

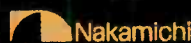
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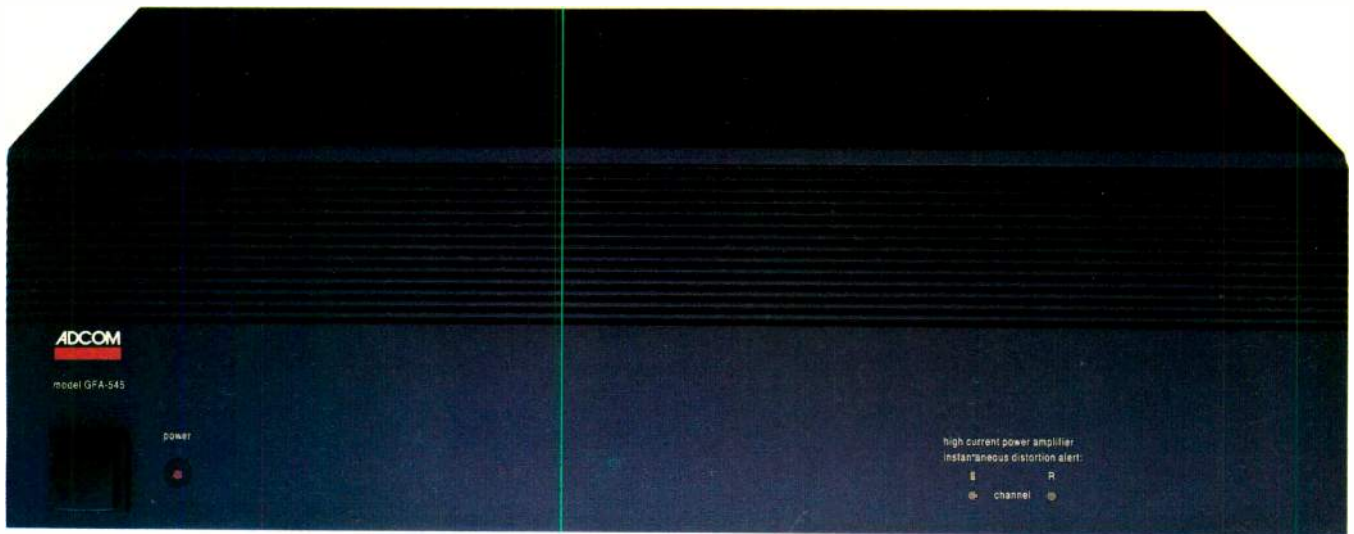


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The Cover Equipment: Nakamichi CR-7A cassette deck.
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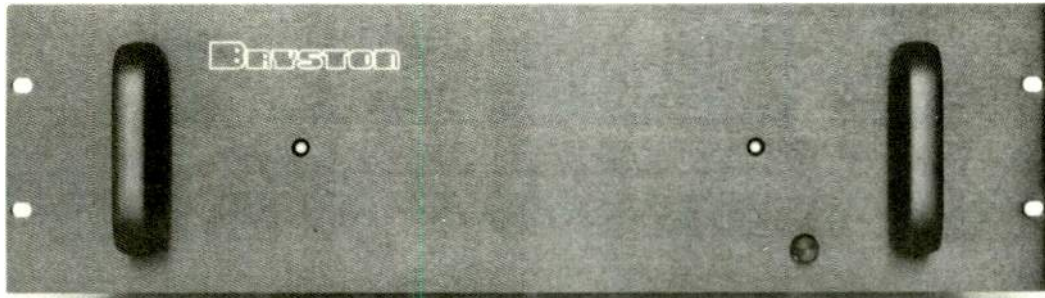
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BRYSTON POWER AMPLIFIERS CONTINUE TO DEFINE THE STATE-OF-THE-ART IN MUSICAL ACCURACY, LONG TERM RELIABILITY AND PRODUCT INTEGRITY.

Bryston design philosophy incorporates three general concepts.

1. Musical accuracy
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.

All components used in Bryston power amplifiers are specified for continuous duty at maximum power, with typical safety margins of 250%.

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.

Following the burn-in period, the amplifiers are monitored for DC bias stability for approximately

another full day. At this point, they are returned to the test bench for another complete checkout of all operating parameters and functions, at which time a test sheet is made, and included in the packing with the unit.

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

INTEGRITY

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

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

We feel that regular sweeping revisions to basic circuit design (accompanied by revised jargon) to be cynical marketing on the part of the manufacturer and insulting to the discerning customer.

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The new TX-Seven and TX-Nine auto-reverse AM/FM tuner/cassette audiophile decks represent yet another example of Carver's ability to solve previously insoluble audio problems and deliver you more musical enjoyment.

**CARVER TUNER TECHNOLOGY
TAKES TO THE ROAD.**

Each deck employs the same Asymmetrical Charge-Coupled FM Detection circuitry as Carver's revolutionary TX-11a home tuner, along with an ingenious automatic computer logic-controlled antenna switching system that further vanquishes multipath distortion.

In point of fact, no other autosound tuner/cassette decks in the world — regardless of price — even begin to approach the TX-Seven and TX-Nine's ability to maintain a hiss-free,

glitch-free, interference-free FM listening environment in your car.

Both also possess a multitude of other useful, state-of-the-art features which will recommend them to the most discriminating autosound audiophile.

COLLIDING WITH MULTIPATH DISTORTION.

By its very definition as a moving reception point, a car's FM tuner constantly falls prey to signal reflections from hills, skyscrapers, bridges and even other vehicles. These extra phase modulating signals trick conventional tuners into producing audible sounds we call multipath.

Startling outbursts of clicks, pops, "picket fencing" and other rude and indescribable sounds.

The trouble is, by its very nature, multipath distortion cannot be cured by conventional circuit "improvements." In fact, the better an autosound tuner is, the more faithfully it is deceived into converting phase modulation into ghastly-sounding interruptions in your favorite station.

COMPUTER LOGIC-CONTROLLED DIVERSITY ANTENNA SWITCHING DRIVES AROUND MULTIPATH.

One way to get temporary relief from interference at home is to move the antenna around slightly. That is in effect what the Carver TX-Seven and TX-Nine do with sophisticated circuitry in your car. Instead of physically moving one antenna, they turn your rear defroster into a second *separate antenna*, 180 degrees out of phase with the first. When multipath occurs, a special smart circuit automatically switches (at the speed of light) to the other antenna, automatically correcting phase and eliminating the multipath before you ever hear it. In serious cases, the circuit actually uses both antenna inputs at once, deriving a signal through sum and difference principles.

ASYMMETRICAL CHARGE-COUPLED FM DETECTION CIRCUITRY BRINGS IT ON HOME.

What little multipath distortion gets through the TX-Seven and TX-Nine's unique smart antenna system runs headlong into the remarkable tuner innovation *High Fidelity Magazine* described as "distinguished (by) its ability to pull clean, noise-free sound out of weak or multipath-ridden signals."

It specially treats the critical, multipath-prone left-minus-right (L-R) signal with a Charge-Coupled circuit that detects "dirty mirror image" signals and cancels them before they can reach your ears. Then the Leading Edge Detector circuit processes the final 5% of the L-R and interleaves it with the tuner's receiver matrix.

Alone, without antenna diversity switching, the TX-Seven and TX-Nine's Asymmetrical Charge-Coupled FM Detection Circuit

delivers a *net noise and distortion reduction of 92.9%*. Together, they set a new standard for clear, clean FM autosound reproduction.

THE MULTIPATH MARATHON: REAL WORLD CONFIRMATION IN THE MISTS OF THE NORTHWEST.

Bob Carver is both a theorist and a practical inventor. Circuits that work on paper get exhaustively tested in the field before release.

So he assigned a hapless engineer to map out the ultimate multipath-ridden route for confirmation of the TX-Seven and TX-Nine's special circuitry. With mountains, hills, huge evergreen trees, skyscrapers, large steel bridges, good robust traffic jams and a few assorted six-story-tall Boeing hangars, it didn't take long to map out a 6-mile course that could regularly deliver at least *287 separate multipath occurrences*.

Engaging the Asymmetrical Charge-Coupled FM Detection circuit and automatic antenna switching reduced occurrences to an *average of two* during the same 6-mile course while listening to the same stations!

Although results may vary in your locale, the same 90+% reduction in multipath has been confirmed in other widely diverse portions of the U.S.: The TX-Seven and TX-Nine work, and work well.

OTHER REMARKABLE TUNING FEATURES, TOO.

First, the TX-Seven and TX-Nine also receive Long Wave and Short Wave stations. And of course, both tuner/cassette decks have plenty of random presets... you can tune any fifteen AM, FM, SW or LW stations quickly for instant recall. Plus auto-scan and manual tuning.

But they also have a system that makes setting up all fifteen presets virtually instantaneous. Just press the button marked BEST and the tuner's logic circuitry will *automatically select* the fifteen cleanest, strongest signals and lock them in on the presets!

And that's *in addition* to your fifteen individual random presets.

As with all Carver products, the TX-Seven and TX-Nine do not sacrifice ease of use for useless, complicated frills. Instead, they answer every possible need without resorting to elf-sized buttons or glitzy flashing light displays.

Their metal-compatible, Dolby® NR, auto-reverse cassette sections rival any in the world. Both the TX-Seven and TX-Nine have separate bass, treble, balance and loudness

and four-way fader controls and a full-function LCD display with night illumination.

All operations are signaled with a gentle "beep" that keeps your eyes on the road, not on the compact, ergonomically-styled deck.

There's even a security code system that renders the TX-Seven or TX-Nine inoperable to anyone but you (and a window sticker to impart this discouraging information to others).

Or, if you prefer, use the quick removal system that slips out your TX-Seven or TX-Nine in seconds for storage in trunk or house.

THE BEGINNING OF THE PERFECT AUTOSOUND LISTENING ENVIRONMENT.

Out of the hundreds of tuner/cassette models currently available, only the TX-Seven and TX-Nine deliver home-stereo quality FM in your car. They achieve it with unique technology. And they are built to outlast your car, no matter what kind of climate you live in.

Coupled with a clean amplifier, such as The Carver M-240 Car Amplifier and state-of-the-art speakers, your ability to transform your car into a concert hall is almost unlimited.

We urge you to audition the TX-Seven and TX-Nine at your Carver dealer soon. They can put you in the driver's seat of a unique, interference-free musical experience.



THE TX-SEVEN AND TX-NINE

TUNER: ♦ Asymmetrical Charge-Coupled FM Stereo Detector ♦ Automatic Computer-Controlled Diversity Antenna Switching ♦ AM, FM, Long Wave and Short Wave Bands ♦ 15 Random Presets ♦ BEST Circuit for Auto-Selection of 15 Strongest Stations (in addition to 15 individual presets) ♦ Preset Frequency Auto-search ♦ Auto-scan Tuning ♦ Manual Tuning ♦ LCD Frequency Read-out. CASSETTE: ♦ Auto-reverse ♦ Programmable Music Search (TX-Nine only) ♦ Computer Logic Activated Controls ♦ Dolby B NR ♦ Dolby C NR (TX-Nine only) ♦ Metal Tape Bias Selector. GENERAL: ♦ Security Code System ♦ Audible Confirmation of All Functions ♦ Separate Bass, Treble, Balance and Loudness Controls ♦ Full-function LCD Read-out w/Night Illumination ♦ CD Line Level Input (TX-Nine only) ♦ Quick Release Removal System ♦ Year Warranty. SPECIFICATIONS: ♦ Tuner S/N: 76dB ♦ 50dB Quieting Sensitivity, ♦ S/N: 65dB with Dolby B NR, 70dB with Dolby C NR ♦ Tape Frequency Response 20 Hz - 15 kHz ♦ Dimensions, 180mm W x 51mm H x 160mm D (DIN mount)

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TAPE GUIDE

HERMAN BURSTEIN

Print-Through and dbx

Q. I have noticed print-through during quiet passages of C-90 tapes that were recorded about one year ago. How can I reduce or eliminate this? I have been recording at a level such that the average VU readings are about -10 dB and the peaks are at 0 dB. I don't think I can record at any lower level. I use a dbx Model 224 unit, and at present there is no noticeable tape noise.—Robert R. Maigatter, Kewaunee, Wisc.

A. There isn't too much you can do to get rid of the print-through on your recorded tapes. It may help somewhat to put such tapes through fast wind and rewind once or twice before playing them, particularly after a long period of storage. In the future, you might get better results with C-60 rather than C-90 tapes if print-through is a serious problem. The C-60 tape has a thicker base and thus provides more protection against print-through.

It may also be helpful to record at somewhat lower levels, say at least 3 dB lower. Once you have S/N of about 70 dB, you have very quiet tape reproduction. With dbx NR, you have S/N in the region of 85 to 90 dB; therefore, it's quite feasible to give away a few dB of S/N without noticeably increasing noise.

S/N Standard

Q. Does there exist a reference standard for the signal-to-noise ratio of cassette decks?—Robert Pepin, Virginia Beach, Va.

A. There is no standard reference for the signal-to-noise ratio of cassette decks (although there is a standard way of measuring S/N).

In the old days when open-reel decks reigned supreme, there were NAB (now NARTB) standard S/N ratios for various speeds and track formats. In the case of decks intended for home use, using the quarter-track format and operating at 7½ and 3¾ ips, the standard S/N was 45 dB unweighted and 52 dB A-weighted. (A-weighting takes into account the relative audibility of different noise frequencies, counting bass-frequency noise far less, and high treble noise somewhat less, than in unweighted measurements.)

De facto, it is pretty much accepted that the minimum S/N for high fidelity is

about 55 dB, weighted. An S/N of at least 60 dB does very well for most people in most circumstances, and Dolby B noise reduction achieves this in most decks. Dolby C gets into S/N ratios of 70 dB or more, and leaves very few people unsatisfied. With dbx NR, one can get S/N of 80 dB or more, and possibly over 90 dB, which leaves no room for complaint.

NR and DNR

Q. I understand how Dolby and dbx NR work, but understand less about Dynamic Noise Reduction. A car deck I have in mind has DNR instead of Dolby NR. How will my Dolby C tapes sound on it? Or should I not use Dolby NR when recording tapes for this deck?—John Stowers, Austin, Tex.

A. You could probably get away with using Dolby B NR on tapes made for that car deck, but I would not recommend using Dolby C. Both Dolby NR systems (and dbx NR) tailor the signal in recording, then treat it again in playback to remove both noise and the effects of the prior alteration. A tape made with Dolby B NR will usually sound a bit bright when played back without this NR system. DNR, which applies selective treble cut at times when there is little high-frequency signal energy to mask noise, may or may not lessen this brightness somewhat, depending on the program material. If it does not, you could use the treble or tone control of your car-stereo system to reduce the brightness; if your system's highs are dull, you might even find this brightness, or some of it, desirable.

A tape made with Dolby C NR, however, is less likely to sound pleasing when played back without Dolby C decoding circuits. The Dolby C NR affects midrange as well as treble frequencies, and boosts the treble far more than Dolby B does. If your car-stereo system had Dolby B as well as DNR, you might be able to tame Dolby C tapes into listenability by using both at the same time. However, the results would still be far less satisfactory than if your car stereo had the proper circuits for Dolby C NR.

In theory, your best choice would be to use neither Dolby NR system when making tapes for the car. In practice, however, you may find it best to record

with Dolby B NR; these tapes will have less hiss when played with Dolby B decoding, as they can be on your home system (and, presumably, your next car stereo), and yet can still be made to sound satisfactory over the system you're now thinking of getting for your car.

Strange Exchange

Q. I have a Nakamichi 582-Z deck and a newer deck, a Nakamichi ZX-7. Each deck does fine in playing tapes that it has recorded, and the ZX-7 does fine in playing tapes recorded on the 582-Z. But sometimes when I use the 582-Z to play a tape recorded on the ZX-7, there are strange "plinking" noises, akin to a drop of water falling into a metal bucket. The noises seem to be associated with transient spikes, such as those produced by record scratches, but I am not certain of this. They always occur at the same place on the tape, and they are audible only during quiet passages. On many tapes, they are not audible at all. I took some of my ZX-7 tapes to my dealer and played them on several Nakamichi decks. None of them produced the noise in question. I have tried a number of remedies, such as changing tape brands, but to no avail. I would appreciate your comments.—James G. Williams, Goodman, Miss.

A. It seems plausible that sharp transients, such as those caused by record ticks, are distressing the 582-Z. The ZX-7 may have better playback protection against such transients than does the 582-Z. Also, the ZX-7 may be better in recording such transients; perhaps it even generates them. This problem may be similar to the effect of phono record warp on the record electronics of some cassette decks. Although the warp frequency is inaudible, it can drive the record amplifiers of some decks into great distortion. Perhaps a low-pass filter which cuts off sharply above 20 kHz or so would be helpful. It would be placed between the tape out jacks of your audio system and the input jacks of the 582-Z. **A**

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

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REACHING FOR THE BRASS RING

Great eras in technology do tend to overlap, and for our good. But we don't like to think that way. We want things sharp and clear. The horse yesterday, the gas buggy today. Trolley cars one evening, the bus the next morning. Analog, digital, is it any different? The new versus the old, as always, and the new is better, isn't it? Not necessarily; not on the instant, anyhow. It might even be worse, for a while.

How many of us really appreciate the shape of the digital future? I wonder. Our noses are still too close to the technology; we are still much too worried about whether it sounds better—or, as some say, not as good. And everybody knows, unfortunately, that digital is new. *New!* Whereas that other word, analog, means old-fashioned. You can't expect big-time publicity campaigns to tone down on *that* selling point, after all.

We could so easily point out—if we wanted to—that analog recording, like photography, is all-natural, a genuine facsimile of the information available "live." Whereas digital, like the moving picture, is a cut-up sampling of bits, static moments frozen into a code to deceive the ears and the eyes alike.

We can argue—we *do* argue—forever on such points, all on an either/or basis. Is digital audio "better," or is analog? It gets us nowhere! Even if we could add it all up for an overall judgment, we'd merely begin again in 10 minutes—things keep changing. What we have to do is look at the overlap. What are the really useful differences, immediate and for the long future; what are the *characteristics*, the features, the exploitable aspects?

Yes, there's a digital revolution. There are always revolutions—that is, we are always talking about them. The Plate Tectonic Revolution (that one is strictly in our thinking). The French Revolution, the American Revolution, the Industrial Revolution, maybe even the New Coke Revolution. *Bang!* Big explosion. Actually, even with an explosion there is plenty of overlap, every time. Revolutions, like volcanoes or earthquakes, take a long time to develop full pressure, and there are long periods of aftershock too. Opera, for instance, was not suddenly invented out of nothing in the year 1600, as we



music students used to be told; nor did the Romantic movement begin with the clarinet solo in Weber's "Der Freischütz" overture along about 1820. That's what I once heard. By golly, if we don't find a revolution at hand, we feel that we have to make one.

We seem to have a terrible distaste for the gradual and continuous change—with certain explosive high points—that is actual history. All we want is the Big Bang. BOOM! What was *that*? The Dawn of Digital, coming up like thunder.

Just to show you I'm still on the audio track, more or less, let me mention two items of recent audio news that fit into the pattern. On the one hand, London Records has been promoting an advanced digital system, ADRM (London prefers four-letter trademarks, like *ffrr*), for the restoration, editing, and preservation of older analog recordings and their reissue on CD. There are already nearly 100 of these in the London catalog. Of course, London is not the only label doing digital restoration of its older tapes, much as ADRM publicity would like us to believe. But London's account of this system is very well presented and sums up the nature and

advantages of digital recording as well as I've ever seen it done. It is easy to read between the lines; in London's view, the digital revolution is over and we must now settle into the digital age.

ADRM's publicity throws light where light should be thrown, on the two really important (and least publicized) digital advantages: Permanence and processing. Permanence, for a signal always ready and untarnished; processing, for safe and easy preparation. In the long run—in the long overlap—these surely will be the vital digital elements, rather than mere sonic quality, which no doubt will change and improve as we move forward.

The digital message is permanent just because it is a code, which may be extracted from its carrier and copied with minimum or no loss, any number of times, through any number of generations. By the same token, the marvelous new subtleties of digital editing (however expensive at the moment) are nondestructive, as well as much more easily and accurately responsive to the dictates of the sound editor's ear than is the old cut-and-patch editing. All this London makes admirably clear in its account of

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In addition to all the expected features, both have some unexpected ones. Like variable output level to correctly match the output level with other system components, and act as a remote volume control. Gold-plated connectors. And full-control wireless remotes.

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The new comes along and, by sheer competition, stimulates the old to move further upward. Thus we get improvements in LPs, in TV sound, and in FM.

ADRM, which you should be able to find at any record shop.

On the other hand, and also saying much concerning the useful overlap of analog and digital recording technology, is that familiar name, Dolby. Announcing still another Dolby system, perhaps the ultimate and most remarkable of all: Dolby SR for professional analog recording. No—not digital recording. It works on any professional analog tape recorder that makes use of the original Dolby A, still the most enduring and universally used NR system after more than 20 years.

Dolby SR is, in effect, an extension of the traditional two-stage Dolby system of selective companding (compressing, expanding). It goes into further and subtler regions, not only the signal at various levels (Dolby A began with four separate bands operating independently) but now also in what the consumer might best think of as tone color. The system responds in incredible detail to the entire sense of the sound, tailoring each aspect for optimum recorded accuracy as well as minimum noise. All this, as you may guess, is in the traditional Dolby manner—that is, the signal is untouched in areas where processing isn't useful, and the whole shebang, the entire processed signal, is "decoded" for playback precisely in reverse, restoring the original as in the other Dolby systems. We're left with the mirror image, more polished than ever.

No more should be said, lest I get into technical hot water. But the significance is plain enough. Dolby SR, used with existing analog recorders, can match or in some areas even exceed the parameters of digital sound—the characteristics that we still find so awesome! So again the old catches up with the new, in its own way. Enough, surely, to give professional analog recording a further burst of life, for longer than you may think. A very useful overlap, especially since, in its usual fashion, Dolby has shaped its SR equipment with a maximum of compatibility to match older Dolby systems (of which it is indeed an extension), even to the rack size and the familiar controls. Conversion is thus uncomplicated, both for record and for playback.

So this is the way things go. Comes the revolution! The new is always sen-

sational but often for a lot of wrong reasons. Meanwhile, the old reaches its elegant apogee of maturity—and is stimulated to move even further onward and upward by sheer competition. So it has also been with the LP, which has never sounded better than now, as I keep on saying. Indeed, it has moved far beyond what we might have imagined possible maybe 10 years ago. So also with TV, which drifted along for a whole generation with its amiably dreadful audio until digital and home video and the rest stuck sharp pins into its complacency. Suddenly, video sound is superb (the newly made part of it) and you'll need the best hi-fi equipment to reproduce it for what it has.

And FM. That once-miracle of radio silence was in many ways comparable to today's digital; it bypassed sonic interference via special coding. FM also coasted along for a generation, after the disastrous stereo compromises of the 1960s, without, shall I say, more than incremental improvements, including Bob Carver's. Now, suddenly, comes a more dramatic attempt, not unrelated to Dolby SR in the use of sophisticated and selective two-stage companding—both in the FM station and, inversely, in the FM receiver. The FMX system, recently announced by CBS and on trial in Connecticut (see feature article in *Audio*, May 1986), would much reduce the hiss in FM stereo with relatively little effect on the stereo itself, thereby increasing the practical stereo listening area to an extent that ought to impress the station owners (who'd get increased business) even more than us listeners. That being the case, I suspect that FMX may move along nicely and give us, at last, some quiet reception in stereo, to match Dolby, digital, and all the rest of our gear. It's in the cards.

The only technical objection to FMX that I have heard comes from that persistent surround-sound gadfly, Larry Clinton in Virginia, who points out that FMX would preclude any further moves into multi-channel surround-sound FM. No room; FMX uses up the possible extra channels. To which I can only say, at this point, 'tis better to have a widened useful coverage for two-channel FM stereo, minus hiss, than any type of surround sound. First things

first, you might say. Besides, you can always create your own surround, and very effectively, by any one of numerous types of surround synthesis from SQ all the way to Dolby Surround. Not to mention the fancy digital chip-based hall-reproducers on the way.

Here again, you see, the new has stimulated the old in a time of coexistence. When you come down to it, this isn't really more than the old capitalist principle of competition that keeps everybody on his or her toes. Some aspects of competition really do work, even if we tend to slide into evil at the flip of a \$50 bill. That's merely human nature, which we all can control if we really want to. I think I like the way competition works in audio, generally speaking—with a few exceptions.

After all this, then, you can see how the digital revolution is shaping up, not with a boom but slowly and systematically. This will go on. You can understand, too, why I find the various discussions of "digital sound" pretty vacuous. In the long run they are unimportant—we'll fix things up. I do not believe that there is an inherent unpleasantness in the digitalization of the musical signal, at least for listening to recorded content. Not at the fine-combed rate at which we are now doing the sampling.

Please note in this connection that the entire body of moving-picture art since the turn of the century, along with all TV entertainment from the beginning, has depended on a coarser "digitalization" of the stream of visible, live motion into discrete, nonmoving bits, one picture after another with blanks between. A series of jerks. Tiring for the eyes? Definitely, even now, and more so with the original, slower, 16-frame movies when they are projected at correct speed. (We speed them up and think it's funny; I think it is a desecration.) Since we have never had analog movies—continuous motion minus breaks—there is no argument. But the parallel to digital sound is strong, just the same. Indeed, the ears are very choosy in the wee small frequencies, and there may be small disturbances going on there as we listen to chopped-up music via digital. But they're not really vital. Not enough to stop the digital revolution and the age to follow.

A



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Matthew Polk's ultimate dream loudspeaker, the SDA-SRS, won the prestigious Audio Video Grand Prix Speaker of the Year award last year. Stereo Review said "Spectacular...it is quite an experience" and also stated that the SRS was probably the most impressive new speaker at the 1985 Consumer Electronics Show. Thousands of man hours and hundreds of thousands of dollars were spent to produce this ultimate loudspeaker for discerning listeners who seek the absolute state-of-the-art in musical and sonic reproduction.

Matthew Polk has, during the last year, continued to push his creative genius to the limit in order to develop a smaller, more moderately priced Signature Edition SDA incorporating virtually all of the innovations and design features of the SRS without significantly compromising its awesome sonic performance. The extraordinary new SRS 2 is the successful result. Music lovers who are privileged to own a pair of either model will share Matthew Polk's pride every time they sit down and enjoy the unparalleled experience of listening to their favorite music through these extraordinary loudspeakers, or when they demonstrate them to their admiring friends.

"Exceptional performance no matter how you look at it"

Stereo Review

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The awe-inspiring sonic performance of the SDA-SRS 2 is remarkably similar to that of the SRS. Words alone can not express the experience of listening to these ultimate loudspeaker systems. You simply must hear them for yourself!

"Literally a new dimension in sound"

Stereo Review

Both the SDA-SRS and the SDA-SRS 2 are high efficiency systems of awesome dynamic range and bass capabilities. They both incorporate Polk's patented SDA True Stereo technology which reproduces music with a precise, life-like three dimensional soundstage which is unequalled and gives you, as Julian Hirsch of Stereo Review said, "literally a new dimension in sound". Each beautifully styled and finished cabinet contains 4 Polk 6½" trilaminate polymer drivers, a planar 15" sub-bass radiator, 2 Polk 1"

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Where to buy Polk Speakers? For your nearest dealer, see page 18.

BERT WHYTE

FINGERING PRINTS

When Compact Discs were introduced, a lot of tales were told about how impervious they were to scratches, dirt, and other artifacts which have always been very destructive to vinyl records. There even was a story that peanut butter could be spread on a CD, and after it was cleaned off, the disc could be played without difficulty. Unfortunately, the CD is a victim of its own propaganda, which, coupled with the "no wear" factor, has lulled people into thinking that it is nearly indestructible. Even though consumers have been generally admonished to hold a CD by its edges and treat it with the same respect accorded vinyl discs, the small size of the CD, its ease of handling, and the early fanciful tales about its total immunity to contamination have made people careless. As a consequence, myriad fingerprints, dust, and assorted detritus must be dealt with.

Last issue, in my discussion of CD error correction, I pointed out that a minor interruption of the music, or a momentary or cyclic noise, may sometimes be amenable to simple cleaning. The most basic form of CD cleaning is to breathe on the disc and then use a tissue or soft cloth to wipe the condensate from center to edge, as if following the spokes of a wheel. A more thorough job of cleaning can be accomplished by wiping the CD—always with radial strokes—with ethyl alcohol. The most readily available household source of this is from a bottle of 100-proof vodka, which is equivalent to 50% ethyl alcohol.

There are various commercial CD cleaning fluids which one hopes will do their job without leaving an invisible and potentially bothersome residue. There are also a number of CD cleaning devices which rotate the disc, but most of them use a circular cleaning motion and not the preferred radial strokes.

One device which works properly is the Discwasher Compact Disc Cleaner. A plastic case contains a circular CD platform with gear teeth around its circumference. A cleaning wheel, also with gear teeth, is mounted in the plastic cover of the case and is fitted with a soft, absorbent cleaning pad. An intermediate drive gear is between the CD platform and the cleaning wheel. The



cleaning wheel is mounted eccentrically, and, when it is rotated by a small crank handle, a radial motion is imparted to the pad. The cleaning procedure involves spraying the CD with the supplied cleaning fluid, placing the treated CD on the platform, closing the plastic cover, and rotating the cleaning pad in either direction for about 20 revolutions. The action is a bit stiff from the gearing and 20 turns are a little tedious, but the Discwasher system does clean CDs effectively. The cleaning kit with case, fluid, and replacement cleaning pad is \$19.95. Of course, refills of the CD-1 fluid and cleaning pads are available.

Of all the contaminants a CD can be subject to, the most common—and the most bothersome—are fingerprints. Now, there are different kinds of fingerprints, and perhaps they should be rated on a "gloppiness index." For example, there is the common, garden-variety fingerprint from normal, clean fingers; the error-correction capabilities of most CD players can cope with these quite nicely. If your fingers are a bit moist or clammy, correction becomes a bit more difficult. If you have an oily complexion and rub your nose or forehead with your fingers and sub-

sequently put a print on a CD, this can stop the error-correction systems of a fair number of CD players dead in their tracks.

The worst-case scenario for fingerprints, those with the highest rating in the "gloppiness index," would involve food. Say you're at a picnic, where your fingers can be loaded with grease from that cold fried chicken or similar foods, and you happen to have a portable CD player to entertain you in your sylvan glade. Or you are at a drive-in burger palace, and after your double-decker cheeseburger and fries, you play some CDs on your car CD player. Picnic or burger stop, you are unlikely to do more than wipe your fingers with a paper napkin or towel. This virtually guarantees your fingers will have a heavy film of oil. If you happen to put some prints on your CD, all but the most sophisticated error-correction systems of the top players will be overwhelmed, and the machine will simply not play the CD.

I did some experiments in which I put fingerprints of various degrees of "gloppiness" on some CD surfaces. To simulate the picnic/burger-stop situation, I dipped a finger into bacon fat, then wiped it with a paper napkin. I

Illustration: Karen Barbour



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MASSACHUSETTS Fitchburg: Fitchburg Music • Gloucester: Glass Sailboat • N. Dartmouth: Creative Sound Systems • Waltham (Boston): Wallham Camera & Stereo • Worcester: O'Connell
MICHIGAN Ann Arbor: Absolute Sound • Birmingham: Almas Hi Fi • Dearborn: Almas Hi Fi • East Lansing: Stereo Shoppe • Farmington Hills: Almas Hi Fi • Grand Rapids: Sound Room • Iron Mountain: Sound North • Lansing: Stereo Shoppe • Portage: Sound Room • Royal Oak: Absolute Sound • Saginaw: Audio Shoppe, Court Street Listening Room • Traverse City: Stereo Shoppe
MINNESOTA Brooklyn Center: Audio King • Burnsville: Audio King • Duluth: Met's TV & Audio • Edina: Audio King • Minnetonka: Sound World • Minneapolis: Audio King •

- Minnetonka: Audio King • Rochester: Sound World • Roseville: Audio King • St. Paul: Audio King
MISSISSIPPI Gulfport: Empress • Jackson: Walters Audio • Pascagoula: Empress
MISSOURI Cape Girardeau: Stereo One • Columbia: D & M Sound • Lebanon: Sight & Sound • St. Louis: Sound Central
MONTANA Bozeman: Thrifty Ear • Great Falls: Rocky Mountain Hi Fi
NEBRASKA Lincoln: Stereo West • Norfolk: Mid City Stereo • Omaha: Stereo West
NEVADA Las Vegas: Upper Ear • Reno: The Audio Authority
NEW HAMPSHIRE Concord: Audio of New England • Lacena: Audio of New England • New London: North Star Electronics • Salem: Goodman's
NEW JERSEY East Brunswick: Atlantic Stereo • Franklin Lakes: Franklin Lakes Stereo • Maple Shade: Bryn Mawr Stereo • Montclair: Perdue Radio • Harrison: AC Audio • Newark: Audio Craft • Linden: Classic Stereo • Shrewsbury: Mornmouth Stereo • Toms River: Rands Camera • West Caldwell: Perdue Radio
NEW MEXICO Albuquerque: Real Time Audio • Carlsbad: Beason's
NEW YORK Albany: Clark Music • Batavia: Unicorn Audio • Buffalo: Speaker Shop • Canajoharie: Chemung Electronics • Elmira: Chemung Electronics • Fredonia: Audio One • Glens Falls: Audio Genesis • Huntington: Audio Breakthroughs • Ithaca: Chemung Electronics • Jamestown: Studio One • Johnstown: Audio Craft • Lima: Classic Stereo • Newburgh: Randz's Electronics • New York City: Audio Breakthroughs, Electronic Workshop • Rochester: JB Sound • Scarsdale: E Video • Ridgeville: Soundings Road • Vestal: Hart Electronics • Waipingers Falls: Randz's Electronics
NORTH CAROLINA Asheville: Mr. Toad's Stereo Room • Sylva: Soundings Road • Charlotte: Stereo Video • Greensboro: Stereo Sound • Jacksonville: Southeastern Electronics • Pineville: Stereo Video • Raleigh: Audio Craft • Lincolnton: Wilmington: Atlantic Audio • Southeastern Electronics • Winston-Salem: Stereo Sound
NORTH DAKOTA Bismarck: Pacific Sound • Grand Forks: Stereo Video • Minot: OHIO Cleveland: Audio Craft • Cincinnati: Stereo Lab • Columbus: Stereo Lab • Dayton: Micro Computer Center • Fairport: Audio Craft • Lima: Classic Stereo • Mayfield Heights: Audio Craft • Toledo: Audio Craft • Westlake: Audio Craft
OKLAHOMA Lawton: Hi Fi Shop • Stillwater: Caruso • Tulsa: Audio Advice
OREGON Beaverton: Stereo Superstores • Eugene: Bradford's High Fidelity • Klamath Falls: Sound Chamber • Pendleton: Royal Mobile • Portland: Stereo Superstores
PENNSYLVANIA Allentown: Bryn Mawr Stereo • Altoona: Sound Concepts • Blakely: Hart Electronics • Bryn Mawr: Bryn Mawr Stereo • Camp Hill: Bryn Mawr Stereo • Erie: Studio One • Frazer: Bryn Mawr Stereo • Indiana: Sound Concepts • Jenkintown: Bryn Mawr Stereo • Kingstons: Hart Electronics • Lancaster: G'n'T Stereo • Montgomeryville: Bryn Mawr Stereo • Natrona Heights: Stereo Land • Philadelphia: Bryn Mawr Stereo • Pittsburgh: Audio Junction • Quakertown: Bryn Mawr Stereo • Reading: G'n'T Stereo • Sellersville: Stereo Shop • Williamsport: Robert M. Sides • Windber: Pro Audio
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RHODE ISLAND N. Providence: Eastern Audio
SOUTH CAROLINA Charleston: Audio Warehouse • Columbia: Stereo Shop • Greenwood: Stereo Shop • Spartanburg: Stereo Shop
SOUTH DAKOTA Rapid City: Team Electronics • Sioux Falls: Sound World
TENNESSEE Chattanooga: College Hi Fi • Cookeville: Network Entertainment • Johnson City: Mr. Toad's Stereo Video • Kingsport: Mr. Toad's Stereo Video • Knoxville: Lindsey • McMinnville: Network Entertainment • Memphis: Opus II • Nashville: Hi Fi Buys
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UTAH Logan store only: Stokes Brothers • Salt Lake City: Broadway Music • Vernal: O'K Lab
VERMONT Burlington: Audio Den
VIRGINIA Bristol: Mr. Toad's Stereo Video • Charlottesville: Sound Machine • Falls Church: Myer Emco • Franconia: Audio Showroom • Leesburg: Evergreen Audio • Richmond: Gary's Stereo • Roanoke: Audiodionics • Virginia Beach: Digital Sound
WASHINGTON Bellevue: Northwest Audio • Bellingham: OC Stereo • Lynnwood: Northwest Audio • Oak Harbor: OC Stereo Center • Richland: Tin Ear Stereo • Seattle: Delimito Audio, Northwest Audio Video • Spokane: Electracraft (Hal's) • Tukwila: Northwest Audio Video
WEST VIRGINIA Barboursville: Pied Piper • Beckley: Pied Piper • Huntington: Pied Piper • Morgantown: Sound Post • Piedmont: Sound Gallery
WISCONSIN Appleton: Sound World • Green Bay: Audio World • Lacrosse: Sound World • Madison: Hacy Medium • Marinette: Sound Seller • Milwaukee: Audio Emporium • Rhinelander: Audio Broker • Wausau: Sound World
WYOMING Cheyenne: Team Electronics • Riverton: Sound Room

Most CD players can cope with fingerprints from normal, clean fingers, but oily prints can stop some machines dead in their tracks.

placed some prints very close to the center hole, on the midsection, and on the periphery of a CD. I tried playing this heavily fingerprinted disc on a variety of players, including some of the most highly regarded and expensive units on the market. None of the several players I tried could cope with this kind of heavy, oily fingerprint. In some cases it was almost comical: When the CD was placed in the motorized drawer and the machine was started, the disc would be pulled into the machine and then promptly rejected, and the drawer would open to the loading position. This was generally the case when a fingerprint was placed close to the center hole. With a CD on which I placed prints only at the middle and outer sections, the best players would start properly; then, as the lasers encountered the first outer whorls and ridges of the fingerprints, they would struggle valiantly to correct the errors, making noises and exhibiting increasingly bad mistracking, and then stop completely.

The Nitty Gritty Company, which makes excellent cleaning machines for vinyl records, has come up with a CD-cleaning machine that is, in my opinion, unquestionably the easiest to use as well as the most efficient and effective method of ensuring pristine CD playing surfaces. The Nitty Gritty CD-1 Compact Disc cleaner measures 12¾ in. x 7 in. x 5¾ in.; its base is covered in wood-grained vinyl, and its hinged top is plastic. The lid's underside has a circular, stationary, foam-rubber platform with a soft and replaceable cleaning pad made of cloth-like material. A motorized CD turntable is mounted eccentrically so that it rotates about two different centers simultaneously. This causes the cleaning path to be almost perpendicular to the CD's signal track. Next to the turntable is a storage well for the Pure CD cleaning fluid, and the on/off switch.

The Pure fluid, which is really more like an emulsion, is spread in a thin line across the diameter of the CD by using the cloth applicator tip of its squeeze bottle. The treated CD is placed on the turntable, the lid with the cleaning pad lowered on for 30 to 60 seconds. The eccentric scrubbing action completely cleans the CD, buffing it to a brilliant, highly reflective shine, and renders the CD free of static. The Pure CD cleaner is also said to leave a protective layer that resists scratches. I had no way of verifying this claim, but I can say that the Nitty Gritty CD cleaner most effectively removed my worst bacon-grease fingerprints from test CDs; they all played flawlessly.

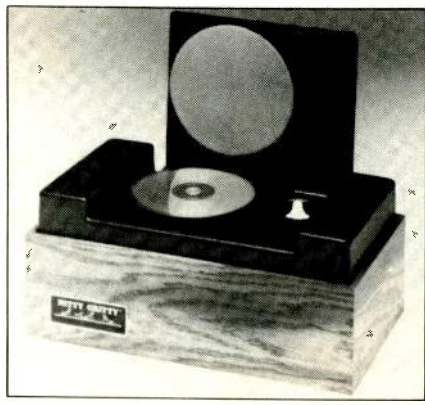
The amount of Pure CD cleaner used per disc is very little, and the two-ounce bottle should clean about 100 discs. The Nitty Gritty Compact Disc cleaning machine retails at \$159, including fluid and several cleaning pads. Refills of the Pure CD fluid are also available.

It doesn't take long to build up quite an investment in a collection of CDs. For many people, maintaining them in top playing condition will justify the price of this Nitty Gritty cleaner. Of course, you can obviate all the bother and expense by simply keeping your cotton-pickin' fingers off your CD surfaces!

Discwasher Compact Disc Cleaner



Nitty Gritty CD-1



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The Age of Aerostar.

It's a new age of versatility. From aerodynamic shape to built-in storage bins, Aerostar is designed to give maximum flexibility to your lifestyle. It's the wagon for all reasons, all seasons!

Aerostar is fun to drive, easy to maneuver, a pleasure to park. It fits in virtually any garage. And its new technology offers features most mini-vans simply don't have.

America's most aerodynamic mini-van.

Aerostar's shape does more for you than look good. The unique wedge design gives it unmatched aerodynamics. These aerodynamics minimize interior wind noise and also contribute to better handling on the road.

Powerful new V-6.

For peak performance, Ford introduces an advanced 3.0L V-6 with electronic fuel injection. This new option turns out 145 horsepower*—39%



more than the best effort of Chrysler mini-vans!

The standard Aerostar engine is a modern 2.3L Four. Like the 3.0L V-6, it has electronic fuel injection for ready response.

Tows almost 2½ tons.

With optional V-6, the high-strength Aerostar can be equipped to tow up to 4,900 lbs.† That's nearly 2½ times more than Chrysler mini-vans.

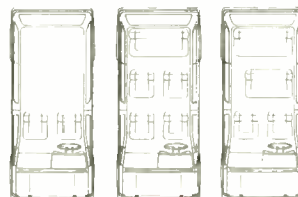
People plus payload.

Aerostar offers a choice of seats for up to 7 adults.** Rear seats slide out easily to create up to 139 cu. ft. of cargo space. A new optional roof rack adds still more capacity—and versatility.

The driver's mini-van.

The Aerostar driver has a commanding view of the road ahead—and rides surrounded by luxury and comfort.

Depending on model and options, you can have: Captain's Chairs with power



lumbar support. A sun roof. Leather-wrapped sports wheel. An electronic instrument panel that reports information from engine rpm to a door ajar.

The passengers' mini-van.

In addition to luxurious room, rear riders enjoy the open feel and ventilation of sliding side windows. Optional stereo systems include rear

controls—plus plug-in jacks for headphone listening.

Aircraft-type heater/air option has rear ducting for all-passenger comfort that most mini-vans lack.

The ride of quality.

Aerostar's luxury-car wheelbase, the longest of any mini-van, contributes to a smooth ride. Yet its overall length of 175" is shorter than other mini-vans for tighter turning ratios, convenient parking and garageability.

Aerostar is built to Ford's high quality standards, and is designed to fit into your versatile lifestyle... beautifully.

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Participating Ford Dealers stand behind their work, in writing, with a free Lifetime Service Guarantee for as long as you own your Ford car or light truck. Ask to see this Guarantee when you visit your participating Ford Dealer.

Buckle up—together we can save lives.

*Horsepower based on SAE standard J1349.
**With optional rear bench seat.

Ford Aerostar vs. Chrysler Mini-vans

	AEROSTAR	CHRYSLER
Aerodynamic for lower air drag	.37Cd.	.43Cd.
Standard 4-cylinder engines	2.3L	2.2L
V-6 engine power option	3.0L	None
Bigger cargo space (cu. ft.)††	139	125
Extra driver legroom	41.4 in.	38.3 in.
Max. opt. trailer towing capacity†	4900 lbs.	2000 lbs.
Longer wheelbase, smooth ride	119 in.	112 in.

†Reduced by passenger and cargo weight in tow vehicle.
††Based on SAE Standard J-1100 Code V-6.



GLOBAL MASTERS

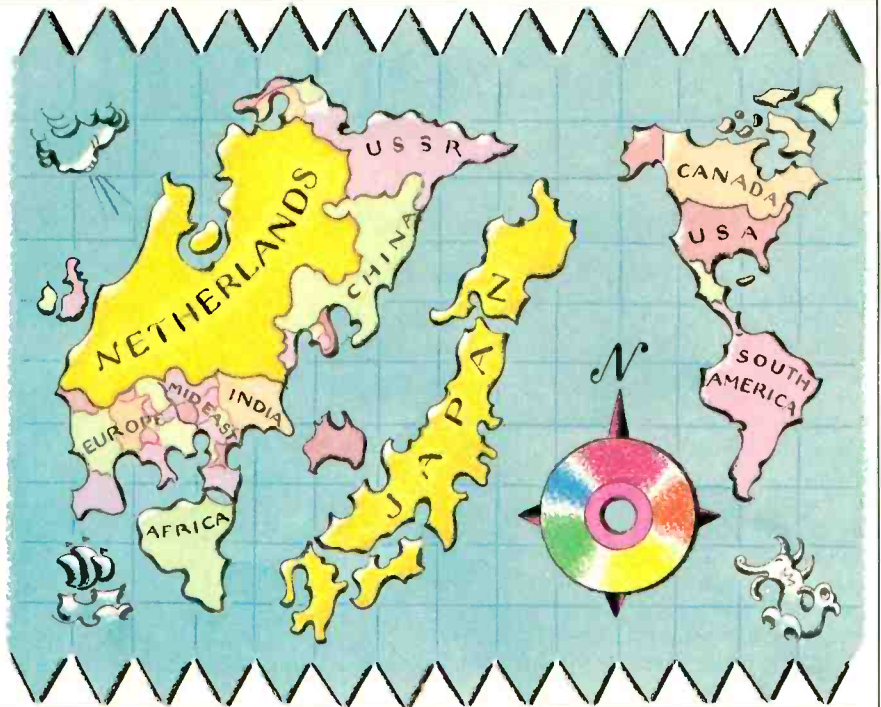
Maybe they're not quite masters of the universe, but Philips and Sony are at least masters of the Compact Disc's population explosion. Not only are they the license-holders of the format—collecting 3¢ on every CD made—and major manufacturers of discs; they also make the million-dollar machines to which most CDs owe their birth.

After Philips and Sony cleverly invented the CD, the next clever thing they did was invent the technology needed to manufacture the damn things. Although much of the manufacturing chain could be assembled from existing technology, such as injection molding, metalization, and label printing, the first link in the chain required a wholly new system. Philips and Sony thus independently developed CD master recording systems; then they installed them in their disc-manufacturing facilities, and sold them to subsidiaries or other companies. Most of the billions of pits in your CD collection were originally etched by a Philips LHH-0400 or Sony DMC-1200 master recorder. Let's take a look at mastering technology and why its mastery puts these companies in the driver's seat.

CD mastering begins with a videocassette and a piece of glass. The PCM audio data contained on a master tape will be transferred to the glass master, where it will be represented as pits. All CDs are ultimately derived from that master disc.

The master tape, a ¾-inch videocassette, carries all of the audio, subcode, and time-code information to be converted to a channel bit stream and fed to the master disc recorder. The audio data is contained in the video fields as PCM data, while the subcode and time-code information is stored on the longitudinal (formerly audio) tracks. The subcode includes control data such as table of contents, track numbers and indices, track lengths, text information, pre-emphasis (on/off), digital copy (prohibited or permitted), number of audio channels (two or four), and catalog number.

The glass master disc, about 240 mm in diameter and 5 mm thick, is washed, lapped, and polished. An adhesive is applied, followed by a coat of photoresist applied by a spinning developer machine. After inspection and



cleaning, the plate is tested with a laser for optical dropouts; any burst dropouts in reflected intensity will be cause for rejection of the plate. The plate is cured in an oven and is then ready for master cutting; if stored, it has a shelf life of several weeks.

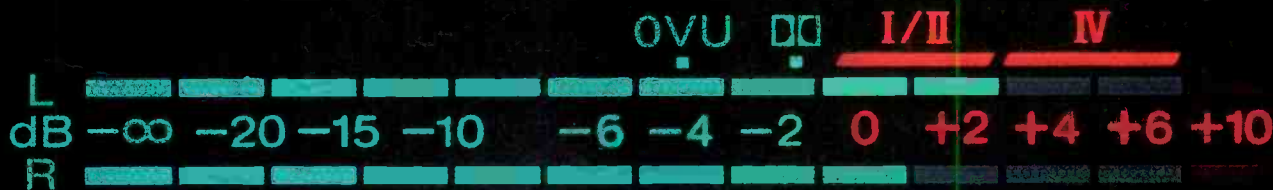
Disc mastering itself is accomplished with a laser mastering machine which exposes the photoresist on the master glass disc. The mastering machine is composed of two units, a control rack and a lathe. The control rack consists of a minicomputer with video terminal and floppy-disk drive, U-matic video transport, PCM audio processor, and diagnostic equipment. The master tape is loaded in the video transport, and the CD encoder uses the tape's subcode, time-code, and digital audio data to carry out multiplexing and CIRC encoding. The encoder generates the channel bit-stream signal; in addition, it outputs signals used for automatic quality control.

A controller provides for automatic system operation, and recording operations are stored on floppy disk. Recording parameters such as linear velocity, master identification number, and program length are entered via controller keyboard. A video display shows indication of process status.

The master glass plate, coated with photoresist, is placed on the lathe. The channel bit stream is input to the master recorder; it is used to intensity-modulate a laser which creates a cutting signal corresponding to the data on the original audio master tape. It is this "cutting" laser which creates the spiral track, in real time, as the master tape is played through the PCM processor. Another laser, which does not affect the photoresist, is used for focus and tracking. In making the spiral data track which extends outward across the disc, the disc's rotational speed and the linear motion of the sled that carries the focusing optics must be very precisely controlled. To obtain frictionless motion, air bearings are used for both mechanisms. Although the optics are similar to those found inside consumer CD players, the mechanisms are built to even more exacting specifications, especially in terms of isolation from vibration. The entire cutting process is accomplished automatically, under computer control.

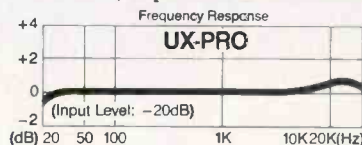
After exposure in the master cutter, the glass master is developed by an automatic developing machine; a laser monitors pit depth and stops development when proper engraving depth has been reached (that is, when the

Illustration: Philip Anderson



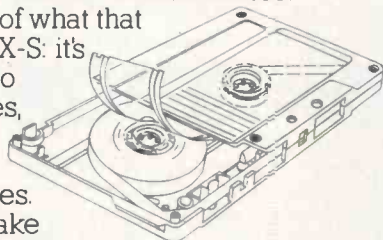
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cassette recording technology and music sources. Now, whether you record on Sony UX or the incomparable Sony UX-PRO, you'll be using tapes with finer and more evenly dispersed magnetic particles, along with improved coercive force to hold those particles even better than before.

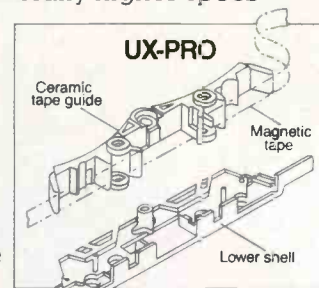
For an example of what that means to you, take UX-S: it's priced equivalently to comparable cassettes, yet delivers sound comparable to *their* high-end Type II tapes.



And when you take UX-ES, you enter a realm that belongs entirely

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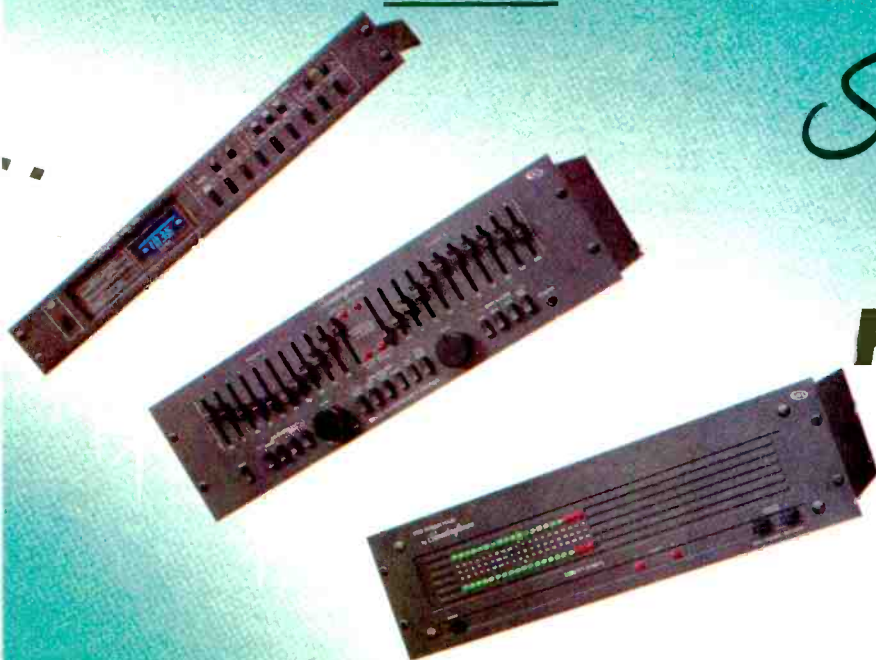
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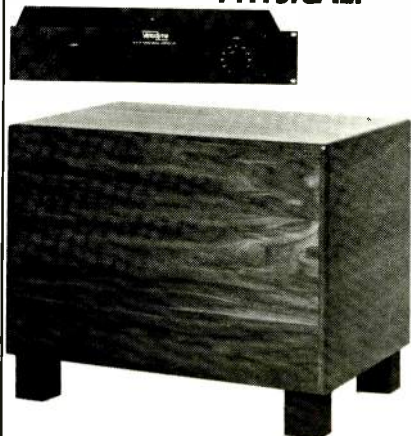
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CD pits are among the smallest manufactured formations. Clean air is therefore critical, and one stogie could put a factory out of business.

etching reaches the glass substrate). The pit depth thus depends on the thickness of the photoresist layer. The optimum data signal would result when there is maximum difference between the light reflected from the pits (seen as bumps, from the laser side) and the surrounding land. This is achieved when (a) the pit depth is one-quarter of the laser pickup's apparent wavelength, and (b) when the pit width is such that the intensity of the light reflected from the pit's bottom equals the intensity of the light reflected from the land between the pits. These two conditions cause interference between the incoming and outgoing light for maximum contrast. In practice, pit depth and width specs must be modified a bit for a more robust tracking signal.

The developed master plate is transferred to an electroplating room; there a silver coating is imparted onto the glass master to result in a metal "stamper." This CD master disc can be played on a system for masters to assess aural and measured quality; it also serves as a reference to evaluate the quality of the final production discs. A negative "father" of nickel is then made from the master disc, and positive "mothers" are made from that; each mother can then generate a number of negative nickel molds from which the actual discs are made.

Injection molding is typically used to produce the finished commercial discs. A polycarbonate material is melted, then injected in the disc mold. After molding, a layer of metal (usually aluminum) is placed on the disc surface to provide reflectivity; this is accomplished by sputtering or by evaporation in a vacuum chamber. The metalization layer is then covered by a photo-polymerized plastic layer applied by a spin-coating machine. This protects the metalization from scratches and oxidation. The label is printed upon this plastic layer. Following inspection, the disc is finished.

Even though the entire production chain is long, at least the mastering process sounds fairly straightforward. However, most CD mastering facilities will probably testify to the difficulties involved. The equipment for a mastering system requires a modest-sized book for specification. The main items include a resist master preparation

system, a master recording system, a developer system, a master disc player system, and disc master electroplating equipment. Other items (from a long list) include microscopes, ovens, chemical-preparation equipment, diagnostic and test equipment, glassware, cleaning and protective materials, desks and hoods, audio monitoring equipment, and dust-free paper.

Site requirements are carefully specified too. Clean air is critical. CD pits are among the smallest manufactured formations—about the size of a smoke particle. One stogie could put your factory out of business. Therefore, the entire mastering process must be carried out in a clean-room environment, with the size and number of particles in the air strictly regulated. Temperature and humidity, as well as ambient air-pollution levels, must also be specified. In the Philips system, the glass disc moves from one process stage to the next in a sealed cartridge. In each process step, the disc is automatically removed from the cartridge and then returned to it. This minimizes manual contact and air exposure, thereby reducing the risk of disc contamination.

Vibration would be disastrous to the cutting process. The laser-beam recorder is mounted on a massive baseplate (Sony uses cast iron, Philips uses granite) with a pneumatic vibration-isolation system. Other considerations include a clean electrical system, demineralized and hot water, compressed air, filtered air, nitrogen, and exhaust of contaminated air.

The facility could be housed in a clean room of 200 square meters. However, many disc manufacturers are specifying substantially larger rooms, with an eye toward additional mastering equipment to accommodate production of audio discs, CD-ROM discs, and future formats.

The total cost for the highly specialized CD-mastering equipment is in excess of \$2 million, plus clean-room construction costs. (The rest of the production chain costs a lot more.) Even so, there's a long line of customers eager to purchase mastering equipment. Philips is happily accepting orders for its turnkey system, but a system ordered today will not be delivered until 1988. That's what I mean about being in the driver's seat. **A**

BECAUSE TOO MUCH PERFORMANCE IS NEVER ENOUGH

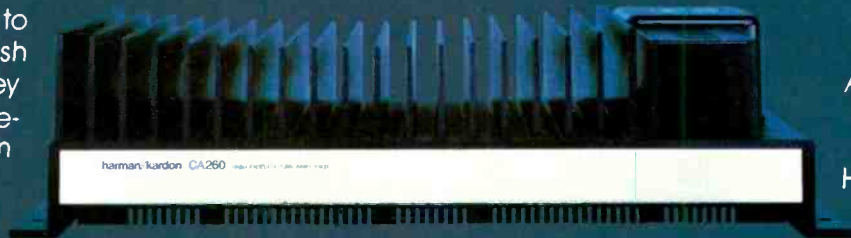


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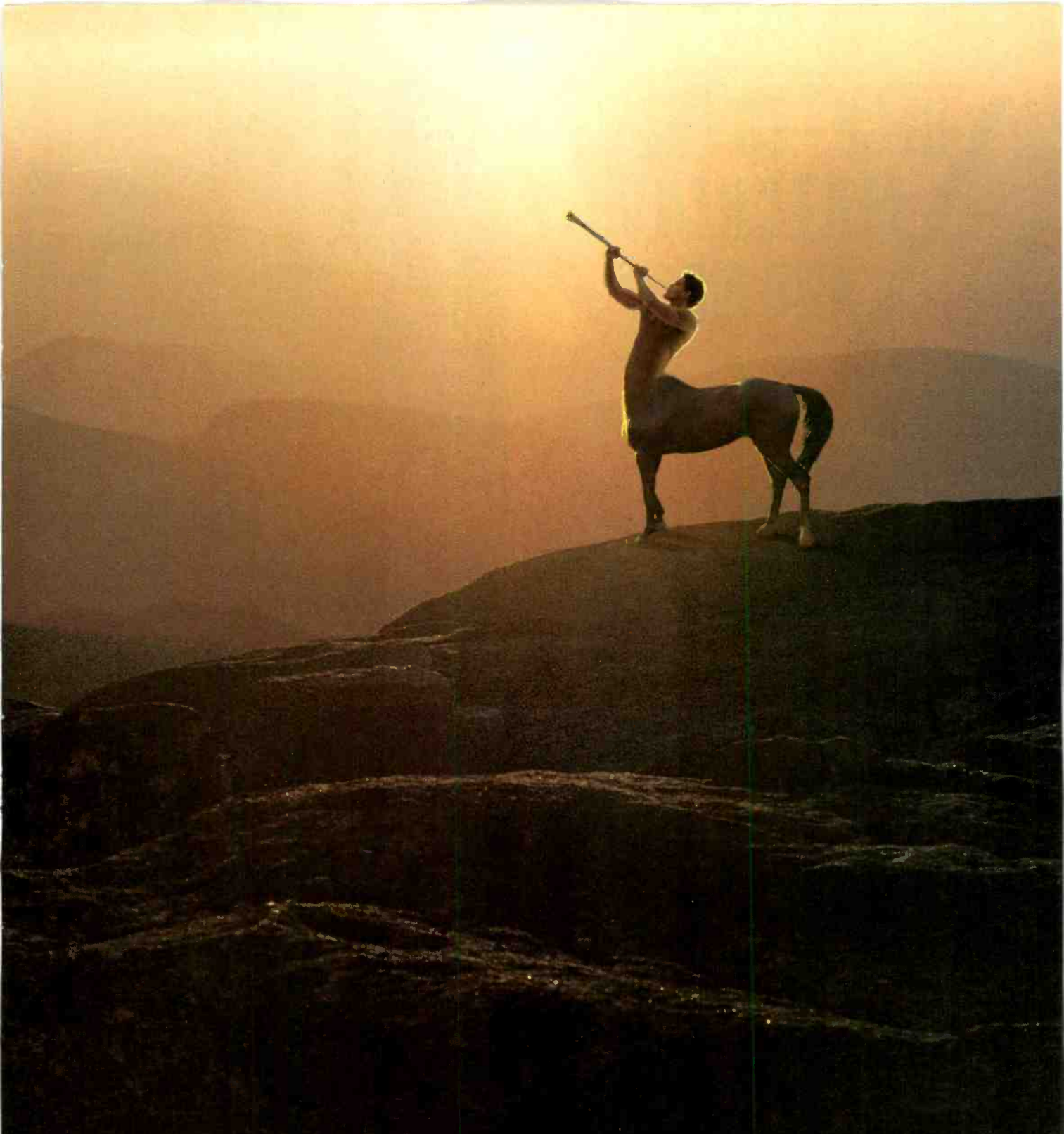


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DECK-TO-DECK MATCHING AND NR:

STRAIGHTENING THE MIRROR

Every person who has a tape recorder does some editing, and every cassette deck used by a serious recordist includes some form of noise reduction. Substantially all decks have Dolby B NR, and many of the current models have Dolby C NR as well. About 10% of the models listed in *Audio's* Annual Equipment Directory (October 1985) include dbx NR. The probability is thus very high that an original recording and any edited copy made of it will have some form of noise reduction.

Because the frequency responses of the mastering, the rerecording and the final playback deck all contribute to the end result, it is important that response deviations be kept as small as possible, when they can be controlled. This is especially true when noise reduction is used. The material that follows provides guidelines on how to pinpoint what errors actually exist, determine their effects, and correct or compensate for them.

Real Frequency Response

For a long time, the only way to measure frequency response (more correctly, amplitude response versus frequency) was to set an oscillator to a number of separate frequencies, one by one, reading the output amplitudes on some sort of meter. The development of the VCO-based function generator led to the availability of sources that could be swept electronically from 20 Hz to 20 kHz. Because the better units had very stable amplitude over the entire frequency range, they were popular for evaluating all types of products. Relatively recent test instruments have introduced a noncontinuous type of

Howard A. Roberson



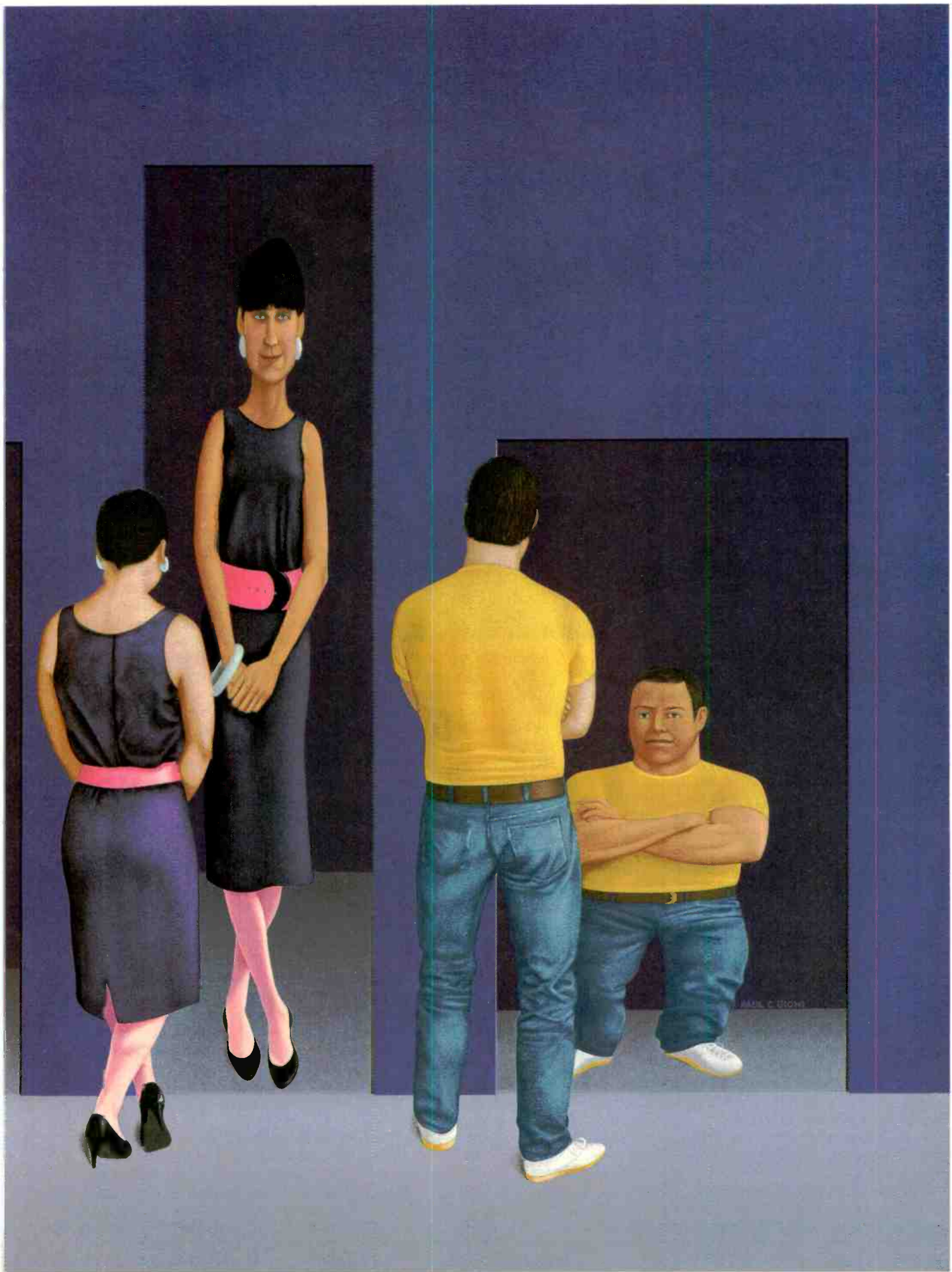


Illustration: Paul C. Gioni

It might not seem logical to decode NR and then re-encode it on retaping, but my tests showed the best results when this method is used.

sweeping: A stepping through many frequencies under the control of a microprocessor.

Unfortunately, for all the appeal and popularity of the current sweeping/stepping sine-wave sources, they should not be used for evaluating the responses of tape recorders, especially if any form of noise reduction is used. The interrelationships among bias, spectral content of the signal, and self-demagnetization effects are such that the response at 10 kHz, for example, will vary with the amount of energy at lower frequencies.

Without noise reduction, these changes are not large, and the response errors are quite small. With noise reduction, however, other factors are introduced which cause much larger response deviations to appear *in the process of evaluating* single decks or an editing system. In past articles and "Equipment Profiles," I have commented that the dbx NR system *must* be tested with a broad-band signal, such as pink noise, so the dbx broad-band detector(s) can sense recording and playback levels properly and set the complementary encoder/decoder gains correctly. Use of a sweeping or stepping signal would generate level variations related to the deck's frequency response errors. These variations would be doubled by the decoder expansion, but the deviations resulting would *not* demonstrate a tracking error in the NR system—they would show the results of using the wrong test stimulus for the device under test. As the computer freaks say, GIGO (garbage in, garbage out).

Because the error that appeared with swept-sine testing of Dolby B NR was small, this system seemed to be immune to any similar sort of false response indication. With the introduction of Dolby C NR, there was—all of a sudden, it seemed—evidence of severe response and mistracking errors with the use of a swept/stepped sine-wave source. The new NR system seemed further damned when it evidenced mistracking at 10 to 15 dB below Dolby reference level (200 nWb/m), even though the response was quite good at -20 dB.

A review of the basic characteristics of both the Dolby B and C NR systems convinced me that a broad-band test



signal was a must for accurate response testing of both versions. However, a serious question remained on the large deviations that appeared when Dolby C NR was tested with pink noise. Figure 1 shows playback responses of three decks, each playing a tape it didn't record. None of the results would be considered acceptable. Was there some sort of measurement error?

After rereading Ray Dolby's paper on the Dolby C NR system, I concluded that I should take a better look at the spectral characteristics of music. Dr. Dolby's paper clearly stated that filtering was included to eliminate the problem of differences in high-frequency responses, but normal pink noise is not that close to music, spectrally. Figure 2 shows the range of maximum levels measured over a period of time in the 10 standard octave bands during a portion of an audiophile recording of "Night on Bald Mountain" by Mussorgsky. In this 'scope photo, take particular note of the fact that the highest levels in the upper frequencies roll off at about 5 dB/octave, from the 1-kHz band on up. The pattern shown is matched closely by most types of music, whether recorded or live.

There does exist, therefore, a very valid reason for shaping the pink-noise signal to make it more music-like. This will yield a more accurate indication of the actual mistracking between the Dolby sliding-band compressing encoder and expanding decoder in the real world of music and tape recorders. The first version of what I call "PN/Music" has a spectrum as shown in the bottom trace of Fig. 3. The roll-off was obtained with the combination of a 1½-octave filter having a 14-dB cut centered on 19 kHz, and a low-pass cutoff filter at 20 kHz. For convenient display analysis, the playback from the deck was given a complementary boost (top trace) by trimming the filter's shape and position to get the flat total response shown in the center. The roll-off frequency chosen is somewhat higher than that of the music sampled in Fig. 2, which makes the test stimulus a bit more challenging than the music sample and closer to what some synthesizers might do. The energy in the 20-kHz band, however, is 15 dB below what it would be without the roll-off—*much* closer to the actual relative levels in music.

Figure 4 shows the results of four test conditions with a high-quality, three-head deck. The top trace is the measured output with the monitor switch on "Source." The second trace is the record/playback response with Dolby C NR at -20 dB, with the pink noise extending to 50 kHz. It would be a mistake to regard what is shown as severe tracking error, for, as seen in the third trace, cutting the noise off at 25 kHz improved the response dramatically. There were relatively minor deviations in response over a range of levels from -25 dB to Dolby level. The bottom trace was secured using PN/Music. Its shape stayed *exactly* the same from the bottom-level noise limit to almost "+10" on the deck's meters, showing that the tracking was actually outstanding—something that would have been obscured if a non-music-like test signal had been used.

Record on One Deck, Play on Another

For the following investigation, a total of seven cassette decks were used. For convenient reference, I assigned numbers to each: Nakamichi BX-300,

#1; Revox B215, #2; Akai GXR99, #3; Technics RS-B48R, #4; TEAC V-500X, #5; Aiwa AD-M700, #6; and Nakamichi 582, #7. This collection represented a wide range of price and performance. All of the decks have Dolby B NR, decks #1 to #5 have Dolby C NR as well, and decks #4 and #5 also have dbx NR. To designate recording on one deck with playback on another, I will use abbreviations; recording on deck #2 with playback on deck #4, for example, will be shown as "R2/P4."

In general, tests were run using the NR systems built into the decks. To pin down the cause of some of the effects observed, I used two outboard processors, a Nakamichi NR-200 for Dolby NR tests and a dbx 224 for dbx checks.

The first task was to ascertain the record/playback responses without NR. Figure 5 shows the results with decks #1 to #5: The responses are all quite flat, but some differences exist. Figure 6 shows what happens when recordings made on deck #1 are subsequently played on decks #1 to #5 (R1/P1 to R1/P5). Similar checks were made of R2/P1 to R2/P5, R3/P1 to R3/P5, and R4/P1 to R4/P5. Collectively, they told this story: Deck #1 showed a high-end boost when playing back tapes from other decks, particularly #2 and #3. Deck #2 played the tape from #1 quite flat, but showed a similar boost with the tape from #3 and a general high-end rise with the tape from #4. Deck #3 played tapes from #2 and #3 very flat, but had a slight droop with the tape from #1 and a roll-off with the tape from #4. Deck #4 showed a sharp roll-off at the high end with all tapes, and had a noticeable droop with the tape from #1.

The differences described here are primarily from the various versions of playback equalization as actually used in the decks. The boosts and roll-offs are *not* from the very small discrepancies in azimuth alignment that existed during the tests. This is the first area of concern to be introduced: Even without NR, the flatness of the playback can be affected by differences in playback equalization, and perhaps azimuth alignment, from one deck to another. With NR, these response deviations can be expanded by action of the decoder. To minimize such effects

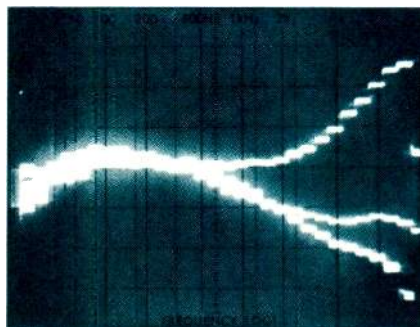


Fig. 1—Record/playback responses using pink noise with Dolby C NR. Deck #1 playback of tape made on deck #4 shows large high-end boost (top trace). Deck #3 playback of a tape from deck #2 has large droop at high end (middle trace). Deck #4 playback of a tape from deck #5 has even more droop, plus roll-off (bottom trace). (Vertical scale for this and all other figures: 5 dB/div.)

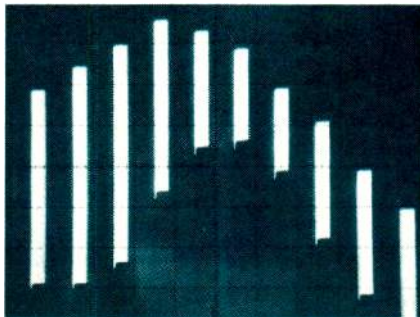


Fig. 2—Range of octave-band maximum levels during a portion of a recording of Mussorgsky's "Night on Bald Mountain."

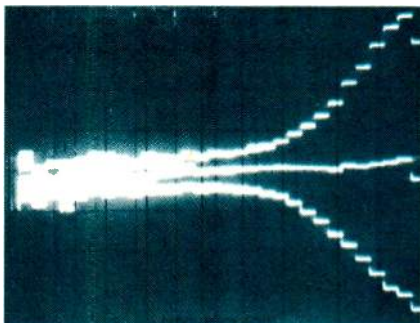


Fig. 3—Shaped pink-noise spectrum to make "PNIMusic" (bottom trace), equalization added after tape recorder's playback to make flat RTA display with flat record/playback responses (top trace), and result without recorder in loop (middle trace).

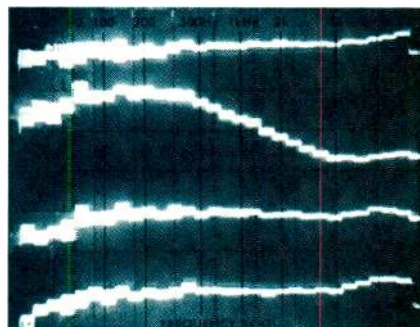


Fig. 4—Four test conditions using a high-quality, three-head deck. From top to bottom: Monitor switch on "Source," record/playback response at -20 dB with pink noise from generator extending to 50 kHz, record/playback with 25-kHz low-pass filter on noise generator's output, and record/playback with PNIMusic. All record/playback responses were made with Dolby C NR.

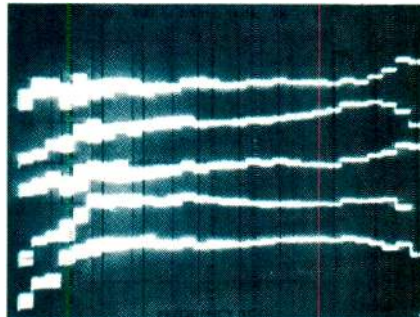


Fig. 5—Record/playback responses without NR for decks #1 through #5 (top to bottom); see text.

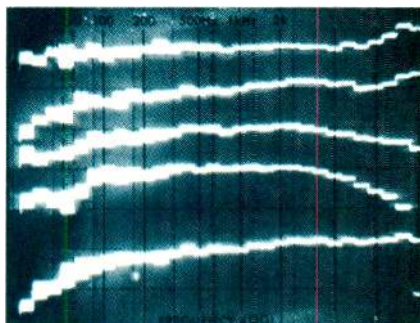


Fig. 6—Responses of tape recorded on deck #1 played back on decks #1 through #5 (top to bottom).

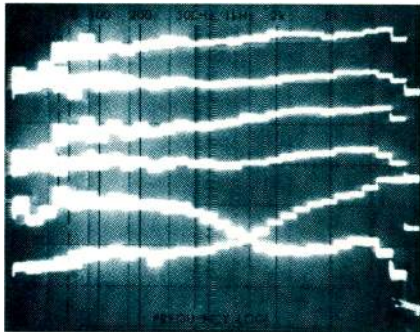


Fig. 7—Record/playback responses with decks #6 and #7. From top to bottom: R6/P6 without NR, R7/P7 without NR, R6/P6 with Dolby B NR, R7/P7 with Dolby B NR, R6/P7 with Dolby B NR showing a rising high end, and R7/P6 with Dolby B NR showing a high-end droop.

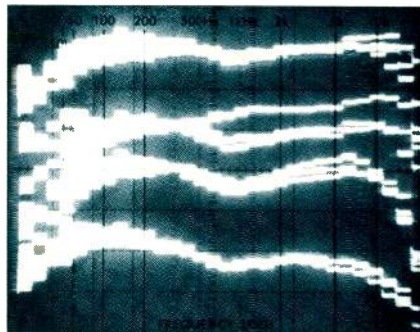


Fig. 10—Dolby B NR responses using Nakamichi NR-200 processor. From top to bottom: R3/P3 to R6/P6, overlaid; R3/P4 to P6; R4/P3, P5, and P6; R5/P3, P4, and P6.

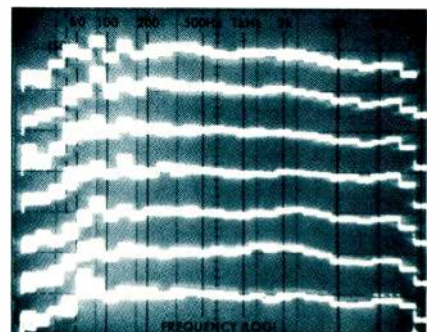


Fig. 13—Effects of decoding and re-encoding using Dolby B NR. Traces are of R7/P7 feeding R6/P6 at levels from -25 to +5 dB. See text.

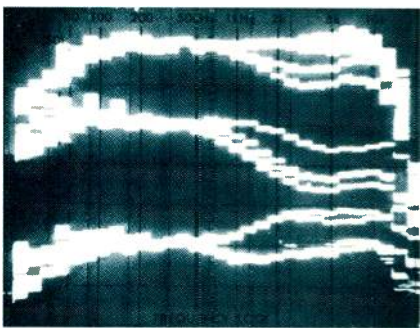


Fig. 8—Responses, from top to bottom, of R4/P3, P5, P6, and P7; R5/P3, P4, P6, and P7; R3/P4 to P7. See text

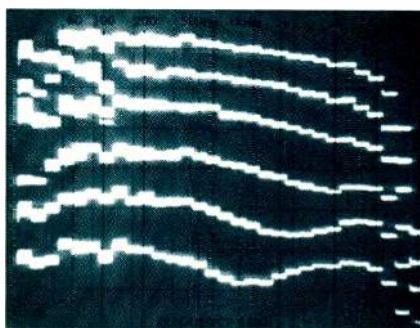


Fig. 11—R7/P6 with Dolby B NR, using Nakamichi NR-200, from -25 to +5 dB.

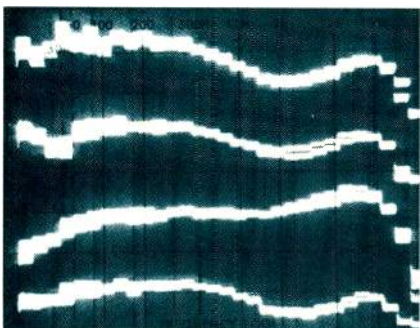


Fig. 9—Effects of multiplex filter on Dolby NR mistracking. Each trace shows overlaid responses of tapes recorded on deck #7, with and without MPX filter, played back on decks #6, #4, #5, and #3 (top to bottom).

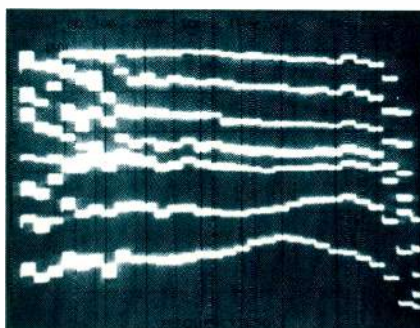


Fig. 12—R7/P6 with Dolby B NR, using Nakamichi NR-200, from about -20 to +5 dB with +4 dB play calibration offset.

when editing tapes, careful deck selection can well be in order.

What Happens with Dolby B NR

Figure 7 shows the results of interchanging tapes between decks #6 and #7. Both decks' record/play responses (R6/P6 and R7/P7) are very good, with or without Dolby B NR, but the R6/P7 and R7/P6 responses (with NR) are very poor. I should point out that all responses were measured with PN/Music, which would ensure the best test results. With deck #7, it was possible to adjust record sensitivity to match Dolby level, but that was not possible to do with deck #6. The latter also has a drooping playback response compared to deck #7. This does appear to be a bad combination for Dolby B NR recording on one deck and later playback on the other.

Figure 8 shows the results for several deck-to-deck crosses: A tape recorded on deck #4 played back on decks #3, #5, #6, and #7; a tape from deck #5 played back on decks #3, #4, #6, and #7; and a tape from deck #3 played back on deck #4 through deck #7. The tape from #4 worked well in decks #5 and #7, and the tape from #3 had just a slight saddle in the mid-highs when played on decks #4 and #6. The rest would be considered marginal or worse.

The tape from deck #7 was then played back on decks #3 to #6 (Fig.

Even without NR, playback flatness can be affected by differences in playback equalization, and perhaps azimuth alignment, from one deck to another.

9), after recording with and without the multiplex filter. The very minor differences demonstrate that use of the filter will not solve the problem.

The next tests used the Nakamichi NR-200 as the Dolby B NR processor for decks #3 to #6. This permitted setting up each deck to match the same NR unit, thus removing the question of Dolby NR differences from deck to deck. I must emphasize that this procedure does *not* eliminate all possible errors in making play- and record-level calibrations. They are minimized, but the two-head decks (#4 and #5) and the 1-dB meter steps of the NR-200 made exact level matching among decks close to impossible.

The topmost trace of Fig. 10 shows the overlaid record/playback responses of decks #3 to #6. There is some spreading at the low end and differences at the high end, but they are quite close in general. The other traces, from top to bottom, show results for R3/P4 to P6; R4/P3, P5, and P6; and R5/P3, P4, and P6. These results are better than those in Fig. 8, where the individual decks' NR systems were used, but the responses are disappointing in showing that effects remained from level and/or response differences.

I mentioned earlier that I could not be certain how well I had matched calibration levels, even when using the NR-200 as the common NR system. Figure 11 shows the Dolby B NR responses for R7/P6 over a range of levels from about -25 to +5 dB. Mis-tracking is certainly in evidence, and there is a general roll-off across a good part of the band at all levels. I then adjusted "Play Cal" on the NR-200 to make the -20 dB response of R7/P6 look the flattest, and reran the range-of-levels test. Figure 12 demonstrates the great improvement in responses over the entire level range with the "Play Cal" offset. A separate check showed that I had increased the play level by +4 dB. I had not expected that this adjustment would be so effective. In addition, I was surprised at the large adjustment needed to compensate for both calibration errors and response effects on overall level to make deck #6 track properly when playing tapes made on deck #7.

All of the above has been predicated

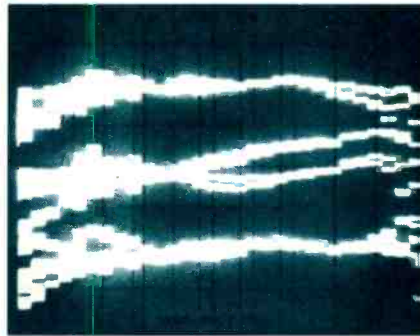


Fig. 14—Overall record/playback responses using each deck's Dolby C NR circuits. From top to bottom: R1/P2 to P5; R2/P1, P3, P4, and P5; R3/P1, P2, P4, and P5.

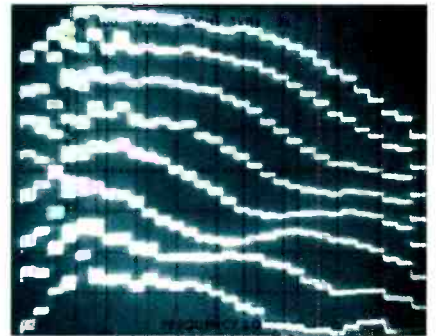


Fig. 16—R5/P6 with Dolby C NR, using Nakamichi NR-200, from -30 to +5 dB.

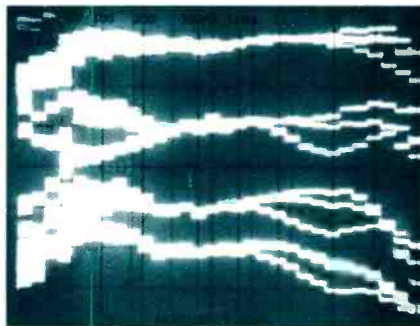


Fig. 15—Record/playback responses with Dolby C NR using Nakamichi NR-200 processor. From top to bottom: R3/P3 to R6/P6, overlaid; R3/P4 to P6; R4/P3, P5, and P6; R5/P3, P4, and P6.

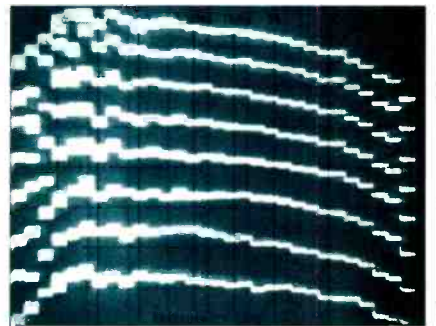


Fig. 17—Same as Fig. 16 but with play calibration offset +5 dB.

on the condition that the ultimate playback deck is not available for the editing and on the assumption that there is no advantage in decoding a Dolby B NR tape just to encode it again in making a copy. In other words, we should copy the Dolby B NR tape with NR out—or should we? It seems to make sense to avoid decoding and re-encoding, but the previous tests have shown many poor results from doing just that. Figure 13 shows the result of R7/P7 as the source for R6/P6, all with Dolby B NR. With this combination, P7 was decoded and R6 was re-encoded; final decoding was done with P6. The range in levels is from -25 to +5 dB, with excellent tracking in all respects. A comparison with Fig. 7 demonstrates

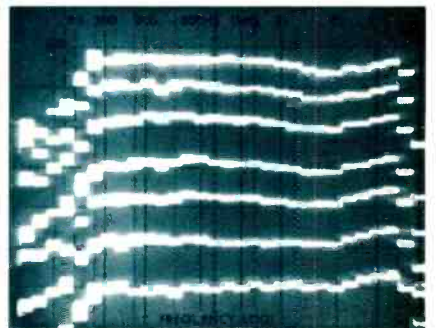


Fig. 18—R4/P4 with that playback feeding R3/P3, with both decks using Dolby C NR, over a range from -25 to +5 dB.

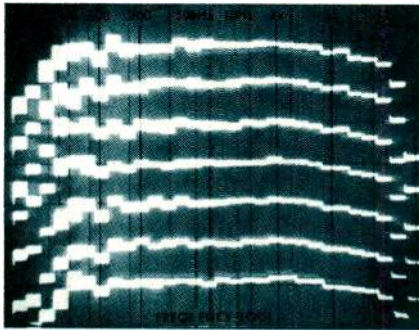


Fig. 19—R6/P6 with dbx NR, using dbx 224 processor, from -25 to +5 dB.

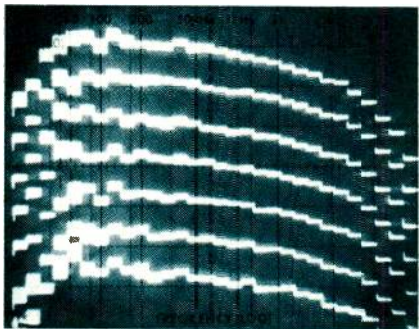


Fig. 20—Same as Fig. 19 but for R5/P6.

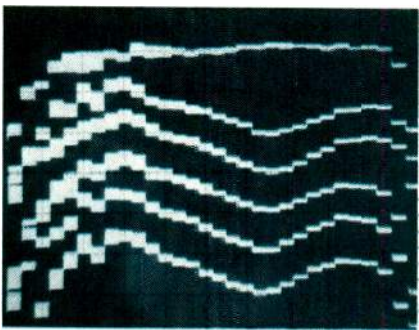


Fig. 21—From top to bottom: R6/P6 using dbx 224, R6/P6 with non-flat equalization before the dbx encoder, R7/P7 with P6 as the input, P7 back to R6/P6, P6 back to R7/P7, and then P7 back to R6/P6 again, making a fifth-generation copy.

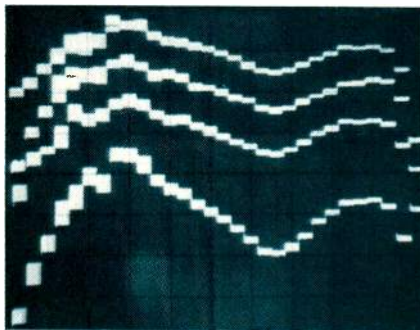


Fig. 22—Buildup of recorder response errors. From top to bottom: Test signal with same equalization as in Fig. 21, R6/P6 with this equalization inserted after the dbx 224 encoder and before the deck's input to simulate recorder response errors, R7/P7 without further equalization and using P6 as the source, and R6/P6 with additional equalization between encoder output and deck input using P7 as the source.

the great improvement gained by doing what seemed unnecessary.

If at all possible, you should make your edited copy on the ultimate playback deck with NR switched in for both decks. Even if the final-play deck is not available to you, follow the same plan, using NR on both decks involved in making the copy. If you are using a double-kwell editing deck, make certain you know what you can and can't do as far as NR is concerned. The probability is that you will *not* be able to decode the tape you're playing and re-encode the copy being made, which would be preferable. You may have no choice but to copy the tape in its encoded form, in which case you can try different tape formulations to see which gives the best final result. It would probably also help to match recording levels so that copies of Dolby-level tones would also be at Dolby level; this may take some experimenting.

To summarize what has been shown: Because of differences in calibration levels and recorder responses, both playback and record/playback, there is likely to be some Dolby B NR mistracking when a tape made on one recorder is played back on another. The best plan when making an edited copy is to decode the original on the

playing deck and re-encode it on the recording deck. It is possible to make considerable improvements in the playback of a Dolby B NR tape recorded on another deck by using an out-board processor and adjusting the play calibration level. An increase in this level will bring up the drooping mids and highs; a decrease will pull down a high-end exaggeration or reduce extra presence. This will be discussed further, after a look at Dolby C and dbx NR.

And Then Came Dolby C NR

Considering some of the poor results I've obtained from testing in months past, I was really interested to see how Dolby C NR would perform using PN/Music. Figure 14 shows R1/P2 to P5; R2/P1, P3, P4, and P5; and R3/P1, P2, P4, and P5. The majority of these responses are really quite good, with the exceptions of R1/P4, which had a sharp roll-off, and R2/P1 and P5, which showed elevated mids and highs. Next, the NR-200 was inserted, with Dolby C NR selected, to replace the NR systems for decks #3 to #6. The record/play responses of each deck were quite good (Fig. 15, top trace), but the playbacks on other decks were not to be applauded.

To get a better feel for what was happening, I used a range of levels from -30 to +5 dB for R5/P6 using the NR-200. Figure 16 displays obvious mistracking and also a severe roll-off at the high end. I went back to "Play Cal" and increased the play level by 5 dB. There was still a general roll-off with increasing frequency (Fig. 17), but the response shape was very consistent over the range of levels. Fairly simple equalization, even a little treble from a tone control, would bring the response to within ± 1 or ± 2 dB over most of the audio band. Further comments on level calibration, responses, and tracking will be made later.

Figure 18 demonstrates the improvement possible with Dolby C NR if there is decoding with the play deck and re-encoding with the editing deck. The combination used was R4/P4 with that playback feeding R3/P3, over a range from -25 to +5 dB. Compare the flatness of these results with the third set of traces in Fig. 15, where the same combination of recorders had a

If at all possible, make an edited copy on the deck which you ultimately will be using for playback, with noise reduction switched in for both decks involved.

boost at 5 kHz and a severe roll-off above that when there was no decoding and subsequent re-encoding between recorders.

The above results illustrate that with Dolby C NR, as with Dolby B NR, the final playback will most likely have the best response if the copy is made on the ultimate play deck. Level calibration adjustments with Dolby C NR also showed beneficial corrections of response deviations from mistracking.

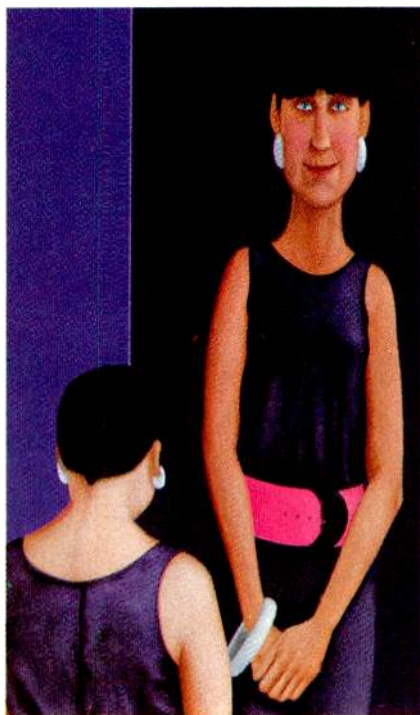
Editing with dbx NR

Although most decks do not have dbx NR, a fair percentage of audiophiles who have more than one deck probably have that capability, and some prefer to use it when editing. Also, among people who have small studios or who are involved in multi-tracking for other reasons, dbx is the NR system in widest use, especially if TEAC equipment is employed.

Figure 19 shows R6/P6 using the dbx 224 processor over a range of levels from -25 to +5 dB. It is obvious that the response droops somewhat at the high end, but there is no change in response shape over the entire range. A slight reduction in bias or a small boost with external equalization would make all of these responses very flat. Figure 20 covers the same range of levels but for R5/P6, also using the dbx 224 processor. The response shapes are very consistent, but the roll-off from the low to the high end is too large to be acceptable. It is true, however, that external equalization would gain a flat response at all levels.

Other checks showed that the dbx system of deck #5 tracked the 224 within ± 1 dB across the band over the entire range of levels—in fact, it was usually within ± 0.5 dB. The dbx circuits of deck #4, a less expensive unit, did not match the 224 as closely, but all points at all levels stayed within ± 1.5 dB. The fundamental cause of the falling responses in Fig. 20 was the lower playback equalization of deck #6 compared to deck #5. This demonstrates the importance of flat recorder responses with the same playback equalization for best results when moving tapes from one deck to another.

I would like to emphasize that the dbx system does *not* multiply frequency response deviations in what is be-



ing recorded. Figure 21 provides proof of this assertion. At the top is R6/P6 using the 224 processor. Next is R6/P6 with equalization inserted *before* the encoder; in other words, a non-flat response was recorded. The third trace shows R7/P7 with the playback output from deck #6 as the input. In the fourth trace, deck #7's playback is the input for R6/P6 again, which goes to R7/P7 again (fifth trace), and finally to R6/P6 (bottom trace). The external equalizer, of course, was used only for the initial recording. There are some slight changes in the responses, but the *fifth*-generation playback using dbx NR was very close to the first playback, and careful examination is required to find any differences.

Deviations in the response of the recorder, however, *do* cause errors. The deviations are multiplied in rerecording, such as when bouncing tracks, but they are *not* multiplied by dbx NR. This is shown in Fig. 22. The topmost trace is of the test signal, with the same equalization as used in Fig. 21. The second trace is of R6/P6; the equalization was applied after the dbx 224 encoder—that is, within the encode/decode loop. Note that this signal is, nevertheless, still very similar to the topmost response. The third trace is

R7/P7, with the second trace (decoded output of P6) as the input signal; no NR or equalization was inserted. Up to this point, the playback looks like the original input, with the addition of the decks' response variations.

In the bottom trace, deck #7's output (the third trace) was rerecorded on deck #6 with dbx NR, and the equalization was inserted once again between the encoder and the input of the deck. As the trace shows, the deviations are double those in the response itself—but this is due to the double use of the equalization. The purpose of the equalization was to simulate a recorder having poor response; the dbx NR has added nothing further to the deviation. When Dolby NR is used, however, response discrepancies could cause some mistracking due to overall level shifts.

The point here is that flat recorder response is even more important in multi-tracking with repeated playbacks and rerecording, where response errors will build up. This is true with or without NR.

Guidelines for Good Editing

Considering the chamber of horrors presented above, the recordist could be quite convinced that avoiding any form of NR is the best course. In fact, if a high signal/noise ratio is not needed, such as with a fair amount of rock music that exhibits considerable compression, editing without NR (except as needed to decode an encoded original) will ensure that there cannot be any response-error multiplication in playback. I suggest marking any tapes recorded without NR to make it clear that NR should not be used in playback.

In your general approach to making recordings, especially originals, make certain that all heads are aligned accurately. Select recording tape that gives the flattest response at -15 to -20 dB both with and without NR, and trim bias, if possible, for the best overall flatness. If you do not have test equipment, rely on listening tests. Checking the "before" and "after" sound quality using FM interstation noise is a good method if you don't have a pink-noise generator. Very few decks these days have record-sensitivity adjustments; consider yourself fortunate if your deck

Accurate head alignment, proper bias adjustment, and matching the tape's record sensitivity are required for original, playback, and editing decks.

has that facility, either manual or automatic. Matching record sensitivity is essential for getting good Dolby NR responses, but the matching is not important with dbx NR.

Some manufacturers state which specific tape formulation was used to set up a particular deck, and that is usually a reliable choice for making an original recording. If a long list of tapes is given in the manual, the information is virtually worthless unless the deck has automatic calibration. One way to select a tape for correct record sensitivity is to record a tone of 400 Hz or so at zero level on the meters, rewind the tape, and check the meter levels in playback. Many decks are set up quite well, and there is a good chance that the tape which shows the same level in record and in playback is the one with the correct sensitivity. This test cannot be run with a noise source at a high level because saturation effects at the high frequencies will cause level discrepancies to appear in playback.

The requirements for the editing deck are the same as for the original/playback deck: Aligned heads, adjustment of bias for the best response, and record sensitivity to match the tape used. Tape selection, of course, can secure excellent bias and sensitivity matching in quite a few cases. If your source is not another tape, then the deck you are recording on is the original as far as taping is concerned. In any event, the recordist is faced with the challenge of making a tape that will perform well on another deck, without that deck being available for checking such things as head alignment or Dolby play-level calibration. And this says nothing about the playback response of that deck.

If the deck that will ultimately be used for playback is available, record your final, edited tape on it. If your source is another tape deck, it should be set for whatever NR decoding is appropriate to the original tape. The signal should be re-encoded by the deck you are recording on, even if the same NR system is used. As the tests described above have emphasized, flat responses are a must for all encode/decode NR systems, and level calibration is a further requirement for the two Dolby NR systems. If the deck used for final playback is not available



and it is a premium deck of recent vintage, the editing deck should be similar, primarily to match the playback equalization. If the final-use deck is of medium quality, it is less significant what the editing deck is. If the quality of the final-play deck is unknown, or you will be editing for decks with different requirements, consider acquiring a deck of recent vintage and of medium to medium-high cost.

If you must make copies of tapes that are already NR-encoded, I recommend that you get a separate processor (or two) with record and playback level adjustments—useful with dbx and close to essential with Dolby NR for the best results. Purchasing a Dolby-level calibration tape will be necessary to get the most out of the processor, and that's a good thing to do even if you just want to check the play/meter calibration of your decks.


If the tapes to be edited have Dolby NR, consider the possibility that you may improve the overall sound by changing play calibration to get better flatness and tracking. If possible, have the person who supplied the original tape put a bit of pink noise on one end of it. The noise should be limited to 20 kHz and recorded at -20 dB, using the same NR as the rest of the tape. By

ear or—even better—with an RTA, you will be able to use the processor's play calibration to flatten the response and then equalize it to make it really flat. Verify your choices by listening to the recorded material: Raise the play calibration level to get rid of dullness and to fill in the middle, and reduce the play calibration level to bring down exaggerated highs and excessive presence. If everything sounds fine, don't change anything.

It may be helpful to remember this fact: With a single recording and subsequent playback on any other deck, none of the NR systems discussed here will generate uncorrectable response errors—at least if level (for Dolby NR) and equalization adjustments can be made between the processor and the deck(s). For example, if record sensitivity is too high with Dolby NR on the recording deck, it can be compensated for by lowering the play calibration level of the processor fed by the playback deck.

Nakamichi and Tandberg decks include sharp cut-off filters above 25 kHz to help remove the possibility that above-band energy will cause Dolby NR tracking problems. With other decks, the user might want to add a low-pass filter if there's any doubt, such as when recording a synthesizer. Because the multiplex filter's response rises between 19 and 38 kHz, it might not prove to be effective enough for this purpose.

Summary

With all of the decks under your control, try to have record and playback heads accurately aligned. Accurate tape-to-deck matching is essential to make the responses as flat as possible for both Dolby and dbx NR and to get the right record sensitivity for good Dolby NR tracking. When copying a tape with NR, decode it on the playing deck and then re-encode it on the editing deck for the best overall results. Remember that differences in playback equalization can have a noticeable effect on the response in final playback. Flat record/playback responses are especially important when rerecording a number of times. Be wary of possible measurement errors if you make your own tests. And finally, good luck and good listening! 

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MATCHING A MIKE

HOWARD A. ROBERSON



In most cases with non-studio recorders, significant improvements in the quality of live recording can be gained by using professional microphones. With a small number of exceptions, these microphones are low-impedance sources with the signal fed via a shielded cable with two inner conductors. This signal pair is actually floating electrically and is *not* connected to the microphone case, which is connected to the shield. Because of the low source impedance, the signal can be fed long distances with very little high-frequency roll-off. As most noise is picked up equally in the two signal conductors, it can be reduced greatly by the use of a transformer or a well-balanced electronic input at the end of the cable run.

Because high-fidelity and semi-pro recording equipment does not, in general, have the three-pin inputs and configuration for proper termination of such cable runs, it is common practice to use transformers that are designed to match the low-impedance source (microphone) with the recorder's input impedance. This sounds pretty simple and direct, and it is. But there's a catch: The input/terminating impedances vary among equipment types.

Most professional equipment will have an input impedance of 20 to 50 kilohms on each high-impedance input. (For example, the Ramsa WR-S208 mixer has 20 kilohms, and the TOA MX-106R mixer-amplifier has 50 kilohms.) Matching transformers such as the Shure A95 Series are designed to match a typical microphone source

of 150 ohms to such input impedances. Nevertheless, many cassette and open-reel recorders have medium-impedance terminations, on the order of 3 to 10 kilohms. If a nonprofessional microphone that matches this impedance is used, there is no deleterious effect from the load. However, with a professional microphone and the typical matching transformer, the input impedance of the deck presents a load that is too low in value.

In recognition of this factor, Shure also offers the A97 Series transformers that are made for medium-impedance loads, and they should be more widely used than they are.

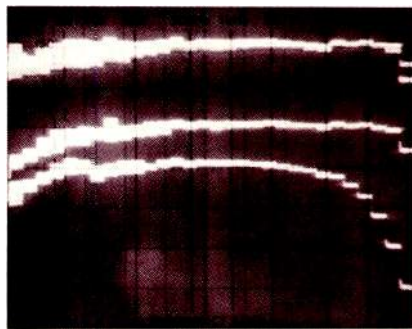



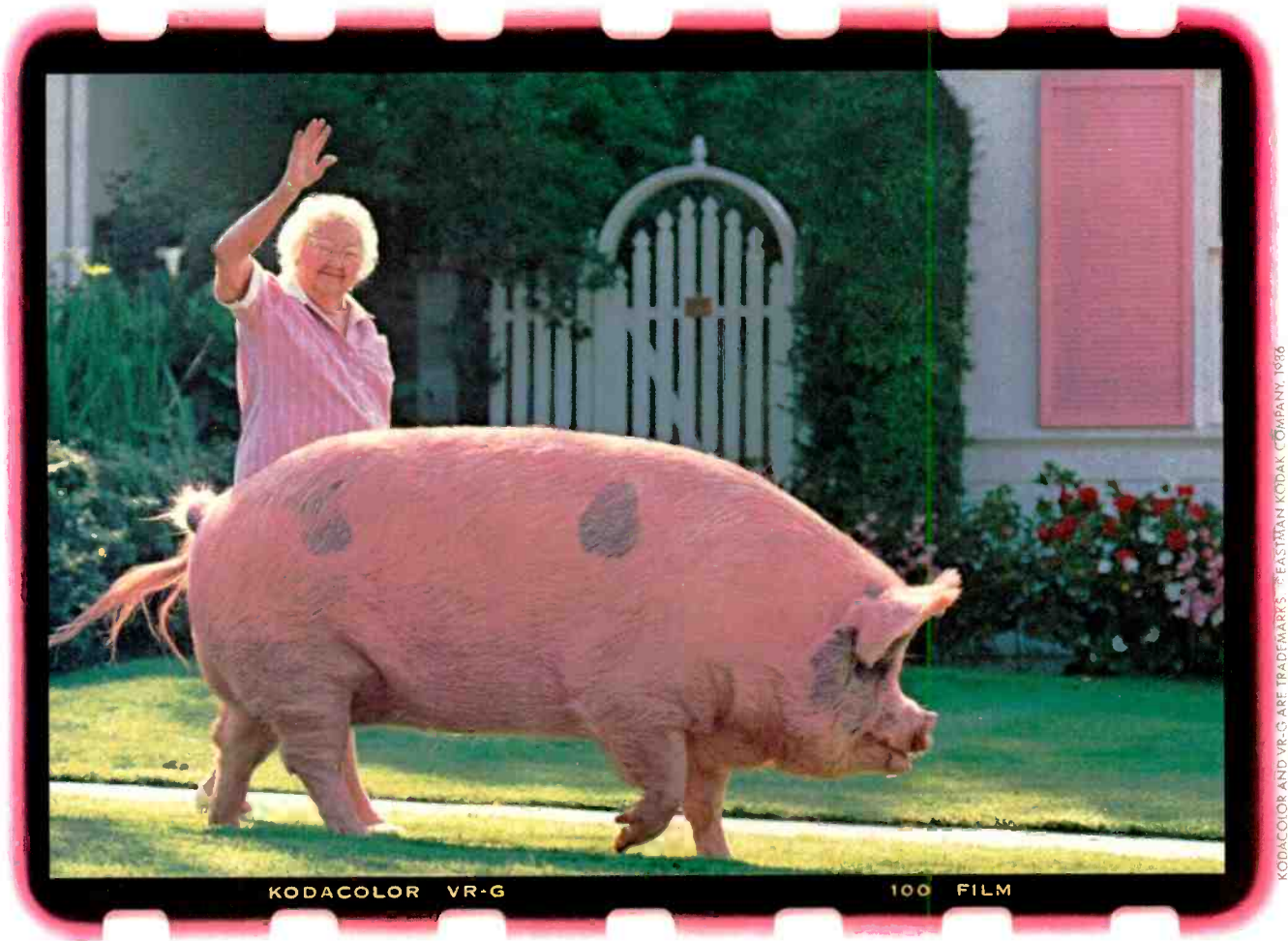
Fig. 1—Effects of input impedance mismatch on frequency response (see text). From top to bottom: Overlaid responses for low/high impedance transformers feeding line input; response for low/medium impedance transformer feeding typical medium-impedance microphone input; response for low/high impedance transformer feeding medium-impedance mike input. (Vertical scale: 5 dB/div.)

Figure 1 illustrates the problem and the solution. At the top are two overlaid traces of pink noise at low impedance fed into the line input of a high-quality deck. In one case, the noise went through a low-to-high impedance transformer; in the second case, a low-to-medium impedance transformer was used. The responses are flat, with just minor differences at 20 kHz. The response in the middle trace was secured with connection made to the recorder's microphone input using the low-impedance/medium-impedance transformer. The bottom trace reveals what can happen with a low-impedance/high-impedance transformer connected to this medium-impedance input. The roll-off is obviously quite severe, and it is *not* a cable-run effect.

The general guidelines to ensure against such losses are: (1) Check the specifications of your recorder in its owner's manual, or contact the manufacturer. Do not accept verbal statements from sales personnel; ask to see the number in published form. (2) If the input impedance is less than 20 kilohms, plan to use low-impedance/medium-impedance transformers such as the Shure A97 Series. Do *not* accept transformers that "will match any input," or which have no technical data sheet (such as comes with the Shure unit). (3) In case of doubt or lack of information, assume that the input on the recorder is medium impedance, and use that transformer. (4) If you do have to guess, and then find that you cannot get a high enough recording level with the medium-impedance transformer, try the low-to-high impedance transformer. There will be a higher voltage output, and there might not be too much roll-off with your particular recorder.

The probability is that low-to-medium impedance transformers will give you better responses—and I expect that's one of the reasons why you bought professional microphones in the first place. 

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1

NAKAMICHI CR-7A CASSETTE DECK

Manufacturer's Specifications

Frequency Response: 18 Hz to 21 kHz, ± 3 dB.

Harmonic Distortion: 0.8%.

Signal/Noise Ratio: 66 dBA with Dolby B NR, 72 dBA with Dolby C NR.

Separation: 37 dB.

Crosstalk: -60 dB.

Erase: 60 dB at 100 Hz.

Input Sensitivity: 50 mV.

Output Level: Line, 1.0 V; head-phone, 12 mW into 8 ohms.

Flutter: 0.027% wtd. rms, $\pm 0.048\%$ wtd. peak.

Fast-Wind Time: 80 S for C-60 cassette.

Dimensions: 17 $\frac{1}{8}$ in. W \times 5 $\frac{5}{16}$ in. H \times 12 in. D (435 mm \times 135 mm \times 306 mm).

Weight: 19.8 lbs. (9 kg).

Price: \$1,350.

Company Address: 19701 South Vermont Ave., Torrance, Cal. 90502.
For literature, circle No. 90



The CR-7A cassette deck introduces Nakamichi's latest automatic calibration system and offers other Nakamichi firsts as well. The microprocessor-controlled auto-calibration process includes the expected record-sensitivity and bias adjustments, but adds an important element to achieve superior results: The playback-head azimuth is first automatically aligned to the record head to eliminate misalignment as a source of drooping high-end response. Then, the bias adjustments can correct for true response deviations. In conjunction with accurate sensitivity adjustments, the best possible Dolby NR tracking is secured.

The azimuth correction is based upon the detected phase (time) difference between the left and right playback channels with a 400-Hz test tone. Time differences between tracks are the same whatever the frequency, and with squaring circuits, the interchannel time error (ICTE) is easily measured. The ICTE is, of course, directly related to the misalignment, and the system's servo drives to reduce the error to zero (in steps of about a minute of arc). I liked the approach and looked forward to seeing how it would fare in the tests. Nakamichi states that their response corrections have a criterion of ± 0.3 dB, and that sounded very good to me, even considering the numerous checks and rechecks of sensitivity and bias during the calibration process. At the conclusion of the procedure, bias and sensitivity data are automatically stored in the CR-7A's memory for that particular tape type, the test oscillator is turned off, user-preferred settings are restored, and the deck rewinds to "0000" and enters record/pause mode, ready to record.

The CR-7A uses Nakamichi's asymmetrical, dual-capstan, diffused-resonance, direct-drive transport for lower audibility of flutter and greater clarity of sound. To gain "smoother tape travel" and "more transparent sound," the capstan drive shafts have a special matte finish and the head assembly includes a pressure-pad lifter. Nakamichi was one of the first manufacturers to use a motor-driven cam to control a number of transport functions, and the three switch cams of the CR-7A inform the microprocessor of system status and tell it how to respond to operator instructions. Automatic slack take-up helps to minimize the chance of damage to tapes.

Quality electronics include direct-coupled recording, line, and headphone amplifiers; a fully discrete playback amplifier with direct coupling from the head; independent power supplies to each circuit, and matched Dolby NR ICs to keep tracking error within ± 0.25 dB.

The CR-7A is the first Nakamichi deck to include a real-time counter, which I'm really glad to see—I had almost given up waiting. I think that every deck directed at the serious recordist should include at least one real-time counter mode. The CR-7A offers the desirable nicety of both elapsed- and remaining-time display modes. The counter is not a true clock, because it calculates tape time from tape motion rather than measuring time directly. As a result, however, it has the more important attribute of staying calibrated even during fast winding. Time calibration takes about 8 S, which is quite speedy, and recalibration will take place if needed after a fast wind. Calibration is lost if a cassette is removed, but since recalibration is fast, this is of little import. The remaining-time calibration is purposely set

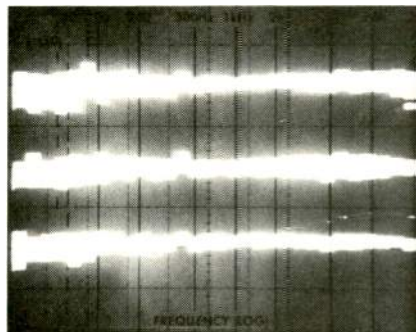


Fig. 1—Record/playback responses for "PN/Music" signal, recorded at -20 dB with Dolby C NR, showing overlaid results from 14 Type I tapes (top), 13 Type II tapes

(middle), and 13 Type IV tapes (bottom). See text. (Vertical scale: 5 dB/div.)

so that it reaches "00:00" 5 to 30 S before getting to the actual end of the tape. This helps to avoid the very end of the tape, where faint tape wrinkles caused by the hub clamps reduce recording quality. Also, the zero reading is a reference point for "Auto Fade." With this switched on, a recording will be automatically faded out at the tape end ("00:00") regardless of the actual counter mode. This is a handy feature, especially for those who can't stand the abruptness of a tape run-out.

Control Layout

A look at the front panel reveals other features of interest. The "Power" button is flush with the panel at the upper left; it would be difficult to turn off inadvertently, and that's good. The eject button, some distance below, initiates a smooth opening of the cassette-compartment door. The "Timer" ("Play/Off/Rec") slide switch is below the eject button and above the headphone jack. The compartment door is just to the right of these controls. With the door removed access to the head and drive assemblies is excellent. Some cleaning tasks are aided by the fact that the unit can be put in play mode without a tape in place, but caution is needed.

Dominating the top middle and right of the front panel is the multi-function display. At the left is the four-digit, three-mode counter display that indicates tape motion, elapsed time, and remaining time. For automatic time calibration, the correct tape length (C-46, C-60, or C-90) must be selected. Little "M" and "S" annunciators under the counter's figures remind the user of the minute/second nature of the readout; there are annunciators for tape length as well, showing the choice that has been made.

To the right of the counter are horizontal, two-channel, peak-responding bar-graph meters, each with 24 segments. All of the segments and some of the scale markings are light tan; "0" up to "+ 10" are red. The large number of segments and the 5-inch length of the bars make for easy interpretation of levels. Below the meter scales is "Auto

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Calibration," which is always illuminated. When that process takes place, "Azimuth," "Level," "Bias," and "Ready" illuminate in order, just below, showing the status of the calibration procedure. "Ready" stays illuminated at the end of the process, and remains so unless the cassette is ejected or the deck's power is turned off.

Next to these indicators, below the middle part of the meters, is "Tape" with "EX," "SX," or "ZX" illuminated to show the tape type (I, II, or IV) selected manually or in automatic calibration. To the right of these is the EQ readout, indicating 120 or 70 μ S. Normally, EQ would be selected automatically along with the tape type, but the CR-7A allows one to switch EQ for particular high-frequency recording needs: 120 μ S for more headroom, 70 μ S for lower noise.

The NR system choices are shown with "B" or "C" indicators, as well as "MPX Filter." "Subsonic Filter" lights up to show if that is being used. Further to the right are the "Source" and "Tape" annunciators, turned on in accordance with the monitor choice made.

Below the display panel, at the left, are the "Counter Reset" button (which does not affect time modes), the three-position memory switch ("Memory Stop/Off/Auto Repeat"), and the "Counter Mode" button. "Memory Stop" obtains a stop at "0000" with a fast wind in either direction. (Holding in the wind button will get a wind through zero, a desirable configuration.) "Auto Repeat" will get a repeated playing of the entire side of a tape.

Below are nine angled transport-control buttons, each with its own status light, arrayed in three rows. The top three buttons, from left to right, control rewind, play, and fast forward; all have light-green indicators. The second three control pause, stop, and record. The first two have light-green indicators, and record has a red one. The bottom row consists of "Fader" (with a down-pointing arrow), "Rec Mute," and "Fader" (with an up-pointing arrow). All of these have red indicators.

When the record button is pushed, the deck goes into record/pause mode ("Rec Mute" also lights up), and a push of the play button initiates recording. A push of the down fader reduces the record level to zero, and "Rec Mute" turns on again when this is complete. Pushing the up fader returns the record level to where it was. During fading, the intensities of the two fader indicators show the status of the fading. Holding in a fader button gets a faster fade than a single tap. "Rec Mute" mutes the signal while held in, but it does not get an automatic stop, as is obtained on some decks.

Below the middle and right side of the display are small buttons for selecting "EX(I)," "SX(II)," and "ZX(IV)" tape types, as well as "EQ," "Dolby NR," and "Peak Hold." As mentioned earlier, the tape-type and EQ switches are used only when manual choices are desired. The "Peak Hold" circuit gives a 2-S display of peaks at any signal level—even very low levels. This low-level capability is more important than it might seem, for it helps the user to judge all levels similarly. When it is on, "Hold" illuminates just below "Peak" at the left end of the meters.

Below the manual tape switches are the "Tape Length" selector button and the manual "Playback Azimuth" control.

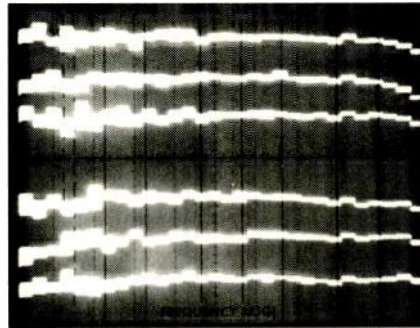


Fig. 2—Record/playback responses to high-level signals with Dolby C NR. Top three traces show response for wide-band pink-noise test signal at "+10" on the CR-7A's meter for Nakamichi EXII, SX and ZX tapes, respectively. Bottom three traces are for record/playback of "PN/Music" signal at "+8" on the meter for the same three tapes. See text. (Vertical scale: 5 dB/div.)

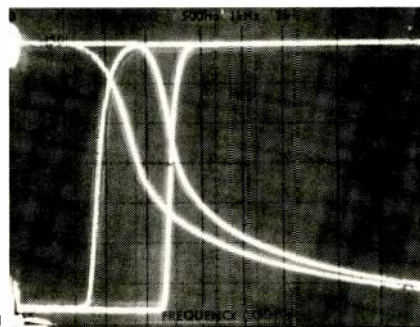


Fig. 3—Action of automatic fader circuits, showing fade-outs (traces descending from left to right) and fade-ins (traces rising from left to right). Left-hand trace of each pair shows action in slow mode; fast-mode fades are to the right. See text (Scales: Vertical, 10 dB/div.; horizontal, 2 S/div.)

I was struck at once by the outstanding flatness of the record/playback responses, particularly with Dolby C noise reduction.

When recording on the CR-7A, auto-calibration would be the normal route, and azimuth calibration would be part of that process. In playing back a tape recorded on another deck or a prerecorded tape, the front-panel azimuth control allows adjusting the playback head's azimuth to match the actual flux on the tape, setting it for maximum high-frequency output. This control is duplicated on the supplied infrared remote control so that the head alignment can be peaked from the listening position. As soon as the control (front-panel or remote) is turned or pushed to get a change, the meter scales blank out and the topmost meter becomes an azimuth-position indicator with a center arrow. Each step made in adjustment is about 2.5 minutes of arc—acceptably accurate in theory and a great convenience in practice.

To the right are the "Auto Calibration" push bar and its "Reset" button, for use in case of error, and the "Monitor" selector bar for source or tape. Along the bottom right of the front panel are four on/off buttons for "Manual Tape/EQ," "Auto Fade," "Subsonic Filter," and "MPX Filter." The "Tape/EQ" switch has an adjacent red indicator; all of the others have annunciators in the display area.

Along the right-hand end of the front panel, from top to bottom, are level-control knobs: "Master," "Left," "Right," and "Output." The "Master" knob is of medium size, and the other three are small. None have knurling, and the friction is slightly too high for easy turning of the small knobs.

The stereo in/out line jacks on the rear panel are gold plated, which is a nice touch. Two "System Remote" jacks—a DIN socket for transport functions and a mini-jack for the azimuth control—can be used to tie this deck into Nakamichi's CA-7 control amplifier.

I removed the top and side cover to examine the internal construction. After some hours of use, the shielded power transformer was noticeably warm to the touch, but still not hot. There are three soldered-in fuses on the power-supply p.c. board, which also contains the bias oscillator. The large logic p.c. board covers almost two-thirds of the chassis area. Below it is a medium-size p.c. board, and at the bottom is another large card which is close to half-chassis size. The soldering is excellent, but there was some flux noted at hand-wired spots. The logic card is well supported, in general, but there was some springiness noted. The overall chassis construction is rugged and very rigid, with large center and side rails from front to back. The transport was quiet in operation, especially in play.

Measurements

Playback responses with TDK and BASF test tapes were within 1 dB at most points, but there was a greater rise (1.6 to 3.0 dB) at the four highest frequencies of the 70- μ S tape. A number of premium decks have shown a rise in this region, although this deck's rise is about 1 dB greater than most others. This comes from Nakamichi's use of playback heads which correspond more closely to the ideal defined in the IEC Standards than to the IEC calibration heads most tape manufacturers use.

Record/playback responses of the CR-7A were checked using "PN/Music" (pink noise rolled off 6 dB/octave at 2 kHz) and a $\frac{1}{3}$ -octave RTA. I was struck immediately by the outstanding flatness of the responses, particularly with

Table I—Record/playback responses (–3 dB limits).

Tape	With Dolby C NR				Without NR			
	Dolby Lvl		–20 dB		Dolby Lvl		–20 dB	
	Hz	kHz	Hz	kHz	Hz	kHz	Hz	kHz
Nakamichi EXII	10.6	20.0	10.6	21.8	10.6	13.0	10.6	22.3
Nakamichi SX	10.7	13.0	10.7	21.1	10.7	10.2	10.7	22.0
Nakamichi ZX	10.6	21.0	10.6	22.0	10.6	15.0	10.6	22.4

Table II—Miscellaneous record/playback characteristics.

Erasure At 100 Hz	Sep. At 1 kHz	Crosstalk At 1 kHz	10-kHz A/B Phase		MPX Filter At 19.00 kHz
			Error	Jitter	
67 dB	60 dB	–100 dB	10°	15°	–31.9 dB

Table III—400-Hz HDL₃ (%) vs. output level (0 dB = 200 nWb/m).

Tape	NR	Output Level						HDL ₃ = 3%
		–10	–8	–4	0	+4	+8	
Nakamichi EXII	Dolby C	0.12	0.17	0.28	0.47	1.3		+6.0 dB
Nakamichi SX	Dolby C	0.07	0.12	0.26	0.76	2.2		+5.1 dB
Nakamichi ZX	Dolby C	0.04	0.07	0.13	0.33	0.81	2.0	+9.2 dB

Dolby C NR. Figure 1 shows the –20 dB responses for Type I, II, and IV tapes (top to bottom). Each trace is actually the stored collection of responses for many tapes having a wide range of performance. The Type I tapes included BASF LH-MI, Denon DX1, Fuji GT-I, Konica GM-I, Magnex Studio 1, Maxell XLI-S, Memorex dB, Nakamichi EXII, PDMagnetics FERRO, Scotch XSI, Sony HF-S, TDK D and AD-X, and Yamaha NR—a total of 14 widely different formulations. The Type II tapes included BASF CR-MII, Denon HD6 and HD8, Loran High Bias, Maxell UDS-II and XLII-S, Memorex CDXII, Nakamichi SX, Realistic Supertape Hi-Bias, Sony UCX, TDK SA and HX-S, and Yamaha CR-X—a total of 13 "noncompatible" tapes. The Type IV tapes were BASF Metal IV, Denon DXM, Fuji FR Metal, JVC ME-P, Konica Metal, Maxell MX, Nakamichi ZX, PDMagnetics 1100 Metal HG, Scotch XSMIV, Sony Metal-ES, TDK MA and MA-R, and Yamaha MR—a total of 13 tapes that are not as similar as some have been led to believe.

I find the results truly marvelous for flatness and consistency, and outstanding for record-sensitivity matching. The vertical spreading of the traces includes statistical effects of the pink noise, any differences in Dolby record-level calibration, any response deviations, and any Dolby C NR mis-tracking. All of the 13 to 14 responses for each tape type were completely acceptable, but the Nakamichi tapes supplied with the CR-7A (EXII, SX, and ZX) were used for the tests that followed.

I checked the record/playback responses with PN/Music at an rms level equivalent to Dolby level (" +8" meter). They looked so flat (Fig. 2, bottom three traces) that I next fed in, at maximum meter level (" +10"), pink noise that was *not*

The peak-responding meters are just that, except the decay time was short, making "Peak Hold" essential for good metering.

Table IV—HDL₃ (%) vs. frequency using Dolby C NR.

Tape	Level	Frequency (Hz)						
		50	100	400	1k	2k	4k	6k
Nakamichi ZX	-10	0.06	0.13	0.04	0.05	0.05	0.06	0.08
	0	0.36	0.47	0.40	0.42	0.40	1.0	1.8

Table V—Signal/noise ratios with IEC A and CCIR/ARM weightings.

Tape	IEC A Wtd. (dBA)				CCIR/ARM (dB)			
	W/Dolby C NR		Without NR		W/Dolby C NR		Without NR	
	@ DL	HD=3%	@ DL	HD=3%	@ DL	HD=3%	@ DL	HD=3%
Nakamichi EXII	68.2	74.2	51.3	57.3	68.2	74.2	48.7	54.7
Nakamichi SX	71.3	76.4	54.8	59.9	71.9	77.0	52.7	57.8
Nakamichi ZX	70.3	79.5	53.6	62.8	71.2	80.4	51.5	60.7

Table VI—Input and output characteristics at 1 kHz.

Input	Level			Imp., Kilohms	Output	Level			Imp., Ohms	Clip (Re: Meter 0)
	Sens.	Overload	>31 V			Open Ckt.	Loaded	2.4k		
Line	43 mV	>31 V		38	Line	923 mV	770 mV	2.4k	+17.3 dB	
					Hdphn.	842 mV	618 mV	18		

rolled off. The results, the top three traces of Fig. 2, show how little roll-off there is even at this very high level. This characteristic is reflected in the excellent figures contained in Table I, showing the -3 dB limits with a sine-wave test tone. The low-frequency response is well extended and very consistent, at both levels and for all three tapes.

Dolby play level indication was high, about 1 dB above the meter-zero level. A number of checks were run to see how well auto calibration aligned the playback head to the recorded flux. Using a 10-kHz test tone for the recheck, there was a consistent 10° phase error between tracks with one tape, which translates to a misalignment error of only 0.3 minute of arc. I used the manual control to try to zero the error with the 10-kHz tone and found that the steps were about 50° of phase in this mode. Nonetheless, I got to within 5° of phase, about 0.15 minute of arc—excellent alignment. The total auto-calibration time was always 15 S or less, with azimuth alignment followed by multiple checking and re-checking of 400-Hz level (for Dolby calibration) versus 15-kHz level (for bias and response). The only time I got an error (indicated by a flashing readout) was when I mistakenly tried to calibrate the Type I tape with manual inputs for Type IV and "70 μS."

The subsonic filter response was 3 dB down at 20 Hz, 20 dB down at 11 Hz, and 30 dB down at 9.8 Hz. The response came back up below this point but was 13 dB down at 7 Hz. The bias in the output during recording was very low. Table II lists a number of other record/playback characteristics. Worthy of note are the excellent 67-dB erasure at 100 Hz and the high separation and crosstalk figures—to say nothing of the low phase error and jitter after auto calibration.

The third-harmonic distortion figures were excellent for all three tapes, and, as Table III shows, those for ZX tape were outstanding. The scan with the spectrum analyzer also showed that distortion was primarily HDL₃, with little evidence of other harmonics. The low level of the distortion made it difficult to measure HDL₃ across the band, and Table IV lists the superior results. Even at Dolby level, distortion was well controlled up to 4 kHz, where tape-saturation effects caused a sharp increase in nonlinearity. Table V provides evidence of how the high maximum output levels of Table III lead to outstanding signal/noise ratios.

Miscellaneous input/output characteristics are shown in Table VI. The line input impedance given is actually a minimum, obtained with all input pots at maximum rotation. With the three pots at a more normal setting, the measured impedance was 83 kilohms—good for minimum loading of other equipment. On the other hand, the line output impedance of 2.4 kilohms is on the high side, particularly if the load is 10 kilohms. A 20-kilohm load would not be a problem. The headphone output drove all phones I tried to very high levels; the output attenuator was needed.

The two sections of the master input-level pot tracked each other within a dB for 60 dB of attenuation, which is excellent. The action of the automatic fader was checked with a 1-kHz tone (Fig. 3) for the two fading speeds, for both fade-in and fade-out. The slow fades are to the left in Fig. 3, and the fast fades are to the right. Although a big contrast exists between the speed of the down-fades and of the much faster up-fades, there is some logic to this approach: The unit fades in fast to be fully up when the music starts, and fades out slowly so the music or applause will trail away to silence. The two sections of the output-level pot tracked within a dB for 40 dB, fairly good. Output polarity was the same as the input in both source and tape modes.

The peak-responding meters met the standards for such meters, with the exception that the 0.7-S decay time was too short. The use of "Peak Hold" appeared essential for good metering. I was not able to verify the accuracy of all the meter-segment thresholds, because they are not tied to specific level figures. Still, the spacing and the results obtained would indicate good dynamic metering. The meter responses were 3 dB down at 10.6 Hz and 20.2 kHz.

There was substantially no measurable change in tape play speed over a range of line power from 110 to 130 V. Over short periods of time, speed variations were on the order of ±0.01%. With selected cassettes, I got flutter values of 0.035% wtd. rms and ±0.055% wtd. peak, very close to the specified values. More typically, I got 0.05% wtd. rms and 0.065% wtd. peak. These are good results but not impressive—and they are noticeably higher than specifications. The fast-wind time for a C-60 cassette was 61 S. There was loose-loop take-up with cassette insertion. Changes in modes and run-outs to stop were all about 1 S.

Use and Listening Tests

The CR-7A owner's manual is clearly written and has helpful illustrations, but some additional detail would aid many users. (I should note, however, that Nakamichi also sent a lengthy technical memo to members of the press, in the form of a news release.)

Sonically, the CR-7A outperformed my reference deck, and the CR-7A's best performance was certainly easier to achieve.

All of the controls and switches were completely reliable during testing and listening. As mentioned earlier, the only problem with auto calibration was a mistake on my part. I really appreciated the wide use of annunciators to show switch status; I had been frustrated so many times in the past with Nakamichi's small, black pushbutton switches—were they in or were they out?

The record, pause, and stop functions all produced light clicks that were down into tape noise with Dolby C NR. I somehow felt personally rewarded with the inclusion of the counter time modes; Nakamichi must have listened to those of us who had pleaded for them. The remote control worked reliably up to at least 20 feet. I put in some prerecorded tapes to try adjusting playback azimuth from my favored listening position, and though about half the tapes were best with the nominal zero setting, others offered a definite opportunity for improvement. Results with the latter demonstrated the value of the Nakamichi approach: There is no other way to match the correction gained by accurate playback alignment.

I have mulled over the question of whether adjusting the playback head, as is done in the CR-7A, is essential to get proper alignment with the flux recorded on the tape. Any deck's heads are aligned at the factory, of course—the playback head is adjusted to match a good alignment tape, and the record-head adjustment is made with a no-skew blank tape. The ability to re-adjust the playback head, however, ensures the best possible playback of any tape, from any machine, with whatever skew; it must also be recognized that record-head adjustments can do nothing about correct playback of recordings made on decks that suffer from azimuth errors. I conclude that this feature is very worthwhile, one which I would like to see on more decks.

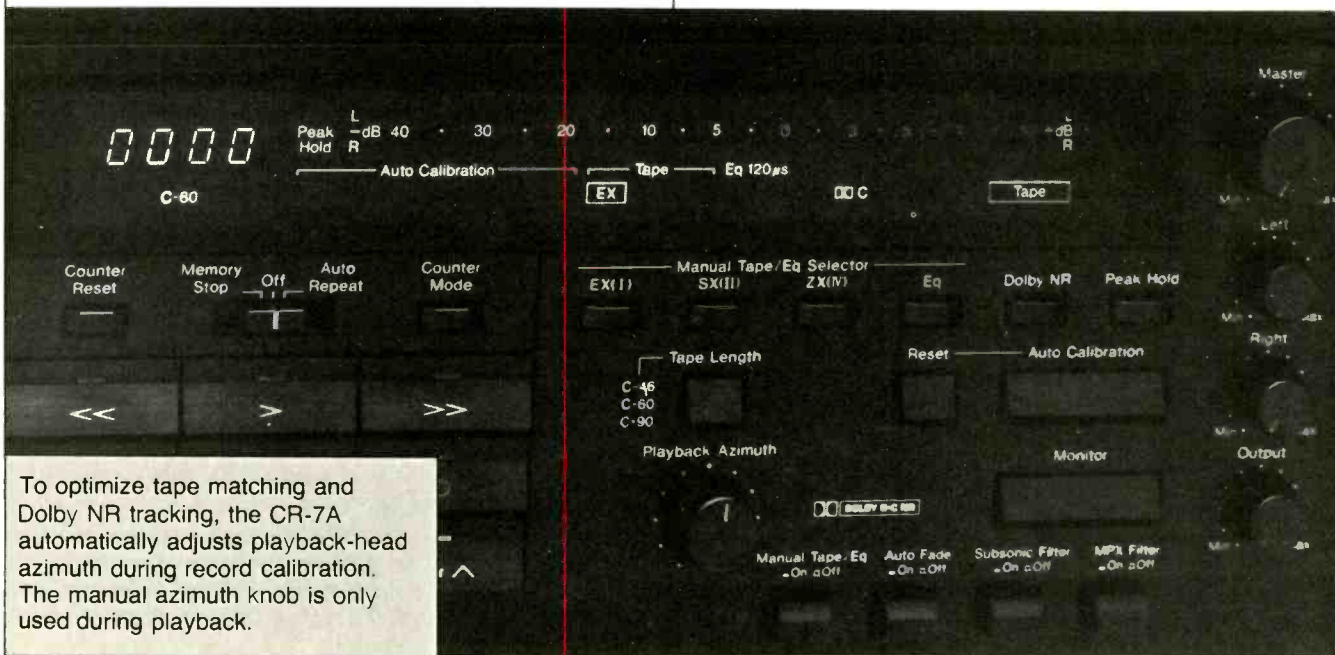
During recording of various sources, I confirmed my earlier conclusion that "Peak Hold" was essential for the best

level metering. I made certain that the peak level went no higher than just below the 3% limits measured during the bench tests. Sources included a number of favorite albums, such as Respighi's *Feste Romane* with Lorin Maazel and the Cleveland Orchestra (Mobile Fidelity MFSL 1-507) and *Buddy Spicher and Friends: Yesterday and Today* (Direct Disk DD102). I did find that with the CR-7A's excellent low-end response, use of the subsonic filter was required with some of the records.

It took me a very short time to decide that the match between the CR-7A's responses with and without Dolby C NR was definitely the best that I have ever heard; I felt similarly about the source/tape comparisons. The frequency response and level matchings accomplished by the auto-calibration system left me nothing to point to as "too much" or "too little." I was very impressed with the CR-7A's ability to retain all of the low bass contained in some of the source material—even at the highest levels. I had found in tests that the flutter was above the stringent specification, but I did not hear any detrimental effects that I could attribute to this. In comparisons with my reference deck, a Nakamichi 582, I judged the CR-7A's sound to be slightly better and its best level of performance certainly a lot easier to achieve.

Overall, the auto-calibration system worked very well indeed and achieved impressive sonic results. The record/playback responses were the best I have measured with Dolby C NR, and in/out and source/tape matchings were outstanding. I wish that the deck had punch-in recording and that the output impedance was lower for some uses, but I'm glad that this unit has counter time modes, manual tape selections, subsonic filter, and manual playback-azimuth control. The price is high, but the Nakamichi CR-7A provides a superlative combination of wide, flat response, low noise and distortion, and a superior auto-calibration system.

Howard A. Roberson



To optimize tape matching and Dolby NR tracking, the CR-7A automatically adjusts playback-head azimuth during record calibration. The manual azimuth knob is only used during playback.

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Manufacturer's Specifications

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Sensitivity: 1 V for full rated power.

Small-Signal Distortion: 0.05% at mid-band.

Frequency Response: 20 Hz to 20 kHz, +0, -0.5 dB.

Hum and Noise: 96 dB below full rated output.

Input Impedance: 100 kilohms.

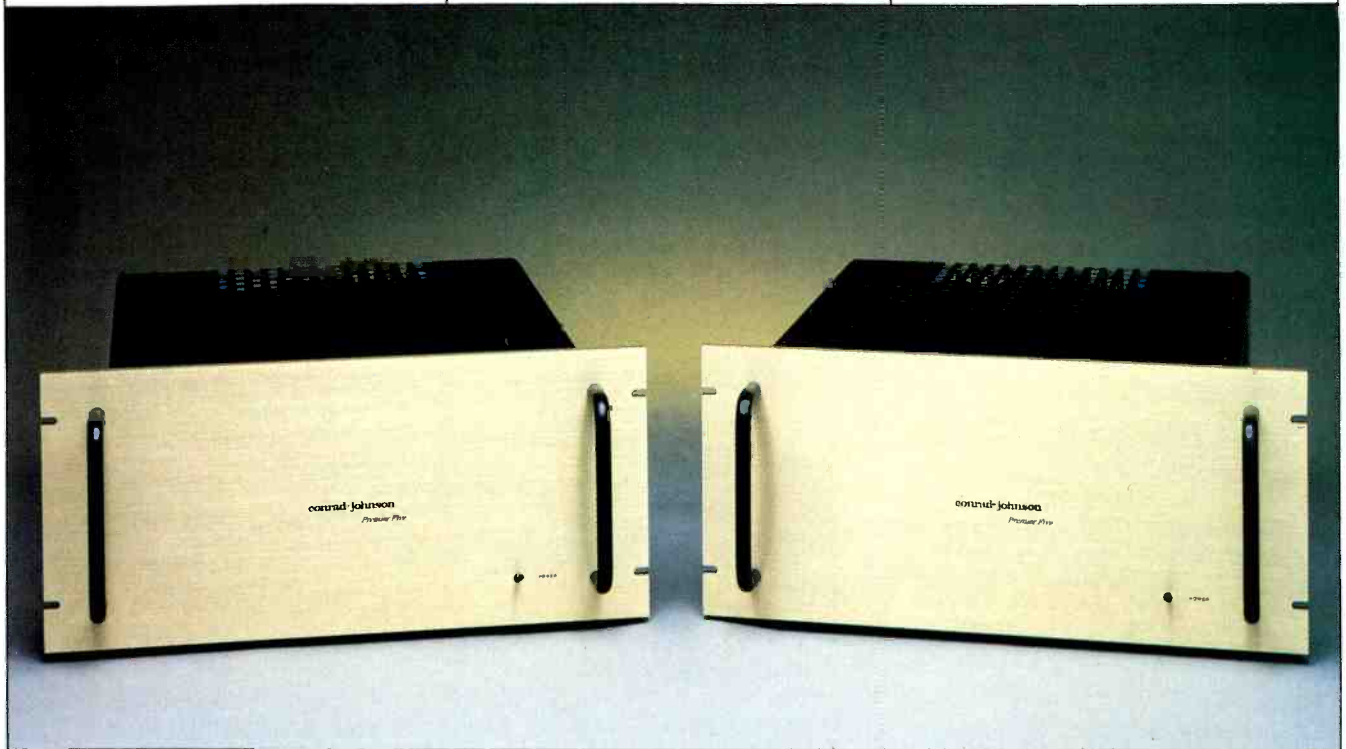
Dimensions: 19 in. W x 9 in. H x 20½ in. D (48.3 cm x 22.9 cm x 52 cm).

Weight: 81 lbs. (36.8 kg).

Price: \$3,000 each.

Company Address: 2800R Dorr Ave., Fairfax, Va. 22031.

For literature, circle No. 91



The Conrad-Johnson Premier Five is a 200-watt, mono, vacuum-tube power amplifier. It is quite large and heavy, and surely will whet the appetite of any tube-electronics lover. I was very pleasantly surprised, a number of months ago, to have a pair of these beauties arrive on my doorstep. I decided that it would be a good idea to review them, as I had spent a good deal of time listening to two other pairs of Infinity RS IB loudspeakers.

Physically, the Premier Five is built more or less like older tube amplifiers, with a main chassis; a large, thick, rack-width front panel; side pieces, and a top cover. However,

instead of using point-to-point wiring between tube sockets and other components, it utilizes a large p.c. board which has most of the interconnections via p.c. traces. The tube sockets are mounted on the p.c. board, and the tubes stick up through holes in the top surface of the chassis. In addition to the holes for the eight output tubes and three front-end tubes, there are holes for a bias pot and a bias-indicator LED for each output tube. The only problem with this construction is that the p.c. board must be partially unwired and swung out if one wishes to replace components on it.

Mounted on the chassis are four large electrolytic capacitors for the power supply, a huge power transformer, and a not-so-huge but still substantial output transformer. On the rear surface of the chassis are a large, four-terminal screw barrier strip appropriate for heavy speaker wire, a plate-current fuse with an LED fuse-out indicator, an RCA signal-input jack, a power-line fuse, and the power cord. The front panel bears a pair of handles and a nonilluminating power switch.

Construction and parts quality on this amp are very good. Reliability is also good, judging from my own experience with the pair under review and with the two pairs owned by Infinity which I had previously auditioned.

Circuit Description

The circuit topology of the Premier Five is similar to that of many older tube designs. The first stage is a grounded-cathode amplifier with two resistors in series from cathode to ground. The signal input is direct-coupled to the grid of the first stage through a 1-kilohm series resistor. Input impedance is set by a 100-kilohm resistor between input and ground. The plate of the first stage is direct-coupled to the grid of the second-stage tube, which is operated as a grounded-plate or cathode follower. The first and second stages use the two halves of a 5751 twin triode tube. Plate-supply voltage to these stages is about 400 V d.c.

The output of the cathode-follower second stage is direct-coupled to the grid of the phase-inverter stage, which is a "long-tailed pair" or differential amplifier. Each tube in the phase-inverter stage is a 6CG7 tube, whose two halves are connected in parallel. The plate outputs of the phase-inverter stage are two equal-amplitude, opposite-phase signals. These are each coupled through four separate capacitors into the grid circuits of four EL34 tubes, which are connected in parallel. Plate-supply voltage for the phase-inverter stage is about 430 V d.c.

This output stage is operated in an ultra-linear connection, with the screen grids of the output tubes fed from taps on the output transformer's primary winding. The B+ for the output stage is about 500 V d.c. Output-stage quiescent current is about 360 to 400 mA.

Output-tube bias is set by a neat arrangement that, to the best of my knowledge, Conrad-Johnson has used on all their tube power amps. Output tube current is sampled across a 20-ohm resistor between each cathode and ground. An op-amp comparator circuit for each output tube compares the cathode voltage to a fixed reference voltage. Each op-amp comparator output is connected, via an indicating LED, to ground. If a particular cathode voltage is higher than the reference, the output of that comparator goes high, turning on the indicator LED. After a suitable warmup of 15 to 30 minutes, biasing procedure requires one to turn the bias pot for each tube until its LED comes on, and then back it off until the LED just goes out. This is simple and neat, though personally, I would rather have a front-panel plate-current meter and switch to select each tube, along with bias pots accessible on the front panel, as on the Audio Research D150 and the older Marantz Model 9.

Overall negative feedback is taken from the output transformer secondary at the 16-ohm tap, through a 5 1-kilohm

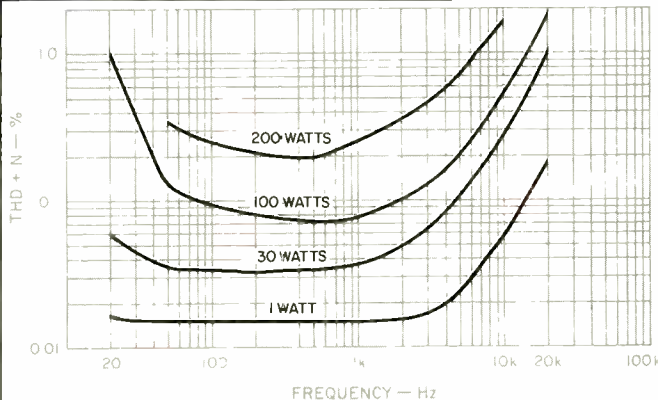


Fig. 1—THD + N vs. frequency for four power levels, with 8-ohm load on 8-ohm tap.

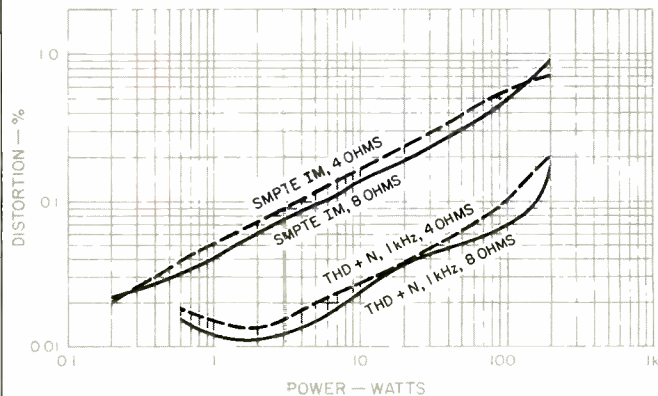


Fig. 2—SMPTE IM (upper curves) and THD + N (lower curves) vs. power for 8-ohm loads on 8-ohm taps and 4-ohm loads on 4-ohm taps. THD + N is for a 1-kHz test signal, with distortion products measured from 400 Hz to 80 kHz.

series resistor, back to the junction point of the first-stage cathode resistors.

In the power supply, the high-voltage secondary is full-wave rectified. A capacitor input filter is formed by two 1,300- μ F, 350-V capacitors placed in series. Across each of these caps is a 100-kilohm, 2-watt resistor. The resistors equalize the d.c. voltage drops across each of the capacitors, and form a bleeder to discharge the capacitors when the power is turned off—definitely dangerous energy storage here. A series inductor, 0.32 henry at 600 mA, couples

In a super system, these amplifiers are stunningly believable. Even in my less lofty setup, I find them ultimately satisfying.

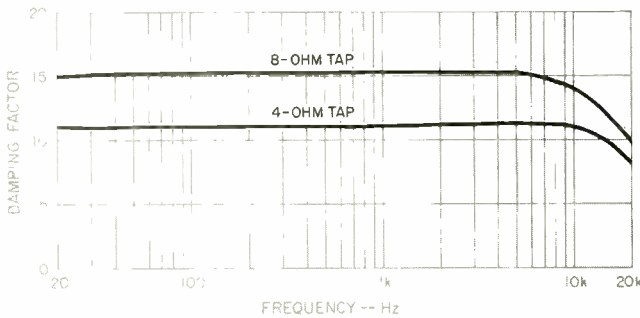


Fig. 3—Damping factor vs. frequency, measured at 8- and 4-ohm taps.

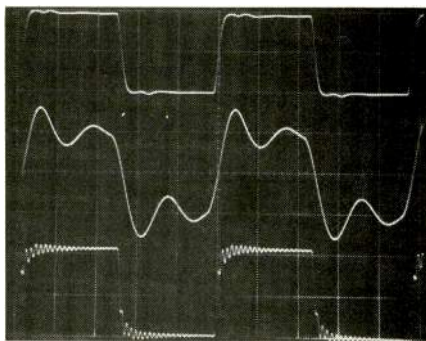


Fig. 4—Response to 10-kHz square wave. Top trace is with 8-ohm resistive load on the 8-ohm tap; middle trace is with 2-μF capacitance

across 8-ohm load, and bottom trace is for open circuit (note marginal stability). Scales: Vertical, 5 V/div.; horizontal, 20 μS/div.

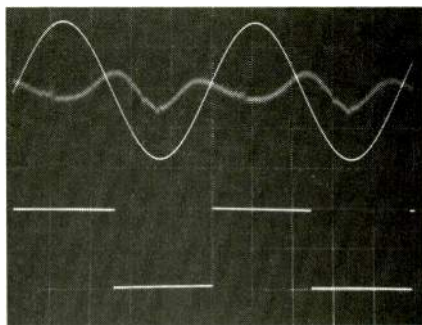


Fig. 5—Top trace: 10-watt, 1-kHz sine wave with distortion products (predominantly even harmonic) shown as residual trace behind it. Bottom trace: 40-Hz

square wave, showing excellent low-frequency response. Both signals delivered into 8 ohms. Scales: Vertical, 5 V/div.; horizontal, 5 mS/div.

the peak-rectified d.c. into another capacitor formed by two 3,300-μF, 350-V units in series. Again, 100-kilohm, 2-watt resistors are placed across these capacitors. A parallel combination of two 2-μF, 600-V film capacitors and one 0.15-μF, 630-V film capacitor are placed in parallel with the final electrolytic filter capacitor. The final filtered high voltage is fed to the center tap of the output-transformer primary winding through a 3-ampere fuse that is paralleled by an LED (in series with a limiting resistor) which indicates when the fuse is blown.

The final filtered high voltage also feeds two solid-state zener-follower voltage regulators that supply the regulated voltages of the front-end stages. Across the output of the regulator that feeds the input-amplifier stage are eight 0.15-μF film capacitors. The regulator that feeds the phase-inverter stage is bypassed by a parallel combination of four 1-μF and two 0.15-μF film capacitors.

Another winding on the power transformer is half-wave rectified and filtered, and feeds two separate zener-follower regulators that provide -48 V bias supplies for each half of the output stage. Like the high-voltage supplies, these bias supplies are full of good-quality film bypass capacitors.

A third secondary winding on the power transformer is full-wave bridge rectified and capacitor-filtered to feed smoothed d.c. to the heaters of the front-end tubes. A fourth secondary winding is half-wave rectified to a plus-and-minus supply which provides the supply and reference voltages for the op-amp's bias indicator circuits. A fifth (and final) secondary winding provides 12.6 V a.c. to power the heaters of the output tubes.

To sum up the Premier Five's circuitry: The amplifier circuit itself is fairly straightforward, with the exception of the cathode-follower buffer between the first amplifier stage and the long-tailed-pair phase inverter. The power supply has a lot more filter storage capacitance than older tube-amplifier designs. This, in conjunction with the voltage regulators powering the front-end circuitry, most likely helps keep things more solid—especially under large-signal conditions. The liberal use of low dielectric-absorption, film bypass capacitors throughout the power supply probably helps sonic performance considerably.

Measurements

The first step in measuring the Premier Fives' performance was to rebias the output tubes to the correct idling current at an a.c. line voltage of 120 V. This current, by the way, is 45 to 50 mA. In my house, the line voltage is more like 112 to 114 V with the amps on. Before I rebased the amps, I measured the mid-band power, at the onset of clipping, with 112 V from the power line. This worked out to about 180 watts.

Voltage gain, with an 8-ohm load on the 8-ohm tap, was 36× or 31.1 dB, which is some 5 dB higher than the usual power-amp gain of 26 dB. For the 4-ohm tap, gain was 26.5× or 28 dB. IHF sensitivity for 1 watt out into 8 ohms was 78.5 mV.

Figure 1 shows THD + N versus power and frequency, for 8-ohm loads on the 8-ohm taps. As can be seen, distortion rises above 1 to 2 kHz for all power levels shown. At higher power levels, distortion also rises at low frequencies.

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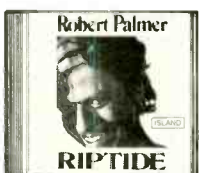
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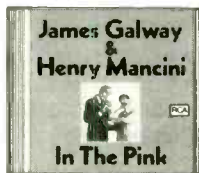
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I wish I could quantify why the Premier Fives sound so good, but I can't. So I turn off my rational side and just enjoy the music.

At 20 Hz, the amp could not produce 200 watts output due to output-transformer saturation.

Figure 2 shows THD + N (measured from 400 Hz to 80 kHz, for a 1-kHz test signal) and SMPTE-IM distortion, for 4- and 8-ohm loads on their respective taps. The amp's behavior on the 16-ohm tap is about like that on the 4-ohm tap. For some reason that I can't figure out, the 8-ohm THD at 200 watts shows onset of clipping, but distortion with 8-ohm loading is lower below 200 watts than with either 4- or 16-ohm loading. With either 4- or 16-ohm loading, the THD residue produced at 200 watts output does not exhibit onset of clipping.

Damping factor versus frequency is shown in Fig. 3 for the 4- and 8-ohm taps. Damping factor is higher yet on the 16-ohm tap, because the feedback is taken from this tap on the secondary of the output transformer.

Rise- and fall-times into an 8-ohm load were $3.5 \mu\text{s}$ at ± 5 V output. Oscilloscope photos for various conditions are shown in Figs. 4 and 5. The top trace of Fig. 4 is for a 10-kHz square wave into 8 ohms, driven from the 8-ohm tap. The middle trace is with $2 \mu\text{F}$ of capacitance paralleled with the 8-ohm resistive load. The bottom trace is for an open circuit; stability here is marginal. Square-wave performance on the other taps is similar, but not the same in terms of ringing and overshoot. The top trace of Fig. 5 shows the nature of the harmonic residue, which is predominantly even harmonic, at 10 watts output at 1 kHz. The lower trace shows excellent low-frequency response with a 40-Hz square wave.

Frequency response at 1 watt output, for 8-ohm loading, is shown in Fig. 6. The IHF signal-to-noise ratio was found to be -82 dB. IHF dynamic headroom measured 218 watts or 0.37 dB, and IHF clipping headroom was 205 watts or 0.11 dB; both were measured with 8-ohm loading and 120-V a.c. line input.

Peak current into a 0.1-ohm load on the 4-ohm tap, using the IHF dynamic-headroom test signal of 20 mS on and 480 mS off at 1 kHz, yielded ± 22 amperes before visible distortion occurred.

Summing up on measurements: The Premier Five tube amplifier has higher distortion figures near full power than most solid-state power amplifiers, although at low to medium power levels it is satisfactorily low. High-frequency stability might be a problem with a load that presents a high impedance at ultrasonic frequencies. My only actual experience as evidence of this occurred when driving an Infinity IRS speaker, with its tweeter disconnected temporarily for test purposes. A buzz in the midrange drivers suggested that the amp was oscillating under this abnormal condition.

Use and Listening Tests

A comment on my personal preference or bias is in order here: Some of my reviews may give the impression that I don't care for solid-state gear and that I prefer tube equipment. I would like to clarify this. Good tube equipment, for me, simply re-creates (or creates, if you will) a more believable, emotionally involving musical experience. Where tube equipment gets it more right is in the areas of spaciousness, depth of image in the sound field, and instrument tonality. Thus far, solid-state gear doesn't quite measure up in my opinion, although the gap is narrowing. I do like to use

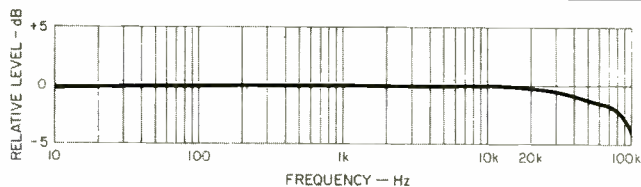


Fig. 6—Frequency response at 1 watt output into 8-ohm load.

solid-state equipment because of its long-term reliability, stability of characteristics, lower power consumption, etc. With this said, on to my evaluation of the Premier Five amplifiers' sonics.

As previously mentioned, I had the opportunity to hear two other pairs of Premier Fives, in the Infinity Systems sound room, on RS IB and IRS loudspeakers. The Infinity system uses a Mitchell A. Cotter turntable with a Goldmund tonearm and Koetsu Onyx cartridge. The resident preamplifier is an Audio Research SP10. With Premier Fives driving the midrange and tweeter sections of a pair of RS IBs, the sound of this system is very good indeed. I have listened to a good number of transistor amplifiers on this system; in comparison to the Premier Fives, they all sound variously less dimensional, more irritating, and ultimately less musical to my ears.

I have heard the personal system of Arnold Nudell, Infinity's president, a number of times. The signal source in this setup consists of an Otari professional open-reel recorder, playing low-generation copies of master tapes, with or without transformerless Dolby A NR units. The signal from the Otari is fed, via a dual 500-ohm volume control, into the bass amplifier and crossovers of an IRS speaker system. Nudell uses Premier Fives to drive the midrange and tweeter panels. Reproduction is stunningly believable, which tells me that the Premier Fives are incredible amplifiers.

In my less lofty home listening environment (using an Infinity air-bearing turntable, Koetsu's new EMC-1B cartridge, Infinity RS IIB speakers, and Stax SR-X/Mk3 headphones), I have found the Premier Fives to be ultimately satisfying. I keep trying other amplifiers and when I go back to the Fives, my reaction is, "Ahhh, all right!" Even my super-critical associate, Geoff Cook, concedes that they are "pretty good amps." The only other power amplifiers that have satisfied me as these do are the Marantz 9s, which sound a little softer and sweeter in the high end and not quite as solid in the bass. Of course, the 9s are no longer commercially available, whereas the Fives are. I like the Premier Fives very much, and would recommend that anyone who can afford them give them a serious audition.

As a concluding point, I wish I could quantify with some measurements why the Premier Fives sound so good. As a measurer, I don't yet have a clue. This is frustrating, and I hope to ultimately find out why. In the meantime, I have no trouble turning off the rationalist, the language-oriented, measurer part of me, turning on my ears, the ultimate measurer, and enjoying the music.

Bascom H. King



**CHOOSE YOUR CASSETTE TAPE
AS CAREFULLY AS YOUR CASSETTE DECK.**



If you own a deck like one of these, you were obviously concerned with low wow and flutter, extended frequency response, smooth tape transport and wide dynamic range. When it comes to choosing cassette *tape*, why behave any differently?

Denon's new High Density HD8 formulation is the finest high-bias tape you can buy. Its "High Technoroum" dispersion and binding plus its metal hybrid formulation guarantee digital level performance on the widest range of cassette decks (including yours). You can keep an eye on things through Denon's new giant window. And enjoy your music knowing HD8 is guaranteed for a lifetime.

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DENON

Digital-ready tape from the first name in digital recording.

Enter No. 14 on Reader Service Card

3

TECHNICS EPC-305MCII CARTRIDGE AND SH-305MC TRANSFORMER

Manufacturer's Specifications Cartridge

Type: Moving-coil, with coreless twin-ring coil.

Cantilever: Tapered pure-boron pipe.

Damper: TTDD (Technics Temperature Defense Damper).

Frequency Response: 10 Hz to approximately 10 kHz, ± 0.5 dB (frequency range, 5 Hz to approximately 100 kHz).

Temperature Characteristics: 5° C to 35° C, ± 1 dB at 10 kHz; standard: 1 kHz.

Output Voltage: 0.18 mV at 1 kHz at 5 cm/S, zero to peak, lateral velocity; 0.5 mV at 1 kHz at 10 cm/S, zero to peak, 45° velocity, DIN 45-500.

Channel Separation: Greater than 25 dB at 1 kHz; greater than 20 dB at 10 kHz.

Channel Balance: Within 1 dB at 1 kHz.

D.c. Resistance: 25 ohms.

Impedance: 25 ohms at 1 kHz (pure resistance).

Compliance: 12×10^{-6} cm/dyne at 100 Hz.

Vertical Tracking Angle: 20°.

Recommended Stylus Pressure Range: 1.00 to 1.50 grams (10.0 to 15.0 mN).

Stylus Tip: 0.2 \times 0.7 mil, elliptical; block diamond.

Weight: 6 grams.

Effective Mass: 0.098 mg.

Mounting Dimensions: 0.5-in. spacing (cartridge already mounted in headshell).

Price: \$300.

Transformer

Type: Step-up, for MC cartridges; amorphous toroidal core.

Recommended Cartridge Impedance: Low, 3-ohm range for load impedances of 10 ohms or less; medium, 15-ohm range for load impedances between 10 and 20 ohms; high, 30-ohm range for load impedances of 20 ohms or more.

Frequency Response: 3 Hz to approximately 300 kHz; 15 Hz to approximately 100 kHz, ± 0.2 dB.

THD: No more than 0.001% at 1 kHz.

Channel Separation: Greater than 90 dB at 1 kHz.

Channel Balance: Within 0.2 dB at 1 kHz.

Shielding: Two layers of Permalloy, cast iron, and outer case.

Recommended Load Impedance: 47 kilohms.

Dimensions: 2 $\frac{3}{8}$ in. W \times 3 $\frac{3}{4}$ in. H \times 8 $\frac{1}{4}$ in. D (6 cm \times 9.6 cm \times 21 cm).

Weight: 9.9 lbs. (4.5 kg).

Price: \$350.

Company Address: One Panasonic Way, Secaucus, N.J. 07094.
For literature, circle No. 92

To overcome the problem of accurately mounting and properly aligning a phono cartridge in a headshell, Technics markets their top-of-the-line cartridges already mounted in one of their headshells, ready for use after vertical tracking force (VTF) and anti-skating force adjustments have been made.

Some of the outstanding features of the EPC-305MCII are the pure-boron tapered cantilever tube that is only a few thousandths of an inch in diameter, which accounts for the low effective mass (0.098 mg); the new damping material (TTDD), which is insensitive to temperature (thus making the cartridge very stable), and the use of a high-energy samarium cobalt magnet in the moving-coil cartridge's design.

Because of the very low output from the EPC-305MCII moving-coil cartridge, it was necessary to design a step-up transformer for it. This special spiral toroidal-core transformer uses amorphous (noncrystalline) magnetic alloy in laminations tens of microns thick. Because of its high saturation characteristics, the spiral toroidal core contributes to wide dynamic range and low distortion in the high range. To achieve a high S/N ratio and prevent hum, the transformer uses four layers of special shielding, which appears to be quite effective since I was unable to induce any hum components in the transformer.

Extreme care must be exercised when mounting the cartridge so as not to bring near it any ferromagnetic (iron,

steel, etc.) objects such as screwdrivers or tweezers. These items may unexpectedly be pulled towards the cartridge's powerful magnets and thereby damage the stylus-cantilever assembly.

Like all Technics phono cartridges, the EPC-305MCII comes mounted in a plastic box which also contains the usual assortment of mounting screws, stylus brush, screwdriver, and removable stylus guard. Also supplied is a printed frequency response curve which appears, at first glance, to be of a generalized nature, but it is actually a true response curve made by the particular cartridge at hand, according to Technics. The plastic box is packaged in a simple cardboard box. The SH-305MC transformer is packaged in a similar manner.

Measurements

The EPC-305MCII, which comes mounted in its own headshell, was inserted into a Technics EPA-A250 (S-shaped) interchangeable tonearm unit attached to a Technics EPA-B500 tonearm base and mounted on a Technics SP-10MKII turntable. The phono cartridge was oriented in the headshell and tonearm with a Dennesen Geometric Soundtracktor.

Where applicable, laboratory measurements of the EPC-305MCII were made using the Technics SH-305MC step-up transformer. The frequency response of the transformer was



The 1-kHz square-wave response (Fig. 3) is one of the flattest I have ever seen. The ringing shown was on the test record and was undoubtedly generated by the cutter head when the master was cut. The arm/cartridge low-frequency lateral resonance was 7 kHz. Despite the unusually low lateral resonant frequency, I did not hear any mistracking or distortion at any time.

Using the Dynamic Sound Devices DMA-1 dynamic mass analyzer, I measured the arm/cartridge dynamic mass at 22.5 grams, and the dynamic compliance at 23×10^{-6} cm/dyne at the resonant frequency of 7 Hz. The vertical stylus angle measured 18° for each channel.

Other measured data are: Wt., 6 grams. D.c. resistance, 21.3 ohms. Opt. tracking force, 1.25 grams. Opt. anti-skating force, 1.5 grams. Output, 0.68 mV/cm/S. IM distortion (200/4000 Hz, 4-to-1): Lateral (+9 dB), 1.1%; vertical (+6 dB), 1.8%. Crosstalk (using Shure TTR-109): Left, -32 dB; right, -30 dB. Channel balance, <0.5 dB. Trackability: High-freq. (10.8 kHz, pulsed), 30 cm/S; mid-freq. (1000 and 1500 Hz, lateral cut), 31.5 cm/S; low-freq. (400 and 4000 Hz, lateral cut), 24 cm/S. Increasing the tracking force to 1.5 grams and anti-skating force to 1.7 grams, the low-frequency trackability (400 and 4000 Hz, lateral cut) was 30 cm/S. The Deutsches HiFi No. 2, 300-Hz test band was tracked cleanly to 86 microns (0.0086 cm) lateral at 16.20 cm/S at +9.66 dB and to 55.4 microns (0.00554 cm) vertical at 10.32 cm/S at +5.86 dB.

The Technics EPC-305MCII encountered no difficulty in tracking all the test bands on the Shure Era III and Era IV Obstacle Course musical test records as well as level 6 of the Shure Era V trackability disc. Rarely do commercial analog records have peak recorded velocities exceeding 15 cm/S. Therefore, this cartridge would be able to track any commercially available record, including the well-known audiophile recordings issued by Telarc, Sonic Arts, Sheffield, Reference Recordings, RCA Point 5, and Mobile Fidelity Sound Lab.

Use and Listening Tests

Listening tests are performed both before and after laboratory measurements. All reported listening tests of the Technics EPC-305MCII were made with the Technics SH-EPC-305MC step-up transformer. During the premeasurement listening evaluation, I was quite impressed with the EPC-305MCII's sonic clarity and transparency of sound, as well as the well-defined and tight bass.

The lack of mistracking and distortion at the resonant frequency of 7 Hz is truly remarkable. I attribute this to the superior design of the Technics EPA-A250 tonearm and, in particular, the super-efficient anti-resonance device that is an integral part of it.

When all the laboratory measurements were completed, it was time for the more serious, final musical evaluation of this moving-coil phono cartridge. As we all know, we listen not to laboratory measurements but to music, and that is the final arbiter in determining how faithfully a phono cartridge does its work. Equipment used in the listening evaluation included the aforementioned Technics tonearm and turntable, an Audio-Technica AT666EX vacuum disc stabilizer, an Amber Model FF 17 preamplifier, two VSP Labs Trans-MOS 150

measured in the range from 40 Hz to 50 kHz; it was found to be flat from 40 Hz to 40 kHz, and -0.5 dB at 50 kHz (Fig. 1).

All laboratory tests were conducted at an ambient temperature of 73° F (22.78° C) and a relative humidity of 65%, $\pm 3\%$. The tracking force for all reported tests was set at 1.25 grams, ± 0.25 gram, with an anti-skating force of 1.5 grams. The EPC-305MCII cartridge was used with the Technics SH-305MC step-up transformer set to an input impedance of 30 ohms. However, I am of the opinion that the best sound was heard when the transformer's input impedance was set at 15 ohms rather than the suggested 30 ohms. As is my practice, measurements were made on both channels, but only the left channel is reported (unless there is a significant difference between the two channels, in which case both are reported for a given measurement).

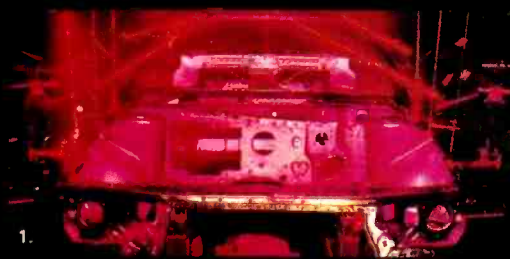
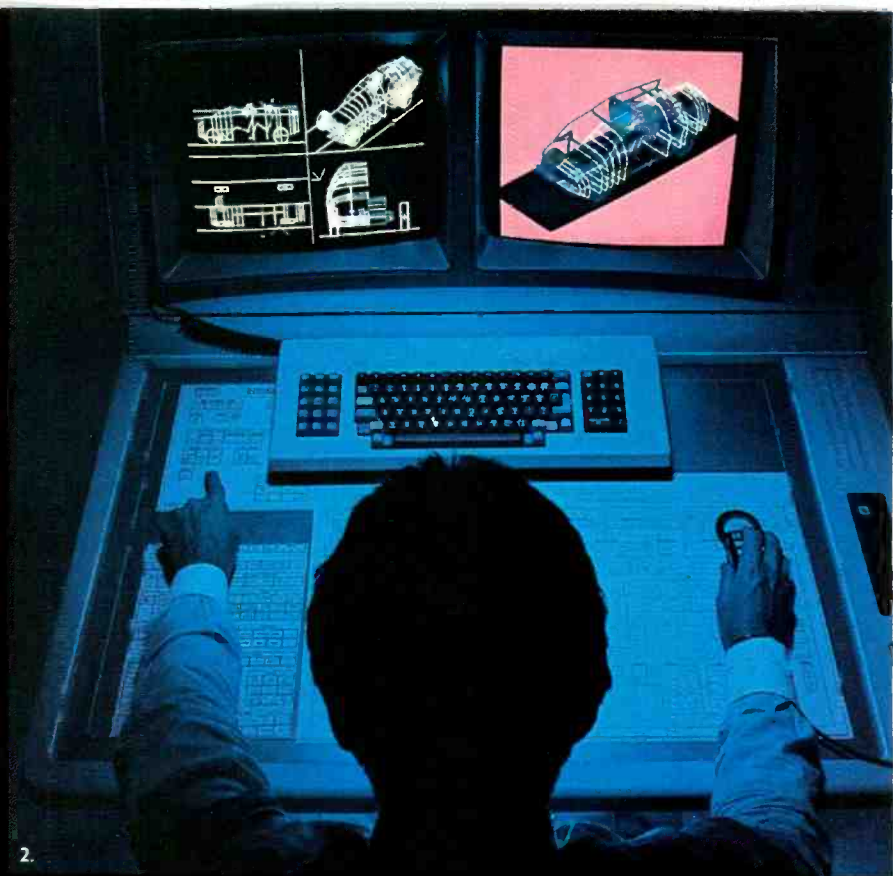
The following test records were used in making the reported measurements: CBS STR-100, STR-112, and STR-170; Shure TTR-103, TTR-109, TTR-110, TTR-115, and TTR-117; Deutsches HiFi No. 2; DIN 45-549; Nippon Columbia Audio Technical Record (PCM) XL-7004; B & K QR-2010; Ortofon 0002 and 0003, and JVC TRS-1005 and TRS-1007.

Frequency response, using the CBS STR-170 test record, is +1.25, -0.0 dB from 40 Hz to 20 kHz. Separation is 41 dB at 1 kHz, 30 dB at 10 kHz, and 26.5 dB at 20 kHz. The data indicates that the EPC-305MCII has excellent response and very good high-frequency separation (Fig. 2).

DESIGNING GM BYTE BY BYTE.

Designing General Motors to become the first 21st century corporation means going back to the drawing board and looking at ourselves in the light of a new age: the Computer Age.

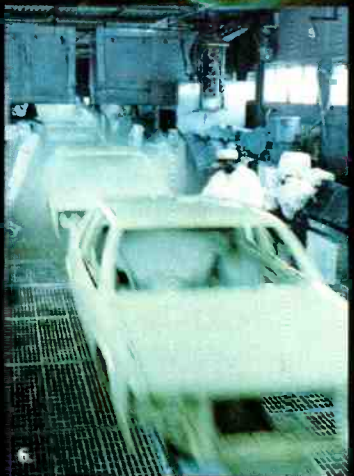
It means thinking in a new mode, accessing the future in a daring, creative new way. Our goal? A sleeker, more streamlined, computer-driven GM—an organization powered by technology, fueled by brainpower, and outclassing all competition. Our inventive use of computer technology in design, engineering, manufacturing, and safety is producing a GM programmed for quicker response to our customers, better efficiency and outstanding performance. A GM designed to bring you into the future. Byte by byte.



THE GM ODYSSEY. SCIENCE NOT FICTION



1. **AUTOMOTIVE DIMENSIONAL CHECKER.** Probing car bodies to assure solid, tight-fitting assemblies are one hundred and twenty-two lasers and cameras.
2. **ADVANCED CONCEPTS CENTER.** Where creative people work together studying lifestyles of today's consumer to help provide for transportation needs of tomorrow.
3. **INFORMATION PROCESSING CENTER.** Electronic Data Systems control center helping to streamline data processing and telecommunications functions, enabling General Motors to become more responsive to its customers' needs.
4. **INSTRUMENT PANEL.** Touch-sensitive cathode-ray tube with multiple functions that include diagnosing service problems in seconds.
5. **MULTIMATCH.** Machine vision system used in various quality-control procedures that increase manufacturing quality and productivity.
6. **NUMERICALLY CONTROLLED ROBOT PAINTERS.** These robotic spray painters provide consistent, high-quality paint finishes on GM automobiles.



I was quite impressed by the sonic clarity and transparency of this cartridge as well as the tight bass it reproduced.

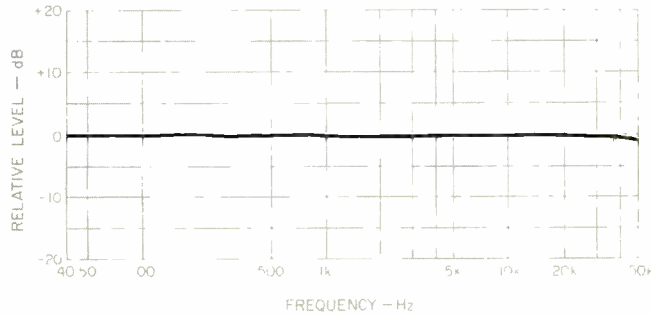


Fig. 1—Frequency response of the Technics SH-305MC step-up transformer.

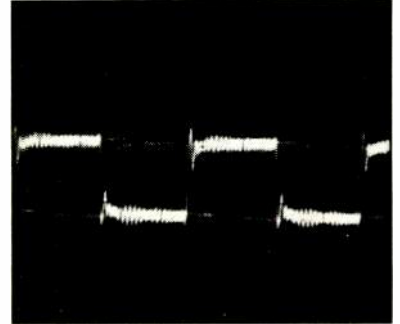


Fig. 3—Response to a 1-kHz square wave.

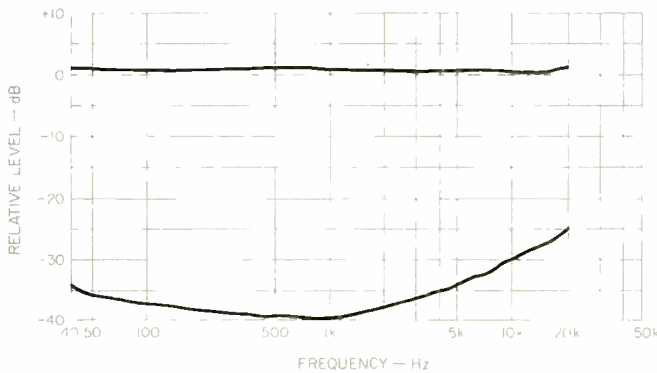


Fig. 2—Frequency response (top curve) and separation (bottom curve) of the EPC-305MCII phono cartridge with SH-305MC transformer.

As in the past, I compared an analog record with its CD version, where both had been derived from the same digital master tape. In this case, it was Mussorgsky's "Pictures at an Exhibition" and "Night on Bald Mountain" (Cleveland Orchestra, Maazel, Telarc DG-10042 on vinyl and CD-80042 on CD). Although the EPC-305MCII reproduced the digital-to-analog vinyl recording very accurately, I feel that there is no contest between the two versions; the CD was superior in every way.

Some of the exceptionally superb recordings I used in auditioning the Technics EPC-305MCII were: *Magnum Opus, Volume 1* (Wilson Audio W-8111); F. I. Tuma's "Stabat Mater" and B. M. Černohorský's "Choral Works" (Prague Madrigal Singers, S. Jányš, Supraphon 1112 3356); Prokofiev's *Excerpts from the Ballet, Romeo and Juliet* (Los Angeles Philharmonic, Leinsdorf, Sheffield Labs 8); Beethoven's "Symphony No. 9" and "Fantasy for Piano, Chorus and Orchestra" (New York Philharmonic, Mehta, RCA Red Seal ARC2-4734, digital); David Foster's *The Best of Me* (Mobile Fidelity Sound Lab MFSL 1-123); *Wild Bill Davison and Eddie Miller Play Hoagy Carmichael* (RealTime Records RT-306, digital); Schubert's *Four Works for Violin and Piano* (Denon OX7141-ND); *Ein Straussfest* (Cincinnati Pops Orchestra, Kunzel, Telarc digital vinyl DG-10098 and Compact Disc CD-80098); and Stravinsky's "L'Histoire du Soldat" and Rimsky-Korsakov's "Capriccio Espagnol" (Chicago Pro Musica, Reference Recordings RR-17).

After evaluating the Technics EPC-305MCII moving-coil phono cartridge and its SH-305MC step-up transformer over a long period of time, I find that the combination compares very favorably to my moving-coil laboratory reference standard, the Ortofon MC 2000, used with the Electrocompaniet MC-2 pre-amplifier. Accordingly, if you can't afford the rather expensive but superb Ortofon MC 2000, then I suggest that serious consideration be given to its near-equal, the Technics EPC-305MCII, a truly superior moving-coil phono cartridge.

B. V. Pisha

amplifiers (each used in the 300-watt mono mode), speaker and interconnecting cables from Discrete Technology, and a Technics SL-P10 CD player. The speakers, a pair of B & W 801Fs and a pair of Janis W1 subwoofers with their Interphase 1A units, are located in my specially designed, live-end/dead-end listening room.

During the long listening evaluation, I found no coloration present but I did find excellent transient response and tracking ability, and superb applause definition. Stereo imaging and depth were excellent. As was predicted, the EPC-305MCII reproduced the very high-velocity cannon shots on the Telarc "1812 Overture" (matrix II) record with no apparent difficulty. The human singing voice, the cello, and the Bösendorfer piano were reproduced realistically.

THE SILENT TREATMENT.

WHY BOB CARVER'S MINIATURE RADIO STATION LEFT THE AUDIO PRESS SPEECHLESS AND HOW IT LED TO THE MOST COMPLETE STEREO TUNER EVER OFFERED.

The new Carver TX-11a Stereo AM-FM Tuner is a technical tour-de-force which further distances Bob Carver's unique products from traditional electronic components — and which can vastly enhance your musical enjoyment.

TWO TECHNOLOGICAL INNOVATIONS.

The performance of the legendary TX-11 Asymmetrical Charge Coupled FM Stereo Detector Tuner is increased by the addition of Ultra High Frequency Wide Band AM Stereo circuitry. With the new TX-11a, AM stereo sounds as good as FM.

Yes, contrary to popular belief, most AM stereo stations have frequency response (20Hz-15kHz), separation (35dB) and signal-to-noise ratios (70dB) audibly indistinguishable from FM stations of equal strength. It's just that **only** Carver offers the technology to appreciate this hidden performance.

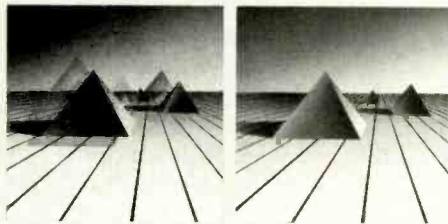
As for FM stereo, the TX-11a virtually eliminates multipath and distant station noise while providing fully-separated stereo reception with space, depth and ambience!

Bob Carver's Asymmetrical Charge Coupled FM Stereo Detector removes (without affecting stereo imaging, frequency response or dynamic range) the hiss, clicks, pops, "picket fencing" and the myriad other unpredictable noises which all too often disturb FM listening.

(Still interested in the story of the miniature radio station and how it impressed hard-to-impress audio critics? Read on. We'll get to it

after we explain why the quartz-synthesized TX-11a Stereo AM-FM Tuner will impress you in your own listening environment).

A CLEANER, WIDER FM WINDOW ON THE WORLD.



Because of the TX-11a's Charge-Coupling and Leading Edge Detection technology, ownership may very well change your listening habits. Right now, you probably confine your FM listening to those stations which are strong and relatively interference-free, avoiding weak stations and those filled with distortion. Your options are therefore limited. The TX-11a can significantly expand your choices by recovering stations previously buried in hiss or prone to sudden tantrums of noise.

Ovation Magazine observed that the circuit, "... may well mean the difference between marginal reception of the station signals you've been yearning to hear and truly noise-free reception of those same signals, permitting you to enjoy the music and forget about noise and distortion."

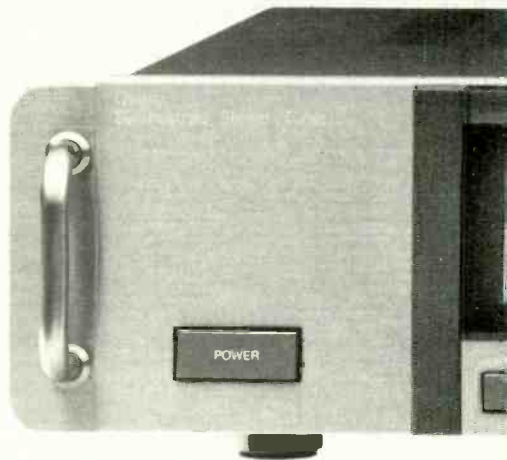
In **Audio Magazine**, Len Feldman said "The significance of its design can only be fully appreciated by setting up the unit, tuning to the weakest, most unacceptable stereo signals you can find, then pushing those two magic buttons."

"Separation was still there; only the background noise had been diminished, and with it, much of the sibilance and hissy edginess so characteristic of multi-path interference."

WHY THE ASYMMETRICAL CHARGE-COUPLED FM STEREO DETECTOR GIVES NOISE THE SILENT TREATMENT.

Thirty years ago, the FCC turned clear mono FM into a substandard stereo medium (with fifteen times poorer signal-to-noise ratio) by approving a broadcast system that is extraordinarily prone to multipath and distant-station-noise.

This system separates stereo into two different bands. Unfortunately, the bands aren't pure Left and Right. Instead, one band is comprised of those parts of a stereo signal that are common to both channels, (L+R, or mono). The other signal, far more fragile and prone to interference, is the difference between the left and right signal (L-R). It bounces off buildings, hills and other objects, and wreaks havoc when



CARVER

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Carver Corporation
P.O. Box 1237 Lynnwood, WA 98046

recombined with the strong mono signal.

Bob Carver's Charge-Coupling circuit takes advantage of the fact that almost all noise and distortion is exactly 180 degrees out of phase with the signal it's part of. The TX-11a Stereo AM-FM Tuner cancels these "dirty mirror" images before they can reach your ears. That eliminates up to 85% of the potential noise found in distant or noisy stations.

But Bob wasn't satisfied and knew you wouldn't be either. So another circuit, the Leading Edge Detector, goes a step further by taking advantage of a little-appreciated FM phenomenon: Just 5% of the L-R signal actually contributes to the stereo experience. The rest simply gets in the way of skyscrapers and mountains.

The Carver leading Edge Detector operates only on this critical 5% of the L-R signal, filtering out noise and restoring just that part of the signal needed by our ears and brain to construct stereo imaging.

Blended back into the mono (L+R) signal matrix, a net reduction of 93% – or better than 20dB of noise reduction – is achieved. All ambient and localizing information is recovered. Only hiss and distortion are left behind. Or, as **High Fidelity Magazine** put it, "...clean, noise-free sound out of weak or multi-path-ridden signals that would have you lunging for the mono switch on any other tuner."



THE LITTLEST AM RADIO STATION.

Before we describe the remarkable attributes of the TX-11a, we owe you the story that proves just how far performance can be extended when a component comes from Carver.

At a recent press conference, Bob Carver unveiled a small antenna connected to a very low powered AM stereo broadcast transmitter (C-QUAM format). Dubbed "Station CRVR," it sat next to a Carver Compact Disc Player and the same TX-11a that's on your dealer's shelves right now.

Bob Carver routed the Compact Disc's signal to the antenna for reception by the TX-11a, and also directly to a preamplifier.

In front of America's top stereo writers, Bob switched back and forth between the transmitted signal (as received by the TX-11a) and the direct CD signal. All listeners had difficulty distinguishing between the outputs of the CD player and the TX-11a Stereo AM-FM Tuner!

Most could tell no difference at all!

HOW AM STEREO GETS THE SILENT TREATMENT WITH THE TX-11a.

- * *Unique de-emphasis curve*
- * *Whistle Stop cancelling circuit*
- * *Pilot Signal cancelling circuit*
- * *Ultra-low noise balanced station detector*
- * *Very wide band, minimum phase intermediate frequency amplifiers.*

Think of it. Compact Disc frequency response and freedom from noise with AM stereo and the TX-11a. Only Carver could pull it off. But then only Carver could do the same for FM, too.

HUMAN-ENGINEERED FEATURES AND CONVENIENCE.

Many tuners with far less exclusive circuitry than the TX-11a have far more complicated exteriors. Bob Carver wanted to make tuning stations easy, not impress you with flashing lights or complex programming.

So thirteen presets, wide/narrow band selectors, automatic/manual scanning and the buttons which activate the remarkable Charge-Coupled circuits (Multipath and Noise Reduction) are all tastefully inset into the burnished anthracite metal face. Full instrumentation including digital station frequency readout, 6-step 10dB-interval signal strength LED's and other monitor functions is recessed behind a panel, visible but not garish.

The result is performance without theatricality. Access without complication.

A tuner **High Fidelity Magazine** called, "By far the best tuner we have tested..."

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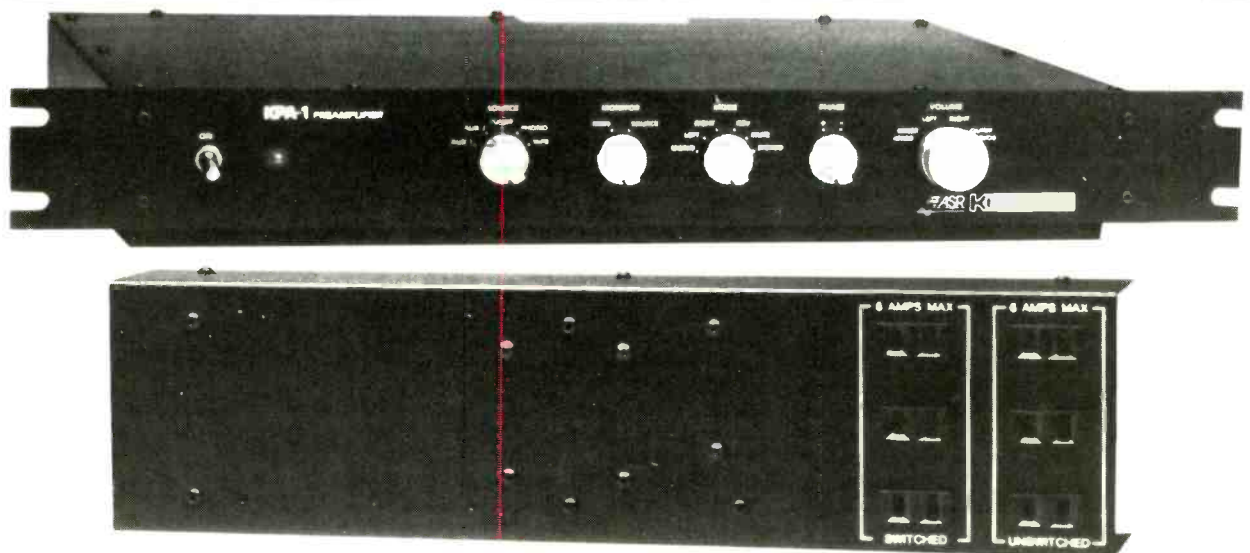
KINERGETICS
KPA-1 PREAMP**Manufacturer's Specifications****Frequency Response:** 1 Hz to 300 kHz, +0, -3 dB, through line inputs.**Maximum Output:** 7.5 V.**THD:** 0.05%.**IHF-IM Distortion:** 0.05%.**Slew Rate:** Greater than 20 V/ μ S.**S/N:** 77 dB, A-weighted, for 5-mV signal at MM or MC input.**Input Sensitivity:** High-level, 150 mV; MM phono, 0.3 mV at 1 kHz for 0.5 V output.**Phono Input Overload:** 155 mV at 1 kHz.**Phono Input Impedance:** MM and MI, 47 kilohms; MC, 5.1 kilohms; adjustable (see text).**Dimensions:** 17 in. W x 2½ in. H x 14 in. D (432 mm x 63.5 mm x 356 mm).**Weight:** 20 lbs. (9.1 kg).**Price:** \$795.**Company Address:** 6029 Reseda Blvd., Tarzana, Cal. 91356.
For literature, circle No. 93

The design of the Kinergetics KPA-1 preamplifier attempts to go beyond conventional standards of "purity" in its quest for sonic excellence. Many audiophiles believe that mechanical contacts, magnetic materials, and ordinary wire can alter sound reproduction in ways that are not conventionally measurable as distortion. The Kinergetics preamp therefore omits balance and tone controls, because they might degrade the unit's sonics. Kinergetics says that switch contacts may interfere with low-level signals, so the preamp's three phono inputs are not switched in and out, but are always active and mixed in a special amplifier, requiring the owner to insert shorting plugs in two of the inputs. This is truly purism in design.

Kinergetics' other circuit innovations go even farther. Components felt to alter a signal's sonics are actually wired into the KPA-1's circuitry, not just simulated by RLC networks. These components are applied to special amplifier stages in such a way as to generate inverse distortion, in order to cancel similar distortions thought to exist in the

input signal. It is difficult to test the validity of this concept because the inverse distortion, like the distortion in the input signal, can seldom be measured.

Magnetic hysteresis, the tendency for a material to stay magnetized, is a gremlin particularly singled out by Kinergetics. While hysteresis is vital to making permanent recordings on magnetic tape, the same effect causes distortion if it occurs in a playback head or phono pickup. The KPA-1 contains a tape playback head mounted on a p.c. board to compensate the tape input. Kinergetics says the tape recording process will probably contain many mechanical contacts, so eight contacts per channel are wired in series to correct the incoming signal. Two stereo phono cartridges are likewise designed into the circuit to compensate moving-magnet and moving-iron cartridge hysteresis. Moving-coil cartridges are not compensated. The output amp section uses long p.c. traces and a short piece of interconnect coaxial cable to develop a signal that counters whatever wire distortion may be present.



Your loudspeakers may well have some of the most refined drive units and crossovers in the whole world. Even so, something still stands between you and all the natural sound they produce: the loudspeaker cabinet. When the drive units vibrate, the cabinet vibrates too, colouring the sound and reminding you that you are listening to loudspeakers rather than a live performance.

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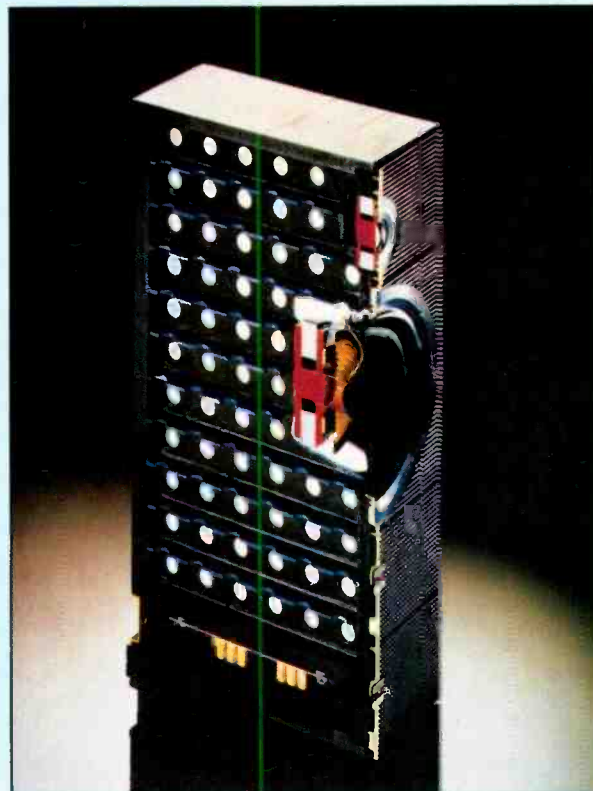


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yet completely effective.

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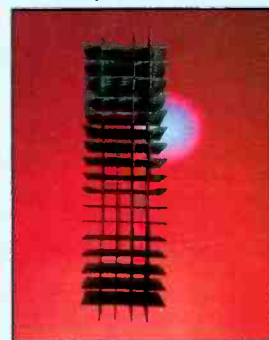
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A hand holds a black Kyocera remote control in the foreground. The remote has numerous buttons labeled with functions like PHONO, MEMORY, TUNER, FM/AM, COAXIAL, AV/AUX, MONI, MUTE, VOLUME, PAUSE, STOP, PLAY, REC, TAPE, and CD. The background shows a room with three black speakers: two small ones on a shelf and one large floor-standing one. The lighting is dramatic, with a warm glow from a window behind the speakers.

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The phono-section signal routing and gain structure are unusual, eliminating switch contacts and yielding low noise, but risking overload.

Control Layout

The KPA-1 is available in a silver or black metal cabinet. Larger than many preamps, its 14-inch depth and attached power-supply module make it difficult to place on a typical bookcase shelf. It is of the standard, 19-inch rack width and has mounting holes; because of its depth, the rear should also be supported with rack-mounting brackets.

Controls on the front panel, from left to right, are a power on/off switch, "Source," "Monitor," "Mode," "Phase," and "Volume." The power toggle does not switch a.c. to the preamp, which is always on if plugged in. Rather, it controls the power-module relay, which switches three of the six 120-V a.c. outlets on the separate power-supply chassis. No balance control is needed, because the volume control is a friction-coupled, dual rotary device with a section for each channel. The unit has no tone controls and no subsonic filter.

On the rear panel is a row of 24 RCA jacks, with each input symmetrically separated to preserve the dual-mono isolation of channels. (For instance, the left- and right-channel main output jacks are 13 inches apart.) Therefore, the owner must split paired interconnect cables to plug them into this preamp. The three pairs of unbalanced RCA phono jack inputs for MC, MM, and MI cartridges are always active and connected to the RIAA equalization network, so Kinergetics supplies accessory shorting plugs to be inserted into the unused phono inputs. (The dealer can also disable unused inputs permanently, as well as change components to optimize loading for particular cartridges.)

There are additional high-level inputs, including RCA jacks for two tape decks, a tuner, and two auxiliary sources, as well as the unbalanced RCA output jacks labeled for the two tape recorders.

The preamplifier's body consists of a 1/8-inch aluminum front panel attached to a U-shaped steel chassis with a removable top cover. Threaded inserts and machine screws are used to hold the top on, a very desirable technique. A thick, four-foot-long, nondetachable d.c. power cable runs from the back panel to the unit's power-supply module. The preamplifier circuitry is mounted on a large, high-quality master circuit board, which is laid out in a symmetrical dual-mono design on either side of the center line. The upper surface uses a ground plane foil, and the circuitry traces are on the underside. Virtually no hand wiring is present, except for the termination of the wires to the remote power-supply module. The RCA sockets are ordinary nickel-plated metal but are directly soldered to the rear of the p.c. board. Similarly, all front-panel controls are soldered directly to the circuit traces at the p.c. board's front edge. The circuit board is huge, allowing ample space between stages, and there is less crowding of parts in this unit than in any other preamp we've tested.

Component quality is high, including that of the compensation items mentioned above—two phono cartridges, a tape head, coaxial cable, and eight contacts per channel (soldered in series). This all-bipolar preamp uses discrete parts, with the exception of two op-amps per channel used as d.c.-servo amps to prevent d.c. offset from appearing at the outputs. The resistors are almost all 1% precision types, and the capacitors are all high-quality polypropylene or

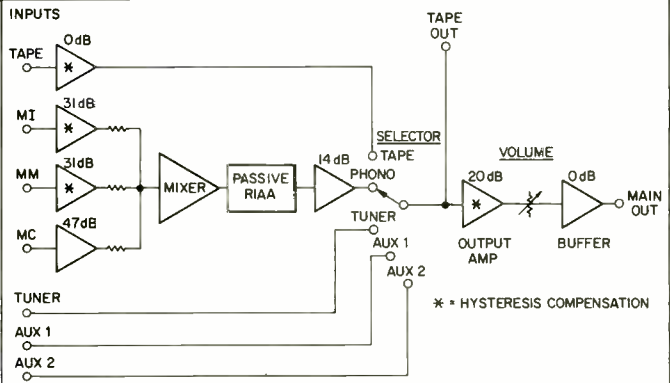


Fig. 1—Simplified block diagram, KPA-1 preamp. Note absence of switching in the phono

stage, compensated input stages (see text), and location of volume control after last gain stage.

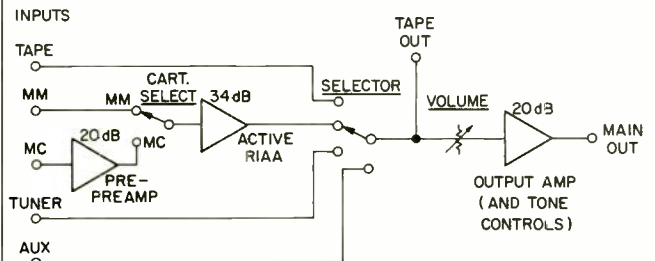


Fig. 2—Simplified block diagram of a conventional preamplifier.

other precision types. The power-supply design allows unregulated d.c. to run into the preamp via the thick power cable. There, it is regulated in three stages on the preamp's main p.c. board, and is dropped from ± 24 V to ± 20 V and finally to ± 17 V.

Circuit Description

The KPA-1 utilizes an unconventional circuit layout which is shown in Fig. 1, a simplified block diagram of a single channel's signal routing and gain structure. Tuner and AUX inputs are wired directly to the selector switch and, when selected, are applied to tape out and output amp in, just as in an ordinary preamp. Tape input goes through the unity-gain compensating stage discussed earlier. High-gain preamps with hysteresis compensation are used for MI and MM phono inputs. Their outputs are mixed with that of the MC pre-amp and further amplified by the mixer stage before being applied to the passive RIAA equalization network. Another 14 dB of gain makes up for the equalization loss, and signal is fed to the "Source" selector's phono contacts.

Unlike typical preamplifier circuitry (shown in Fig. 2), the KPA-1's volume control attenuation is applied after the line amplifier's 20-dB gain. Usually the selector switch is fol-

An imaginative extension of audiophile purist philosophy, the KPA-1 makes liberal use of quality parts.

lowed immediately by the volume control, so levels are cut down before a similar 20-dB amplifier. Owen Bennett, the unit's designer, explained that his design priority was to avoid any switching in the low-level phono stages. With three active phono inputs, signal-to-noise ratio was optimized by using shorting plugs in the two unused phono inputs and having the volume control follow the line amplifier. However, this design trade-off exposes the Kinergetics preamp's line section to very high gain levels without attenuation, and it runs the risk of overloading this section with only moderately high signals.

Measurements

Two KPA-1 preamplifiers were tested, prompted by the first unit's fairly high distortion reading of 2.75% THD + N when the MM input was driven at 50 Hz to produce output of 1.75 V at the tape outs. This affected the THD + N reading only in the MM position, so other measurements were carried out on this first sample. The second unit generally measured quite similar to the first, except for the MM distortion peak. This second sample measured less than 0.1% THD + N, 20 Hz to 20 kHz, tape input to main output, at maximum gain, and at 7.5 V output. These satisfactory measurements indicate that the KPA-1 should be considered a quiet, low-distortion preamp.

The MC phono input provided a maximum of 60.3 dB of gain and a signal-to-noise ratio of 70.9 dBA, measured for a signal level of 0.775 V (0 dB) at the tape output. Phono frequency response (Fig. 3), also measured from phono in to tape out, was ± 1.5 dB, 20 Hz to 20 kHz, for the MC and MI stages, and ± 2.0 dB for the MM input. This frequency response performance might have produced the audible differences between the KPA-1 and our reference preamps.

As mentioned above, the preamp's unusual gain structure achieves low noise at the expense of sensitivity to overload. The unequalized phono signal from any of the three phono inputs is heavily amplified before the passive RIAA equalization stage; clipping occurs in the 19-dB gain mixer stage, with even moderately high-velocity recordings. Input overload was at about 23 mV for MM and MI phono inputs and 3.2 mV for the MC input, very low by today's standards. The passive equalization does not protect the mixer stage from high-velocity, high-frequency signals.

Note the placement of the 20-dB output amplifier stage before the volume control instead of after it. This output stage, which amplifies whatever is selected via the selector switch, has a healthy output clipping point of about 13 V; however, a 1.3-V input will drive it to clipping. As mentioned above, most preamp designs place the volume control just in front of the line amp, so levels are cut down before the 20 dB of gain from the line amplifier.

What might appear to be phono input overload is actually overload in the output section. A signal of 8.3 mV at the MM input—or 1.53 mV for MC cartridges—is enough to produce the 1.3 V necessary to clip the output stage, and these conditions are regularly exceeded when playing modern recordings. The manufacturer agrees that the KPA-1 has a lower overload point than other preamplifiers but believes that the overload condition would not regularly occur in home use.

Use and Listening Tests

Equipment used to evaluate the KPA-1 included a Linn Sondek turntable with a Magnepan Unitrac 1 arm; Yamaha MC-1000 and Shure V15 Type V-MR cartridges; Meridian, Technics, and Magnavox CD players; a Mark Levinson ML-7 reference preamp; Mark Levinson ML-9 and Crown Micro-Tech 1000 solid-state power amps, and B & W 801F Special and Snell Type A-III speakers. Controlled listening tests were carried out with an ABX Co. comparator after matching outputs of the KPA-1 with coauthor Clark's preamp. New Monster Cable was used between the amp and speakers.

Clark's CD player has both fixed and variable outputs. When this player's output was set low, the KPA-1's output section was not overdriven, and the resulting sound was free of clipping. However, using the CD player's fixed high-level output in a double-blind A/B/X test, the KPA-1 distorted, and it was correctly identified in 16 out of 16 controlled attempts, a statistically significant result.

Coauthor Greenhill used the KPA-1 in his system with phono cartridges and a tape deck. In open, non-A/B/X listening tests, a moving-coil cartridge displayed an overly bright sound and a flattened sonic perspective, while the MM response was smooth and showed good separation of instruments and voices. Bass peaks from several Telarc orchestral records seemed to be softened, overly full and lacking in impact. Using a Tandberg TD-20A-SE 15-ips reel-to-reel deck, the KPA-1 reproduced a prerecorded Rumanis Recordings tape of a Schubert quartet with intimacy, ambience, and good recovery of instrumental timbre. The phono section of the KPA-1 was subjectively very quiet.

The KPA-1 preamplifier, to sum up, is an interesting and imaginative unit which exemplifies purist circuit construction. This is revealed in the many quality parts in the main signal path, e.g., superior capacitors and precision resistors. The intent of the design goes further, however, in that it attempts to compensate distortions in other parts of the audio chain. The output stage's location appears to us to make the KPA-1 vulnerable to overload, and we look forward to a Kinergetics preamplifier with a revised gain-block structure. *Laurence L. Greenhill and David L. Clark*

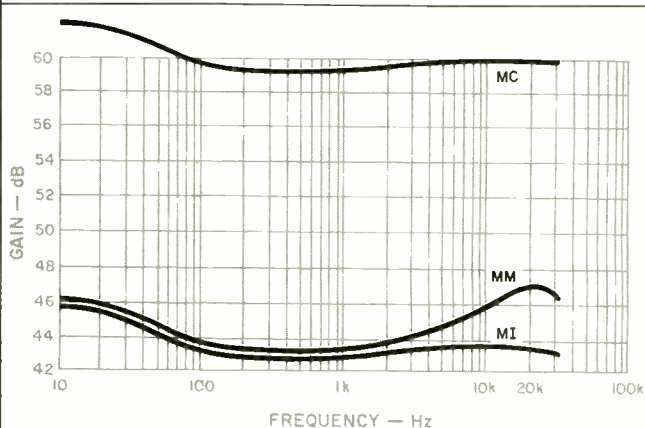


Fig. 3—Phono gain and frequency response, measured at tape output.

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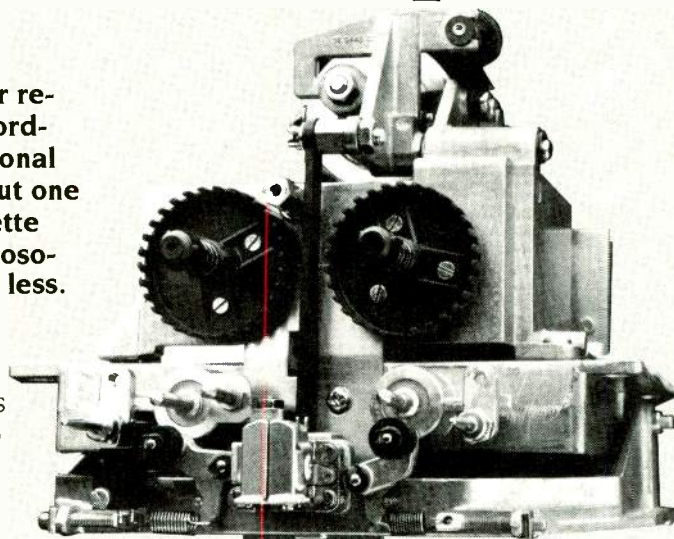
3. *An Azimuth Stable Headblock*—This is difficult to achieve in the cassette format because the headblock must move in and out of the cassette shell. Nearly all other decks use an inherently unstable "sled" mechanism. But the B215 uses a pivoting die-cast headblock mounted on precision bearings (.001 mm tolerance) to assure the stability required for optimum high frequency response.

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For one astute listener's evaluation of the B215's sonic qualities, please note the review in Volume 8, #7 of *Stereophile*. Reprints are available on request to the address below.



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ONKYO M-510 AMPLIFIER

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Top-quality power amplifiers have gotten harder to review in recent years. The classic power-amplifier problems—a lack of drive capability in the deep bass, a lack of sweetness in the upper midrange, and an inability to handle the loudest and lowest passages—are still around, but few new designs have serious flaws in these areas. Virtually all contemporary power amplifiers are at least listenable, and most are quite good. Sonic differences are still important, but they now tend to be differences in nuance and in the ability to deliver power into the extremely demanding loads presented by some top-quality speakers.

This capability to drive diverse loads is particularly important. As amplifiers have gotten better, it has become clearer and clearer that amplifiers form a "system" with the speakers they drive. Many of the audible differences between amplifiers change when the speaker is changed, often in unpredictable ways: An amplifier with a lean lower midrange on one speaker can be just right on another. A transparent midrange can suddenly become a bit hard and analytic. Tight bass can become too full, and vice versa. Imaging can shift from realistic to overetched and dramatic.

The causes of such interactions are far from clear in spite of ongoing technical research in this area. When one changes amplifiers, speakers that present seemingly simple resistive loads behave as differently as do ribbon speakers, which often show a load under 2 ohms, or electrostatics, which generally are a complex reactive load. Sound character also changes as much at low and moderate levels as it does at the high levels, where clipping might become a problem.

These problems are a good reason to take any amplifier or speaker review with a large grain of salt, and to insist on auditioning any amplifier with your



choice of speaker. They also make it almost mandatory that you find a good dealer who will actually pay attention to the sound of what he sells and work with you to get a proper "system balance." You cannot buy a high-end amplifier "off the rack" and expect to get the sound you pay for. Dealer support is critical.

The best amplifiers can, however, minimize these problems and risks by providing the capability to drive almost any load. The Onkyo M-510 is a particularly good case in point. Though Onkyo is known largely for more basic electronics, along with some exceptional FM tuners, the M-510 is very definitely a high-end product. It is one of those flagship designs—created without regard to cost and market size—that rarely leave Japan, but command worldwide recognition when they do.

The M-510 lists for \$4,200, but its performance justifies its cost. It delivers an incredible amount of power into even the most demanding loads. It is conservatively rated at 300 watts per channel into 8 ohms, 500 watts into 4 ohms, and 800 watts into 2 ohms. Its dynamic power rating is greater than 400 watts into 8 ohms, 750 watts into 4

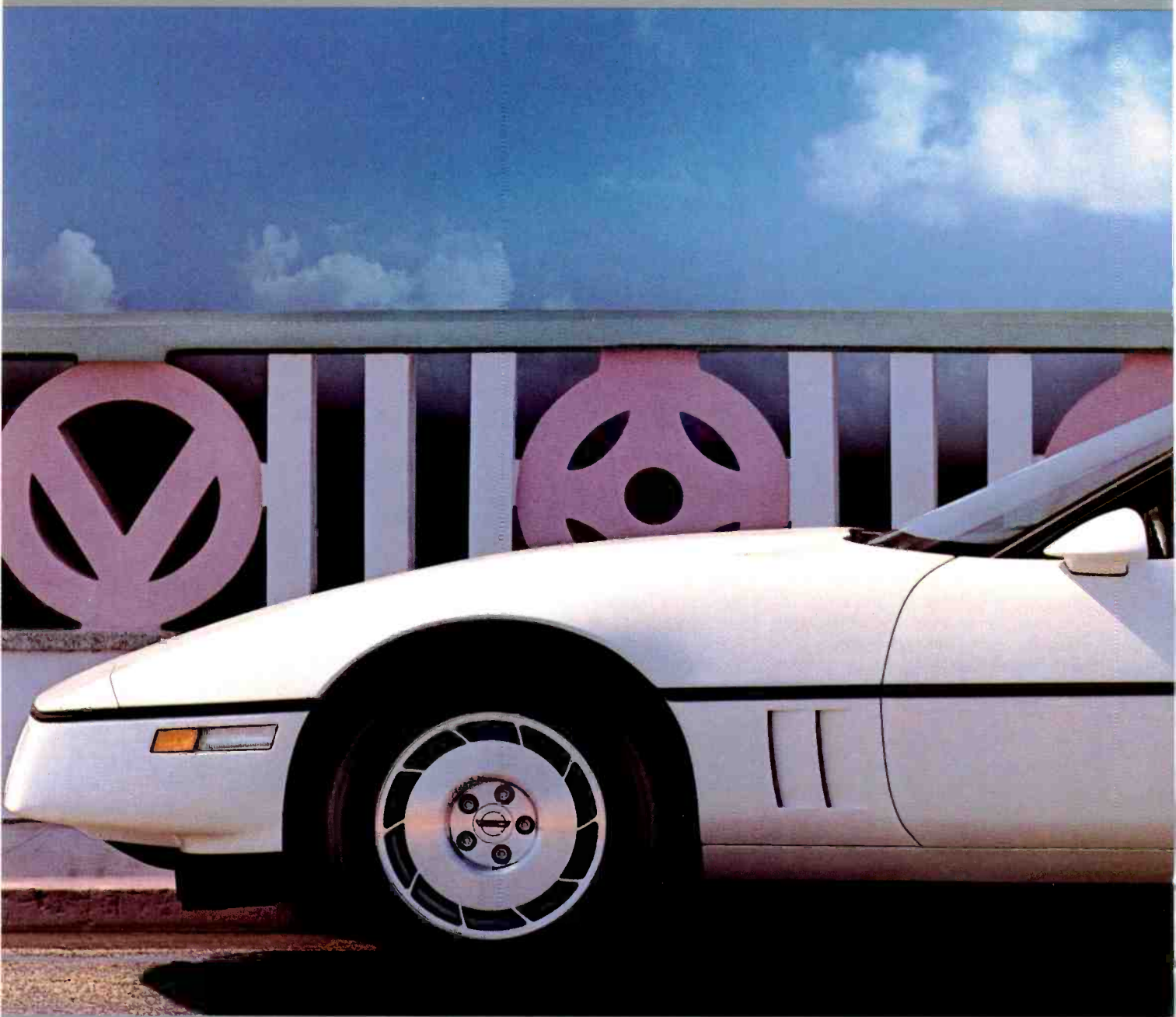
ohms, 1,300 watts into 2 ohms, and 2,100 watts into 1 ohm. Harmonic and IM distortion are specified as below 0.005% for a bandwidth of 5 Hz to 100 kHz. The rated damping factor at 50 Hz into 8 ohms exceeds 300.

Onkyo is known for its good basic electronics, but this amplifier is definitely high-end, beautifully made and styled, and offering exceptional features.

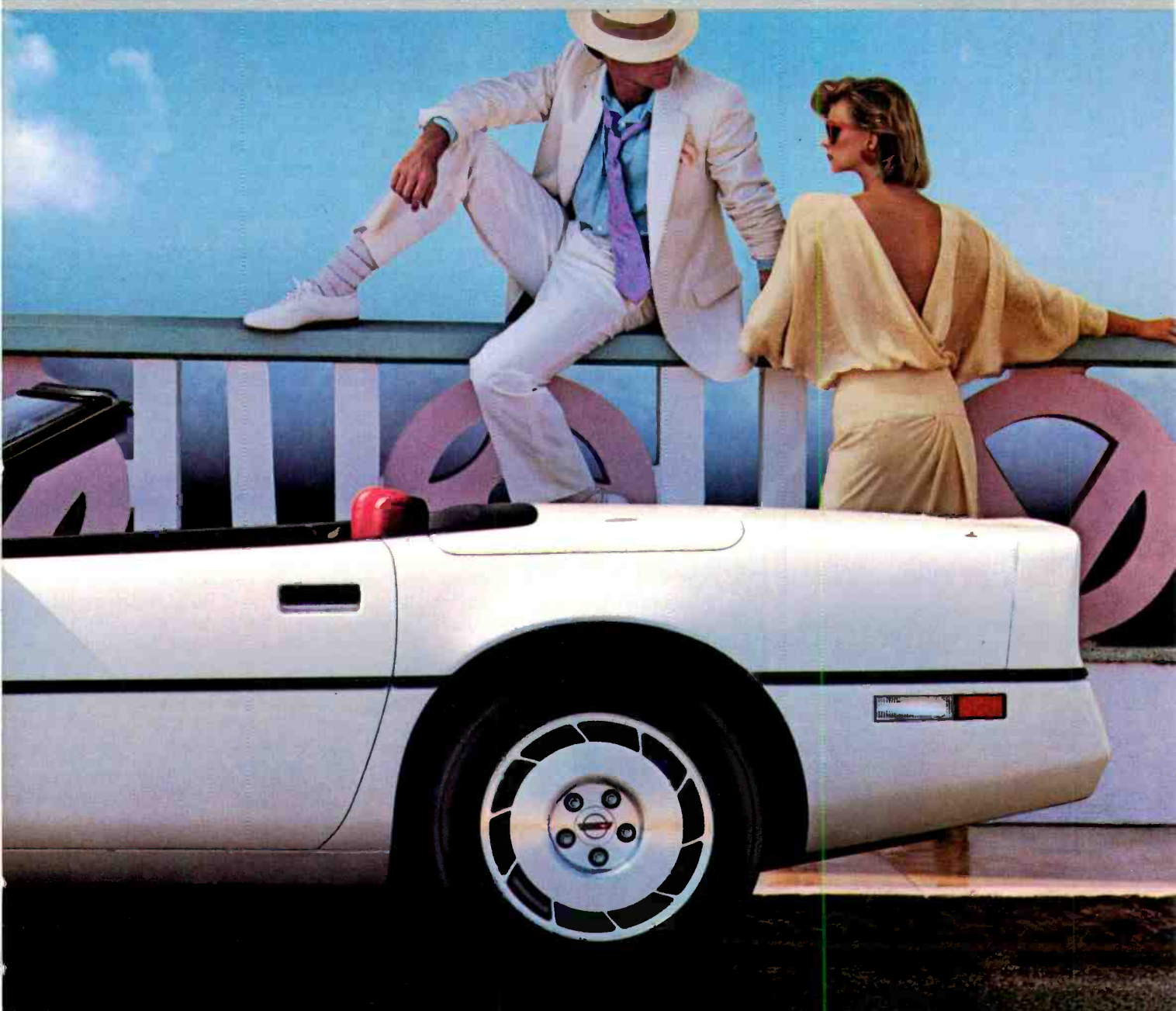
Big power means a big amplifier, and the M-510 comes in a package that weighs about 150 pounds and measures 20 inches wide × 10½ inches high × 20½ inches deep. The amp is beautifully made and styled, with exceptional features. It comes in silver trimmed with the champagne gold that is currently fashionable with Japanese high-end audiophiles, and it has rosewood side panels. The M-510 has peak-reading meters with switchable gain and individual power supplies. There is a choice of direct inputs or inputs with variable gain. Switchable

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relays allow the choice of either of two speaker pairs, or both. The cabinetry is excellent, and the speaker connectors are massive binding posts that can take virtually any speaker cable.

The M-510 has a number of other outstanding design features. A dual-mono design, the amp has separate power supplies which use a complex combination of a large toroidal transformer and a small "real phase" transformer said to smooth out fluctuations in the charging current coming from amplifier/speaker interactions. If you are a capacitor lover (someone must be!), there are two 33,000- μ F power-supply capacitors per channel. All inputs are direct-coupled, and a servo system is used to protect against d.c. and against a.c. below 3 Hz. Speaker protection is also exceptionally good, as suits an amplifier rated as capable of surge powers of 2.5 kilowatts. While the owner's manual does not describe the circuit topology in detail, the M-510 uses Class-A drive and Class-AB circuitry which is specially designed to reduce switching distortion, with 14 output devices per channel.

Most important, the sound of the M-510 lives up to its features and technology and does so with a very wide range of speakers. The amp not only works well with speakers which are comparatively easy loads, such as Thiel CS2s and Magnepan MG-IIIBs, but delivers outstanding performance with such far more demanding speakers as Infinity RS IB panels and Apogee Scintillas. Although the M-510's sound character does vary slightly according to the speaker being used, performance is uniformly good.

The bass is always tight, deep, and realistic. The Onkyo's performance in this area is better than that of any tube amplifier I have yet heard, and equals that of any transistor amplifier I know of except the 200-watt Krell mono amplifiers—which cost \$7,500 a pair. The difficult transition from upper bass to lower midrange is well handled, and there is only a slight trace of leanness—excellent performance in this area for any transistor power amplifier.

The midrange is natural and well balanced, and the transition to the upper midrange and upper octaves is also exceptionally smooth. Timbre is convincing, although with a slightly for-

ward character. This amp slightly emphasizes the upper midrange without creating hardness or an aggressive sound character. The treble response is very smooth and clear, and there is exceptional air and detail in the top octaves.

The handling of dynamic contrasts—rapid shifts from low to high levels, and sudden transients—is uniformly excellent. The M-510 is very detailed and transparent, and the imaging is clear and well spread. The sound seems to extend to the right and left of the speakers without clustering around them or leaving an apparent hole in the middle. Sound-stage height and width are very good indeed, and depth is good to very good. Unlike some other high-power amplifiers, the M-510 has a very live and dynamic character even at moderate listening levels. This adds to the excitement in the music without exaggerating it.

The M-510 is a world-class product. Its sonic colorations are minor, and its overall performance compares favorably to some of the most expensive and most favorably reviewed American-made transistor designs. In my opinion, the Onkyo is clearly superior to most of its high-end competition in its ability to deliver a consistent sound character into a wide range of demanding loads. All its features would be useful in any sophisticated, high-end system, and are a real pleasure for anyone (such as a reviewer) who wants to rapidly switch between speakers, confirm power levels, or correct consistent small imbalances in level.

If I have any practical reservations about the M-510, they concern the need to pay attention to overall system balance. Like most top-ranking transistor power amplifiers, the Onkyo is transparent and accurate to a demanding degree. It requires proper attention to system adjustment and balance, and is not the amplifier for any audiophile searching for a soft or forgiving design. Nevertheless, the M-510 raises Onkyo to a whole new plateau of high-end sound quality. One has to hope that this same amplifier technology can be made available in a less costly version, and that Onkyo will develop an equally good preamp!

Anthony H. Cordesman

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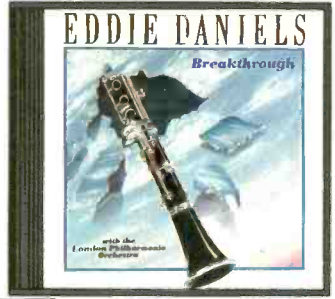
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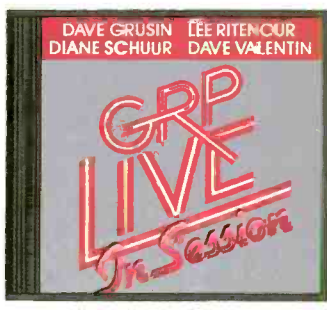


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Like a Rock: Bob Seger & The Silver Bullet Band
Capitol PT-12398, \$8.98.

Sound: B+ Performance: A-

Bob Seger's recording career has been an erratic affair, to say the least. Some of his best work has been recorded horribly; this hasn't really impeded his ability to reach an audience, but his art has suffered in the process. From his first hit single, "Ramblin' Gamblin' Man," his records have had a shrill, annoying sonic quality which has made them sound like they're coming over a radio even when they're being played on a terrific system. It's hard to call a record a classic when the sound quality is as bad as it was on *Night Moves*. Finally, with *Like a Rock*, Seger's producer/manager Punch has enlisted a capable engineer, David Cole, to coproduce, and *voilà*, Seger has dynamic range, full fidelity, and a real bottom to his sound!

If that weren't amazing enough, the music, too, is way above par for Seger, whose last two albums have been on the tepid side. Although the well-intentioned single, "American Storm," is not among Seger's best, the rest of the album has a lot of lyrical and musical depth. He will be accused of sounding

like Springsteen, as usual, but let's just say that it works.

There's no danger of Seger bowing to musical fashion—for instance, the thought of his using synthesizers and drum machines is out of the question. But he's at last gotten to the point where the musicianship of his band is up to mid-'70s standards, giving us nice, old-fashioned guitar solos (not the Van Halen variety) and a solid organ/piano foundation (courtesy Craig Frost, ex-Grand Funk).

It ain't Seger's raunchiest record or his rockiest, but in terms of combining strong songs with sonic clarity and quality performances, *Like a Rock* has a leg up on most of his other records. No great surprises, but improvements are always welcome, and there's nothing here to disappoint.

Jon & Sally Tiven

Secret Dreams and Forbidden Fire: Bonnie Tyler
Columbia OC 40312.

Sound: B+ Performance: B-

It's too bad they don't have surround-sound on records as they do in some movies—this would make one fabulous demo disc. Producer Jim Steinman, our latter-day Phil Spector,

continues to prove that whether you be Meat Loaf, Air Supply or Bonnie Tyler, you're ultimately making a Jim Steinman record. It's the only kind where you go out humming the production.

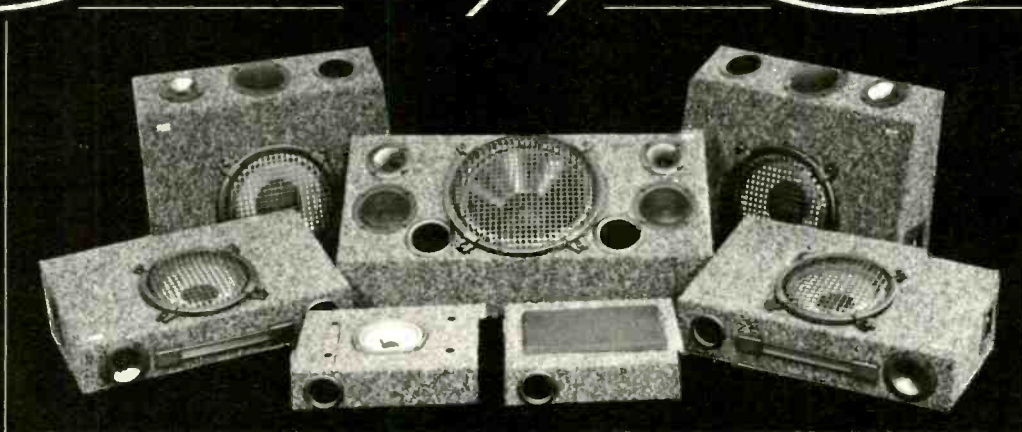
Tyler and her throaty vibrato made a comeback under Steinman with *Faster than the Speed of Night*. That 1983 album and a hit single buried her country crossover image (which was strange enough for a Welsh rocker, of all things) and turned her from a female Rod Stewart to a female Meat Loaf. *Secret Dreams* continues this transformation. I'm not complaining, mind you; with all the Pat Benatar clones on the market, it's great to hear someone who's her own girl, even if that girl's a guy. Which may explain why the best song here is a forceful dance/rock tune called "If You Were a Woman (And I Was a Man)."

That song, like the album's best moments, sounds as if it were born during a thunderstorm on Bald Mountain. Tyler's musicians are magicians—pianist Roy Bittan and drummer Max Weinberg of Bruce Springsteen's E Street Band, guitar wiz Eddie Martinez, and saxophonists Lenny Pickett and Michael Brecker. Among other stars, Todd Rundgren sings backup and, on one song, duet vocals. Every instrument gets what amounts to a Steinman-style solo—a forward mix in a synthesizer-fed maelstrom.

Ironically, the three songs written by Steinman alone are as silly as his pro-



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On Milton Nascimento's beautifully recorded album, one can hear the musical influences of Europe, the Americas, and Africa.

duction is soaring. I can't imagine any teenager listening to "Rebel Without a Case," for instance, with a straight face. I can't even write down the title and keep one. And yet, the musicianship ultimately tips the scales in the album's favor.

Tyler, with her sometimes-strained range and occasionally uncertain phrasing, acquits herself only partially in some instances and not at all in "Band of Gold," the 1970 Freda Payne hit here recycled as a potential TV-show theme song.

What a nest of contradictions! "If You Were a Woman" and "Holding Out for a Hero" are two of the best Corvette-summer songs you're likely to find, but even the worst songs here are conquered by Steinman's musical panzer division. Combining the best and worst of two worlds, *Secret Dreams and Forbidden Fire* is currently the best comic book on vinyl.

Frank Lovece

Encontros E Despedidas: Milton Nascimento
Polydor 827 638-1, \$9.98.

Sound: B+ Performance: A-

Milton Nascimento is one of Brazil's national music treasures. His work has gathered an international audience and gained the respect of jazz musicians worldwide. *Native Dancer*, Nascimento's 1975 album with saxophonist/composer Wayne Shorter (co-founder of Weather Report), is still considered a classic melding of Brazilian and American musical styles.

As a vocalist and songwriter, Nascimento is one of the very finest. Although primarily adopted by jazz fans here in the U.S., Nascimento's music, sung in his sometimes swooping, sometimes mellow, always interesting style, would be more accurately described as pop than as jazz. His songs are usually lyrical and introspective even when making a political statement, as on this album's "Lagrima Do Sul" (Southern Tear), dedicated to South African activist Winnie Mandela. A listener can hear music from Europe, Africa, and the Americas—all the elements which have combined to create Brazil.

Encontros E Despedidas (Meetings and Farewells) features flutist Hubert



Laws and guitarist Pat Metheny on one track each. Admirably, these American artists, although quite likely hired in an attempt to help the record gain recognition and sales, support the music rather than distort it to fit their musical images.

The strongest commercial tracks (for the U.S. market) are "Portal Da Cor" (Threshold of Colors) and the title cut, but there is much good music throughout to recommend this album to both pop and jazz fans. Nascimento's voice is a beautifully natural instrument. The musical arrangements are generally simple and supportive, as on "Quem Perguntou Por Mim" (Who Asked for Me), but are sometimes undermined by the production. There is a general overuse of reverb techniques intended to create a bigger, more contemporary snare-drum sound. For instance, there's a lot of gated reverb, a mixing technique in which the echo or reverb used on the snare drum is routed through a noise gate to create dramatic and often explosive (albeit unnatural) decay times. With a beat that departs from the standard 4/4 time signature of rock, the music sometimes gets overwhelmed (as on "Rádio Experiência"), but it is strong nevertheless and survives very well.

The album was digitally mixed and mastered, and pressed on Quiex vinyl. The result is excellent, the recording being quiet and dynamic. The basic tracks were recorded with analog machines in Brazil and then sent north to Lion's Share Studios in California to be mixed by one of the premier recording

engineers in the country, Humberto Gatica. (Gatica is probably best known for his work on "We Are the World.")

Encontros E Despedidas is a fine musical experience. It would be a perfect place to start finding out more about a great musician.

Hector G. La Torre

Mistrial: Lou Reed
RCA AFL1-7190, \$8.98.

Sound: B+ Performance: B-

Lou Reed stands accused of selling out. Many are the critics and fans who have found his appearance in motor-scooter ads an occasion for finger-pointing. Apparently Lou doesn't think



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Lou Reed rocks with tough conviction on *Mistrial*, an exceptional album he's recorded with economy but without stinginess.

this is fair, and he refuses to sit still for it. In a rowdy, defiant rock tune, which I submit as Exhibit A, Lou intones, "I want a mistrial/to clear my name/I want to bring my case to the people of New York City." And bring it he does; The Rolling Stones would do well to rock with as much tough conviction as do

Lou and partner Fernando Saunders on this exceptional album.

Exhibit B is "No Money Down," a perfect application of the principle of economy without stinginess which lies behind the arranging, recording, and mixing of almost every song on this album. The sound of the drum ma-

chine, used for nearly all the percussion, is neither insubstantial nor brash; the programming by bassist Saunders is unusually tasteful. Reed's voice is centrally positioned just a little less forward than the drums, and the rest of the carefully treated sounds recede to a considerable depth.

Reed admits in a typically smart and candid lyric that he used to have a bad attitude, and on a few cuts he still does: Witness the slight chauvinism of "Don't Hurt a Woman" and the snide superiority of "Mama's Got a Lover." But despite these lapses, this album provides as many exhibits for Lou's defense as there are songs.

Susan Borey

Born Yesterday: The Everly Brothers
Mercury 826 142-1 M-1, \$8.98.

Sound: C +

Performance: B

The second Everly Brothers album of the '80s, again a Dave Edmunds production, is a more comfortable construction than its predecessor, *EB84*, even if nothing quite matches the pure thrill of that album's "On the Wings of a Nightingale."

No matter. When Don and Phil Everly share a song, all kinds of magic can still happen. The title track (the only new Everly composition here) recalls the sweetness of such Everly classics as "Let It Be Me." Other highlights are their lovely run at Dire Straits' "Why Worry"; a previously unreleased Bob Dylan song, "Abandoned Love"; the goofy and exuberant "Amanda Ruth" (a latter-day "Wake Up Little Susie"), and an early-'70s-vintage Sutherland Brothers song, "Arms of Mary." The song selections are really cagey ones and showcase those historic brotherly harmonies beautifully.

The band here is essentially the same as on *EB84*, featuring players who know well what notes to leave out. In keeping accompaniment simple, there is all the more focus on the brothers' drawing-card vocals.

One consumers' note: The cassette and Compact Disc versions of *Born Yesterday* add a bonus track that is well worth hearing: Sam Cooke's "You Send Me," a song Don and Phil sing pretty enough to make you weep.

Michael Tearson



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The Blind Leading the Naked: Violent Femmes

Slash Records 25340-1, \$8.98.

Sound: B+ Performance: A-

Careening enthusiastically from R&B and rockabilly through '60s pop and psychedelia to hardcore thrash, *The Blind Leading the Naked* represents a maturation of vision and musicianship

for the popular cult band Violent Femmes.

Gordon Gano's lyrics have shifted from cynical despair toward a more positive (and marketable) black humor. He still touches on politics ("No Killing"), social satire ("Children of the Revolution"), and religious imagery ("Faith," "Love & Me Make Three"). But the irony is much more transparent and

amusing than on this Milwaukee band's previous releases, and there are even some delightfully quirky love songs (check out "I Held Her in My Arms" and "Breakin' Hearts").

The Femmes' playing is more confident and polished than ever. They create lively, varied sonic textures with exotic instrumentation and sparse arrangements propelled by Brian Ritchie's versatile, growling guitar and Victor De Lorenzo's tasty percussion. Guest musicians help too. Jerry Harrison's production makes very good use of aural space, with clear left/middle/right and foreground/background delineation and crisp, well-articulated instrumental lines.

Gano's vocal mannerisms and sour melodies inevitably bring to mind Lou Reed and The Velvet Underground. However, the Femmes are having fun here, imposing their distinctive personality on the stylistic eclecticism they've chosen, to forge a synthesis full of surprises.

Michael Wright

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Blue Tomorrow:

The Swimming Pool Q's
A&M SP-5107, \$8.98.

Sound: B Performance: B -

There are two sides to every record. Few albums highlight this fact so well as the second major-label release by Atlanta power-folk quintet The Swimming Pool Q's. Side one offers more rollicking good fun than a big, ol' Georgia pig roast, and more contemplative stargazing than walking hand-in-hand with your sweetheart. From the ethereality that opens "Now I'm Talking About Now" to the swinging, sing-along booziness of the comical "Laredo Radio," this first side shuttles back and forth between coffee houses and biker bars. What fun! Side two, however, is—well, I can see why it's side two.

What tips the platter in the band's favor is a consistently joyfu guitar sound that makes palatable all but the most frivolous songs here. Brit producer Mike Howlett apparently injected a



lot of experimentation, with synthesizers and nothing less exotic than an electric dulcimer complementing Jeff Calder's and Bob Elsey's easygoing guitars and J. E. Garnett's decidedly rocking bass. Unfortunately, Howlett couldn't do anything for some of the group-credited lyrics, which on the second side range from absurdly devastating to silly.

Calder and the dusky-voiced Anne Richmond Boston trade lead vocals, with the former usually getting the fun-

ny stuff and the latter the rock ballads. They occasionally switch around, to their detriment; both suffer from somewhat constricted ranges, though they're find for their specialties. Still, I can see Boston eventually adding enough depth and coloration to her voice to become a formidable power.

I'm compelled to add that nothing of this fine band's quality is the least bit evident in *Blue Tomorrow's* horrendous album cover, a closeup of the band in a fake pasture. *Frank Lovece*

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LUDWIG, TO THE NINES

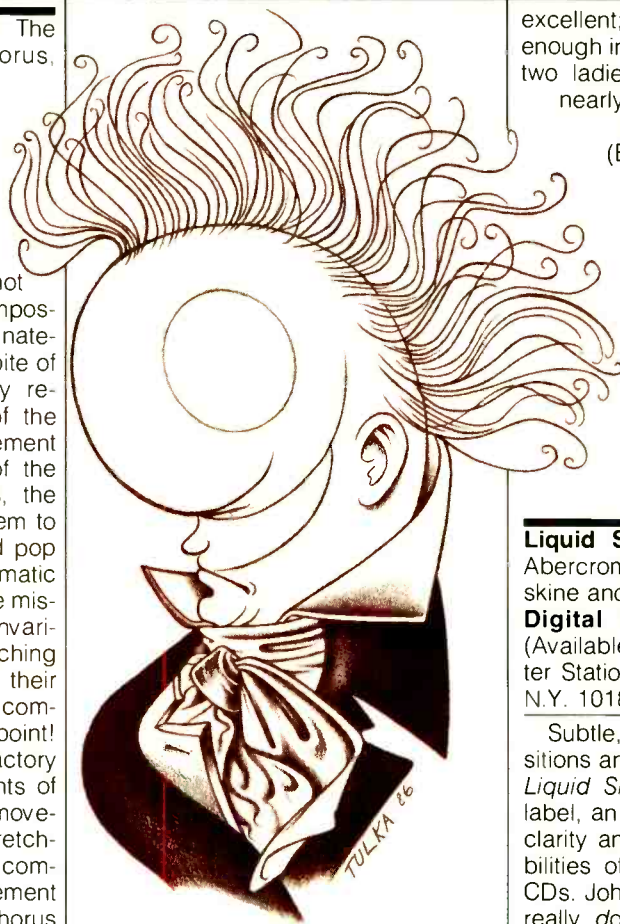
Beethoven: Symphony No. 9. The Cleveland Orchestra and Chorus, Christoph von Dohnányi. Telarc CD 80120.

The Ninth Symphony has been the ultimate bugbear for the LP, right from its beginning. At last, the big symphony meets its match!

Beethoven, need we say, did not write for the LP. Indeed, of all composers he seems to be the most obstinately difficult to put on records, in spite of the thousands of them already released. It's not only because of the uncomfortable lengths of movement after movement, but because of the rude, violent dynamic contrasts, the persistent soft passages that seem to amplify the hiss and scratch and pop of older discs, the sudden dramatic silences—same result—and those misleadingly gentle passages that invariably end in an explosion, catching generations of gain riders with their meters pinned. An exasperating composer, from the technician's viewpoint!

There has never been a satisfactory LP solution to the four movements of the big Ninth Symphony. No two movements will fit on a side without stretching the limits, no matter how we compromise; all but the big final movement with four solo singers and large chorus are felt to be too short for a side to themselves. Some LP versions have committed the unthinkable, breaking the slow third movement in half, for two sides. A three-sided version leaves one or more sides very short—and who wants to add extra music to the Ninth, either before or after? Nobody in his right musical mind. On a single LP without splitting something, either one side or the other is unconscionably long and, of course, the loudest music comes practically next to the LP label. What can you do? Nothing.

Yet look at this little one-sided CD! Everything's here, beginning to end, unbroken, no local stops, express all the way. Every loud part, every explosion, is taken care of easily; every soft part plays as quietly as a mouse; the sudden and unexpected dead silences, as in the scherzo second movement, are exactly that, except for the loving die-away of the orchestral reverb down to zero.



An interesting performance too. To be sure, it is fast, very speedy in every movement. That's the current way of things (and it might just help get the music into the spaces available). Older versions, dozens of them, tended toward much pomp and beetle-browed intensity—and very slow tempi. On records, the faster speed makes for a lot easier listening. Remember that in Beethoven's time "live" concerts went on for four or five hours. That's not our tempo at all today. Yes, a lot of the marvelous detail in the big symphony is lost in a golden blur at these fast tempi. I missed them, especially the woodwind passages. But it was not any lack of precision, just the haste and the big blur, which is otherwise very desirable.

The Cleveland is one of the most precise orchestras in existence. The grandiloquent bass soloist in the last movement is Robert Lloyd and he is

excellent; Siegfried Jerusalem is good enough in the short tenor solo, and the two ladies do not shriek and squall nearly as much as most do in their horribly uncomfortable parts. (Beethoven did some dreadful miscalculating in this last movement, as all who have sung it know too well.)

All in all, the details gained in the CD format make up for those blurred by fast tempi in the earlier movements. I'd rate this as a very good Ninth Symphony for today.
Edward Tatnall Canby

Liquid Silver: Andy LaVerne, John Abercrombie, Eddie Gomez, Peter Erskine and the Essex Quartet.

Digital Music Products CD 449. (Available from DMP, Rockefeller Center Station, P.O. Box 2317, New York, N.Y. 10185.)

Subtle, quiet, inventive jazz compositions and a crystal-clear sound make *Liquid Silver*, from Tom Jung's DMP label, an unusually enjoyable CD. The clarity and detail exemplify the capabilities of the best digitally recorded CDs. John Abercrombie's guitar tones really do float like liquid silver over Andy LaVerne's piano accompaniments—especially in Bill Evans' composition "Turn Out the Stars."

LaVerne and Jung recorded the various ensembles featured here with an intimate sonic perspective, using just enough ambience to create the impression of being in a small room. They recorded in a studio rather than a concert hall, so the acoustical character is rather clinically neutral. It's warmed up with carefully controlled ambience and reverb from the studio and from various signal processors, but the recordists never allow these techniques to obscure the clarity and sonic accuracy of the sound. The sound stage is exactly right for this music too. The recording has all the expected spatial qualities of depth, width, and height, but they are restrained to preserve the intimacy this music requires. What the recording lacks is a sense of being in a particular place.

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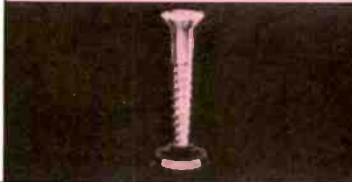
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 KENNY LOGGINS — Playing With The Boys



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MESSIAEN: Turangalila-symphonie;
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 Les Escales du sommeil Philharmon a
 Orch; John Shirley-Quirk, Los Angeles
 Phil. Esca - Pekka Salonen (2 CD Set)
 BERG: Violin Concerto; Three Pieces for
 Orchestra, Op. 6 Pinchas Zukerman;
 London Symphony Orch./Pierre Boulez
 "The Flute At The Court Of Frederick The Great"
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Pianist Andy LaVerne and the other musicians on *Liquid Silver* have been recorded intimately, with processors adding warmth without lessening clarity.

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In "Letter to Evan" LaVerne uses a string quartet, and in "King's House One" a piano quintet. The fresh, rich string sound emerges from total silence, hanging in the air between the speakers. Bass too is wonderful. In "How My Heart Sings," Eddie Gomez has plenty of solo opportunities. The sound of his instrument is well defined, strong but not overpowering.

LaVerne's harmonic vocabulary is principally modern jazz, but his frequent departures evoke a rather Debussy-like style. In the first movement of "King's House One" you can hear the familiar modes and whole-tone scales as well as impressionistic harmonies (sixth, ninth and eleventh chords), but they are used in a very personal, expressive way. In the middle movement of "King's House One" LaVerne incorporates elements of Hindemith's neo-classic style.

The album package and booklet, designed by Jim Henderson, reflect the quiet good taste of the music and



the production, with interesting, useful information about the performers and the music. Photographs from the recording sessions show the arrangement of the performers and the mikes. All these elements contribute to a greater understanding of the recording and help make *Liquid Silver* beautiful in every respect. *Steve Birchall*

The Pugh-Taylor Project: Jim Pugh and Dave Taylor
Digital Music Products CD 448.
 (Available from DMP, Rockefeller Center Station, P.O. Box 2317, New York, N.Y. 10185.)

This CD, another ambitious recording from DMP, could be described as

an exercise in sonority. As many as 19 musicians were used in the recording—though not all at one time—with Jim Pugh's tenor trombone and Dave Taylor's bass trombone acting as sort of left/right stereo anchors. There is also a clarinet and bass clarinet, saxes from soprano to baritone, flutes, all sorts of percussion, piano, bass, strings, and liberal use of synthesizers.

The music is original material, written to explore the range and tonal resources of this large and diverse group of instruments. Most of it is sonically interesting—some people might even like "Red Balloons," which I choose to call semi-organized noise. The best tracks are 5, 6, and 7, with "Futures" generating some very exciting sounds with wide-ranging dynamics. It serves as a great test and "showoff" piece. As usual, Tom Jung's engineering is of the highest order, with every element ultra-clean and furnished with interesting acoustic perspectives. For sheer sound, this is a knockout! *Bert Whyte*

Canyon: Paul Winter
Living Music LMRCD-6.

As an early avatar of New Age music, The Paul Winter Consort provided the blueprint for dozens of disciples, including the entire Windham Hill crowd; Winter drew a diagram, etched with classical melodies, ethnic rhythms, the occasional Asian scale, and modal forms of improvisation that look to jazz without an edge. Lay this



Jim Pugh



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This Paul Winter disc, recorded in a canyon and a cathedral, is one of the most compelling recordings he's made in years.

blueprint over an environmental activist and you've got *Canyon*, one of many recordings that Winter has made evoking a unity between music and nature, man and his environment, and in this case, cathedrals and canyons.

Canyon is split roughly in half, with recordings originating in the depths of

the Grand Canyon and the Cathedral of St. John the Divine in New York. At times, Winter cross-fades the tracks so a canyon recording merges into a cathedral cut.

The spirit here is mystical. Although the pieces are called improvisations, there is a compositional unity in their

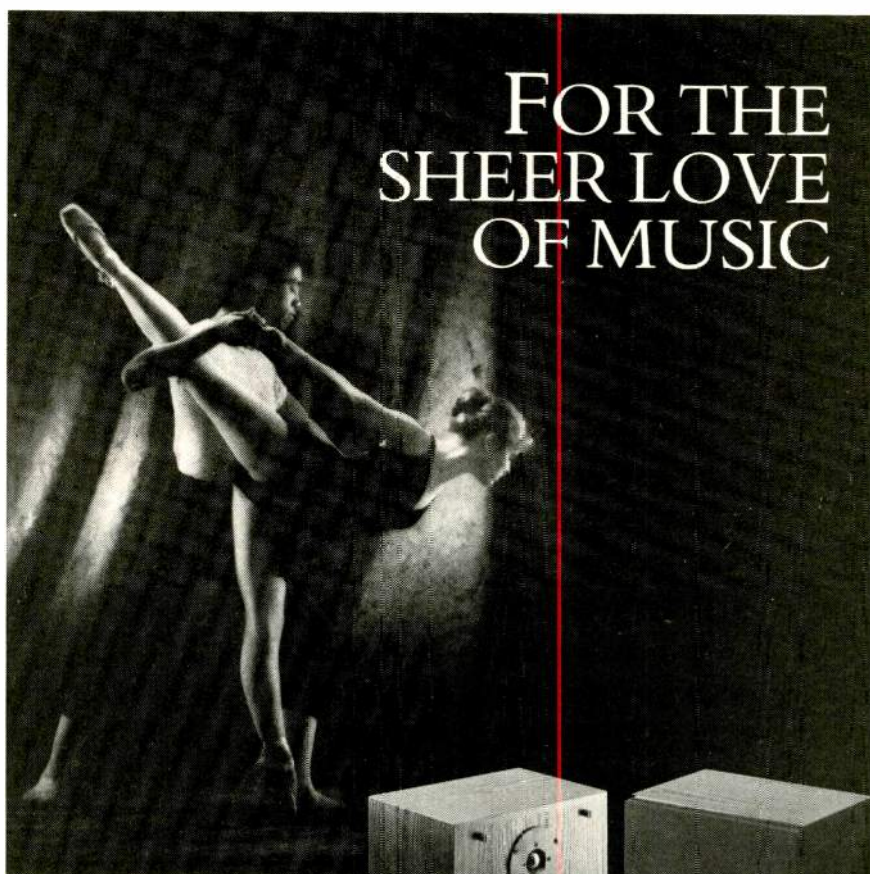
harmonies, dynamics, and rhythms. So ensemble pieces like "Bright Angel" and "River Run" progress towards predictable crescendos, with Winter's soprano saxophone intertwined with Paul McCandless' oboe and John Clark's blunted French horn in soaring, ecstatic melodies.

Percussionist Glen Velez adds an ethnic veracity to *Canyon*, preventing it from becoming just another New Age ethnological forgery. His buzzing bendir, sort of an African snare drum, empowers "Grand Canyon Sunrise," and the pandereta drum, from Spain, lends a gurgling, churning backdrop to "River Run."

Although Winter remains trapped in the soporifics of pseudo-mysticism, *Canyon* is one of the most compelling and free recordings he's made in years. It's far removed from the rapid *Common Ground* or the execrable saccharine of *Concert for the Earth*. He breaks no new ground, but does harken back to his golden *Icarus* era.

Paul Winter is well served by the Compact Disc recording. The live ambience of the canyon, with the Colorado River rushing by, tends to flatten out the dynamic range. However, the cathedral lends a clarity and resonance to Winter's improvisations, especially with the textural interplay of cellos and percussion. If you've been put off by Winter's cloying distillations of world music in the last few years, *Canyon* is a welcome opportunity to reintroduce yourself to this influential musician.

John Diliberto



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She's the Boss: Mick Jagger Columbia CK 39940.

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Jagger burns through the nine cuts on *She's the Boss* and sends sonic sparks flying. This analog recording, digitalized for Compact Disc, is hot, and it's Big Lips himself who deserves the credit. Fresh out of The Stones' school of production, Jagger here alternately teams up with two of production's finest—Nile Rodgers (see interview in *Audio*, September 1985) and

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On *She's the Boss*, the digital medium highlights a crisp presentation in which the producers' ideas are neatly realized and never overdone.

Bill Laswell—for a set of cuts that leap out of the speakers and singe the fine hairs in your ears.

"Lonely at the Top" kicks the disc off with a percussive firecracker flaming out of the digital silence. Jagger's voice is placed at mid-center while drums slam away cleanly behind him, and Pete Townshend's neat guitar figures fly high and free in both left and right channels. Later on in this cut, Jeff Beck's guitar sears a smoking hole where Mick once stood.

Mick certainly has friends in high places. Among the other star-power instrumentalists assisting him on this disc are Herbie Hancock, Jan Hammer, Bernard Edwards, Ray Cooper, and reggae's premier rhythm duo, Robbie Shakespeare and Sly Dunbar. Sly's Simmons drums on "Running Out of Luck" have such presence that they pop out of the speakers.

Despite the multi-layered instrumentals and special effects characteristic of a Jagger production, there is true clarity to each individual element; for instance, you can hear the vibration of each string on Townshend's guitar in "Hard Woman," the only slow number on the album. There is also a sense of sparseness that comes from Mick's experience in the blues tradition. Fancy effects are rarely repeated and no single element bleeds messily into another. The digital medium highlights this crispness of presentation. Listen, for instance, to the overdubbed, half-speed echo of Mick's own voice on "Running Out of Luck." It's a neat idea, neatly realized, never overdone. The synthesized white noise that drags from right to center to left on "Just Another Night" appears only once, and is so wonderfully transparent that it doesn't obscure the instrumental segment it passes over.

Great dynamic range, great clarity, great sense of space and instrumental location, great music, great performance, all under the thumb of Mick Jagger. So, Mick, tell us again—who's the boss?
Paulette Weiss

This Is Big Audio Dynamite: Big Audio Dynamite
Columbia CK 40220.

Maybe Mick Jones sang "Should I Stay or Should I Go" one time too

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many; whatever it was, Joe Strummer decided Jones should go, and kicked the cofounder of The Clash out of the band. Jones landed on his sneaker-shod feet and is making a lot of noise these days with his new band, Big Audio Dynamite, and the debut album of nearly the same name.

This is a quirky recording, complex and simple at the same time. The complexity results from the insertion of tape loops—pieces of speeches, bits of TV programs, and other pop-culture detritus—and from an electronically doctored production that sends sound effects zooming from channel to channel and breaks up vocals and instrumentals into snippets that repeat and repeat and repeat.

The occasionally stream-of-consciousness lyrics demand attention, commenting on politics and pop culture with a mixture of wry amusement, anger, and clinical observation. It's nice to know that Jones still has a sense of humor, considering all he's been through and the miserable social conditions he comments on.

Despite the impression of complexity, the song structures and melodies are simple as can be, neat little skeletons on which all the other stuff is hung. The tunes are attractive, and the synthesized, techno-pop beat actually makes danceable songs about AIDS, apartheid, and shooting your Mum and burning the cat.

The audio component of this Compact Disc is the big dynamite story here; the sound is full, clean, and crisp. The constantly shifting aural planes are brilliantly revealed, as is the dramatic movement from channel to channel. The extended dynamic range that digital recording is capable of is not called for on *This Is Big Audio Dynamite*, but the presencing of instru-

With elaborate effects embellishing some very basic songs, this CD from Big Audio Dynamite is complex and simple at the same time.

ments is impressive, as are those miraculous CD silences.

If the contents of *This Is Big Audio Dynamite* don't blow you away, the sheer sound certainly will. A must-hear.

Paulette Weiss

J. C. Bach: Three Concertos for Harpsichord and Strings. The Tokyo Solisten; Huguette Dreyfus, harpsichord.
Denon 33C37-7672.

Johann Christian Bach, youngest of the three musical sons of old J. S. Bach, is the least like his father and the most like Mozart—a good reason for listening to his elegant, polished music, an immensely sophisticated sort of background music in its time. It lacks the depth and passion of so much Mozart, but this is where the child Mozart first developed his own style, virtually in J. C. Bach's comfortable lap in London. Bach was the reigning favorite there, following that clever entertainer Handel, and Mozart worshipped him long before he ever heard of Johann Sebastian.

Three suave and delightful concertos here, the first, in G, very typical of literally hundreds of mature works by "the London Bach." The harpsichord is very near to a piano, delicate and melodic—nothing like old Bach's much more massive harpsichord music. The small string group is ever so eloquent, and politely keeps silent when the harpsichord has something to say. Such ineffable gentility! It says much about our own uncouth age.

Interestingly, the other two works, one in a minor key, are youthful Bach, before he came to London, and are noticeably influenced by his much more serious-minded teacher/brother, Carl Philipp Emanuel Bach of Hamburg. Just barely, one might say—a hint here and there of pathos. But no more than a hint, for J. C. was not the sort of man to go overboard in any passionate way.

This is a perfectly balanced recording with really lovely playing by the very French Huguette Dreyfus and the very Japanese Tokyo Solisten. These latter would have astonished Bach in his London surroundings, especially if they had played as expertly as they do here.

Edward Tatnall Canby

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EDWARD TATNALL CANBY

LIQUID GLASS



Philip Glass: Songs from Liquid Days
CBS FM 39564.

Sound: B+ Performance: B

Songs from Liquid Days is a song cycle with lyrics written by Paul Simon, Suzanne Vega, David Byrne of Talking Heads, and Laurie Anderson. With lyrics in hand, Philip Glass created musical settings and gathered quite a diverse group of players and voices to perform them.

Glass' settings shimmer as you listen to them, with layer upon layer of the little repeated musical figures for which he is famous. The diversity of the singers cast for the project is one of its greatest strengths. The three singing sisters who make up The Roches work as an angel chorus in direct counterpoint to Linda Ronstadt's bell-clear, warm voice on the Anderson piece "Forgetting." Bernard Fowler's smoky, almost jazzy voice carries the Simon piece "Changing Opinion," a meditation on an electronic hum that fills a room. By contrast, Douglas Perry's op-

eratic tenor is perfect for the solemnity of David Byrne's "Open the Kingdom." Janice Pendarvis, one of New York's finest session singers, brings a rich, dark, burnished glow to the very nervous music Glass wrote for Vega's "Lightning."

The recording of *Liquid Days* makes very full use of stereo separation, with a pronounced left-to-right spread of instruments. Stereo miking of the piano is another very important ingredient in the wide-screen sound of the project. It all creates a grand effect. The raw sound of the LP impressed me only until I subsequently heard the chrome cassette (FMT 39564), which has much more presence. On cassette, the upright bass and cello have a remarkable growl which I felt in my gut; on the LP, they are barely whimpers. The voices, too, sound rounder and truer on tape. No contest. Take the cassette over the LP. (A Compact Disc is also available.)

By no means is *Songs from Liquid Days* for everyone. Pop and rock it most assuredly is not, although ele-

ments of both are integral to the project. From the classical side, Philip Glass aficionados may be put off by what they may perceive as a commercial sellout. But they would be wrong to see it that way. *Songs from Liquid Days* is a fascinating work bursting with textures and nuance in composition, recording technique, and performance, and all of this can only be appreciated in repeated listenings.

Michael Tearson

Lutoslawski: Symphony No. 3, Les Espaces du Sommeil. The Los Angeles Philharmonic, Esa-Pekka Salonen; John Shirley-Quirk, baritone.
CBS IM 42203, digital.

Here are two remarkable, bewildering, and big new works—exciting and impressive too—state-of-the-art music by a Polish composer who is now in his 70s, obviously a veteran at composition. What comes with the music here is equally interesting—a very young and totally competent Finnish conductor (with a name to remember) and an American orchestra that plays for him with immense commitment, both to the composer and to the young leader's effortless understanding of the music's enormous complexities. And there is John Shirley-Quirk, a British baritone previously heard in many a standard oratorio, and not always with beauty. Here, singing in French, he is superb.

So is the recording—the bewilderingly complex sounds that rush forward in torrents, the beautifully balanced baritone solo in "Espaces." You may not like the music on first try, but this excellent recording can't leave you other than mightily impressed.

How to describe this Lutoslawski? Like Penderecki, whose music tends to leave me cold for all its enormous impact, Lutoslawski is a sort of neo-mystic modernist, writing on a vast scale straight out of such earlier styles as Mahler's and Bruckner's. The music of both these composers is complex and thick beyond belief, often moving past music into strange noises, shoutings and roars, and also into improvised segments not precisely written down. That is the wave of the present, it seems, and is it ever a headache (or maybe a challenge) for the recording engineer! All but impossible. Still, the

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music is all but impossible to perform, yet it *is* played, and it *is* recorded.

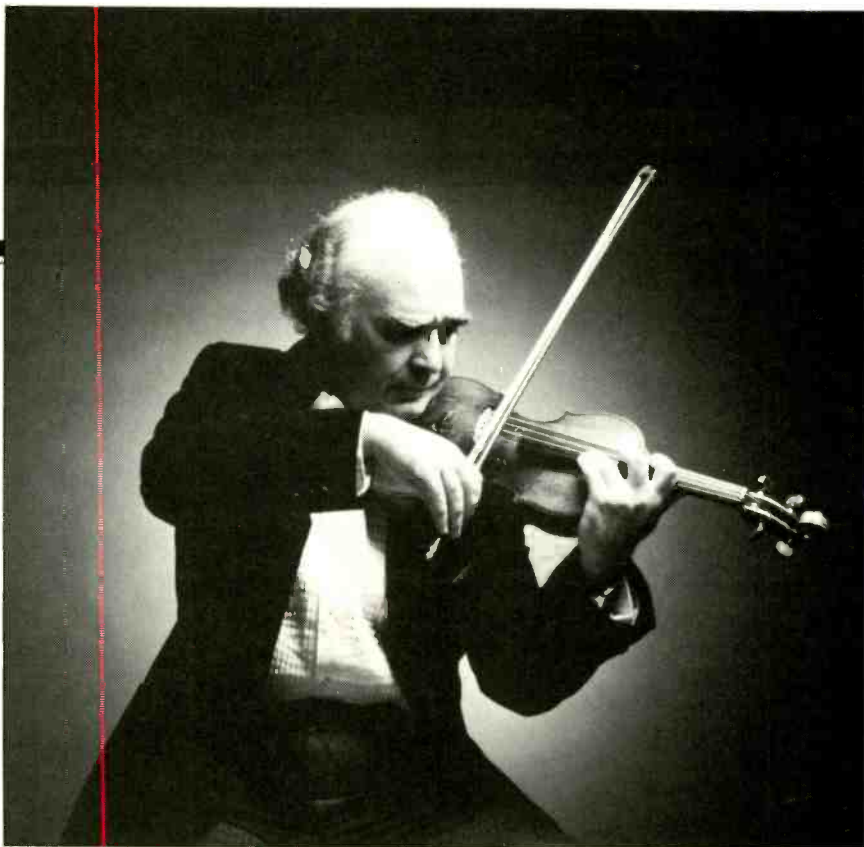
Lutoslawski, for my ear, is far more digestible than Penderecki, in spite of the complexity. His music is almost Brahms-like in the clearness of its architecture, and its principal themes are just as easy to follow. That's one good reason why these sounds are solid as *music*, whatever the mystic background and in spite of the size and length. The Third Symphony (1972-1983), for instance, has two huge movements, the first of which is a kind of vast prelude to the second movement's musical climax. By golly, this works, and you are easily aware of numerous returning ideas that are interesting to hear. Good stuff, I say.

The "Espaces du Sommeil" (Spaces of Sleep) is also remarkable; the restrained, careful writing for baritone voice is of the highest craftsmanship, perfectly suited to the words, never lost in the huge orchestra. For antecedents, think back to Mahler's songs with orchestra and to Ravel's "Shéhérazade" of 1903 (not Rimsky-Korsakov's) for woman's solo voice and orchestra (there are eight recordings of this work currently in the catalog).

The baritone solo sound is especially gratifying, both musically and in the recording. So often on LPs, solo voices come through loud and clear to the point where you cringe with dislike! Not here. Shirley-Quirk's French is absolutely silky; his voice is never too loud for comfort, yet it is always audible with



Esa-Pekka Salonen



the orchestra. A revelation as to what *can* be done on records with the solo voice when things go right on all counts. I wish it happened more often. Let me add kudos for the invisible but very much present Esa-Pekka, who is ultimately responsible for much of this audio glory.

If this music is available locally on CD (CBS M2K 42271), by all means choose that format, the better to cope with the enormous sounds.

Beethoven: Violin Concerto, Op. 61; Consecration of the House Overture, Op. 124. The Utah Symphony; Joseph Silverstein, violin.
Pro Arte 228, digital.

A few instants of the splendid, shiny, full-bodied sound of this recording and I knew that it was top rank—it is the most satisfactory version of this concerto that I have heard, both in the performance and the audio. A great recording by anybody's standards.

Note quickly that *there is no conductor*. The soloist himself not only plays but keeps the orchestra in order—he is now their music director. Though we make much of virtuoso conductors these days, we should understand that an orchestra conducted by the soloist, or from the keyboard, was standard until Beethoven's day. Impossible in music such as this? Just listen. Given half a chance, today's better orchestras are entirely capable of playing by

themselves, intelligently, with no more than a helpful nod or small gesture now and then to keep things together.

There are more precise and brilliant versions of the celebrated violin concerto, with much bigger names attached; what distinguishes this performance is what I can best call informed sanity. Silverstein, concertmaster of the Boston Symphony for 20 years and a chamber-music leader as well as solo player, knows the music in all its aspects, from the inside out, so to speak. His Utah orchestra ever so clearly respects this and plays with a wholehearted cooperation that any ear can understand. There is a oneness which is rare when visiting virtuosi perform—often they are at odds with other elements after too-brief rehearsals.

In the usual virtuoso performance, the concerto can seem interminably long, because, paradoxically, it is so often wrought up and overly tense. Here, all is relaxed and, shall I say, appreciative, so that the architecture of the music and its own intensities are heard. The work seems somehow shorter and in good proportion. You can't ask for more.

The recorded sound, digitally laid down (the CD version is all digital), is remarkable. The ensemble is solid and impressive, in an adequate but not overwhelming space—no chords are blurred one into another as in too much recording. And yet the individual parts, the instruments in their groupings, are

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Pictured above, left to right, are: The T95, T55, T65, and, the TL900, TL50C, TL600.



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The *Viennese Sommerfest* is a faceless potpourri of music, with everything played alike, good or bad, heavyweight or light.

unusually clear. All sorts of things can be heard effortlessly and in a natural perspective, including details that are often lost. My only reservation, a very mild one, is that the soloist is a bit too close and loud, though no more so than is usual in solo violin works with orchestra.

The LP version, with Direct Metal Mastering and Teldec vinyl, is nevertheless rather less than silent in my copy—or am I getting spoiled by CDs? In any case, one does hear the 33⅓ turning rhythm, with a slight swish at each turn, perhaps only on my particular copy. Some LPs, these days, do

manage to eliminate the turning sound. I recommend the CD version (Pro Arte CDD 228).

Viennese Sommerfest!: Music of Von Suppé, Beethoven, Mozart, Richard Strauss, and Johann Strauss. The Minnesota Orchestra, Leonard Slatkin. **Pro Arte PAD 224**, digital, \$11.98.

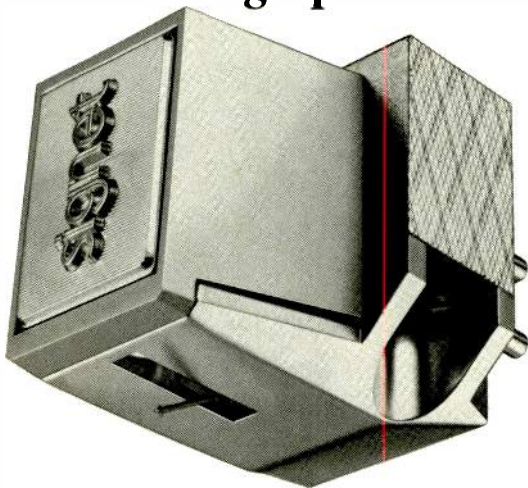
I found this record a little painful. It comes from a relatively new label that is, as they say, "aggressive"—it is going all-out to conquer, and doesn't mind lambasting us with self-proclaiming glory. In terms of sonic quality, though, the records (also CD and cassette) seem to be tops.

This particular Viennese festival is pretty far from Vienna, past or present. It is a hard-boiled, high-tech, steely set of performances, lacking a great deal in the grace and humanity that are the first thoughts in much Viennese music. The South versus the North? It seems that way.

The program sequence is a faceless potpourri (as mixed-up as that metaphor!), everything played alike, good or bad, heavyweight or light. "Poet and Peasant," the gentlest of insignificant overtures when done in a relaxed and genial manner, comes first. Conductor Slatkin treats it like Doomsday, which merely makes it sound preposterous (though terrific in sonic impact, I'll admit). Then come a couple of little Beethoven potboilers, tinkling military marches—and suddenly, Mozart's "Eine Kleine Nachtmusik," roaring in full blast from a huge string orchestra! That elegant and sophisticated work is supposed to be intimate indoor music. Surely the musicians all know this, and they try to sound right. You can hear their knowledge of it. But the hamfisted high tech wins again. Evidently there is some miscalculation in relative volumes here.

The second side, featuring the Strausses, is easier and more fluent in the playing but hardly as graceful or ingratiating as this music ought to be. The Viennese style is an exacting tradition, with all those hesitations, the musical bowing and scraping, sounding very free but actually quite rigid in the way it has to be done, as every Viennese musician knows. We get the gist of it here but not more. The music hesi-

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On a fine, digitally recorded album, pianist Ruth Laredo gives these short Tchaikovsky pieces just what they need.



tates in the wrong places. And the high-tech sound can be heard at every climax.

Somehow, this whole Pro Arte operation, a very extensive one with numerous orchestras and plenty of solo luminaries already snagged, has a stridency that seems undignified for an important musical center such as the Minnesota Twin Cities.

Canteloube: Chants D'Auvergne, Vol. 2; Triptyque. The Royal Philharmonic, Antonio De Almeida; Frederica von Stade, mezzo-soprano.

CBS Masterworks IM 37837, digital.

Tired of Philip Glass? Weary of the latest emesis of "So-and-So's Best Hits"? Bored with the endless stream of (yet more) new recordings of the same symphonies or songs? Here's a ravishingly lovely, digitally recorded LP, a welcome break from the expected. Canteloube (1879-1957) and his Auvergne folk-song cycles have been recorded before (most notably two decades ago, by Anna Moffo), and they're often included in recitals. But the luxuriant, florid, playful melodies have never until now sounded so fresh, so alive, so at one with singer and orchestra.

If you know one or two of the little narrative poems, you know just about all of them: Simple pastorals, love lyrics, faintly seductive invitations. But, as

with the Berlioz "Nuits d'été" or the tradition of Spanish and French song cycles whose styles they share, these are remarkable not for their textual splendor but for their musical richness. The harmonies are lush and exotic but oddly disciplined; they are serenely, confidently romantic even at their most impressionistic. These are not great canvases but irresistibly lovely musical watercolors, gentle distillates of sound you can allow to fill the room without feeling guilty for not giving them every ounce of your attention. Frederica von Stade brings to them her usual superb control, her excellent French, and her flawless timing, finding in the baker's dozen of songs what Leopold Stokowski once called the "poetic fusion of erotic emotion with humor."

Also on this fine LP is Canteloube's setting for three songs by Roger Frère, composed in 1914. The "Triptyque" is charming but unexceptional, best in the "Lunaire." Frère and Canteloube—

and this singer and orchestra—do indeed "sing of nature and its robust grace."
Donald Spoto

Tchaikovsky: The Seasons, Op. 37; Humoreske; Natha-Valse; Polka de Salon; Mazurka de Salon. Ruth Laredo, piano.

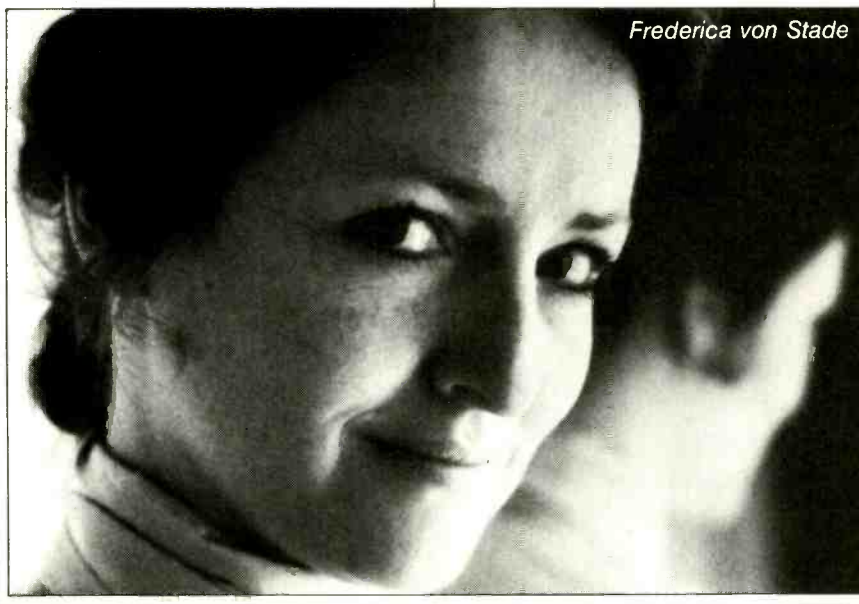
Nonesuch 79119, digital, \$10.98.

If you are ready to venture out beyond big orchestras and long operas, the piano isn't a bad sound to explore on your hi-fi, to put it mildly. Here is a fine, digitally recorded, all-Tchaikovsky collection—no long pieces, just music which one might call super salon. These works could make an excellent introduction to Romantic-period piano art. They are more easygoing than the big sonatas and showpieces but offer more content and variety (as well as virtuosity) than the true salon music of that time, which was the live background music for polite society.

"The Seasons" is very unlike "The Four Seasons" of Vivaldi, in case you wondered. It goes by months in its subtitles ("By the Fireplace" for January, "The Song of the Mower" for July, etc.), but the music has no sonic relationship to what happens around the year. The 12 short pieces range widely, with plenty of contrast, both soft and loud, not really anybody's background music. These are hardly beginner's pieces. On the other hand, they are not the sort that requires your very close attention. They tell their own story, briefly and easily, in spite of all the fancy finger work.

Ruth Laredo gives these pieces just what they need—lots of technique, some profundity (but not too much). She has chosen an extra four pieces of the same type, more dance-like (waltz, polka, mazurka) to round out the program. These last four, being dance, will carry you on even more easily than the first dozen.

I was delighted to find here several of the originals for Stravinsky's divertimento "Baiser de la Fée," one of old Igor's most ingratiating works. Remarkable—here the music sounds for all the world like Tchaikovsky, which indeed it is, and yet the Stravinsky versions are just as thoroughly Stravinsky, though borrowed with only minor changes. A masterful adaptation.



Frederica von Stade



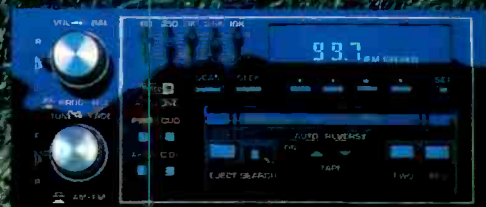
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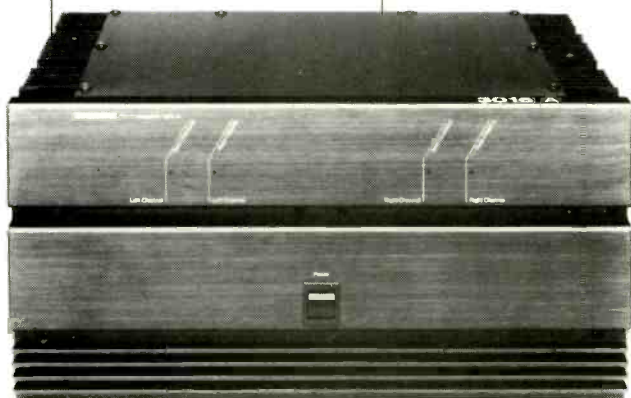


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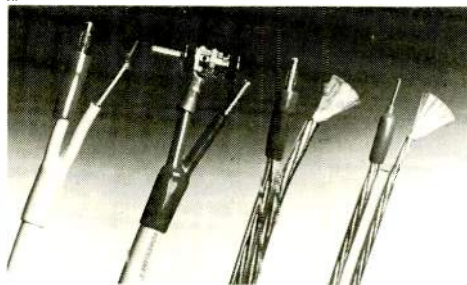
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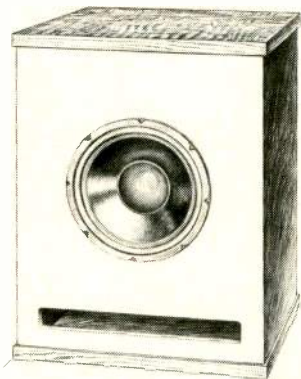
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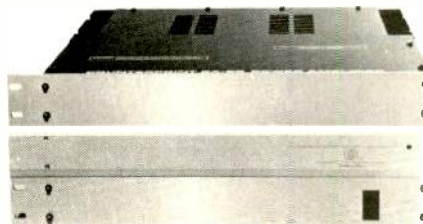
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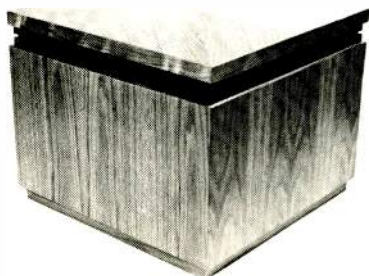
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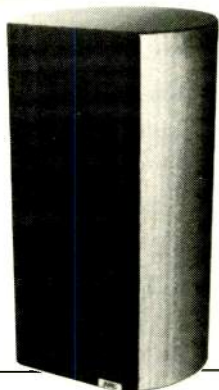
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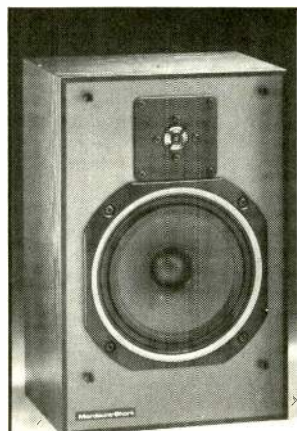
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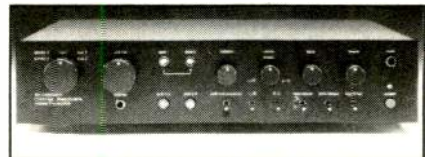
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