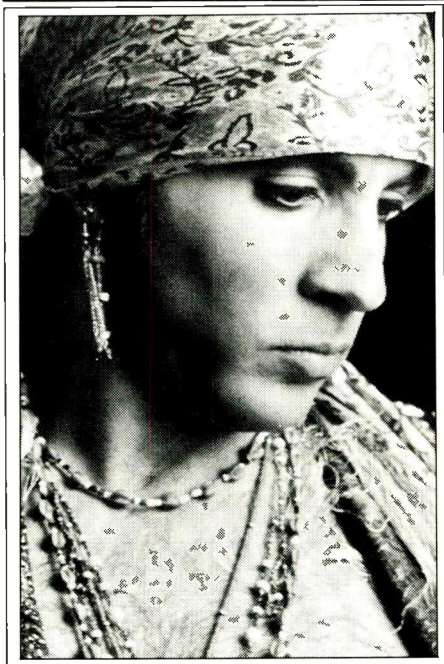
Little Steven's latest has guitars that are big and warm and powerful. It's terrific to hear them blasting out of silence.



ent styles—hard rock, Latin-tinged rock, and reggae.

Freedom—No Compromise follows the path of its predecessor, and that is good . . . and bad. Good because more strong statements need to be made, but bad because the album breaks no new musical ground. The lyrics are saying different things, but they are lying in the same musical beds. It's as if some of these songs had been sitting on the shelf since 1984. Admittedly, the vocal duets with Rubén Blades on "Bitter Fruit" and Steven's former employer Bruce Springsteen on "Native American" add a new dimension, but it's not enough.

Ironically, one of the prime components that should have stayed is missing: The great, loose, live bands gathered for the first two solo releases are gone. These bands are essential to Little Steven's heavily guitar-oriented version of Phil Spector's "wall of sound." Instead we have a somewhat stiff record where the basic drum-machine parts have not been very well integrated into the sound of the live drummers. Possibly adding to the sterile sound is the fact that six recording studios on two coasts were used. (A seventh was the mixing site.)

Despite the seven studios, the final sound quality of *Freedom—No Compromise* is very good. Those of you who believe that rock guitars are better off in a total analog domain will want to hear this album. The guitars are big and warm and powerful but with added signal accuracy. It's terrific to hear those guitars blasting out of the silence of a CD surface. The album was recorded using an analog multi-track master and digital two-track mix.

Freedom—No Compromise is a worthy CD because of its bold lyrics and musical solidity. Its failings are its stiff arrangements that never let the music flow, and its repetitiveness. Next time, Manhattan should increase the recording budget to make possible the use of a full-time band. Also, Little Steven, who produces, arranges, and writes all his material, should seriously consider a coproducer. You sometimes have to forget your ego when you've got this much to say. *Hector G. La Torre*

Tribute: Ozzy Osbourne and Randy Rhoads
CBS Associated ZGK 40714.

Sound: B+ Performance: A

Death at an early age—a hazard of the rock life—was the straw drawn by 25-year-old Randy Rhoads when his plane crashed in 1982, cutting short the brief career of one of the most influential guitarists in rock history. Now Ozzy Osbourne's *Tribute* to his friend and musical collaborator gives us a moving glimpse of Rhoads' massive talents in concert during 1981's Canadian tour, the last to be recorded before his death.

Tearing through songs which represent Ozzy's main lyrical themes (self-satire and indictment of a world gone mad), Rhoads makes his ultra-smooth, fat-toned fretwork the star. (Also noteworthy is Tommy Aldridge's drum solo on "Steal Away.") Most of the time, Rhoads impressively reproduces his now-classic studio lines with only minor variations, although occasionally he cuts loose with scalar flights of fancy, as on "Suicide Solution." "Crazy Train" contains *the* '80s metal solo, and the program ends with a wonderfully intimate acoustic studio outtake.

Unfortunately, the overall sound is not the best (the CD is *far* better than the LP), but care has been given to highlighting Rhoads.

In his short life, Randy Rhoads achieved a stature on his instrument which places him up with Eddie Van Halen and right under Jimi Hendrix in the rock guitar pantheon. *Tribute* is a valuable memorial to a musician of almost mythic proportions.

Michael Wright

Collection: Richie Havens
Rykodisc RCD 20036.

Richie Havens Sings Beatles and Dylan
Rykodisc RCD 20035.

Richie Havens has a chicken molé kind of voice. It has a rich, chocolatey texture without the sweetness of syrup or candy. Its smooth darkness bears an unforgettable meaty tang. His is a voice of substance, a voice to be reckoned with.

You may know this voice from the '60s, when it seasoned folk songs and literate pop songs with its distinctive, smoky flavor. Or you may know it as the voice propelling Amtrak commercials across your TV screen. If your experience is limited to the tube and the train, you're in for a treat. If you were a fan in the '60s, you're in for an all-out feast.

Rykodisc recently released two comprehensive CDs of Havens material. One is a mixed bag of older tunes, many of them familiar titles even if you


Ozzy Osbourne

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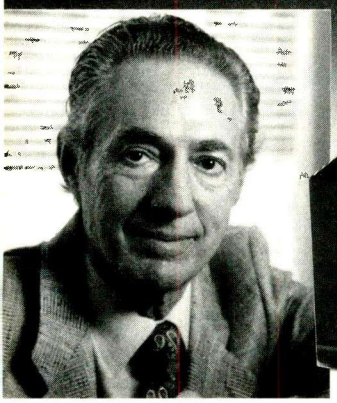

*—**Leonard Feather,** Celebrated Jazz Critic for the L.A. Times, Washington Post News Service and Author of many books including "The Jazz Years—Earwitness to an Era."*

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With ease and assurance, Richie Havens' smooth voice rides the rhythmic waves set up by his own speed-strummed guitar.

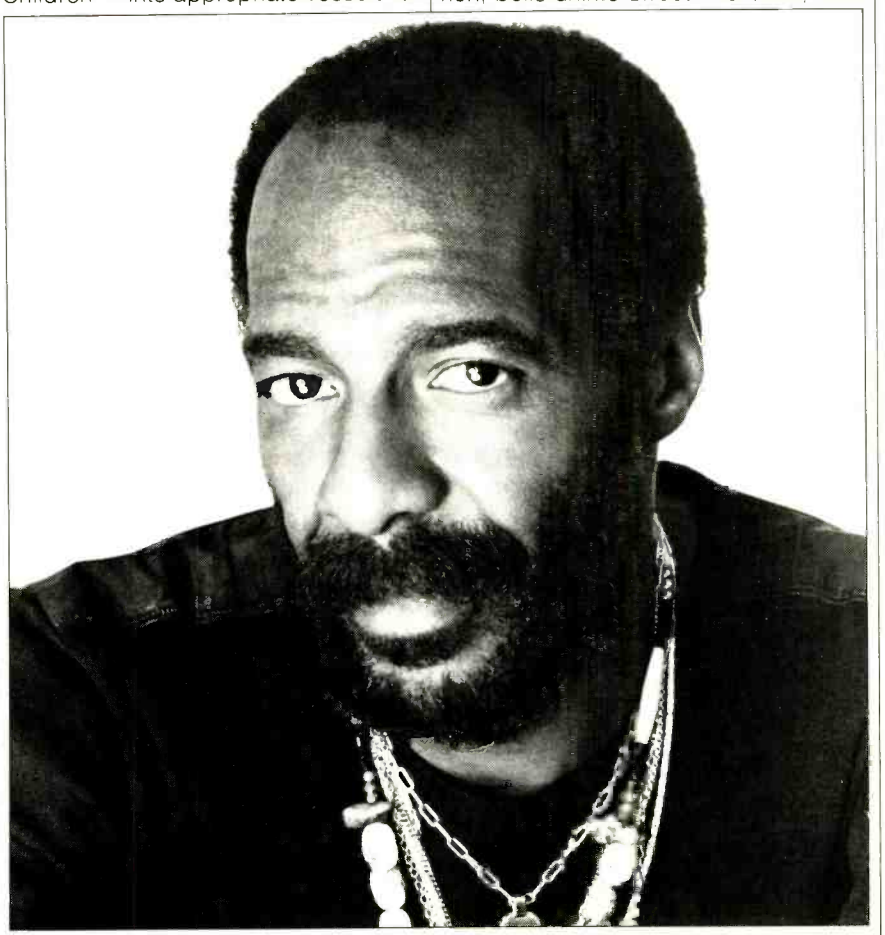
haven't heard his versions. The second is a collection of Beatles and Dylan material, songs strongly associated with Havens in the past, here reworked for the '80s.

Collection features 17 gems, all with the heft and shine of timeless treasures. The opener, "Woman," is full-tilt Havens. His own speed-strummed acoustic guitar sets up rhythmic waves that his voice rides with ease and assurance. Recorded front and center, his singing takes over the foreground, leaving the full instrumental arrangement to serve as an unobtrusive support in the background. This is a Havens original, as are six other cuts.

The singer's performance of other artists' songs has always been idiosyncratic. He molds familiar tunes—among them The Bee Gees' "I Started a Joke," James Taylor's "Fire and Rain," Marvin Gaye's "What's Going On," and Graham Nash's "Teach Your Children"—into appropriate vessels for the dark liquid of his voice. His "What's Going On," for instance, is more solemn and thoughtful than Gaye's sharper, angrier performance, and the tune of "Fire and Rain" is almost impossible to discern in the first few moments of Havens' version. Highlights of this disc are the beautiful, bluesy "San Francisco Bay Blues" and the frenzied "High Flying Bird."

The sound is excellent. Instruments are clean and clearly defined in space. Separation is good. Although some (if not all) of these cuts are analog recordings, only one—"It Could Be the First Day," which is afflicted with tape hiss—shows any sign of age.

The second disc, *Richie Havens Sings Beatles and Dylan*, features utterly splendid sound and arrangements that occasionally go beyond idiosyncratic all the way to quite peculiar. Technically, the sound reproduction is faultless. Bass notes are full and rich, bells chime sweet and clear, and certain percussive effects are so realistically compelling that my three normally blasé cats woke abruptly from catnaps with ears perked and eyes searching the speakers for the living source of their disturbance.



These songs are Havens hallmarks; his "Here Comes the Sun" made the Top 20, and Bob Dylan himself told Havens that the singer's version of "A Hard Rain's Gonna Fall" was the best he'd ever heard. However, most are reworked with odd synthesizer, electric keyboard, and percussion arrangements that shake up our easy familiarity with these old favorites. For instance, the beautiful, melancholy "Long and Winding Road" displays strange percussive effects reminiscent of bamboo poles or plastic bones rattling in the wind, an effect which also appears in "Eleanor Rigby." Sometimes the emotional tone seems off kilter. An angry, defiant song like "Working Class Hero" gets a fairly mild-mannered delivery, while the tongue-in-cheek "Rocky Raccoon" gets a rather serious, straightforward treatment that misses the tune's inherent lightheartedness.

Havens, however, is splendid throughout, his voice going from smooth and mellow to ragged and bluesy, from quiet and introspective to rockin' and rollin'. *Richie Havens Sings Beatles and Dylan* is a strange album, but always intriguing. *Paulette Weiss*

Let It Loose: Gloria Estefan and Miami Sound Machine
Epic EK-40769.

Sound snaps out of this Compact Disc like the crack of a whip. Crisp and sharp, with a bite that leaves its mark, the production on the new Miami Sound Machine CD, *Let It Loose*, is about as good as it gets.

Correction: This is the new *Gloria Estefan* (in large type on the disc jacket) and Miami Sound Machine (small type) recording. Now, I have nothing against Gloria, who is a pretty terrific singer and quite possibly the driving force behind the Machine. It's just that the stars of this disc actually are the magnificent sound and the bubbling-hot arrangements, heavy on percussion and laced with horns. I dunno, Gloria . . . . It seems just a little unfair.

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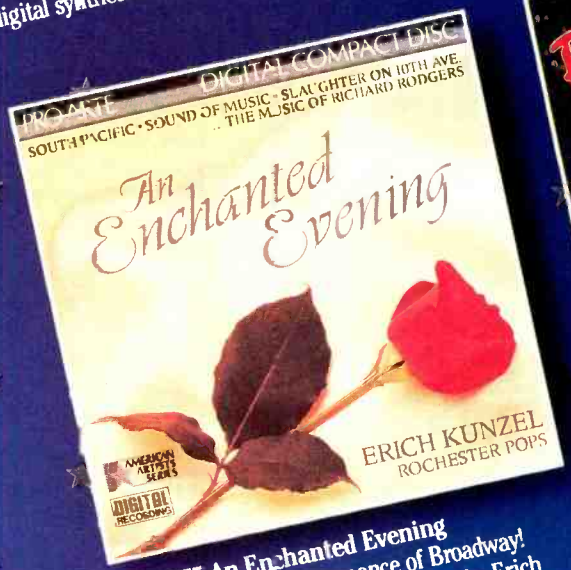

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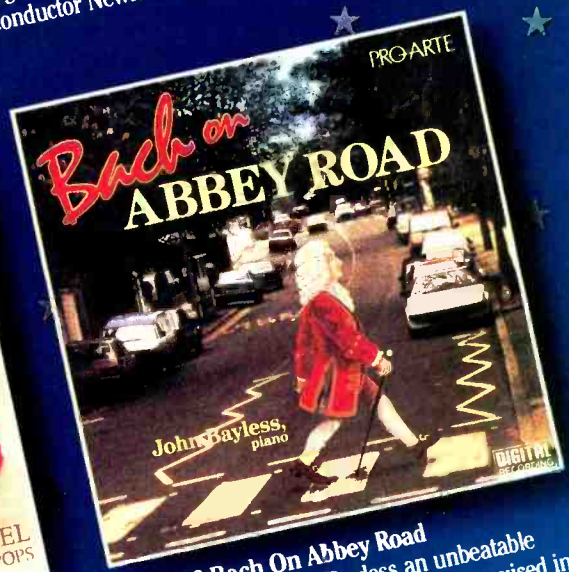

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Though Gloria Estefan is a great singer, the real stars are the magnificent sound and hot arrangements.

Doesn't the Machine at least deserve *equal* billing?

But I digress. The disc is a knockout, as was the Machine's first. The expert blend of ultra-modern synthesizer with hot Latin percussion and horns gives *Let It Loose* a distinctive and exciting sound. Every cut is rich with texture. The opener, "Betcha Say That," one of the album's several chart hits, starts with a reversed electronic "whoosh" followed by crisp handclaps, sharp percussion, blaring, brassy horns, and clear, smooth bell notes. Over all of this, Estefan's voice rides in the foreground, clear and strong and self-assured. The space between each element is clean and defined, providing admirable clarity. This style of arrangement, a kind of open-stitched sound weave, is characteristic of all the uptempo cuts. Slow numbers tend to have a softer blend. "I Want You So Bad," for instance, features a solid synthesized wash of orchestral electronics behind Estefan's lead vocal.

The songs themselves are uniformly good, although none has the wallop of "Conga," the fiery, full-speed-ahead cut that powered Miami Sound Machine's previous album. "Rhythm Is Gonna Get You" is the second-generation attempt to clone "Conga." It is remarkable but definitely lacks the electrifying exuberance of the group's first big hit.

For the record, the splendid production is by Emilio Estefan, Lawrence Dermer, Joe Galdo, and Rafael Vigil. The latter three members of the production crew also wrote most of the material, and Dermer and Galdo arranged all the songs except "Anything for You." Only Emilio is a member of the performing group. Maybe *these* guys should get top billing.

Paulette Weiss

A Decade of Steely Dan
MCA MCAD 5570.

Sound: A– Performance: A–

Steely Dan and the Compact Disc are a match made in audiophile heaven. It's a meeting of two perfectly complementary kinds of perfectionism: The CD's sound fidelity and the Dan's meticulous performance.

Just about all of the subtleties of Steely Dan's music were quite audible

on their LPs. Conversely, very little got on unintentionally—there were no accidents, and hardly any ambience, tone, overtone, or inflection that wasn't intended. Now that the sound is even clearer, no new levels of musical meaning emerge; no new ambiguities or imperfections show up, either. What you *do* get with the additional clarity is the chance to appreciate the full extent of the Dan's perfectionism, which is most mind-boggling on the most nearly perfect tracks like "Peg," "Rikki Don't Lose That Number," and "Do It Again." The tiny fraction of auditory information that you couldn't hear on the record turns out to have been just as perfect as everything you *did* hear.

A good example is Donald Fagen's double-tracked lead vocal on "Do It Again." You hear one vocal in each ear, and though the unison is fantastic, the tonal shadings and inflections of the two performances are slightly different, and they're treated slightly differently in the engineering process—or is it your ears, or the hemispheres of your brain? The distinctions you're led to make are so fine that questions arise concerning the nature of perception.

Even the heart-stopping, cliffhanging silences prove to be subtly complex. Just before the punchline "FM" in the song of that name, the silence, which is the silence of a room about to explode, contains the electronically sustained ghosts of the multitude of sounds that abruptly peaked—and vanished.

The Dan began their career maintaining a mysterious silence about which band member or hired gun contributed which astonishing performance to their recordings. Their move towards full disclosure on later albums was gratifying, but that still didn't answer those nagging questions about the earlier LPs. So the extremely detailed liner notes included here are of considerable significance. To those who spent—as some of us did—long hours patiently piecing together the clues, the most surprising fact to come to light is that a lot of that amazing virtuoso guitar is played by none other than the Dan's own Walter Becker. In a way, it's yet another example of how this Compact Disc adds to one's respect for the achievement of Steely Dan.

Susan Borey

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MICHAEL TEARSON
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Bad: Michael Jackson
Epic OE 40600.

Sound: B+ Performance: A

Although inevitable, it's really unfair to judge *Bad* against *Thriller*, an extraordinary album that came along at precisely the right moment to rocket Michael Jackson onto a rather dangerous pedestal. After an unprecedented oversaturation with both the man and his music, we find Jackson facing a twin challenge: The public demands not only that he top himself artistically, but also that he give them a new image to adore (and eventually to discard).

Bad complies with neither demand, but so what? It is masterfully crafted and brilliantly executed music, full of emotion. The production, controlled by Quincy Jones and Jackson, is not so much slick as sparkling, with each sound having maximum punch and presence. Percussion-intensive, the 10 songs hop along on a framework of synthesizers and metallic punctuation that always manages, somehow, to have a *warm* edge.

The best songs are the ones that rely on grooves for momentum. The ballads, although giving Jackson a little more room to stretch out vocally, tend to fail when they become too feathery and ethereal. But the grooves, pounded out by a crack collection of session players "helped out" by Stevie Wonder, percussion wizard Paulinho da Costa, and The Andrae Crouch Choir, grab you like skin-tight leather.

Both "Dirty Diana," a serious jab at vampiric groupies which is whipped into high gear by Steve Stevens' scathing guitar, and the title track, which features Jimmy Smith on a satiny Hammond B3 organ, are as compelling and insistent as anything you'll find in pop. The vocals and percussion on "Speed Demon" swoop and carom off the beat like a small roller coaster. The biggest surprise is the strong contribution from songwriting newcomers Siedah Garrett and Glen Ballard, whose "The Man in the Mirror" shines with the best lyrics on the album.

Alongside the sterling production and performances, Jackson's own lyrics, which are not consistently powerful or even inventive, become the album's weak link, but only in a sense. They are, after all, the vehicle for his voice, which has developed into an even more versatile tool. Whether he nails a note or toys with it by shrieking, whispering, crooning, whooping, or sighing, it's obvious that Jackson is in control, and that he loves to sing.

Susan Borey

Recently: Joan Baez
Gold Castle 171 004-1.

Sound: B Performance: B

Recently, the first new Joan Baez album in quite a while, is a nervy piece of work yet thoroughly in character for this singer. Several of the songs are quite well known in their original versions, but Joan can still put something fresh into them. Her excellent performances of Dire Straits' "Brothers in Arms," U2's "MLK," and Peter Gabriel's stirring "Biko" are all strong examples of this, as Baez's passion suffuses her readings. Jimmy Webb's "The Moon Is a Harsh Mistress" does not fare as well, because Baez simply overpowers the song. Her own compositions, "Recently" and "James & the Gang," are as disarmingly candid as we have come to expect from her confessional pen. Fine performances, too. "Do Right Woman, Do Right Man" is riskier than most, with Baez singing the first verse a cappella before settling down a notch as the band kicks in.

The album's sequencing does not entirely work. For instance, "Do Right Woman" seems out of place between the political "MLK" and "Biko." On the other hand, the live recording of the spiritual "Let Us Break Bread Togeth-

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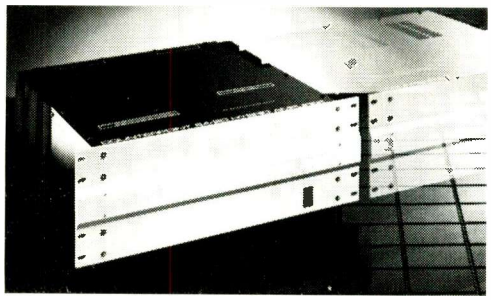

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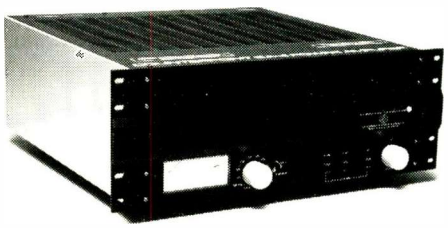

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Tom Verlaine's minimalist orchestration complements his introspective verse, and the effect is often chillingly beautiful.

chaps who don't use synthesizers to get you moving. Devilishly clever, as Daffy Duck used to say. The instrumentation and Ken Foreman's lead vocals are offbeat without being off-the-wall, and the cast of characters is a riot. Thrashing Doves isn't Warren Zevon—no headless Thompson-gunners here—but they do give us "Jeu on the Payroll" and a bourgeois-bombing demolition man who "reminded me of old Guy Fawkes." Sprightly and danceable, though with occasional bits of melodic monotony, *Bedrock Vice* is great fun. I haven't the vaguest idea what the title means, though.

Frank Lovece

Flash Light: Tom Verlaine
I.R.S. 42050.

Sound: B+ Performance: A

Jagged angularity has always marked Tom Verlaine's original style, and you'll find it deeply etched into the little epiphanies of *Flash Light*.

Nestled into sparse, chiming arrangements, Verlaine's cryptic lyrics are like a poetic strobe light freezing moments of found art into precious miniatures: Snatches of conversation ("Say a Prayer"), a letter ("The Scientist Writes a Letter"), rumination ("The Funniest Thing"), a girlfriend's poem ("One Time at Sundown"). Thank you, I.R.S., for printing the lyrics on the sleeve.

Verlaine's minimalist orchestration complements his introspective verse and is often chillingly beautiful, as in the trills embellishing "Song." With only the briefest of solos, his spidery guitar

The intimate tracks on the late Steve Goodman's *Unfinished Business* sound terrific, far more charged than the produced ones.

crawls just behind the vocals, which at times move intimately from sung to spoken.

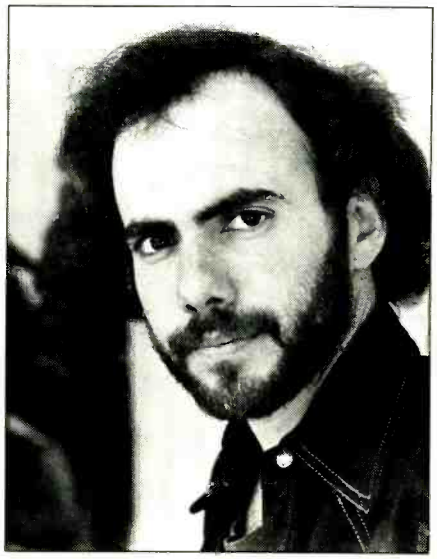
Flash Light illuminates our everyday world with an intelligent vision all too rare. This is good art. *Michael Wright*

Unfinished Business: Steve Goodman
Red Pajamas RPJ 005. (Available from Red Pajamas Records, P.O. Box 36E77, Los Angeles, Cal. 90036.)

Sound: B– Performance: B–

Unfinished Business from the late Steve Goodman is a loving tribute, an album that provides a glimpse into the creative process of a wonderful man and performer.

The best tracks are the four simplest ones. These include "A Fool Such as I" and "God Bless Our Mobile Home," both duets with Goodman's good buddy Jethro Burns, recorded at radio station WFMT. Listening to them, I can almost see the devilish twinkle that



would light up Steve's eyes when he was playing with somebody particularly hot. Other highlights are a magical, live solo recording of "The Dutchman" and a lovely, bittersweet solo of "My Funny Valentine," recorded in his manager's office. It closes the album most appropriately.

The other six cuts are assorted studio leftovers, mostly demos of songs Steve was working on when he succumbed to leukemia in 1984. These are not the best he ever did, but they are warm songs that range from the spunky, funny "Don't Get Sand on It" to the wistful lament of "Whispering Man" to the romantic heartbreak of "Mind Over Matter."

Some of the produced tracks sound a bit raw and, not surprisingly, unfinished. Still, the sound is more than serviceable. And except for the very rough recording quality of "My Funny Valentine" (which is, after all, virtually a field recording), the more intimate tracks sound terrific, far more charged than the produced ones.

Unfinished Business is not the best Steve Goodman album. But it shouldn't be; there would be no justice in that. *Michael Tearson*

EDWARD TATNALL CANBY

CHRISTMAS PRESENCE

Illustration: Rick Tulka

Christmas at the Church of Saint Luke in the Fields. Saint Luke's Choirs; William Entriken, organ.
Classic Masters CMS 1006. Available from Classic Masters, 426 Henry St., Brooklyn, N.Y. 11231.)

Saint Luke's is a not very big brick church in lower Manhattan that was originally built in 1821, in what is loosely called the Federal style. Semi-Georgian outside, replete with white and brass and round arches inside, it does not need to proclaim that it is Episcopal of the highest sort; it simply looks it.

I lived just around the corner from Saint Luke's for a year during World War II. I quickly discovered this little gem of an architectural wonder just out of sight of my window, and often went to walk about it. Definitely a church one could not forget. In 1981 the whole place burned down, except the tower and three blackened walls. In a short time, thanks to gifts that poured in, the building was on the way back, and after four years it was restored.

This is an out-and-out Christmas recording from the cover on in, but no need to put it into a special category, because the music is good—varied, interesting, and well performed with taste. The atmosphere is authentically Anglican, even though the music may be French, German, Austrian, or American—very typical of the Anglican persuasiveness in the mother country. All the words, of course, are in English, except for some church Latin. And the sound of the choir, all-American, has a goodly portion of that English character one hears overseas or on the telly.

This is a well trained choir, very accurate in pitch and excellent in its phrasing and breathing. It is not boisterous and loud like some of our more enthusiastic American choirs in other churches, but rather a bit on the reserved side, at its best in the gentler music. There are works by Bach, Mozart, Fauré and Pachelbel, American carols and spirituals, and a few well-chosen solos for voice, for organ, and for organ and harp. A brace of continental carols include one arranged by Brahms. There is also "Silent Night" in three different versions and an unfamiliar "O Come, All Ye Faithful" to round out the Christmas spirit. And, perhaps, please the summer listener as well.

In 1979 the old church installed a brand-new "classic" organ by Casavant, from Quebec. Artfully tailored with mechanical key action but electrical stops (a major aid to the performer, whose hands were already busy on several keyboards), that organ was destroyed in the fire. An almost exact replica was installed, and it is this second organ you hear on the record, an "old" organ in its bright colors and presence but somehow also a very English-sounding instrument, seemly and respectable, never strident.

The album was produced, recorded, and edited by Christopher Greenleaf. The continuity he achieves between works, notably in the pitch matching, is excellent here, where in many such records the tape editing is all too apparent. Interference from New York City traffic is minimal—inside, Saint Luke's still sounds as though it is "in the fields," as it once truthfully was.

John Adams: Harmonielehre. The San Francisco Symphony, Edo De Waart.
Nonesuch 79115-1, digital.

John Adams, still remarkably young, is of a new generation taking off in a traditional vein from the well-known music of the minimalist school—a format that is always intriguing for audio people because it started as tape music, back with Steve Reich's early experiments in endless tape-loop repetition with gradual change. Adams, however, is going far afield from the minimalist base into a much larger synthesis of older and more disparate styles.

Though this curious process has living acoustic-instrument players producing sounds that often seem electronic, Adams is adding an equal retrospect back into the much larger historical past before there was any audio. That's what the music in this recording is all about. It is a big piece, two LP sides, for large "conventional" orchestra in a concert-hall space, with a conductor up front (and perhaps a few synthetic sounds here and there too). You'll hear echoes of everything you know since Beethoven. In particular, there are strong sounds of Mahler, Schoenberg, Debussy, Stravinsky (early), Bartók (late)—the gamut of recent giants. And Sibelius! His influence above all can be heard here, and Adams has a very perceptive understanding of that composer's special way with late-Romantic music. Sibelius' stock is going up today as we discover in him things that only now gibe with our present way of thinking,

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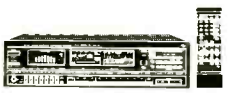

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things that were not apparent to the listeners of his day.

Can you enjoy Adams? Yes, if you can accept a somewhat bloated seriousness. Young composers these days go in for the biggest and the mostest as a matter of course; only in later years do they come to a feeling for economy! This piece, quite recent (1985), is so imposing, so enormous in sound, that Tchaikovsky is made lean and stripped down in comparison. Very neo-Romantic—and minimalist only here and there.

Adams is no climber toward the popular audience, as some other minimalists have definitely been—if with success. This piece will never hit the classical charts. But it is solid, and it is honest. You could like it a lot.

As to audio, you may guess that the Adams sound for the mikes is like that of the big-time past. Full-bottomed, thick, not really easy to record, with very few "hi-fi" effects, though there is plenty of sonic variety. Surely an important step in the direction of synthesis, bringing the abundant past into touch with present new music.

The Long Island State: The Old Bethpage Singers. (Available from The Old Bethpage Restoration Museum Gift Shop, Round Swamp Rd., Old Bethpage, N.Y. 11804.)

Local LP initiative is one of the most heartening aspects of audio in the last 35+ years. This one is typical—there is no "label" or record company, just the name of a sponsoring outfit (which at least had the sense to put its address on the album—many don't). And yet it is a first-rate, professional production, technically on a par with any "biggie" label. Both the audio production and the album itself are expertly and attractively set forth, with notes and color photos.

Old Bethpage, on Long Island, is one of those mannered restorations complete with antiques, refurbished old houses, crafts, lots of people decked out in period costumes, and, in this case, The Old Bethpage Singers. The music they perform on this disc (19th-century American songs) is lively and amusing, if not exactly on a Beethoven level. The performance is largely modern—but how can it be otherwise?—and might surprise the folks of 1820 or 1850, who most assuredly did it differently, but who cares? The spirit is right, and the feeling is definitely historic. After two sides of this Americana, I was impressed. It does have a real flavor and persuasiveness that makes you think. This is how it was.

We have to remember, of course, that minus audio, early Americans of the middle and upper classes had a remarkably vague and sketchy idea of cultivated music of the European sort. You can hear this in the works of William Billings of Boston (not on this record) and many another of the Revolutionary era, a European sound but full of crudities, strong in their way. Some of that is on this disc. Folk music was not recognized as it is today, but it

clearly also influenced the "European" music we tried so hard to cultivate.

From around 1830 on, when we began to develop "real" Western music with correct harmonies and few of the earlier bizarre sounds, America became increasingly proud of what, by European standards, was pretty provincial stuff. Still, real geniuses did appear, and two are on this disc: Lowell Mason, the early hymn writer, and Stephen Foster, whose genius for melody could stand next to Schubert's. No wonder "singing societies" proliferated to produce these delectable sounds, unheard-of before!

Play through the Old Bethpage recording and you will get a real sense of this all-American development, with a special emphasis (of course) on Long Island. Listeners to this group's live performances on Long Island must get the same.

Boléro: The London Symphony Orchestra, Yan-Pascal Tortelier.
JEM Classics JC 101, digital.

The label under which this LP has been issued, JEM Classics, brings to mind those "gems" of this and that lightweight music that were often released in the heyday of the early 78 record—Gems from Great Opera (three minutes long!), Gems of the Symphony, and so on. Pleasant and harmless tidbits, taxing the brain not in the least. The LP record brought not only much greater length and bigger sounds but, as we know, a greater musical sophistication to millions. The "gems" still persist in various theme music and mood recordings, but now we need to keep an eye and an ear on them. Often they include modern gems of good music, very well performed.

So it is here. There are two larger works, at the head of each LP side, the Ravel "Boléro" and the Prokofiev "Romeo and Juliet" ballet suite. Both are given unusually fine performances by the London Symphony. You can forget the rest—the creaky old "Song of India" and an equally flabby item from a late Shostakovitch film score. They're short and expendable.

The key to this LP's value is the London Symphony. Again and again, this orchestra has risen up in high-level performances of music that, for most ensembles, is too overplayed to excite much interest. The orchestra's playing is intelligent, careful, and beautifully styled, with an impeccable ensemble sound—and this under almost any reasonably competent conductor. That's what we have here. (Too bad that JEM forgot to put the name of the orchestra on the record sleeve!)

The digital tape was made in the famed EMI Studios on Abbey Road, once home of The Beatles, presumably by EMI engineers. The sound is excellent with a very big bottom, effective especially in the Prokofiev. The LP pressing/cutting is to be rated as good commercial quality, no more, with some faint edginess and a windy surface noise at the sides' beginnings.

IMPROVISIONS

Photograph: Frank Driggs Collection

Dance of the Love Ghosts:
John Carter
Gramavision 18-8704-1.

Sound: B+ Performance: A–

John Carter is more than a jazz clarinetist, composer, and leader. Like Duke Ellington, Miles Davis, and John Coltrane, he's a conceptualist, an artist with a vision beyond his instrument. Carter's vision has been evolving since the mid-'60s, with now-forgotten albums like *Self-Determination Music*. After a decade of relative quiet, Carter has emerged in the 1980s as a major, if not yet influential, voice in modern jazz composition.

On a series of records for Black Saint and now for Gramavision, Carter has revealed his style of collective improvisation in a structured setting, where solos emerge from the context of his music and do not simply exist as freewheeling virtuoso displays over standard chord changes.

Dance of the Love Ghosts follows last year's successful *Castles of Ghana*. With an expanded group of 11 musicians, Carter recalls the orchestral expanses of Duke Ellington's "Liberian Suite" with melodic interplay between percussion and horns.

Solos spin out like tops in a maelstrom: Carter squeals into the upper registers of his clarinet, cornetist Bobby Bradford leaps with Carter and then calls out a battle clarion, Marty Ehrlich joins the charge on bass clarinet. Bassist Fred Hopkins is a cornerstone to *Love Ghosts*, navigating with deft assurance on the title track or stalking a menacing ostinato on "Journey." And drummer Andrew Cyrille turns in one of his best performances in years, with a steady cymbal ride centering furious volleys and barrages.

Love Ghosts is the third work (*Dauwhe* and *Castles of Ghana* preceding) in a planned series of five recordings that Carter has dubbed *Roots and Folklore: Episodes in the Development of American Folk Music*. It sounds pedantic, and when Carter gives voice to his story, as he does on "The Silent Drum" and "The Captain's Dilemma," it *is* pedantic.

But those are rare moments on *Love Ghosts*, an album that hangs suspended between modern jazz and ancient African music, its sounds ranging from pulsing African rhythms, to the space blues of "Moon Waltz," to Benny Powell's plunger trombone solo on "Journey." While so many jazz artists are returning to their be-bop origins, playing it safe over standard tunes and changes, Carter is exploring the juncture between serious composition and improvisation. *Dance of the Love Ghosts* is an uplifting celebration and one of the best jazz recordings of 1987. *John Diliberto*

Glazed: Earl King and Roomful of Blues
Black Top BT-1035.

Sound: B Performance: A–

Earl King earned his place in blues history in 1955 with "Those Lonely, Lonely Nights," a two-chord ballad of pure New Orleans rhythm-and-blues that sold some quarter of a million copies. Although the singer/guitarist's follow-up efforts never achieved similar success, his reputation nevertheless continued to grow along the Gulf Coast through his work as a session player and distinctive songwriter.

Glazed boasts original material of wit and obvious craftsmanship. King is equally at home with mainstream ballads and with material like "Love Rent," an ode to the cost of young thrills when you're over the hill. His songs are punctuated by deliberate guitar lines that are often reminiscent of a more relaxed Albert Collins.

King is backed by the aptly named Roomful of Blues, a nine-man band whose years on the road have given them a polish and casual interplay that's rarely matched by hastily assembled studio groups. The arrangements are fully developed, and Roomful's bright horn section perfectly cradles King's guitar. This thoroughly professional set does King and New Orleans R&B rare justice. If he were only a more affecting singer, *Glazed* would contend for best blues album of the year. *Roy Greenberg*

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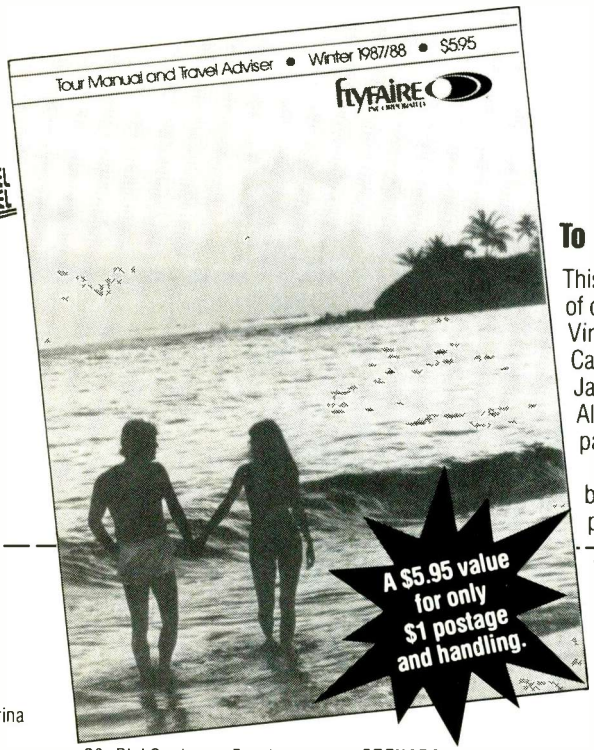

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Jazz and classical Indian music merge on this LP, which features beautifully recorded drums played by Zakir Hussain.

Making Music: Zakir Hussain **ECM 1349.**

Sound: B– Performance: B

Groups like Oregon and John McLaughlin's Shakti have been merging classical Indian music with jazz for years. Indian tabla player Zakir Hussain adds nothing new, but he's no novice at the game. He was doing Indian fusion in the early '70s and was an integral member of Shakti. With McLaughlin on guitar, saxist Jan Garbarek, and Indian flutist Hariprasad Chaurasia, Hussain continues the meeting of jazz and raga forms.

East and West have found a common ground in improvisation, and that's the basis of this recording, on which intuitive interplay revolves around raga forms adapted by Hussain. The title track is an expansive work with a bending, freestyle flute improvisation from Chaurasia. Playing open-holed, bamboo instruments, he elicits subtle curves and glides like tall grass caressed by the winds. The theme emerges, a graceful combination of unison and counterpoint; then, off to the solos.

Each musician emerges from the others, segueing from combinations of duets, trios, and quartets, one picking up the theme of another. McLaughlin returns to his Shakti form, moving from intricate filigree to blistering speed runs, often embroidering Hussain's complex rhythms.

Garbarek's presence is unusually disruptive. The normally sensitive saxist overplays, screaming when a whisper is needed. His prominence in the mix often washes out the interplay of the other musicians. Only on the title track and on "Sabah," where he plays soprano instead of tenor, does he seem to find the slipstream. On "Sabah" he blends like a chameleon with Chaurasia's flute in a unison line, each emerging from the other in solos. It fades out all too fast.

Hussain's drums are beautifully recorded, all their bends and talking murmurs beautifully captured. There is no overdubbing of his playing, but the placement of tablas across the stereo field exaggerates his dexterity, making him seem like a multi-limbed dervish of percussion.

Hussain has kept a loose hand on this record, allowing long passages of improvisation that sometimes work, as on "Making Music" and "Sunjog," and sometimes don't, as on the overlong prelude to "Anisa." He never builds that wild momentum of Shakti, nor the lush colorations of Oregon. But Chaurasia's serpentine flute and Hussain's tablas make this music worth hearing.

John Diliberto

MCMXXXVI: The Classic Jazz Quartet **Stomp Off SOS 1125.** (Available from Stomp Off Records, P.O. Box 342, York, Pa. 17405.)

Sound: B+ Performance: A–

Each of the four players in this fairly new grouping is a seasoned musician who has batted around the world of traditional jazz for many more years than he might like to admit. The only one who has made a name for himself, if you could call it that, is clarinetist and soprano saxist Joe Muranyi, who played with Louis Armstrong's All Stars. The others include cornetist Dick Sudhalter, who also produced the date; guitarist Marty Grosz, who arranged five of the selections and sings on one, and, on piano, the late Dick Wellstood, who on occasion dabbled in the law during fallow periods.

These are not weekend musicians, however. These four have somehow weathered the many storms in jazz, keeping alive a rich and varied past which is all but unknown today as jazz goes further and further out into space.

What this group does is prepare. They think their way through the thousands of tunes (old and new) which present melodic possibilities, and then they set out to extract the essence of those tunes, no matter how unseemly some of them might be. Together they produce a masterly grouping of diverse sounds which might seem impossible with only four players—no bass and no drums, by preference.

From the 1922 Grofé/Whiteman "Wonderful One" to Lerner and Loewe's "Wouldn't It Be Loverly," this unusual quartet shows the extent of its tunesmithing. I can't begin to suggest the subtlety, the time and tempo shifts, the sly insinuating of melody by one instrument while the horns wail away, the riffs, modulations, mutes, and quotes, all done in an inimitable fashion. The sound owes something to everybody who went before this group, but it is uniquely their own. The playing is of quite a high order.

Besides the two already mentioned, selections include "The Mood that I'm In," "Rose of the Rio Grande," "Chloe," "A Melody from the Sky," "Inka Dinka Doo," "Blue River," "Hallelujah," and an original, "Home No More," by Sudhalter.

I think you'll want to hear what these men have done with this somewhat unusual material.

Frank Driggs

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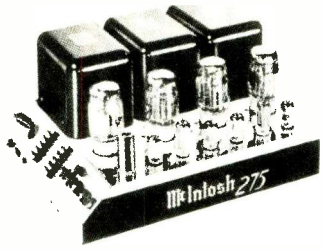

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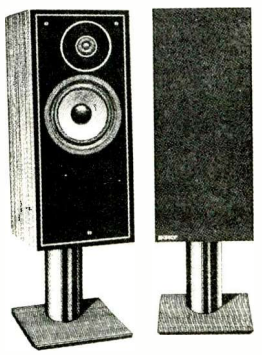

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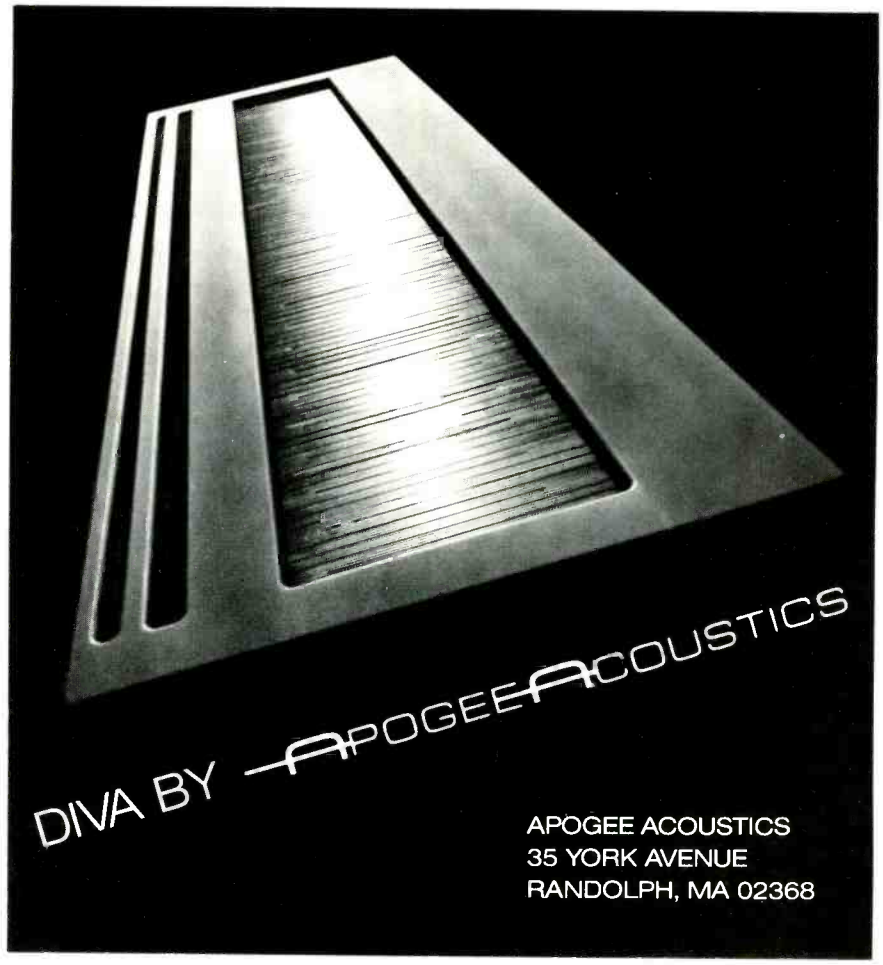

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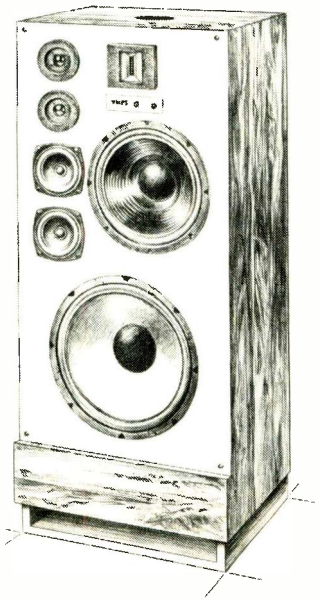

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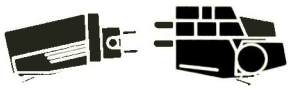

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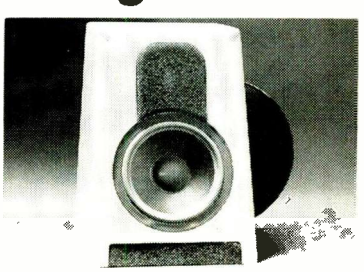

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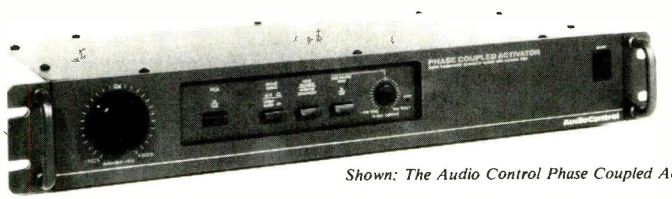

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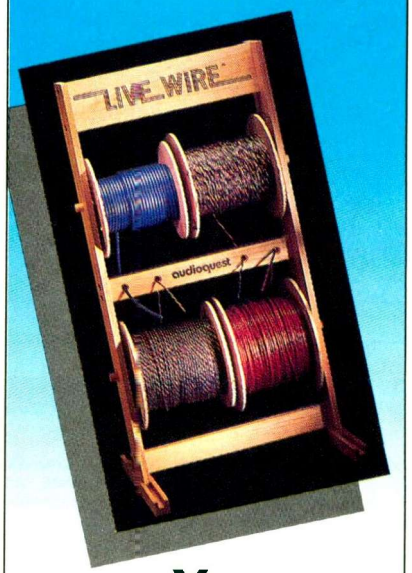

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