Audio

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TAPE COMES OF AGE

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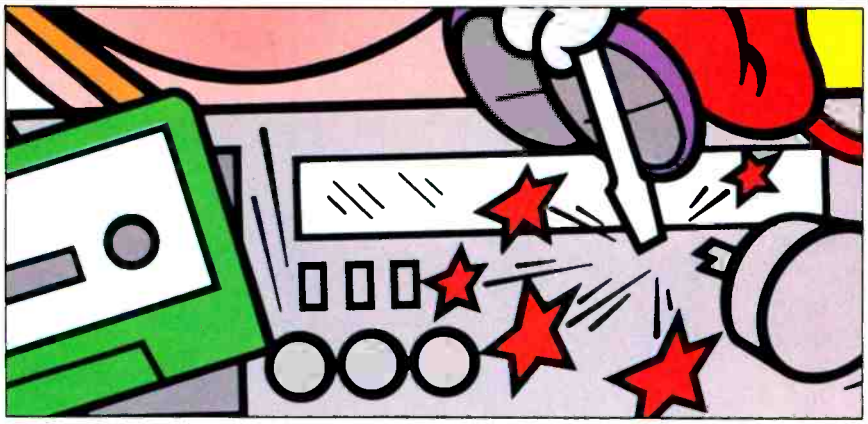
SEPTEMBER 1984 VOL. 68, NO. 9



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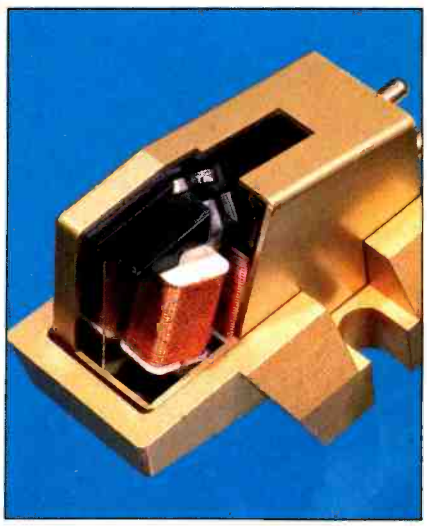

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MUSIC REVIEWS

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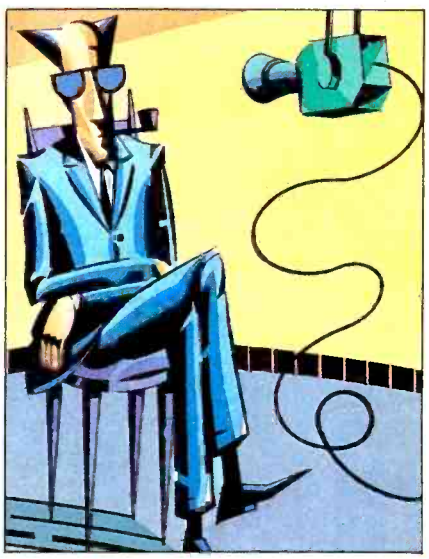

See page 6.

Is your luxury car wealthier than you are?

At Subaru, we don't think an exorbitant price tag should stand between you and a luxury car.

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Our luxury cars are sensibly priced because they're equipped with luxuries you want, and not loaded down with garish ones you don't need.

Standard appointments include air conditioning, plush velour interior, power windows and steering, electronically tuned AM/FM six speaker sound system, sun roof, even a fold down arm rest in the back seat. And the GL-10's black exterior trim gives them the look of luxury cars priced much higher.

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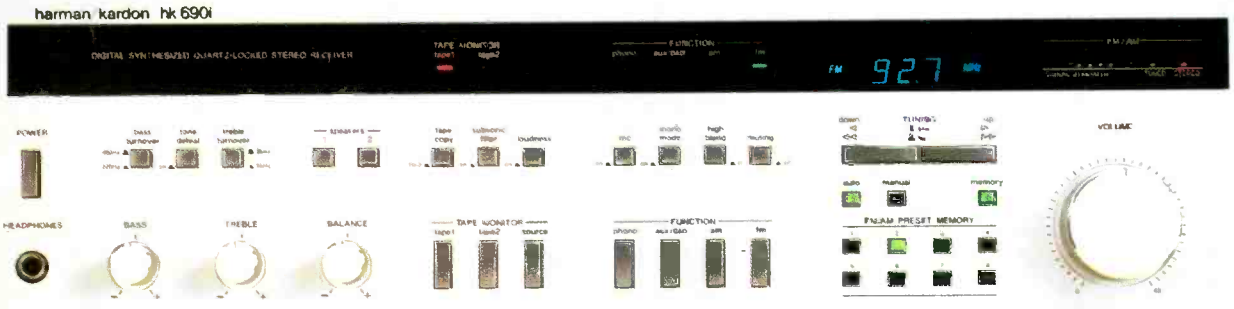
ARTISTRY IN HIGH FIDELITY



The hk690i is Harman Kardon's unique expression of ultimate artistry in high fidelity. In it are found the same control of technique, mastery of detail and creative excellence inherent in every great and enduring work of art.

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EDWARD TATNALL CANBY

THE PEELED EYE

Of the many gaudy mail-order catalogs that come my way each week, with such prosaic names as Bean's, Brent's, Breck's, Burpee's, Brookstone's and on through the alphabet, there is one that really hits my fancy—*The Sharper Image*. Now there's a name to conjure with! This outfit sells high-tech consumer stuff, at appropriate prices. For instance, I recently bought, elsewhere, the most convenient bathroom scale I've ever used; it reads the same as the one in my doctor's office and cost me $10. *The Sharper Image* has a scale with "four separate computer memory banks" to remember your weight last week and last month; it costs $119, but I'll hand it to them: For an added ten bucks you can have an all-mechanical model straight from West Germany. That's sharp thinking for you.

I've been bothered and fascinated for a long time by this matter of the sharper image. Mostly, we don't have it, or we have lost it. But, with all this present convergence of video, audio and the personal computer into ever more compact and more elaborate consumer entertainment centers, it has been borne in on me that we in audio have had a sharper image all along, since Major Armstrong's FM sound back in the '30s and '40s. The Sharper Audio Image. High Fidelity! Could there be a more exact description?

The more you delve into technical specs, the closer is the relationship between a sharp *visible* image and an accurate *audio* image. In both cases this is a matter of faithfulness to some sort of original (even in the case of the eyes), in terms of lack of distortion, absence of "noise," i.e., meaningless and unwanted extraneous signals—and, most of all, a matter of sharply defined detail. In visible imaging we call this resolution, resolving power, but we can apply the same to an audio signal. For when you come down to it every sort of "fuzziness," of poor resolution, is actually a distortion, a blurring of the message, a reduction of its information content, whether to the ear or to the eye.

True, much "noise" is technically not a part of our signal at all, hence the feasibility of noise reduction. But, in the end, even noise is distortion, interfering with what we hear or see.

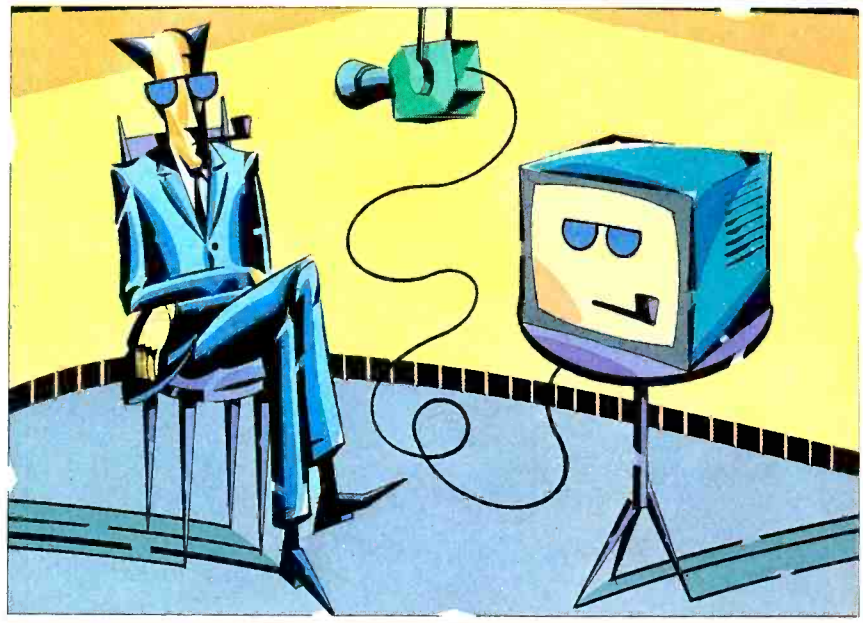


Illustration: Philip Anderson

These matters are very quickly coming to a lot of heads today in the ferment of change. Suddenly, here and there, sharpness becomes crucial where before it hasn't much mattered. And at the same time, in other areas, the steady trend towards ever greater fuzziness, the decidedly Unsharp Image, goes relentlessly onward. As we know from TV experience, there are ways to get around a lack of sharpness, using artistic ingenuity. Not everyone is bothered by faulty video resolution in the TV soaps and the "interview" shows—they are mostly close-up. Easy way out, and quite okay—who's complaining? Nor is the still-present TV sound incompatible—it, too, is "close-up," that is, mostly simple speech, not requiring super-hi-fi for its message. And, we can always use, and do use, lip reading.

But in the new "third world" of the personal computer the resolving power suddenly gets important—especially where the "ordinary" TV tube is used. How well can you read the facts and figures on the screen? How small can the letters and words be, and how many can appear at a time? TV tubes are just fine for large blocks of color and great big words that sell their own message—in monosyllables. But when your computer speaks in big monosyllables it's not giving you what you want for your money, as thousands have discovered. So we have the "monitor" tube, with improved resolution. You can read words on it, whole pages of them.

You think that hasn't had any effect on the general public? It's *having* it, every minute of the present day, as inevitably as the thousands of babies born in the same time, so many per minute, year in and year out.

I went to a cheapie movie last week, or rather, watched it via public TV, projection style. The film was extraordinarily fuzzy but it didn't matter much. On the other hand, at the end, I was jolted to discover that I could not read a single word of the credits that rolled by. Just a lot of blurred and meaningless lines. People do not usually fuss when they don't see sharp credits; they are mainly *pro forma*. But when the same thing happens on a cheap computer, as are now selling in the millions—what then? The sharpness idea is contagious! The fire will spread. All it will take, for the setting, is a few major advertising campaigns for the new "Sharper TV"—when and if. This is surely already in the works.

Once again, and as never before, the medium is the message. A sharper video image opens new "program" techniques, more detailed pictures, faster action, greater clarity in the plot line. If and when practical. It should be, in Phase Three of the marriage of

AUDIOPHILE FILE™ XL-S

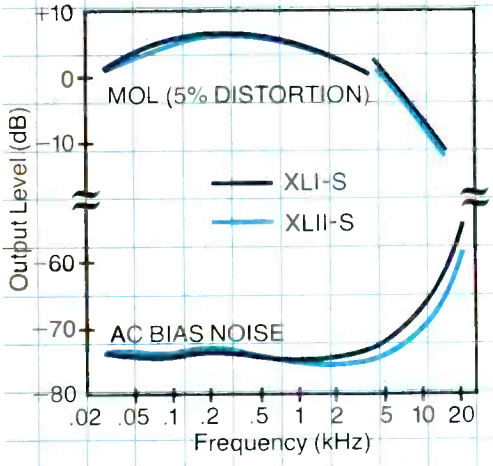
COMPACT DISC COMPATIBLE

Maxell introduces the new XL-S audio cassettes; a series of ferric oxide tapes which deliver a level of performance that can capture the sound nuances found on Compact Discs more faithfully than other ferric oxide cassettes on the market.

There are a number of areas where this achievement is apparent.

GREATER DYNAMIC RANGE.

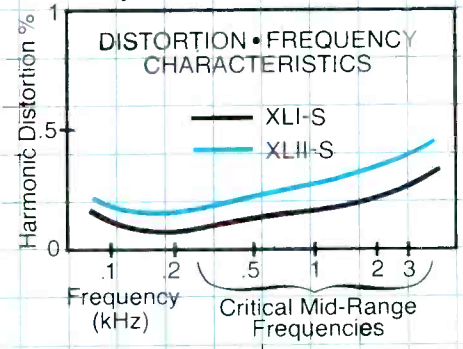
Through a new formulation of our magnetic particles, we were able to reduce the perceived residual AC bias noise level by 1 dB in the critical 2 kHz to 10 kHz mid-frequency range. And simultaneously increase sensitivity and maximum output levels by as much as 2 dB.



As a result, the dynamic range of each tape has been significantly expanded. So you get a better signal to noise ratio and a fuller impact of the dynamic transients exclusively inherent to digital CD recordings.

LOWER DISTORTION.

The newly formulated particles also contribute considerably to XL-S's low output fluctuation, as well as its virtual distortion-free reproduction, especially in the critical mid-range frequencies. This, in turn, accounts for our XL-S tape's enhanced sound clarity.

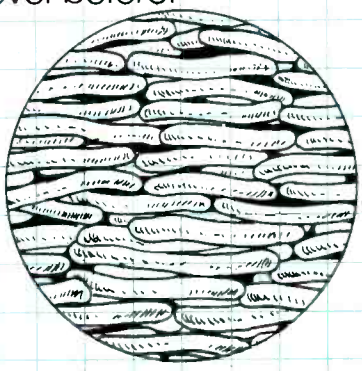


IMPROVED MAGNETIC PARTICLES.

Our refined particle crystallization process is the basis for all of these accomplishments. Maxell engineers are now able to produce a more compact needle-shaped Epitaxial magnetic particle of extremely high uniformity.

This allows us to create a greater ratio of total surface area to unit weight of magnetic particles.

As a result, our XL-S tapes now have the ability to record more information per unit area than ever before.



PACKING DENSITY OF UNIFORM PARTICLES.

Which is why Maxell high bias XLII-S and normal bias XLI-S are unsurpassed at reproducing the sound qualities found on today's finest recordings. Regardless of whether your frame of reference is analog or digital audio discs.

For technical specifications on the XL-S series, write to: Audiophile File, Maxell Corp. of America, 60 Oxford Drive, Moonachie, New Jersey 07074.

IT'S WORTH IT.

A sharper video image opens new "program" techniques, more detailed pictures, faster action and greater clarity.

audio and video with, er, a third party, the computer. (Three-way marriage? We'd better find a better, if duller, term to protect the moral sense.

Then there is that indefinable and powerful compatibility which must always exist between media in a dual format, involving sight and sound together. On traditional TV we have had lo-fi, the fuzzy image, in equal terms for both picture and sound and the combo has been a vast success. But lately people are discovering—and business is advertising—the virtues of improved TV sound. The most unsettling and miraculous development in this area is surely the new videocassette sound from Sony and its parallel in VHS. Suddenly—from the bottom straight to the top! Imagine it, hi-fi reproduction from videocassettes that rates well above everything in our hi-fi audio except the topmost digital—is *that* unsettling! And already this sound is being relentlessly plugged, the surest way to bring it to the notice of the many Mr. and Mrs. John Q. Publics in all their multitudinous clones. Does it now behoove the lowly TV tube, what with these mounting pressures, to produce a Sharper Image? And what about the TV source, the present broadcast system? It's already edging into stereo—what, then, of the proposed doubling of lines, for a really "hi-fi" picture and yet with compatibility, even so, for the lingering old-style tubes? First we hike up one side of the dual message, then the other.

So, you see, the pressure for a Sharper Image mounts in many directions. The video biz is indeed finally beginning to catch up with us in the concept of high fidelity. The new video is not going to burst into bloom, as the seed catalogs say, until, in my Phase Three, the tubeless video picture really takes over. But that, too, is coming on strong, and sooner than most of us could have guessed. (I've decided to wait for a word processor until I can have it with a *big*, flat screen not more than an inch or two deep. IBM is talking in these terms, as are others; little screens are already on the market.)

In digital, the Sharper Image is rampant and on an unheard-of scale. How many billion bits can we now process per second? John Q. and his wife are already impressed, since they owe so much to the new electronics that can process so much in so little time. One of my favorite historical memories, speaking of bits, goes back, in mind at least, to the early transatlantic cables. Did you know that, to their dismay, the first operators found that the on-off digital-style telegraph code was rendered so fuzzy after a few thousand miles that at first only a word or so a minute could be transmitted? Like an ordinary light bulb that took about 30 seconds to fade on and then off again.

It remains to be pointed out that, with all of this potent movement towards sharpness and better resolution in both audio and video messages, there still is a much longer tradition of precisely the opposite—a steady, enduring

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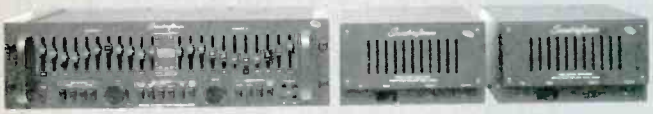

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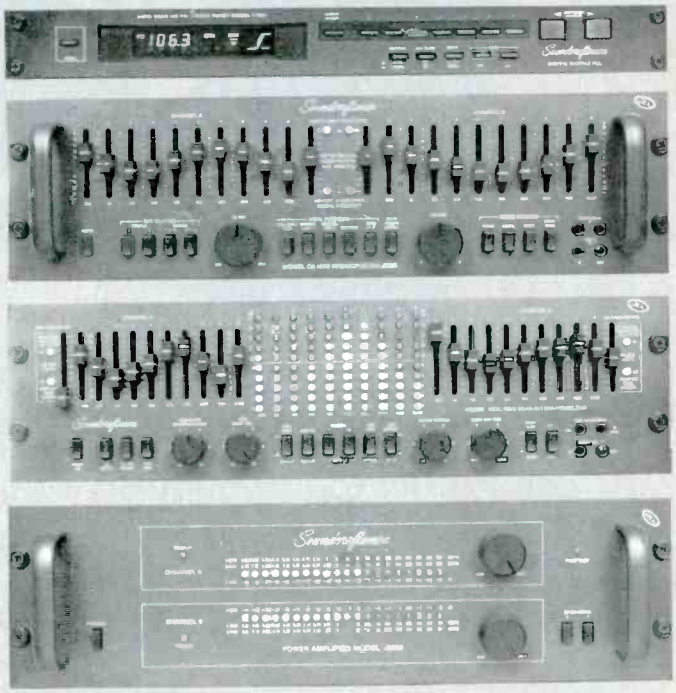

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In some areas, we progress to sharper images. In others, we have progressed to bigger and fuzzier ones, due to business economizing.

trend away from sharpness and towards a lower resolution. Mostly, this is due to business economizing, but that aspect is, in the end, surprisingly unimportant. Public acceptance is what counts.

Have you ever looked at the celebrated landscape photographs of the middle and late 19th century, taken with big cameras which used huge glass plates, often the cumbersome "wet plate" prepared in a portable darkroom on the spot? The lenses of those days were imperfect, with much blur and distortion out at the edges, but the main body of the picture had a sharpness, especially in an original print, that is hard to believe. As late as 1929, I took B/W stereo pictures on glass plates (dry process!) that to this day, when magnified in the viewer, astonish.

In 1933, I acquired the original Ciné-Kodak Eight, to my mind the best-made home-movie camera ever produced. It had a little button of an f/4.5 lens and an imprint so tiny on the film you could not read it with the naked eye—but you should see the detail in a five-foot-square projection!

You will find this same acute sharpness in every direction in those earlier years. I think, for instance, of my ancestors' cut glass, as compared to the similar pressed glass, same patterns, we find in today's supermarkets.

And it's the same with an original reproduction proof—cold type, that is letters and words produced via the photographic medium, has a fuzzy edge when compared with a proof made from "real" poured-metal type.

In these and other areas we have progressed to bigger and fuzzier and we still progress. Super-8 color movies are too fuzzy for me. Zoom lenses, lots of light, blurred details. Instant still pictures are the same. *Not* sharp. And now—all hail the disc camera! To my mind this is the worst compromise we've ever indulged in, for sharpness, and yet the system is a success. Like TV, the disc pictures are mostly close-up, nearby people and babies and dogs—not landscapes. The Unsharp Image is a part of this medium and determines its content—or is it the other way around?

To my perverse mind, sharper is always going to be better. And that applies to audio as it does to photography. But the commercial question as to *which* sharpness, in *which* usage, will lead to raging success with the public is one that, as speakers say, we must address with care. You bet. As always, the canny guy who picks the right Sharper Image is going to clean up. Ditto the outfit that chooses the most suitable fuzziness—whether in sound or sight. Some of those who do this last trick are among the canniest of all. Like Kodak, for instance, if in a negative way. But don't think that the Fuzzier Image is necessarily the way to success! It all depends. In any case, we in audio hi-fi proved long ago that our own Sharper Image was the right way to go. And still is.

Save up to $25 during the Shure 60th Anniversary Rebate Sale.

Buy a genuine Shure cartridge or replacement stylus between September 1 and October 31, 1984 and get a hefty cash rebate direct from our factory. Just supply the information requested below, mail it to Shure and earn up to a $25 rebate on a quality phono cartridge—up to $10 on a stylus.

A Shure cartridge is the best investment you can make to improve the sound of your system. And a Shure replacement stylus will reduce record wear, extending record life. Remember, with Shure, you're getting 60 years of audio experience. Get all the details on this offer at a Shure dealer near you or write Shure Rebate Offer, 222 Hartrey Ave., Evanston, IL 60204.

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N91ED	Upgrade for M91E Replacement for M91ED	$ 5

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KEN POHLMANN

BIT BY BIT

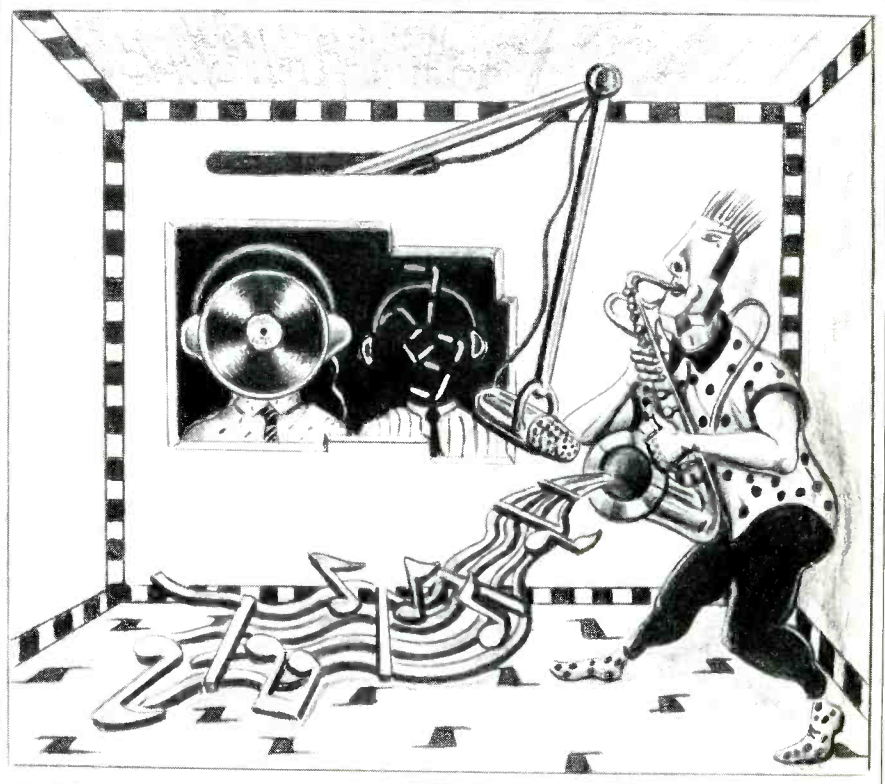


Illustration: George Blume

In essence, the task of recording and reproducing music can be simply summarized—we want to form a representation of the music. Obviously, the closer our representation is to the original, the better. Unfortunately, reality is stubborn in its ability to defy recreation, and we are left with a challenging endeavor as we attempt to create an approximation of the original event. The essential problem lies in the complexity of even the simplest acoustic waveform and the dual nature of the information it carries. No matter which recording system we employ, our task is the same: To completely characterize an acoustic event, we must store both correlated time and amplitude information. Thus, a vinyl LP has a groove, the length of which implicitly encodes time, and lateral variations which encode amplitude. In a digital system, both time (implicitly again) and amplitude are stored as discrete pieces of binary information.

We've discussed sampling, a method of periodically taking a measurement. Of course, taking a measurement is meaningful only if both the time and value of the measurement are stored. Thus, sampling represents the time of the measurement, quantization represents the value of the measurement or, in the case of audio, the amplitude of the waveform. Sampling and quantization are thus the twin pillars of digital audio. Together, at least in theory, they can completely characterize any acoustic event.

Of course, as I've mentioned, reality isn't prone to duplication, thus our goal is one of approximation. Both sampling and quantization become variables which determine the accuracy of our approximation. An originally analog waveform may be mapped into a series of pulses; the amplitude of each will yield a number which represents the analog value at that instant. It is apparent that the greater the rate of the sampling, the better the representation of the waveform. Nonintuitively, the sampling of a bandlimited signal is a lossless process; so long as we sample at twice the highest throughput frequency, sampling is a perfect technique. But the choosing of the amplitude value is a different story. An analog waveform has an infinite number of amplitude values whereas we can only choose from a finite number of increments, so our chosen value will be only an approximation to the actual. In other words, there is an error.

Let's use an example to illustrate that, yes, even digital has error, and differentiate this error from the one inherent in an analog system. Suppose that I've connected two voltmeters, one analog and one digital, to my recording console, and, at the instant of the last cannon shot in the "1812 Overture," I read both meters, reading the voltage corresponding to the acoustic input signal. Given a good meter face and a sharp eye, I read the analog needle as showing 1.278 V. My digital meter, a rather cheap model, has only two digits and thus I read 1.3 V. If I pay a little more for a three-digit meter, I might read 1.28 V, and a four-digit meter would give 1.278 V. Now, both types of meters are always in error. The analog meter errs because of the ballistics of the mechanism and my difficulty in reading the meter. Even under ideal conditions, at some point, any analog measuring capacity is lost in the device's own noise. With the digital meter, the nature of the error is different. My accuracy is limited by the resolution of the meter, that is, by the number of digits displayed. The more digits, the greater our accuracy, but the last digit will always round off relative to the actual value (1.278 was rounded to 1.3). Under the best conditions the last digit would be completely accurate (1.300 shown as 1.3) and under the worst conditions the rounding off will be one half increment away (1.250 rounded off to 1.2 or 1.3). The philosophical question of which is better, analog or digital, has already been decided in the marketplace—at least as far as voltmeters are concerned. For equal or less cost, we can build digital meters with greater resolution, ease of use, and reliability. A digital readout is an inherently more robust kind of measurement; we gain more information about an analog event when it is characterized in terms of digital data. The analog voltmeter has gone the way of the slide rule.

Back to audio digitization: Quantization is the technique of incrementing an analog event to form a discrete number. In terms of the quantizing hardware, the number of increments is

determined by the length of the data word, in bits; just as the number of digits in our voltmeter determined our resolution, the number of bits in our digitization equipment determines resolution. As we will see in a future column, that decision (primarily an economic one) takes place in the design of the analog-to-digital converter. An eight-bit byte would accommodate 2^8 = 256 increments, a 16-bit byte would map 2^{16} = 65,536 increments. The more bits the better, but there will always be an error associated with quantization because the limited number of amplitude choices contained in the binary word can never completely map an infinite number of analog possibilities. No matter how many increments are available, there can always be an analog amplitude in between. At some point, the quantization error becomes audibly indistinguishable, but exactly what word length provides that luxury still isn't clear.

Word length determines the resolution of our digitizing system, and hence provides an important specification to measure the system's performance. Sometimes our chosen increment will be exactly at the analog value; usually it won't be quite exact. At worst, the analog level we desire to encode will be one half increment away, that is, there will be an error of one half the least significant bit of the quantization word. For example, suppose the binary word 011000 maps the analog increment of 1.20 V, and 011001 maps 1.30 V, and the actual analog value at sample time is unfortunately 1.25 V. Since 011000 and ½ isn't available, I would have to round up to 011001 or down to 011000, either way, I would be in error by one half of an increment magnitude. In characterizing digital hardware performance we may formulate a ratio of the total number of increments covered by our quantization scheme to the maximum incremental error. This ratio of maximum expressible amplitude to error determines the signal-to-noise ratio of the digitization system. For example, a 16-bit system would yield a S/N ratio of 65,536 ÷ 0.5 = 131,072; in terms of a more familiar dB measurement, this is about 98 dB. The S/N relationship can be conveniently expressed in terms of word length as S/N (dB) = 6.02n + 1.76 where "n" is the number of bits. Using the formula, a 16-bit system again works out to 98 dB, whereas a 14-bit system is slightly inferior at 86 dB. [*Editor's Note*: The common approximation is to multiply the bits by 6, yielding 96 dB for 16 bits and 84 dB for 14.—*I.B.*] In a later column we'll see that a digital S/N specification is a slightly different animal than an analog S/N specification.

Quantization is more than just word length, it is also a question of hardware design. There are many techniques available to accomplish quantization and different strategies determine how the analog signal is mapped onto the increments; we could use techniques such as linear or nonlinear distribution, monotonic or magnitude-and-sign, or many-to-one or one-to-many. Those algorithm decisions influence the efficiency of the available bits as well as the relative effects of the error. For example, a linear quantizer produces a relatively high error with low-level signals which span only a few increments. A nonlinear system such as a floating-point converter could be used to amplify low-level signals to utilize the fullest possible incremental span; while that improves overall S/N ratio, the noise modulation byproduct is undesirable and requires special masking.

Sampling and quantizing are, therefore, the two fundamental design criteria for a digitization system. Sample rate determines bandlimiting and thus frequency response, and word length determines S/N ratio. Although bandlimited sampling is a lossless process, quantizing is one of approximation. Incidentally, quantization error is akin to noise—fortunately, with 14 or 16 bits it exists below most analog noise floors, and its effects can be further masked in the recording chain with a purposefully introduced noise called dither which makes quantization noise perceptually benign. In general, a word length of 14 or 16 bits with a sample rate of 44.1 kHz or 48 kHz yields remarkable fidelity, comparable to, or better than, the best analog systems. And that statement isn't meant to disparage the quality of analog audio—rather, it pays dear tribute to analog recording. It required an extremely sophisticated digital system, capable of processing 1.5 million bits per second, to rival Edison's wiggling groove.

IVAN BERGER

DOWN THE AISLE

Audio Visions

Pundits began talking of "the marriage of audio and video" as soon as audio output jacks reappeared on the back of some TV sets. (Such jacks had been available on some TVs, such as Conracs, back in the '50s, and on Heathkits ever since.) But it took more than sound-output jacks, LaserVision discs with hi-fi

sound, or even Hi-Fi VCRs to make the marriage a reality. Now, with stereo sound soon to be available in normal TV broadcasting, the two media are at least necking in the corner—or so it would appear from some of the items I saw at the Summer Consumer Electronics Show in Chicago.

Stereo TV is hardly catching the industry flat-footed. In the past year or two, most companies have equipped at least their top-end sets for plug-in stereo-sound adaptors, and now will offer the adaptors as well as sets with stereo decoding built in—for example, Fisher, GE, Magnavox, Mitsubishi, Panasonic, Pioneer, RCA, Sanyo, Sony, Toshiba, Zenith . . . even NAD, whose 20-inch MR20, with built-in decoder, is their first TV. I also noticed audio/video component systems from NEC, Fisher, JVC and Pioneer; all had lasers, one way or another: CD players in the NEC, Fisher and JVC, a LaserVision video disc player in the Pioneer.

A few of the new stereo-equipped sets had other features worth noting. Pioneer's SD-25 monitor, for instance, has space for any two of three optional modules which add UHF/VHF (non cable-ready) tuning, RGB computergraphics input, or sing-along (*karaoke*) capability. The remote control facilities include sharpness, color, tint, contrast and brightness.

NAD's premiere set featured three video inputs (one on the front panel), an r.f. video game/computer input (also in front), and remote-switchable r.f. inputs for use with premium cable services. Sony had a 26-inch table model. And Toshiba showed a prototype digital set, the CZ-2094, with such features as picture-in-picture superimposition, freeze-framing of the inset picture, and RGB computer inputs; the price is expected to be just under $1,200.

I saw no sign of a universal TV-stereo decoder for use with older sets lacking multiplex-out jacks. Technics, however, had one new AM/FM/TV-sound receiver, the SA-850, with

stereo decoding built in, and three other models (the SA-550, SA-450 and SA-350) with monophonic TV-band reception plus jacks for an optional decoder. The tuners cover just the VHF band—no UHF or cable channels. Sorry, MTV fans.

So far, there seem to be no videocassette decks with stereo TV decoders, though Sony's Beta Hi-Fi models have jacks for the MLV-1100 multichannel sound adaptor ($200). Sony also issued a fat catalog of Beta Hi-Fi software, and announced a new high-speed Beta Hi-Fi duplicator, the Sprinter, which should fatten it still further. Sprinter uses contact printing, allowing two-hour programs to be duplicated in 1½ minutes. Sony and Toshiba both announced low-priced Hi-Fi decks, for $800 and $850,

respectively. Sony also showed a "Hi-Fi-ready" deck, the SL-HFR30, which accepts an external Beta Hi-Fi adaptor; Aiwa announced a Hi-Fi-ready portable a few months back!

Meanwhile, the VHS camp mounted its own Hi-Fi counterattack, with models announced by Akai, NEC, Panasonic, GE, RCA, Sharp and Hitachi. Panasonic's PV-9600 portable was the smallest Hi-Fi-model.

Pioneer introduced 8-inch LaserVision discs. The first ones announced were 20-minute music videos selling for $10.99. But 40-minute discs, costing about $5 more, will be available for use with Pioneer's home *karaoke* module mentioned above and with their 60-videodisc jukebox, which also has *karaoke* facilities (mike inputs, a mixer and reverb).

The better to hear all this, several speaker manufacturers (B&W, Boston Acoustics, Pioneer, Polk and Proton) offered magnetically shielded models which could be snuggled up against a color set without affecting its picture, and NAD showed an

experimental, self-powered one. Naiad showed a small amplifier for video use, with tone controls and several high-level (but no phono) inputs.

The number of audio signal processors for video use is beginning to catch up with the number of pure video ones. From ADC, there's a video sound processor with volume expansion, DNR noise reduction and stereo synthesis. Three new

Tandberg's advanced engineering offers less.

Tandberg's dedicated staff of audiophile engineers long ago decided that ideally there should be nothing between the listener and the music . . . no IM, no THD, no TID . . . no audible distortion of any kind.

However, in the real world of audio electronics, "nothing" wasn't easy to come by; virtually every aspect of the signal path, and the circuitry that supports it, required reevaluation. Tandberg embarked on a 5-year research project to systematically localize and eliminate *every* source of audible distortion, however subtle.

In Pursuit of Nothing

The practical result of our concentrated research effort is the remarkable TPA 3006A Power Amplifier. Breaking new ground, and old rules, the TPA 3006A employs unique *zero feedback* MOSFET output stages. This is a difficult design topology, but the only one guaranteed to eliminate the audible time domain distortions undetected by conventional test methods. Available power output is 150 watts per channel into 8 ohms and 235 watts per channel into 4 ohms, with less than 0.02% THD/IM.

And, although MOSFETs have been used before, our constant-source impedance driver stage design is specifically engineered, for the first time, to take full advantage of these remarkable output devices.

The voltage and current limiting protection circuits of conventional amplifier designs also proved to be major obstacles to full fidelity. Tandberg's MOSFET configuration eliminates the need for all such circuit limitations; the MOSFET stages themselves are maintained at full linearity by a unique Voltage Comparator Circuit. The TPA 3006A, therefore, has an output-current capacity exceeding 25 amperes per channel, supported by a massive, tightly regulated toroidal transformer power supply with over 30,000 microfarads of filter/storage capacitance.

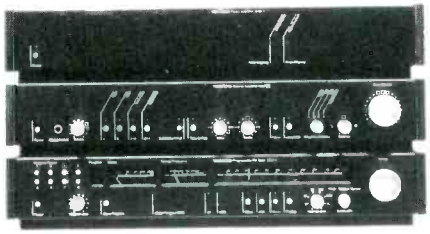
Damaging DC is kept from the output signal path via our (patented) Thermic Servo Loop system that monitors the amplifier's output, automatically and instantaneously rebiasing the amplifier as necessary . . . but, unlike other designs, with no connection whatsoever to the musical signal.

Once the major areas of power amplifier distortion were eliminated, Tandberg engineers were free to pursue the much more subtle, less definable sources of sound degradation.

Further technical nuances

Tandberg's pursuit of absolute fidelity led to the use of carefully chosen, costly high tolerance components: 1% metal-film resistors for their stability and low noise; plus sonically superior polypropylene capacitors (instead of electrolytic and ceramic types) are used in all audio stages. And, all audio stages employ discrete (no ICs!) circuitry for maximum headroom and minimum distortion.

Tandberg has even reevaluated circuit board design. The lowest possible noise levels and totally identical performance between channels could be realized only when there is symetrical parts layout and the reverse side of the circuit boards copper-plated to form a shielding ground plane; all housed in an unusually compact, nonmagnetic, anodized extruded-aluminum chassis.



Compact & Cost Effective

Never before has a power amplifier of this degree of performance been compact enough to match our TCA 3002A Preamplifier and the world-famous TPT 3001A Programmable Tuner.

It should be evident that in the TPA 3006A, Tandberg has mounted an all out assault on audible distortion, breaking new ground in those areas that elude conventional measurements . . . and designers.

The final proof, of course, is in the sound. Audition the TPA 3006A at your Tandberg dealer . . . and hear why our engineers feel that they have achieved a quality of music reproduction comparable to the most costly esoteric units, in a compact, cost-effective design that is unobtrusive in any room setting.

For a Technical Paper on the remarkable TPA 3006A Power Amplifier and a beautiful color poster showing the complete Tandberg family of purist audio components, send $2 for postage and handling to: Tandberg of America, Dept. AM, One Labriola Court, P O Box 58, Armonk, N. Y. 10504.

TANDBERG

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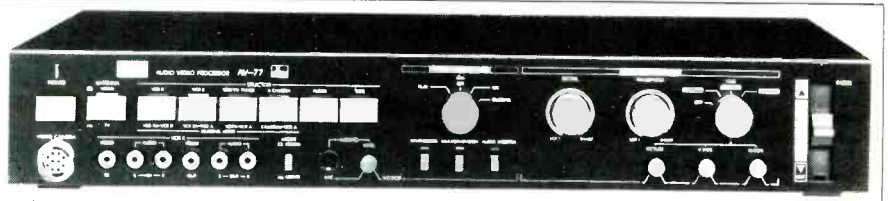
If you've ever wanted headphones you could sit in, The Acoustic Chair may be just your cup of tea.



enhancers from dbx include an expander, an impact restorer (which expands transient attacks), and a bass enhancer (not a subharmonic synthesizer, as you'd expect from dbx, but an expander that operates only below 250 Hz), each priced at $149.00. Pioneer introduced a surround-sound processor, the SP-101, which also includes a bass synthesizer; at least 57 movies now on LaserVision discs have soundtracks which Pioneer says will benefit from the surround treatment, and there should be at least as many videotapes which will.

Sansui now has a combination audio/video processor, the AV-77. It includes facilities for two-way videotape dubbing, as well as audio/video recording from a TV tuner, audio component or video camera. The jacks for the camera, the second VCR and a microphone are on the front panel. Audio processing facilities include dbx noise reduction and stereo synthesis, while video processing includes sharpness, detail, hue, solarization, fading in and out of both picture and sound, and vertical and horizontal picture "wipes."

Akai's AV-U8 combines an integrated amplifier (20 watts per channel) with an audio/video switcher and a 4-inch, black-and-white monitor screen. The latter allows you to monitor a video dubbing while you watch something else on your main TV screen.

Audio Armchair

Over the years, hi-fi buffs have mounted loudspeakers in walls, ceilings, chests, and even in armchairs. For the audiophiles who must have high-level sound agitating their pinnae, hi-fi headphones have been one answer, but they can grow uncomfortable over long periods; so a British sound engineer, Stephen Court, has developed what could well be the ultimate in listening comfort.

The Acoustic Chair, as he calls it, looks like any other plush, high-backed winged armchair, but each wing has three loudspeakers buried inside the framework to handle middle- and high-frequency sounds. The lower and bass frequencies are reproduced by four bass units, mounted in a chamber under the seat and connected to hidden vents in the backrest.

The upper bass and mid-range are handled by roll-surround, stiff-cone drivers in the wings, all aligned for phase accuracy with the HF units. Crossover networks are in the bass chamber, with input terminals beneath the chair. The impedance is 8 ohms.

The performance of this chair is

sonically impressive, as a deafening undistorted level can reach the ears from an 8-watt input. It is important to know that only a small amount of sound leaks into the room, certainly not enough to disturb other people there. The vents at top and bottom allow the low frequencies to be heard by ear and felt by bone conduction.

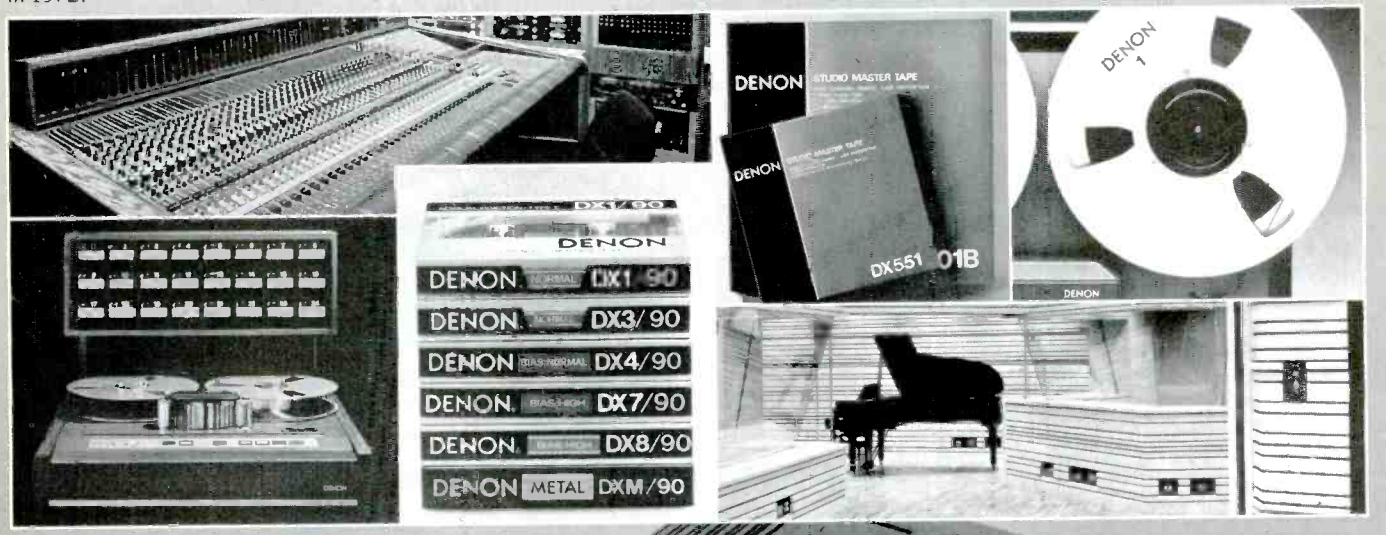
This form of "easy listening" must be paid for: I have heard whispered prices, according to finish, of around £860 to £1,000 sterling (about $1,186 to $1,380). *Donald Aldous*

TO MAKE A CASSETTE TAPE SOUND LIKE MUSIC, YOU'VE GOT TO KNOW WHAT MUSIC SOUNDS LIKE.

Think about it. What other tape manufacturer also builds professional recording equipment including 24-track and digital studio tape recorders? What other tape manufacturer has 72 years of experience as a major record company? Other tape manufacturers may talk about "digital ready," but do you know Denon *developed* the digital recording process in 1972?

It is this unique combination of technical and musical expertise that led Denon to use Dynamic Distortion Testing to optimize DX cassette tape performance in the presence of real musical signals, not mere laboratory test tones. The result is the most *musical* of all cassette tape.

Denon DX-Cassette tape. When we claim it's better, we say it with music.



DENON

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Nippon Columbia Co., Ltd., No. 14-14, 4-Chome, Akasaka, Minato-Ku, Tokyo 107, Japan

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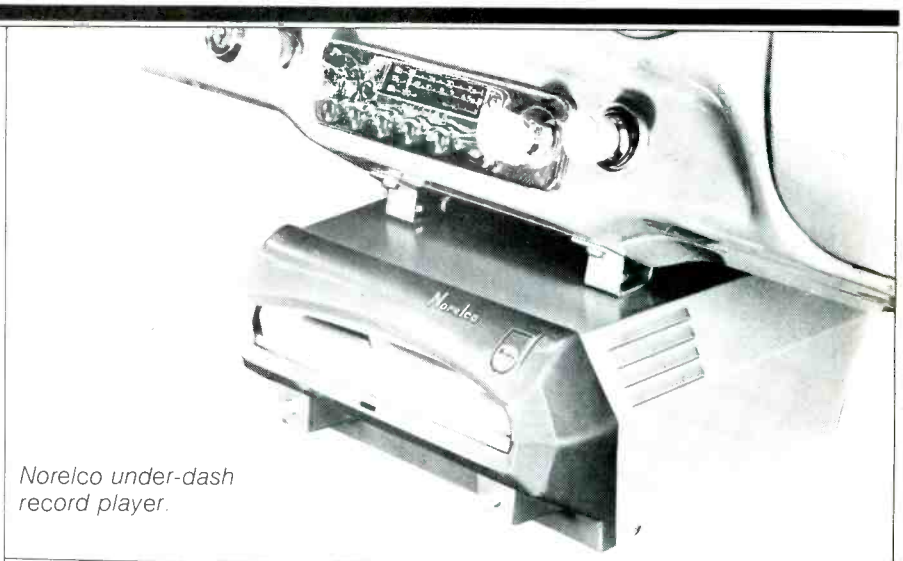
IVAN BERGER

FROM DISC TO DISC

For 50 or 60 years now, we've been able to tune in music in our cars. But being able to play the music of our choice there is a much newer development.

Probably the first attempt at bringing this convenience to a mass market was Chrysler's Highway Hi-Fi, of 1956. It played, of all things, phonograph records; the obvious problems of vibration and the need for a special small-diameter, 16⅔-rpm recordings killed that pretty quickly. Judging from our photo files, Norelco had something similar; but we lack details. Chrysler made another try, with a 45-rpm, 14-record changer, in 1960.

Open-reel tape was never a contender—too hard to thread while driving. But tape cartridges and cassettes were another story. Three such systems burst upon us in the '60s: The short-lived, four-track tape cartridge (descendants of which still survive in broadcast studios); the 8-track cartridge which became, for quite a while, the U.S. mobile-music standard, and the Compact Cassette.



Norelco under-dash record player.

The 3M-Wollensak 8075 8-track recorder offered decent quality and Dolby NR—but cassette had already won the battle.

The cassette showed up in cars almost as soon as it was invented—but that was thanks to a "Car-Mount," designed to hold a portable Carry-Corder under the dash. The system was bulky, low-powered (it apparently used the Carry-Corder's meager amp and speaker) and, of course, monophonic. Soon, however, in-dash and under-dash stereo cassette units were available; they sold fairly well in Europe, but not here.

In this country, the lead had gone to the cartridge tape systems. They had been stereo from the outset, and their endless-loop design meant they didn't need to be ejected and flipped over halfway through—a convenience for the driver. What's more, their higher tape speed (3¾ versus 1⅞ ips) gave them better fidelity than cassette. There were problems, to be sure: The cartridges were bulky (about four to six times as big as cassette, if memory serves); the tape was a bit more prone to jam or develop flutter; the three track-changing interruptions played hob with classical-music continuity, and the lack of a true fast-forward mode (or any rewind whatsoever) made it very inconvenient to find any particular song or section of the tape. But once Detroit started offering in-dash, 8-track stereos, it looked as if that was the ball game.

Only it wasn't. With chrome tape and Dolby NR, the cassette first matched and then surpassed 8-track's fidelity. For those who demanded endless music, auto-reverse players and recorders came to be. And recording your own tapes at home was far easier with the cassette, which had a third as many mandatory interruptions. Further, the large numbers of monophonic but stereo-compatible cassette portables gave owners of in-dash cassette units a way to play their tapes that 8-track users couldn't match.

It took a while before 8-track makers even tried to respond to cassette's advances in fidelity. And by the time they did, it was too late—those who cared about sound were already into cassette—and those still into 8-track were, almost by definition, ones who didn't care that much. The 8-track recorders with Dolby NR and other advances failed to sell. Eight-track had become, irredeemably, the low-priced spread.

By the time you read this, it may be possible to buy a CD unit for your car. A disc player? Isn't that where we came in?

An early 8-track player, designed for under-dash use.

Welcome to the golden age of Luxman

Luxman's special champagne gold series: The L-400, K-220, T-240, L-210, K-240, L-430.

Believing that form follows function, Luxman creates a special champagne gold series of sophisticated audio components. Inside, precise hand-crafted electronics. Outside, elegant, classic design. With pure, clear sound to match. See and hear how over 50 years of refinements and innovations, now backed by The Alpine Touch, ushers in the golden age of Luxman. Start by calling 1-800-257-4631.

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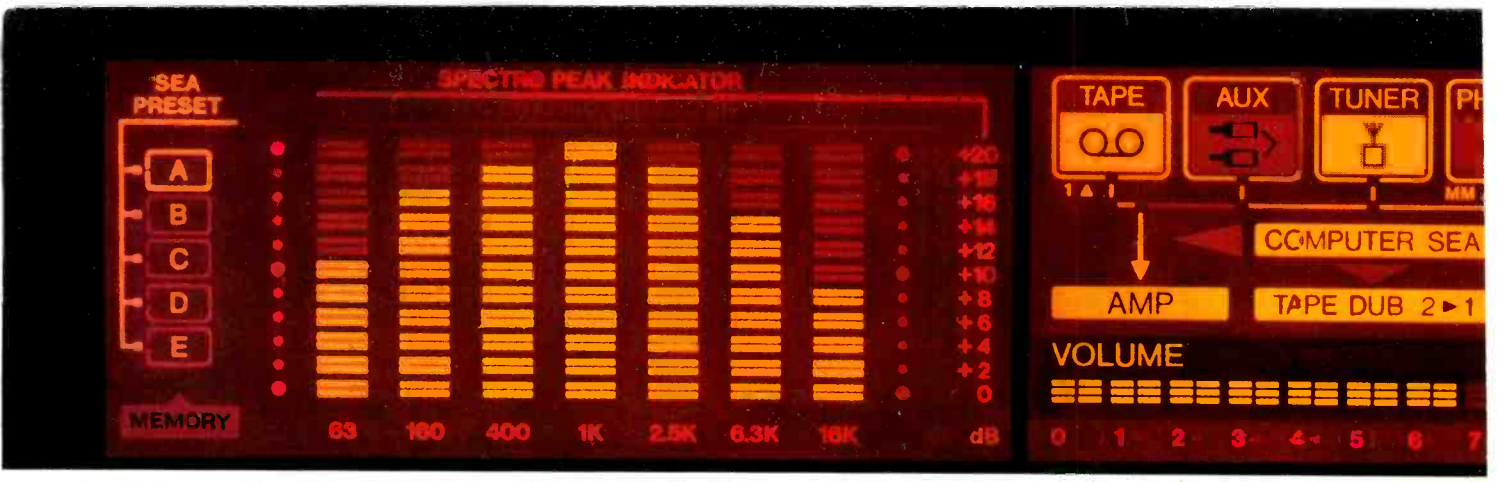

THE ULTIMATE MACHINE

JVC'S NEW R-X500B RECEIVER IS A SUPERB EXAMPLE OF HOW FAR JVC WILL GO TO BRING YOU THE ULTIMATE IN SOUND.

Some hi-fi equipment delivers slightly higher fidelity. Especially when it's designed by JVC. In fact, JVC's entire line of high fidelity components is known throughout the world for technological brilliance and painstaking craftsmanship.

The R-X500B receiver is a case in point. With the technology of JVC's power amp, equalizer and tuner, plus remote equalization and unheard-of-refinements, it is virtually without equal.

ADVANTAGE: A POWER AMP WITH INCREDIBLE POWERS

The R-X500B boasts two of the highest refinements in power amp technology available today—Dynamic Super A and Gm Driver. Dynamic Super A improves performance in two significant ways. One, it renders music reproduction silky and pure by eliminating offensive switching distortion. Two, it capably controls speaker motion by forming an ideal interface between the amplifer and the speaker.

HIGH FIDELITY

JVC's newest technology, Gm Driver, improves actual in-use performance at all listening levels, high and low, by driving the power stage at a constant voltage.

ADVANTAGE: AN EQUALIZER WITH A GRAPHIC DIFFERENCE

Since 1966, when JVC pioneered equalizers for home use, we have remained in the very forefront of equalizer technology.

The computer controlled graphic equalizer in the R-X500B is a superb example of engineering to achieve an end. It combines unequalled versatility with automatic capabilities, while maintaining sonic integrity.

Five equalized responses can be memorized for instant recall at a touch.

And an infrared wireless remote control makes it possible to adjust equalization from your armchair without sacrificing sound quality.

In a further refinement, JVC engineers opted for an LSI to handle electronic switching for both channels at seven different control frequencies. The result—electrical loss and tonal degradation never enter the picture.

ADVANTAGE: A TUNER AS SMART AS A COMPUTER

The R-X500B puts an advanced microcomputer in charge of the digital synthesizer tuner and references it to the accuracy of a quartz oscillator, making it highly versatile and easy to use. The microcomputer lets you preset 15 AM and 15 FM frequencies, scan them all for 5 seconds each, read out aerial signal strength in 5dB increments, plus much more.

SPECIFICATIONS

AMPLIFIER SECTION
Output Power
100 Watts per channel, min. RMS, both channels driven into 8 ohms, from 20Hz to 20kHz, with no more than 0.007% total harmonic distortion.

Signal-to-Noise Ratio ('66IHF/DIN)
Phono—80dB/66dB
Video/Aux/DAD/Tape—100dB/67dB

RIAA Phono Equalization
± 0.5dB (20Hz -20kHz)

S.E.A. SECTION
Centre Frequencies—63, 160, 400, 1k, 2.5k, 6.3k, 16kHz
Control Range— ± 10dB

FM TUNER SECTION ('78 IHF)
50dB Quieting Sensitivity
Mono—14.8dBf Stereo—38.3 dBf

Signal to Noise Ratio (IHF-A Weighted)
Mono/Stereo—82dB/73dB

ADVANTAGE: JVC

It is the attention to engineering detail and craftsmanship evident in the R-X500B which separates every JVC hi-fi component from all others. JVC makes changes in design for the sake of improvement. Not just for the sake of change. And the result is the difference between excellent and average. See, and hear, this difference at your nearest JVC dealer.

JVC

JVC COMPANY OF AMERICA, High Fidelity Division, 41 Slater Drive, Elmwood Park, N.J. 07407 JVC CANADA LTD., Scarborough, Ont.

Enter No. 13 on Reader Service Card

CD player prices have been dramatically reduced. There are several in the $400 to $500 range, which may mean "under $300" at retail.

CD-player-only unit, both covered in depth in the July *Audio*.

Fujitsu is planning a car CD player and was showing a prototype—but no production schedule was given.

Pioneer is well along with its plans to introduce a car CD player in January of 1985. Their two-unit approach couples a small operating module which fits into almost any dashboard with a hide-away processing module which can be located under a seat, for example. This CDX-1 car CD player also has a doorless loading slot, and its anti-vibration design is said to eliminate tracking errors, obviously of importance in a car CD player. Equally important is a sensor which can detect an excessive rise in ambient temperature, whereupon playback is automatically disengaged. No price set as yet.

Finally, I must report on a most unusual new CD player from Technics. How about a CD *changer* that can currently play 51 CDs, and is ultimately expandable to play 251! This is the Technics SL-P15. The unit performs up to all the usual CD player parameters and is equipped with wireless remote control.

Technics has a number of new technologies at work here, but essentially the CDs are loaded into a 50-selection magazine, and a playing mechanism, whose remote ancestor may have been a vertical-play Seeburg jukebox, does the job. Special interfaces and extra magazines are needed for playback of the group of 251 CDs.

All these discs can be programmed in any sequence; you can play record 3, band 2, then shift to record 104, band 5, and then on to record 14, band 1, and so on, ad infinitum. The mind boggles! One shudders at the thought that some of these wall-to-wall background music freaks could program music for every minute of the day for more than ten days! Yike!

Needless to say, commercial broadcast interests see the possibility of a machine like the SL-P15 replacing their poor-sounding tape-cartridge carousels. The SL-P15 will probably be available in the fall, at a price of $1,500.

(Editor's Note: Magnavox, Hitachi, and Sony all have changers in the works as well, but so far none from these three are being offered in the U.S. In Japan, Sony's unit is being sold through a second party to the *karaoke* sing-along club and bar market—*E.P.)*

Two popular CDs used to demonstrate the qualities of the various players were Telarc's Sampler Volumes I and II (CD-80101 and CD-80102). Volume I starts out with a rip-snortin' version of John Williams' "Superman" theme, while Volume II begins with a rousing rendition of Arnaud's "Olympic Fanfare." The two discs contain 38 selections and most positively demonstrate the musical and sonic virtues of the Telarc CDs.

Next month, in Part II of the 1984 SCES roundup, a look at some interesting new audio electronics, loudspeakers, and assorted devices.

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The best live up to it.

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Memorex presents High Bias II, a tape so extraordinary, we're going to guarantee it forever.

We'll guarantee life-like sound.

Extraordinarily flat frequency response at zero dB recording levels, combined with remarkably low noise levels, means music is captured live. Then Permapass,™ our unique oxide-bonding process, locks each oxide particle—each musical detail—onto the tape. So music stays live. Not just the 1st play. Or the 1000th. But forever.

We'll guarantee the cassette.

We've engineered every facet of our transport mechanism to protect the tape. Our waved-wafer improves tape-wind. Silicone-treated rollers insure precise alignment and smooth, safe tape movement. To protect the tape and mechanism, we've surrounded them with a remarkable cassette housing made rigid and strong by a mold design unique to Memorex.

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YOU'LL FOREVER WONDER,

IS IT LIVE, OR IS IT MEMOREX.

HERMAN BURSTEIN

Automatic Sensitivity Adjustment

Q. My cassette deck has a microprocessor which, according to the manufacturer, automatically sets the bias, equalization, and sensitivity levels. Does this also set the Dolby level?—William H. White, Fullerton, Cal.

A. Yes. If the deck has been correctly adjusted at the factory with respect to Dolby reference level, the automatic sensitivity adjustment performed by the microprocessor makes any required change, for the particular tape that is being recorded.

Tape sensitivity refers to the amount of signal output delivered by the tape for a given signal input to it. For the Dolby noise-reduction system to work properly, the level of the signal presented to the encoding (treble-boost) system must match the level presented to the decoding (complementary treble-cut) system. If a tape has high sensitivity, which signifies a relatively high signal output—or a lower signal input required for a given signal output—allowance for this must be made in recording; the signal output in playback will thereby match the signal input in recording.

Belt Source

Q. I own an open-reel tape deck which is about six or seven years old. It is now inoperable because the drive belt has stretched with age. I have tried electronics parts stores and wholesale houses in search of a replacement belt, but it appears that my belt is different enough from anything currently available that nothing will work. I have been told that the manufacturer of my deck has suspended all U.S. operations. Do you know how I can get a new belt?—Al Beckett, Oklahoma City, Okla.

A. Try Projector-Recorder Belt Corp., Department SR, 147 Whitewater St., Whitewater, Wisc. 53190.

Cassette vs. Open-Reel Decks

Q. I am no longer satisfied with my present cassette deck and am trying to decide whether to trade up to a better one or to buy an open-reel deck. Open-reel looks attractive to me for several reasons: I can buy 10½ inch reels of unspliced tape used only once from a local radio station for only $1.00 apiece. I could record much more material on a (10½-inch) reel even at the high speed of 7½ ips. I am concerned with the limits of dynamic range of cassette, inasmuch as phono records are improving and my collection contains more and more discs made from digital and half-speed masters. I would like your opinion on cassette versus open-reel.—Chris Sellers, Ames, Iowa

A. As cassette decks and tapes have steadily improved, it has become increasingly difficult for most persons to detect a significant difference between a fine cassette unit and a fine open-reel one. Metal-particle (Type IV) tape has further decreased the difference; at the same time, improvements in the other kinds of tape—ferric oxide (Type I), chromium dioxide or ferricobalt (Type II), and ferrichrome (Type III)—have left them a scant distance behind metal tape. Important increases in signal-to-noise ratio—owing chiefly to dbx (about 30 dB) and Dolby C (about 20 dB) noise reduction—have made cassette a truly high-fidelity medium. Such improvements permit the recordist to sacrifice a few dB of S/N by recording at a slightly lower level, thereby avoiding tape saturation and consequent distortion and loss of high treble.

The consensus seems to be that unless you're directly taping live material, you can do about as well with cassette as with open-reel. On the other hand, the advent of improved recorded material, in particular the Compact Disc, presents a new challenge to tape recording, so that the superiority of open-reel, particularly at speeds of 7½ and 15 ips, may again become evident—at least for a while, until cassette catches up again.

As you recognize, open-reel, particularly if you have a deck that takes 10½-inch reels (some cannot accept reels larger than 7 inches), will afford you longer recording and playback time per reel. Further, editing is easier with open-reel than with cassette.

Perhaps the most audible inferiority of cassette with respect to open-reel, particularly if open-reel is operated at 7½ ips or more, lies in the area of azimuth alignment. The faster speed of open-reel causes a given degree of azimuth misalignment to have less adverse effect on treble response. True, the wider track of open-reel is disadvantageous with respect to the azimuth problem, but this disadvantage is substantially overcome by the faster speed. On the other hand, cassette deck manufacturers—at least those making quality units—are paying closer and more effective attention to accurate azimuth alignment.

In view of all the factors you have mentioned, I slightly incline toward open-reel in your particular case. But I think you should do some careful listening to both cassette and open-reel decks before you make *your* decision.

Service Problem

Q. About two months ago I took my open-reel tape deck to be cleaned and serviced. When it came back it was worse than it had ever been; it wouldn't run in fast forward and it wouldn't rewind without spilling tape all over the place; in operating mode it would drag as it came to the end of a reel. When I brought in the deck, the only problem was the drag. I wish to take my deck back, but I am afraid that the shop may mess it up even more. Where can I get my deck fixed properly?—George Pruitt, Pemberton, N.J.

A. The Tape Guide cannot recommend specific service shops. Try to obtain the name of an *authorized* service shop in your area from the deck manufacturer, from a local audio dealer, or from the yellow pages of your telephone book.

Whatever service shop you decide on, be sure to do two things: (1) Demonstrate the problem you have so that you and the shop agree as to what it is, and so that it is clear that all else is working well. (2) When you pick up the deck, have the shop demonstrate that the problem has been fixed and that all else is working properly. Service shops are not always eager to do so, but unless they are you probably shouldn't engage their services.

If a great deal of time hasn't passed since your deck was serviced, I think you might give that service shop a chance to correct its work, provided it is willing to do so at no or minimal cost to you.

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.

AUDIOCLINIC

JOSEPH GIOVANELLI

Protection-Circuit Problem

Q. I have a receiver which I purchased some time ago. Every once in a while a relay will click and the sound disappears from my loudspeakers. However, the signal is still present at the input of my tape recorder. Sometimes, the relay will again click and the sound returns. At other times, I can bring the operation back to normal by a sharp rap on the side of the unit. Does this sound like some kind of protection-circuit problem?—Robert W. Thompson, Glendale Heights, Ill.

A. The relay is part of a protection circuit. You may be driving your amp beyond its limits, thereby activating the protection circuit (and the relay) when the temperature on the heat-sink rises to an appropriate point. The fact that the tape recorder is still fed by its correct signal is at least partial proof that your protection circuit is triggering.

Sometimes these circuits will "take off"—even when the receiver is not being overdriven or when there is no signal fed into it. This may represent a malfunction of the protection system. It may also signify there is a lack of good ventilation around the equipment, which would result in a gradual rise in heat-sink temperature. This, in turn, would trigger the protection circuit.

Using Timers

Q. How safe are timers when used with a stereo system? I have always understood that such timers have the same effect as pulling the a.c. power cord out of the wall outlet with the system turned on.—Rocky Ciesick, Panama City, Fla.

A. Cutting off the power has virtually the same effect whether it's done by pulling the plug, shutting off the system's master switch, or interposing an external switch, such as a timer. The more components switched on or off at once, the bigger the surge on the a.c. line. Therefore, it might be more advisable to use the timer to turn on only the components which need to be on at that time—for example, just the tuner and the tape deck, when you are taping programs off the air.

The only problems I have found with using timers occur when using mechanically controlled tape decks or tape decks and phonographs with idler-wheel drive systems. Mechanically controlled tape decks use your finger pressure on the "Play" key to push the pinch roller against the capstan. On such decks, the roller must be left in position for the period between set-up and timer actuation, which can permanently flatten the roller at that point. (This does not happen on solenoid-operated decks, whose pinch rollers are moved into position electrically.) In some decks and turntables, transport drive idlers will also be engaged under pressure, again possibly producing flat spots. Flat spots on the pinch roller or drive idlers cause wow and, sometimes, physically noisy operation.

In general, if a tape deck has a timer-recording switch or switch position, it is safe to use it with a timer. All other components are also safe, except for idler-driven phonographs (which are becoming less and less common).

Stylus Life

Q. How many hours can a stylus play records before you must replace it?—Robert Hirose, Los Angeles, Cal.

A. Stylus life varies markedly, depending on such factors as stylus shape, tracking force, anti-skating force, the overall loudness of the discs being played, and the amount of foreign matter the stylus encounters in its travels. There are also variations in the durability of the individual gems from which styli are ground. Use the manufacturer's recommendations as your guide, and have your stylus checked from time to time (especially when it nears or passes the end of its rated life) on a stereo microscope (one with independent left and right optical systems). Good stereo microscopes are expensive, but many dealers have them.

If the tonearm is handled carelessly, so that the stylus is dropped onto a disc or the turntable, the stylus may need replacement after virtually no playing time at all.

Muting Again

In the October 1983 "Audioclinic," you fielded a question concerning the −20 dB muting switch found on many amplifiers and receivers. The owner's manual supplied with my receiver stated the following about this switch:

1. It extends the useful range of the volume control. With high-output signal sources, with efficient speakers or with sensitive headphones, you may find that the sound is too loud over most of the range of the volume control, i.e., you are restricted to using only settings near the lower end of the control range. By engaging the low-level switch, you can use the full range of the volume control for normal listening.

2. It provides optimum signal-to-noise ratio for low-level listening in quiet environments. For example, if you are listening to soft music late at night and the surroundings are quiet, the low-level switch minimizes the already low residual of the preamplifier and tone control circuits.

3. It provides a convenient, temporary cut in volume (as your response in Audio *stated).*—Joe Mazzini, Montgomery Creek, Cal.

Digital Turntables

Q. Are there such things as digital turntables? If not, why are more and more phonograph records being digitally recorded if they are just to be played back on analog or conventional phonographs?—William Scaramazca, Swedesboro, N.J.

A. The phonograph is an analog system, and even digitally recorded master tapes must be converted to analog form for phonograph disc mastering. But studios are making more and more of their masters digitally, both in preparation for the release of these recordings in such digital formats as the Compact Disc and to get better quality in their LP releases. Digital masters have less noise and distortion and more extended high- and low-frequency response than analog masters, and they are not gradually degraded by constant recopying in the process of converting multi-track originals to two-track stereo releases. (There are, however, some who feel that digital recordings sound harsher.)

The Compact Disc player might be considered the "digital turntable" you asked about. But it, of course, plays only digital CDs—some of which were made from analog masters.

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

ULTRX

MOST PEOPLE WOULD CALL IT OVERKILL.

The new ULTRX™ R100 receiver isn't for everybody.

You don't really need 100 watts per channel* of virtually distortion-less power. Unless you like listening to today's ultra-high quality recordings at "live concert" sound levels.

And a remote-controlled digital tuner with 20-station memory is probably more than enough—unless you're a dedicated FM listener with wide-ranging tastes.

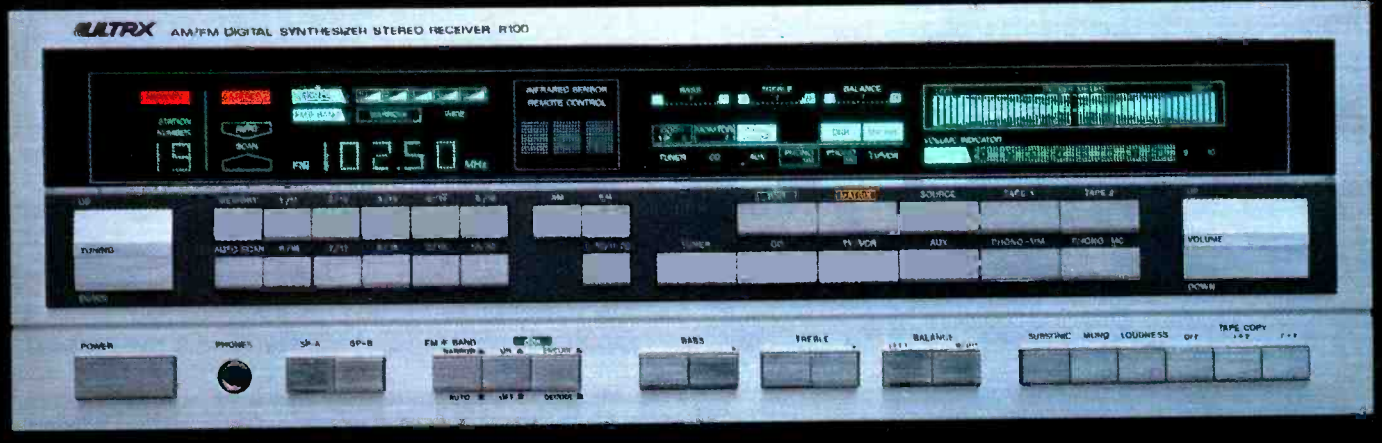
Likewise, most people could get along without the built-in dbx and DNR noise reduction systems. Except those few who've become spoiled by the almost eerie absence of noise in CD digital recordings. With the dbx, any cassette deck can make virtually noise-free recordings, while the DNR "cleans up" existing noisy signals.

Unless you're a nut about *video* sound quality, too, you won't have much use for the TV/VCR inputs and stereo synthesizer circuit.

The R100 is packed with features that are best appreciated by an audio perfectionist. It may be the best-equipped receiver ever built.

Get an ULTRX dealer to put an R100 (or one of our other new receivers) through its paces for you.

Some people might call it overkill. But you'll call it overwhelming.



Beyond the Ordinary.

*Minimum Continuous Average Power per channel, both channels driven into 8 ohms, from 20-20,000Hz, with no more than 0.009% Total Harmonic Distortion.

Enter No. 26 on Reader Service Card

Linear Power Crossover

The XO1 active stereo crossover, from Linear Power, can be set to any of 19 frequencies (between 74 Hz and 17 kHz) by plugging in an IC-sized frequency module. A remote frequency selector, the XO-controller (shown at right in the photo) is available to installers, allowing them to check the effects of different crossover frequencies by turning a switch while sitting in the car.
Price: XO1, $149.95.
For literature, circle No. 100

Fried Loudspeaker

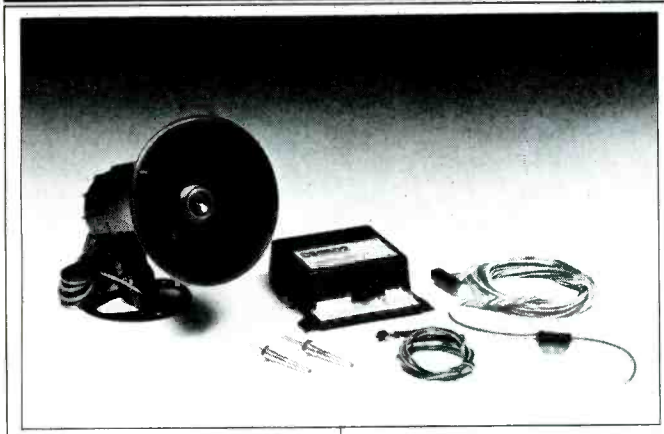
The Fried A/3 bookshelf loudspeaker replaces the A/2, which was introduced in 1981. Among its new features are a polypropylene bass-mid driver with ventilated voice-coil, a new dome tweeter, and a new crossover network in which the drivers are connected in series rather than in parallel. According to Fried, series networks provide more homogenous, smooth and dynamic sound, and better stereo imaging.
Price: $580.00 per pair.
For literature, circle No. 102

Koss A/3 Portable Radio/Cassette

The Koss Music Box personal portable stereo line now includes a cassette player with Dolby B NR and an AM/FM tuner pack. The 10½-ounce player features the SafeLite, a yellow LED which warns when sound pressure through the headphones reaches 95 dB SPL. The SafeLite is calibrated for Koss's Sound Partner folding headphones, which come with the system.
Price: $129.95.
For literature, circle No. 101

Yamaha Headphones

Now you can wear a Porsche: Yamaha's new YHL-006 headphones were styled by the Porsche Design group. They curl up into a palm-sized package for carrying or storage, and their diaphragms are in unique, ball-shaped enclosures which sit on the ear and are held in place by a flexible headband. The "Y" cord has a 3.5-mm mini plug; a ¼-inch plug adaptor and a case are provided. Price: $40.00.
For literature, circle No. 103



Crimestopper Car Alarm

The Crimestopper CS9502 alarm is a keyless system which arms itself through the car's ignition system (thus qualifying for insurance discounts on cars with passively-armed systems). The system can also be overridden to allow valet parking; in this mode, a chirp reminds the user to re-arm the system later. An LED status indicator shows the arming mode and indicates when intrusion has been attempted. A backup battery circuit triggers the alarm (a 110-dB siren) when the car battery is disconnected.
Price: $149.95, plus installation.
For literature, circle No. 104

Discwasher Anti-Static Gun

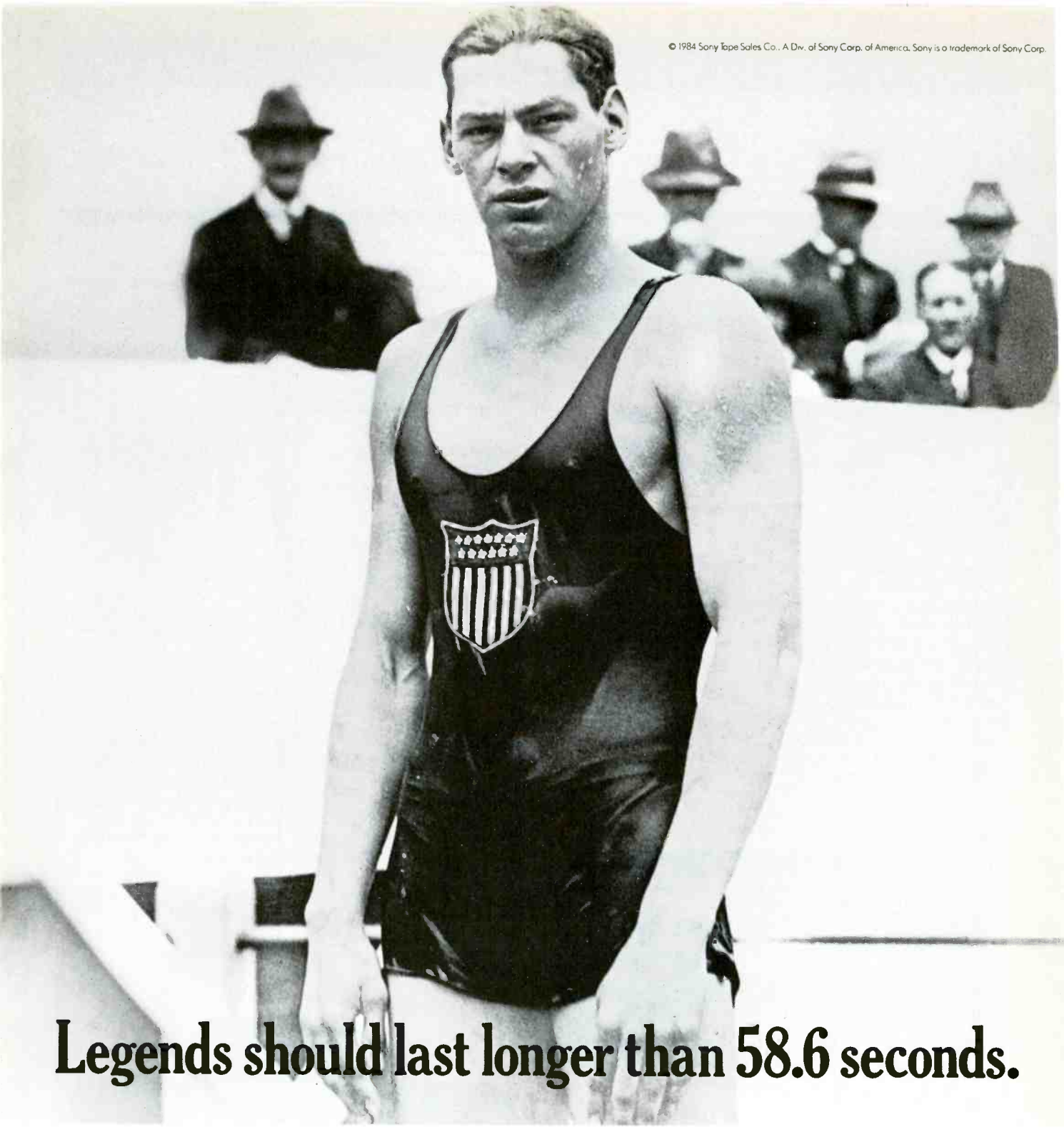
The Zerostat 3 anti-static gun, imported by Discwasher, has an attachable test light. The gun produces positive or negative ions, depending on the direction of trigger movement, and requires no batteries or refills.
Price: $23.00.
For literature, circle No. 105

Aiwa Beta Hi-Fi VCR

The V-5 Beta Hi-Fi videocassette recorder, from Aiwa, is a portable with an unusual configuration. Unlike most portables, this one has its tuner, timer and power supply built in, making it heavier than most portables, but still, at 13.7 pounds, it's probably the lightest tuner/timer/VCR. As a portable, it records sound monophonically; the Beta Hi-Fi stereo signals are provided by the amplifier/adaptor unit shown beneath the VCR. The amp section delivers 5 watts per channel into 8 ohms, from 20 Hz to 20 kHz, at 5% THD or less; there is also a preamp output for use with external sound systems.
Price: $950.00, including amplifier/adaptor and wired remote control.
For literature, circle No. 106

Pioneer System

The Pioneer SC-5 offers more opportunity for personal involvement than the average one-brand system. In addition to the usual components (a digital tuner, front-loading turntable, dual cassette deck, seven-band equalizer and three-way speakers), it has a built-in mixer, handling up to five inputs, with pan-pots to locate sources in either channel or between them. Microphone and headphone jacks (and a.c. convenience outlets) are accessible on the front of the rack. The system also features cassette storage drawers, the usual record-storage space, and a digital timer.
Price: $2,199.95.
For literature, circle No. 107



Legends should last longer than 58.6 seconds.

The legendary Johnny Weissmuller. A record-breaking 58.6 seconds for the 100-meter Freestyle at the 1928 Olympics. All told, 5 gold medals and 5 Olympic records at the '24 and '28 Olympic Games.

Unfortunately, you couldn't capture the Weissmuller legend on Sony Tape back then. But new legends will be made and new records set this summer in Los Angeles. Capture them on Sony Tape. And let the legends live on.

For $1.00 rebate on T-120 and L-750, see participating retailer.

Sony Tape. The Perfect Blank.

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Part II

HISTORY OF MAGNETIC RECORDING

ROBERT ANGUS

In 1947, while John Mullin was proving the worth of the Magnetophon tape recorder he had brought back from Germany, a research team at Bell Laboratories (consisting of physicists John Bardeen, Walter Brattain and William Shockley) was developing a device which would revolutionize tape recording along with just about every other aspect of electronics—the transistor. Manufacturers of magnetic recording equipment didn't pay much attention—they were too busy developing wire and tape. Magnecord, which had been organized in 1946 to produce wire recorders (first for broadcast use and almost immediately for public consumption) abandoned that format in favor of tape in the fall of 1948. Magnecord's PT-6 quickly became the workhorse of recording studios and radio stations, as well as finding favor among hi-fi buffs.

One day the following year, David Apps of General Motors Laboratories approached Magnecord with an unusual request: Could the company build a tape recorder which could capture sound stereophonically? GM had been using a PT-6 to analyze automobile noise, but the results were unsatisfactory because they lacked spatial perspective. Perhaps a stereo unit might solve the problem. Magnecord quickly modified a PT-6, installing two record/play heads 1-5/16 inch apart along the tape path. The upper one recorded left-channel sound, the lower one the right. Having made its first stereo recorder, Magnecord made two more for display at the 1949 Audio Fair in New York.

The musical applications of the stereo recorder were obvious to Magnecord's engineering-oriented management team, so in 1950 they hired a musical coordinator, a young recording engineer and audiophile named Bert Whyte. Whyte's first chore was to use the stereo machine to record as many different types of music as possible. A highly personable and persuasive man, the Chicago-based Whyte proceeded to talk just about every musical agglomeration that blew through the Windy City into letting him show them what stereo sound could do for their music. Benny Goodman, Lionel Hampton, Jimmy McPartland, the U.S. Navy Band, Woody Herman, and the Chicago Symphony all passed before Whyte's Magnecord for a series of recordings, many of which still exist. None, however, has ever been released commercially because of union problems and the fact that they were recorded as experiments.

Talking Woody Herman and Goodman into letting him record was child's play compared to Whyte's next challenge, explaining stereo to James Caesar Petrillo, then president of the American Federation of Musicians. Six years earlier, Petrillo had brought all commercial recording in America to a screeching halt while he held out for a recording trust fund for his members. The major record companies, who had been bloodied in that battle, weren't about to tangle with Mr. Petrillo again.

Magnetic recording was known before the turn of the century and recording on tape has its 50th anniversary this year. But it was only after WW II that tape recording truly came of age—thanks to important developments like polyester backing for tape, stereo recording, the Philips cassette, chrome particles, video recording, noise reduction, etc.

Norelco 2500 cassette player

Magnecord PT-6

Norelco open-reel

Scotch 111 "Living Letter"

Whyte and Magnecord, on the other hand, had nothing to lose. So he made an appointment to see the union leader, bringing with him a tape he'd made of a Leopold Stokowski concert in Urbana, Ill. "He sat there and listened," Whyte remembers, "and as he listened, I could see his face clouding up. When the tape ended, he scowled and said to me, 'Of course, you realize that we'll have to work out a pay scale for stereophonic recordings. Since there are two channels on the tape, I'd consider that two recording sessions. Each man in the group would have to be paid twice.' "

Whyte realized that stereo would never go anywhere under that arrangement. The record companies simply wouldn't sit for it. "Yes, Mr. Petrillo," Whyte replied, "but don't you see? If stereo catches on, everything will have to be rerecorded since there are no stereo recordings now." Petrillo thought that over, considering the increased work for his members—and the jump in record company contributions to his new trust fund. The scowl gradually faded into a benign smile. "Yeah," he answered, and the meeting was over.

Halfway around the world, something was happening that would alter the tape scene just as profoundly as had any of the previous developments. In the fall of 1945, a handful of Japanese engineers had leased some space in a burned-out Tokyo department store to start a company. They weren't sure exactly what they were going to do, but one thing was certain: It would be different from the things other companies were doing. Their first efforts were handmade pieces of broadcasting equipment to be used by the government radio network, NHK.

One day in 1948, the company president, Masaru Ibuka, was delivering a piece of equipment to the NHK studios when he happened to see a device on the desk of one of the U.S. occupation officers who oversaw NHK operations. It was a tape recorder. Suddenly Ibuka knew what the company was going to make.

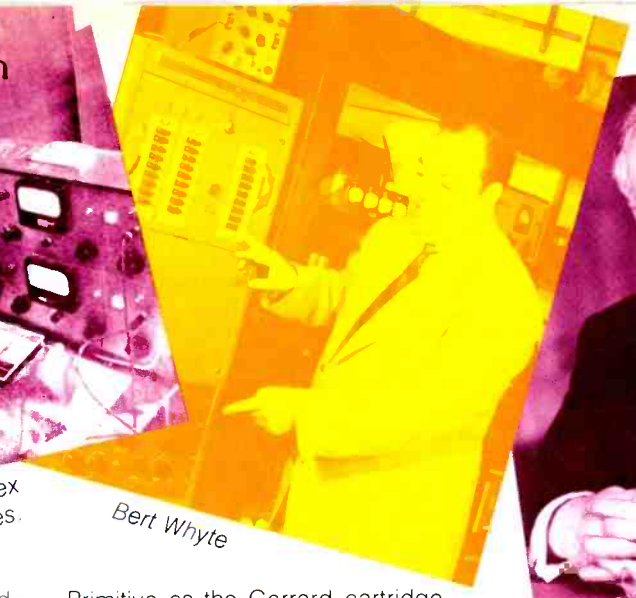
It took the company which was to become Sony two years to do so, partly because nobody in Japan knew how to make recording tape. Ibuka and his associates experimented first with cellophane as a base, but found it stretched under tension and expanded in humid weather. Next, they tried paper. The results were better, but the paper tore every time the tape caught in the transport. "It was a blessing in disguise," Sony's Board Chairman, Akio Morita, whose cousin supplied the paper, recalled recently. "We had to take painstaking care in designing and manufacturing all of the parts along the tape path, to be sure the tape wouldn't snag." Old-timers say that at first the paper was laid out on the floor of Sony's "new" factory, a warehouse in the Shinagawa district of Tokyo. Workers then ran back and forth along its edges, spraying on the magnetic powder and binder with an airbrush.

Morita today admits that those first tapes weren't very good, particularly when compared to 3M's product. But they improved, and by late 1949 Sony had a prototype tape recorder. Early in 1950, the first Sony recorders went on sale in Japan. They cost $400, a lordly sum in postwar Japan, weighed over 100 pounds and were about the size of a small steamer trunk.

Back in the United States, some visionaries were talking about the day when tape might replace the ubiquitous long-playing record. Recording Associates, as early as 1950, published a catalogue of recorded music on tape, and other entrepreneurs talked confidently of putting the major record companies out of business. The record companies responded initially by ignoring the whole thing.

As a result, companies who wanted to offer music on tape either had to record their own or acquire recordings from European sources who hadn't been able to make deals with the independent U.S. labels. The result generally was music of less than compelling interest performed by artists nobody'd ever heard of. One of the first to record specifically for tape—and to observe professional quality standards—was

Chet Smiley with several Ampex open-reel machines.



Bert Whyte

James C. Petrillo

Chet Smiley of Livingston Audio Products. Smiley packed up a stereo Magnecord in 1951 and flew to Florence, Italy, to record a number of classical performances at the May Festival. To these he added organist Hack Swain in a number of programs of old favorites and finally the *piece de resistance*—Lenny Herman and the Mightiest Little Band in the Land, then performing at the Hotel New Yorker.

Then, in 1954, the dam broke, with RCA Victor the first major label to produce its own prerecorded open-reel tapes. In quick succession came Vox Productions, Mercury Records (for whom Whyte had been consulting) and Westminster. The tapes' cost was high—$12.95 for a half-hour stereo program, at a time when discs cost $4 and frequently contained 50 percent more music.

Everybody loved tape's high-fidelity sound—and the fact that, in the early 1950s at least, it was the only way of hearing true stereo. But cost was an important consideration. So was convenience. Together, those two factors spawned a number of unlikely products, beginning with a device which fit on top of conventional professional turntables, converting them into tape decks. The three-wheeled unit, made by Presto, included takeup and feed tape reels, a playback head assembly and a capstan wheel driven by the turntable spindle. Then there was the Garrard cartridge, two full-sized reels of tape sealed inside a plastic shell. The British record changer manufacturer had visions of producing a tape transport which would hold and drop these cartridges in sequence for automatic play. Midway through the 1960s, Sony would offer a machine which changed conventional tape reels automatically. If you wanted one with your name engraved on a silver plaque on the chassis, it would have cost you $995.

Primitive as the Garrard cartridge was, it was the first step toward what would be the biggest revolution of all in audio recording, Philips's development of the Compact Cassette. But first came the RCA cartridge, an oversized precursor of the Philips cassette, which used standard quarter-inch-wide tape at a speed of 3¾ inches per second. Then came a short-lived square cartridge developed by Columbia Records and 3M (the takeup reel was inside the player). And then, in 1963 and 1964, the Compact Cassette. All were attempts to get over the public's fear of tape handling and threading, and were designed to make tape players more compact, efforts which would pay off some 15 years later in the video era.

Video, in fact, was only being hinted at in tape recording circles during the 1950s. In fact, Bing Crosby Enterprises had shown a black-and-white open-reel video recorder as early as 1951 and on January 4, 1927, a Russian immigrant to Britain, Boris Rtcheouloff, had applied for a patent based on Poulsen's invention, describing a system for recording pictures and sound on wire or "a travelling strip of magnetic material." The Rtcheouloff application even goes so far as to describe a rudimentary video camera.

It wasn't until 1956 that video recording became a reality at the professional level, with the Ampex VRX-1000. It was first used by CBS for "Douglas Edwards and the News," on November 30. Shortly thereafter, NBC became the first network to broadcast an entire program recorded on videotape, "The Jonathan Winters Show." And just after the New Year, 3M would begin marketing reels of videotape at $307 each.

The first hint of video recording for the home also came in 1956, when RCA announced that it was working on what it called a See-Hear video tape player, which would enable homeowners to play prerecorded programs through their television sets. Like other RCA pronouncements on video, this one wasn't followed up with actual products.

Beginning in 1954, with the first use of Bell Telephone Laboratories' transistor in a consumer product—this one a radio, manufactured in Texas for Regency—the move toward complete elimination of vacuum tubes in recording devices began. That same year, and not coincidentally, Sony produced the first Japanese-made transistors, under license from Bell. It would take 10 years before transistors completely displaced tubes in tape equipment, but the handwriting clearly was on the wall, and it said "Solid State."

By the early 1960s, the sale of open-reel tape recorders was booming, along with other audio products. Consumers, unaware of the changes taking place beneath the surface, were

Wollensak Model 1515s, c. 1974, left, and c. 1954.

Du Pont chemist Dr. Paul Arthur, Jr., inventor of chromium dioxide, six grams of which are needed for a C90 cassette.

paying as much as $399 for so-called professional models from Concertone or Bell Sound Systems. You could buy a do-it-yourself kit from Eico for $300 or pay $200 for the Wollensak 1515, a recorder which was fast becoming the Coke bottle of the tape field. Not a thing of beauty, the mono version went on sale in 1954. With very minor changes in its cosmetics and profile (but significant improvements in its interior, including a stereo version in 1963), it lasted until 1978, when the last ones were made for schools.

But the days of the home open-reel boom were numbered. In Holland, Philips had developed a compact dictating system which it would introduce in Europe during 1963 and in the United States the following year. Also in 1963, the first video recorder intended for the home made a fleeting appearance in the basement of the Cinerama Theatre on Broadway, in New York.

Of these, the one producing the greatest impact initially was Philips' Carry-Corder. Over the next 20 years, it would spell the end of open-reel tape recording in the home, open the whole new field of portability and spur the development of new types of tape better suited to the Compact Cassette's peculiar requirements.

For the first year or two, purchasers of Norelco Carry-Corders got a single blank tape (later three) with their machines. The manufacturer felt that since the units would be used for dictation, there really was no need to supply blank cassettes in quantity.

The Dutch hadn't counted on the cussedness of people. Nobody ever accused those first cassette recorders ($199 at first, later $149, and about the size—but not the weight—of two bricks side by side) of being high-fidelity instruments. But almost from the first, people began recording music on them to play back where their home stereo systems couldn't go. Accordingly, the need for blank tape arose almost at once—and the leading tape brands of the day (Ampex, Reeves Soundcraft, Audio Devices, BASF and Scotch) attempted to meet it. By 1966, Maxell was producing Japan's first cassette tapes.

The cassette might have remained in that rough-and-ready state if it weren't for a development taking place in, of all places, India. There, a young engineering graduate of Stanford University and Cambridge was finishing out a tour of duty with the Peace Corps. Ray Dolby (formerly a member of Ampex's first video-recorder design team) was a music lover who was intrigued by the problem of noise in tape recording, which seemed to be inherent. The nights in India were long, and Dolby had lots of time to think about the persistent hiss he heard in the quiet passages of his favorite tapes. Then he hit on the idea of breaking up the frequency spectrum during recording, with certain frequencies and certain volume levels of the signals recorded at higher levels than other combinations. Then, during playback, these signals would be suppressed by exactly the same amount, along with the accompanying background noise or hiss. Dolby's invention found immediate application in professional recording, where Decca Records in England bought every unit he could produce during his first five months in business.

What turned the cassette into a high-fidelity recording medium, however, was the development of a low-cost version of the system Decca was using, one which could be built into home recording equipment. The idea came from Henry Kloss, then president of KLH. The recorder in which he planned to use it was an open-reel model, but when Kloss moved on to establish Advent, he took the idea of a low-cost Dolby noise-reduction circuit with him and applied it to that company's first cassette deck.

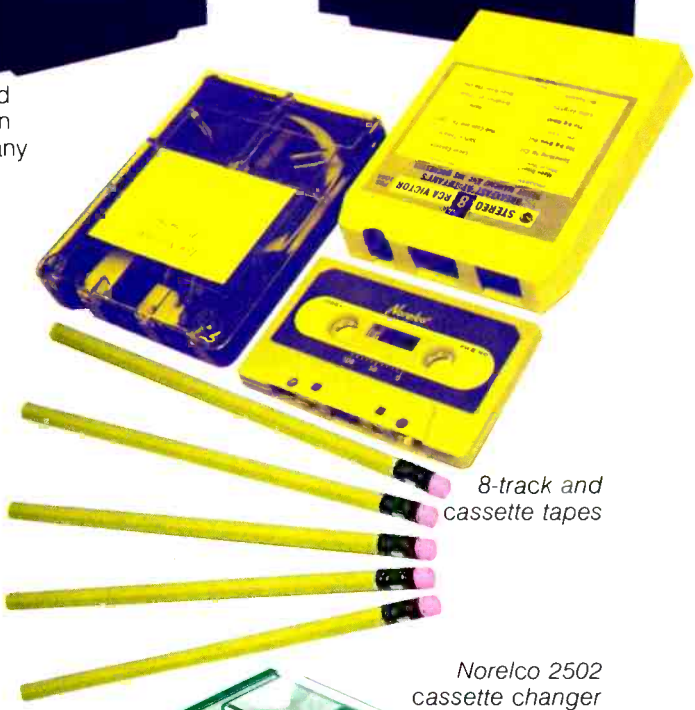
During this period, Dolby appeared before the Audio Engineering Society to describe his system, and mentioned casually that there was no reason why the circuit KLH was using couldn't be reduced to an integrated-circuit chip and incorporated in every cassette recorder. In 1973, Signetics produced such a chip. Harman-Kardon then beat Advent to the punch by using the new chip to upgrade a cassette deck it had just introduced.

The coming of cassette helped bring Scotch 111 and the other first-generation red-oxide tapes to the end of their

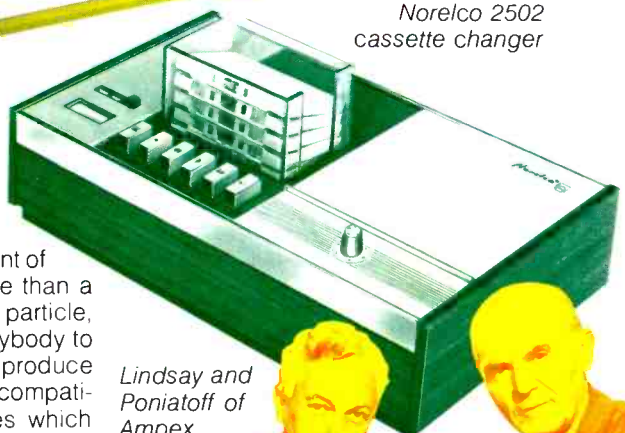
An original Philips "Carry-corder" (Photo; Courtesy C.G. Nijsen, Philips and J.A.E.S.)

Ray Dolby

Ampex Model 200, right, c. 1948, was followed by the Model 300 a year later.



8-track and cassette tapes



Norelco 2502 cassette changer

long careers. At 3M and at Philips, work had begun on a new tape particle, pure metal, rather than the oxides which had been used for 30 years. The chemists and engineers were trying to do the same thing that Dolby did, improving the signal-to-noise ratio of tape recordings by making backgrounds quieter. "We all knew that it was the ferrite bits in the oxides which did all the work," 3M technical manager Del Eilers says now, "that the oxidized bits caused all the noise because no signal was recorded there. So we figured that if we could coat a tape with particles of pure iron, we could dramatically reduce residual noise levels, while doing something dramatic about frequency response and other characteristics." The catch was that pure iron filings or powder proved highly unstable. Exposed to oxygen in the air, they would immediately oxidize, sometimes with explosive results.

There is no evidence that anyone was ever killed or injured in these explosions, but both Philips and 3M experienced them, and there was apparently some damage to equipment. So the idea of metal tape was put on the back burner.

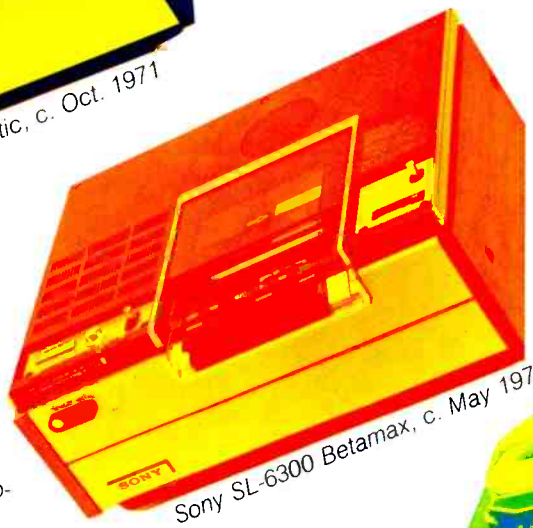
Meanwhile, E.I. du Pont de Nemours & Co. had patented a process for producing chromium dioxide, a product not found in nature. The trouble was that, at first, nobody seemed to know what to do with it. The scientists at du Pont thought that because of its high coercivity, it might have an application in magnetic recording. Accordingly, in 1969, the company sent a marketing/engineering team to New York to explain to the tape industry how chromium dioxide could be used to make superior audio recordings, particularly in cassette recorders designed specifically to accept it, as well as in video applications. Interest was high, and du Pont signed licensing agreements with BASF, making it the exclusive manufacturer in Europe, and with Sony, which had all rights to the product in Japan. That meant that any Japanese tape manufacturer wishing to produce chrome tape would have to talk to Sony first. If they produced the tape commercially, they would have to pay Sony royalties as well.

The predictable result was a race to develop a chrome substitute. The first step in that direction came in the early 1970s when Pfizer Inc. developed 2228, a high-quality gamma ferric-oxide particle which could be mass-produced. Previously, some tape makers had formulated their own particles from raw materials supplied by chemical companies like Pfizer, while in other cases, small firms, many engaged in producing paint pigments (as was Pfizer), purchased finished particles.

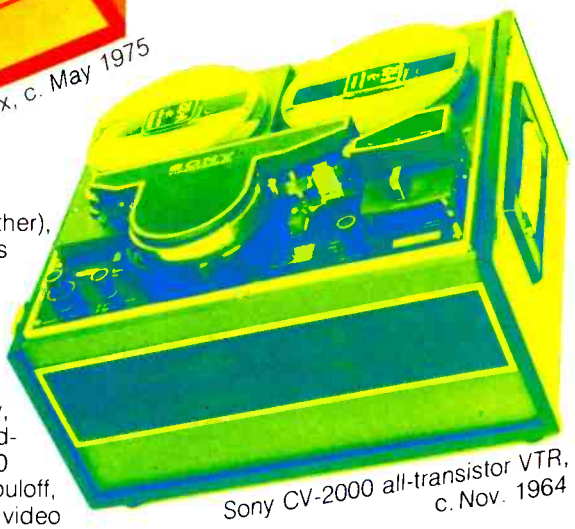
In any case, the development of 2228, which was nothing more than a very good quality ferric-oxide particle, made it possible for almost anybody to go into the tape business and produce a high-quality coating. It was compatible with the ferric-oxide tapes which had been produced during the 1950s and 1960s in terms of signal biasing and equalization, but it offered much better uniformity and particle size ratio. It could also be combined with cobalt particles to achieve even better frequency response and signal-to-noise ratio—but only when biased and equalized at a level somewhat higher than previously used and specified by Philips in its patent licensing agree-

Lindsay and Poniatoff of Ampex.

Sony VP-1100 U-Matic, c. Oct. 1971



Sony SL-6300 Betamax, c. May 1975



Sony CV-2000 all-transistor VTR, c. Nov. 1964

ments. Since its introduction, virtually every improvement in ferric oxide tape has involved the use of 2228 or an equivalent as a basic building block.

Indeed, du Pont had run afoul of the Philips patents when it first tried to use chrome for cassette recording. So after protracted negotiations, the Dutch company amended its standards to permit biasing and equalization for chrome. As it happened, these specifications worked equally well for cobalt-enhanced 2228 particles, and soon every Japanese tape manufacturer other than Sony was offering its own version of chrome-biased ferric-oxide tape. By 1976, it had become necessary for companies like Maxell to clearly identify each tape's bias and equalization characteristics on the cassette or package.

By far the most bizarre event of that decade of change was the announcement, late in 1963, by a previously unheard-of British electronics firm, Telcan Ltd., that it had developed a home video recorder which could sell for the incrediby low price of $94. It used half-inch tape at a voracious rate—an 11½-inch reel provided only 11 minutes of playing time. The day of Telcan's demonstration was a cold and wintry one; the pictures reaching the black-and-white monitor in the basement of the Cinerama theatre from local TV stations were smeary, unclear and unacceptable. So were the recordings the Telcan unit made of them and played back to the assembled press corps. Sniffed the highly respected *Television Digest* in its report, "Telcan't."

Telcan didn't go away immediately, but neither did recorders appear in stores. Instead, the company reorganized and talked about a kit version for $164 (it never appeared, either), while other kitchen inventors offered working models of their own so-called brute-force recorders.

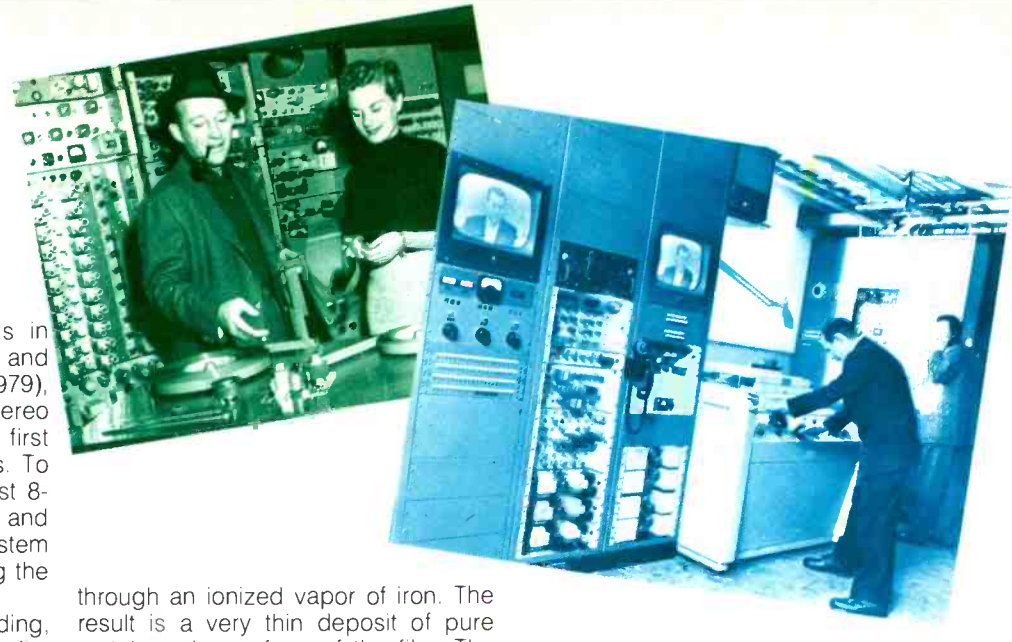
The whole idea might have died there. Instead, Ampex, Panasonic and Sony, using the helical scan recording idea advanced nearly 40 years earlier by Boris Rtcheouloff, introduced black-and-white video recorders designed for home use and priced between $1,000 and $1,200, or about three times the cost of the best audio cassette deck at the time. These recorders provided much better results than Telcan's, but they had their own problems. One was that tapes recorded on one machine might not play back on another unit, even if both were the same brand. Another was that the Ampex, at least, was a service technician's nightmare. Once something went wrong with it, it usually went into the closet and was forgotten.

Akio Morita believed that it was Sony's task not only to develop and produce products which were revolutionary, but also to teach people how to use them. Accordingly, Sony bought television time in New York to explain to viewers who didn't know that they needed home VCRs what the recorders were for and how easy they were to use. The commercials zeroed in on the time-shifting feature, which Morita has always felt was the most important. They didn't sell many recorders—all three models disappeared within a year or two—but they did raise consciousness when it came to video recording and to Sony.

Sony's first real video recorder hit was the introduction of U-Matic recorders in 1970, in conjunction with a number of other Japanese manufacturers who had agreed in advance on a single format. This time, recordings were fully interchangeable from one machine to another and from one brand to another. The recordings were in color this time, and the tape was protected by a cassette-type shell. However, the manufacturers made no real effort to sell U-Matic as a home medium; instead, the recorders were sold to educational and industrial users, to cable television systems and even to local broadcasters.

Two years later, home viewers got their chance, with a console called Cartrivision. It contained a 25-inch color TV set in addition to the cartridge video recorder, at a cost of $2,400. Very few people had that kind of money, and many of those who did had no use for another 25-inch receiver. Besides, the sets didn't always work, and very few programs were available for the system.

Home video finally became a reality in 1975, when Sony introduced the Betamax. Panasonic and JVC followed up quickly with VHS machines early in



The Crosby Enterprises VTR used high tape speed past fixed heads, but was abandoned when Ampex showed its unit in 1956. First use of Ampex's VRX-1000 was for "Douglas Edwards and the News" in November 1956.

1976. Since then, improvements in these systems have come thick and fast—the first portable VCRs (1979), the first VCRs with high fidelity stereo sound (1982) and, in 1983, the first one-piece Beta camera-recorders. To them were added in 1984 the first 8-mm camera-recorders from Kodak and the first really compact VHS-system camera-recorders from JVC, using the ultra-small VHS-C videocassette.

Like the story of video recording, that of recording tape remains unfinished as these lines are written. As home video developed, recorder manufacturers found that the high-bias audio chrome and cobalt-absorbed ferric-oxide tapes, which began appearing around 1970, were ideal for recording video as well.

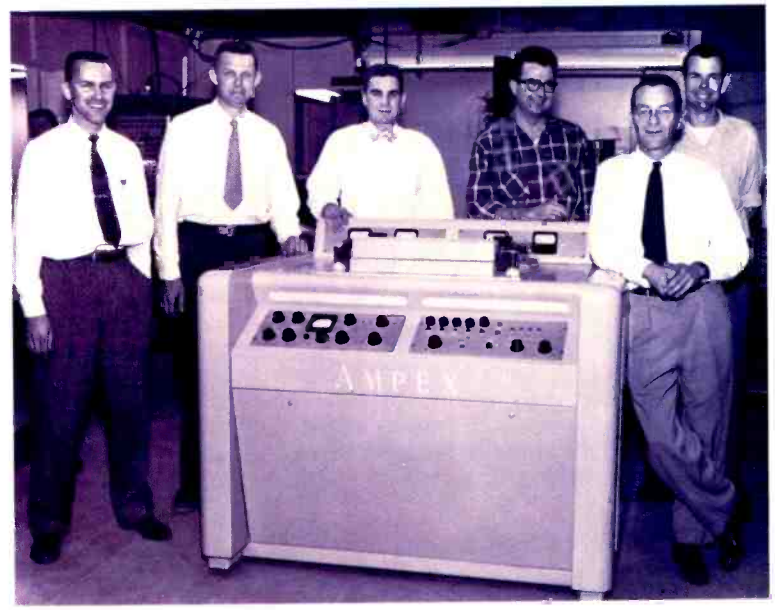
In 1979, 3M's technicians finally found a way of producing metal-particle tape without explosions, and without the tape oxidizing the first time the user took it out of the box. The secret: Allow the thin surface skin to oxidize just enough to protect the rest of the metal coating underneath and combine traces of other metals with iron to inhibit oxidization. 3M contacted a number of recorder manufacturers before going public with its tape. Of the lot, Tandberg was the first to develop a recorder designed to take full advantage of the ultra-high-bias tape.

3M thought it had stolen a march on other tape manufacturers. It was aware, of course, of Philips research on metal particles, but it believed that the Dutch had not yet solved the stabilization problem. The company was astounded, therefore, when a Japanese maker, Kanto Denko, not previously involved in tape manufacture at all, announced that it had a metal particle, and proceeded to sell it to any Japanese manufacturer who cared to buy.

Metal particle tape has yet to find a niche in video recording, though the recent introduction of an 8-mm recorder-camera designed to use it suggests that it is about to do so. In the meantime, there is another form of metal tape which has been used for several years in the manufacture of microcassettes. "We originally called it metal-plated," a 3M technician told me, "when we began research on it back in 1963." He explained that the process involves passing a charged plastic film through an ionized vapor of iron. The result is a very thin deposit of pure metal on the surface of the film. The coating is much thinner than one of metal particles, but it's also more even, with virtually no gaps or dropouts. Panasonic patented a process which works in the early 1980s and labelled the result Angrom. Indications are that we'll be hearing more about both types in the years to come.

And what about the Compact Cassette, which for practical purposes buried the open-reel home recorder in the early 1970s? Well, you can mark 1984 down as the year in which it finally surpassed the long-playing record in terms of prerecorded sales, due in no small part to another idea of Sony Chairman Akio Morita. Back in 1980, Morita reasoned that what the world needed was a very compact, very lightweight high-fidelity cassette tape player that could be enjoyed through high-quality, comfortable headphones. Virtually everybody at Sony tried to talk him out of it. For one thing, they pointed out, nobody had ever heard of a portable player without a loudspeaker. And if you put in a speaker that sounded like anything, the unit would be heavy. No record function? Likewise unheard of. Morita stuck to his guns (after all, he was the chairman of the board). He even had a name for the new player: Walkman. Some of his associates cringed. It would never play in America, they said, and persuaded him to let the players be introduced under another name there. Within 18 months, everybody had forgotten the first name (Soundabout); the Sony Walkman was the hit of three continents and the Sony headquarters building in Shinagawa had a museum in the basement containing blatant copies by several dozen competitors.

The magnetic recording industry entered a new era—or at least the audio portion of it did—in 1978 when Sony introduced the first PCM digital recorder. Since then, PCM units have come down in price, size and complexity to the point where virtually any audiophile can afford one, alongside his hi-fi video recorder and professional-quality Compact Cassette deck. In the 1980s, it's virtually an embarrassment of riches for the tape-oriented audiophile.



The Ampex VRX-1000 included three items basic to all current VTRs: Spinning heads, FM recording of the video signal, and time-base error correction. The design team included Fred Pfost, Shelby Henderson, Ray Dolby, Alex Maxey, team leader Charles Ginsberg, and Charles Anderson.

An error of 20', or one third of a degree, (see text).

How Important Is Tape Azimuth?

HERMAN BURSTEIN

Not least among the factors that enable a cassette system to maintain essentially flat response out to 15 kHz or more is accurate azimuth alignment of its record and playback head or heads. A considerable number of queries received by my "Tape Guide" column grow out of the problem of achieving and maintaining such accuracy.

Azimuth refers to the orientation of the head gap with respect to the direction of tape motion. To simplify discussion, we'll temporarily assume that a tape head has but one gap (rather than the two needed for stereo). In the *absolute* sense, correct azimuth alignment denotes that the gap of a tape head is perfectly perpendicular to the direction in which the tape moves, as in Fig. 1. If not, we can say there is absolute azimuth error, depicted by the angle in Fig. 2; for clarity, the angle is greatly exaggerated.

Absolute azimuth error may be caused by the head being mounted with its gap slantwise to the tape path or by the tape skewing with respect to the gap when in motion, as in Fig. 3. Such error tends to produce increasing loss of signal as frequency rises (Fig. 4); we can call this azimuth loss. The loss occurs not on the tape but in playback.

Whether azimuth loss does occur depends on *relative* azimuth error—on the azimuth of the playback head relative to the azimuth of the record head. For compatibility among tape decks, it is desirable that both heads be correctly aligned in the absolute sense, as in Fig. 1; therefore, both will then have the same azimuth, so that relative azimuth error is nonexistent.

However, if absolute azimuth error does exist, but is the same in both the record and playback heads, the errors cancel; there will be no relative azimuth error and no azimuth loss.

Thus, it is advantageous to have a two-head deck, so that the same head is used for record and playback. Even though the head may not be in absolute azimuth alignment, the errors in record and playback will tend to cancel, and there tends to be little or no azimuth loss when playing a tape recorded with that head. (The possibility of some azimuth loss, usually slight, still exists because, depending on the quality of the cassette and of the deck, the tape might skew differently in recording than in playback, resulting in relative azimuth error.)

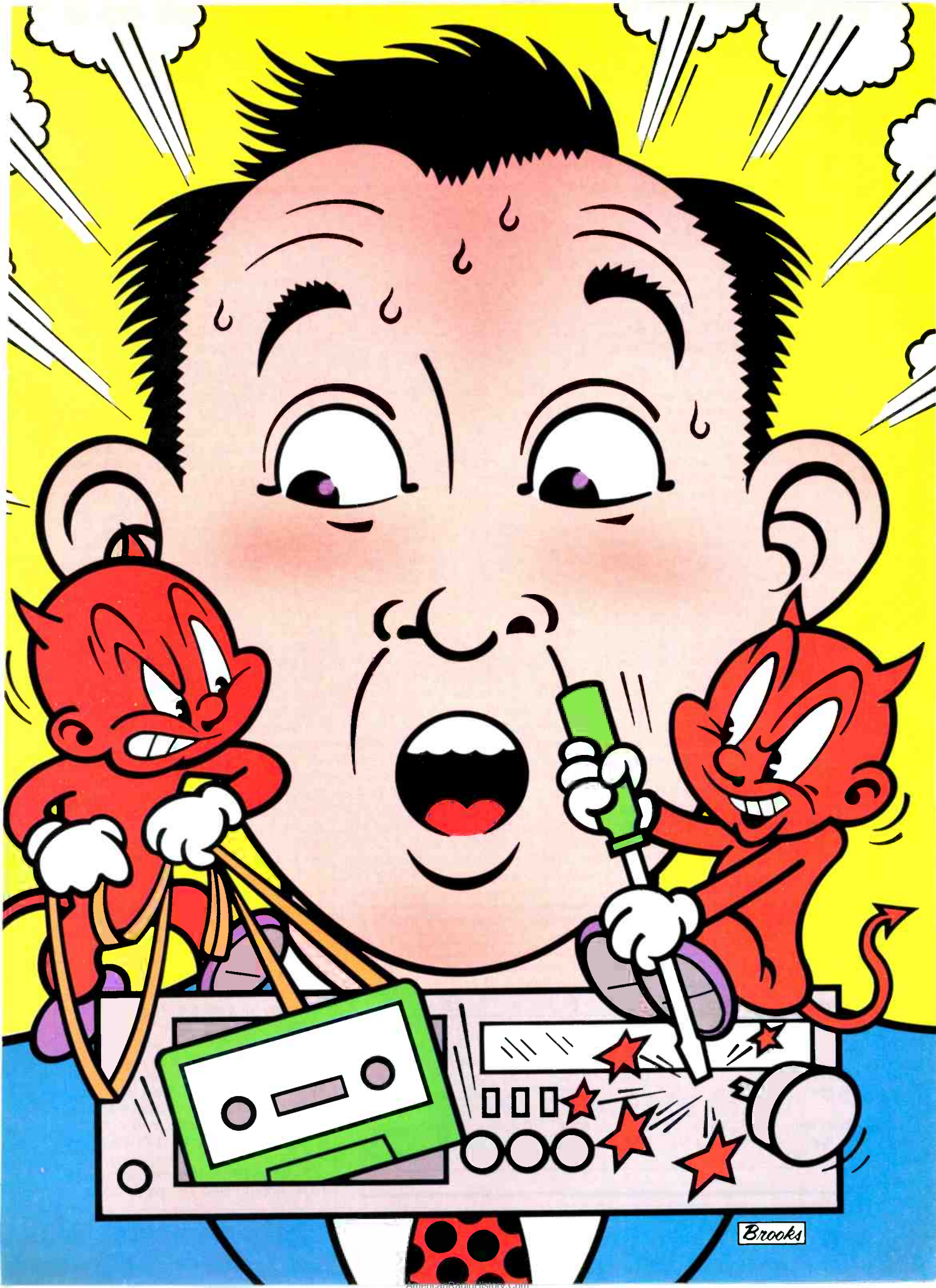
Significant azimuth loss can more easily happen with a three-head deck, one which employs separate heads for record and playback. Such loss occurs still more easily when different decks are used to record and playback, as with borrowed, traded, and commercially prerecorded cassettes and those tapes recorded on a formerly owned deck.

In sum, it is relative azimuth error which concerns us (although this does not diminish the importance of absolute azimuth alignment to insure compatibility among decks). Hereafter I will simply say azimuth error to denote relative error. Also for simplicity, I will assume that azimuth is absolutely correct in recording, with error occurring only in playback; after all, it isn't until playback that the consequence of azimuth error was manifest.

Azimuth Loss and Tape Format

We have already noted that azimuth loss increases as frequency rises. The loss also increases as tape speed is reduced. (Both causes of increased loss are really different sides of the

Illustration: Lou Brooks



same coin: The loss increases as the wavelength decreases—and wavelength, which is speed divided by frequency, grows shorter as frequency rises or as speed drops.) Because of this, the azimuth problem is more acute at the cassette speed of 1⅞ ips than at the speeds of 3¾ and 7½ ips commonly used in home open-reel decks.

On the other hand, azimuth loss decreases as track width is narrowed. So the cassette's narrower track (0.024 inch, versus 0.043 inch on four-track open-reel tape) partially offsets the effect of its lower speed as compared to open-reel tape (Table I). But the azimuth problem still remains greater for cassette systems.

Azimuth error angles of less than 1° can produce disastrous treble loss. Therefore, since the angles we deal with are very small, they are usually not stated in degrees but in minutes (60ths of a degree)—for example, 12′ instead of 0.2°.

From Table I, we see that an azimuth error of only 12′ (0.2°) produces a possibly acceptable loss of 3.07 dB at 10 kHz and a truly unacceptable loss of 7.77 dB at 15 kHz. Greater azimuth errors produce losses far out of keeping with the concept of high fidelity. (It should be recognized that the losses in Table I are additional to treble losses caused by other factors in a tape system, such as tape saturation, electrical characteristics of tape heads, insufficiently narrow gap in the playback head, improper equalization in recording or playback, tape properties, etc.)

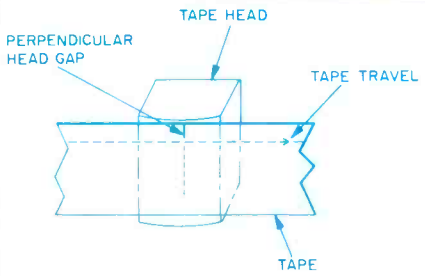


Fig. 1—Correct absolute azimuth.

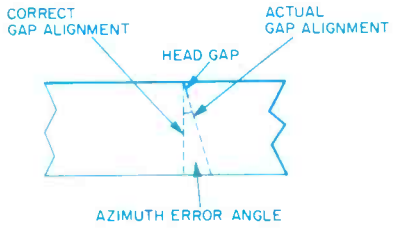


Fig. 2—Absolute azimuth error (exaggerated, for clarity) due to head misalignment.

For a cassette system to maintain fairly good response out to 15 kHz, Table I indicates that the azimuth error angle, α, must be kept under 9′; for good response out to 20 kHz, α = 6′ is at the edge of acceptability. Preferably, α should be kept to no more than about 3′, which produces a loss of less than 1 dB at 20 kHz.

It may be of interest to visualize how small the values of α under discussion are, and thus appreciate the care that must be exercised by deck and cassette makers and by others in dealing with the azimuth problem. To do so, the following takes only a few moments. Assume a gross, totally unacceptable error of 20′ (or one-third degree). On an 8½ × 11-inch sheet of blank paper, draw a light, thin vertical line down the middle from top to bottom, with Points A and B respectively designating top and bottom of the line. One-sixteenth inch to the right of Point B, mark Point C. Connect Points A and C with a light, thin line. Lines AB and AC will now form an angle of 20′. Darken line AC for 1-13/16 inch, starting from the top, and designate the bottom of the darkened line as Point D. If AB corresponds to tape width (0.150 inch), AD corresponds to the upper gap of the head of a cassette deck (0.024-inch long). Although we *know* that AD deviates from vertical, our eye cannot *detect* the deviation. Clearly, azimuth alignment by eye is out of the question. (On the other hand, some people can do a fairly good job of aligning the playback head by *ear*, using a tape containing program material with substantial high frequency content or using an azimuth alignment tape containing a high frequency.)

It is clear from Table I that open-reel tape, with its higher speeds, can tolerate greater azimuth error than cassette, despite the cassette's narrower track. This is especially true of 7½-ips open-reel format. For example, Table I shows that an azimuth error angle of 6′ is at the edge of acceptability (down 3 dB at 20 kHz) for cassette, while with 7½-ips open-reel tape, a 12′ error is within the edge. Looking at Table I from another point of view, we see that, for a given azimuth error, 7½-ips open-reel tape suffers much less treble loss than the 1⅞-ips cassette.

At 3¾ ips, however, the azimuth problem is only slightly less for open-reel than for cassette. The advantage of faster speed is nearly cancelled by the disadvantage of greater track width. Hence 6′ azimuth error is approximately at the edge of acceptability for both formats; Table I shows that such error produces a loss of 3.07 dB at 20 kHz for cassette, and a loss of 2.42 dB at 20 kHz for 3.75-ips open-reel tape.

In the past, a few cassette decks have incorporated 3¾ ips as an extra

Table I—Playback loss (in dB) due to azimuth error in common home tape systems.

Format	Frequency (kHz)	Azimuth Error, α (Minutes of Arc) 3	6	9	12	15
Cassette	10	0.18	0.73	1.67	3.07	5.03
	15	0.40	1.67	3.97	7.77	14.64
	20	0.73	3.07	7.77	18.65	∞
Open-reel, 3¾ ips	10	0.14	0.58	1.33	2.42	3.93
	15	0.32	1.33	3.12	5.95	10.47
	20	0.58	2.42	5.95	12.05	∞
Open-reel, 7½ ips	10	0.04	0.14	0.32	0.58	0.91
	15	0.08	0.32	0.74	1.33	2.11
	20	0.14	0.58	1.33	2.42	3.93

speed for improved fidelity. One of the improvements is greatly reduced azimuth loss. For example, an azimuth error of 9′ produces only 1.67 dB of loss at 20 kHz with a tape speed of 3¾ ips, compared with 7.77 dB of loss at 1⅞ ips. For cassette, the edge of acceptability goes from about 6′ at 1⅞ ips to about 12′ at 3¾ ips.

The azimuth problem becomes all the more pronounced in two slow-speed tape systems, not yet discussed here, that have become part of the audio scene—1⅞-ips open-reel and 15/16-ips cassette. To illustrate, assume an azimuth error of 6′, which is at or within the edge of acceptability for other systems discussed thus far. This would produce losses of 2.42 and 5.95 dB respectively at 10 and 15 kHz in a 1⅞-ips open-reel system, and of 3.07 and 7.77 dB in a 15/16-ips cassette system. Such losses are unacceptable for high fidelity.

General Principles

If we stay within the area of "moderate" losses—say, not exceeding about 10 or 12 dB—we may infer from Table I and other data that square-law principles apply (in approximate fashion) to azimuth loss. Azimuth loss increases roughly as the square of any increase in angle of azimuth error, frequency or track width, and as the square of any *decrease* in tape speed. In other words, if you double the azimuth error angle, the recorded frequency or the track width, the loss in output will quadruple; if you double the tape speed, the azimuth loss will diminish to one-fourth of its original value.

In the area above "moderate" azimuth losses (say above 10 or 12 dB), the square-law principles give way to losses that move precipitously toward infinite as azimuth error increases, frequency rises, tape speed declines, and track width increases.

The table and other data also show that maximum acceptable azimuth error tends to decrease in proportion to any decrease in tape speed or increase in track width. To illustrate, maximum acceptable azimuth error tends to be halved if tape speed is halved or if track width is doubled.

The Colinearity Problem

For simplicity, Figs. 1, 2, and 3 show only one head gap. But cassette tape heads ordinarily have two, one for each stereo channel. Each gap is about 0.024 inch long, and the two are spaced about 0.011 inch apart. Ideally, they should be colinear, that is, both in the same straight line, so that if one is correctly aligned for azimuth the other is too.

However, depending on the quality of the head, the gaps may depart from colinearity, as shown in Fig. 5 (greatly exaggerated, there, for clarity). In such circumstances, the optimum alignment is that yielding equal azimuth loss in each channel.

Calculating Azimuth Loss

When azimuth error is stated (in an equipment review or elsewhere), it is given either as an angle (α) or as phase shift (P) at a specified frequency. If one has a pocket calculator with trigonometric and logarithmic functions, the following equations enable one to readily translate α into azimuth loss or P into α.

$$L = 20 \log \frac{\sin(180T)}{\pi T} \qquad (1)$$

where
- L = Relative level in dB,
- T = (Tan α × F × W) ÷ S,
- α = Azimuth error angle, in degrees,
- F = Frequency in Hz,
- S = Tape speed in ips, and
- W = Track width in inches.

(Common track widths are 0.043 inch for quarter-track open-reel, 0.024 inch for stereo cassette. The 180 and π factors convert degrees into radians, the "20 log" term converts the answer to dB.)

To illustrate, assume that azimuth error α = 0.1° (or 6′), and we wish to know the azimuth loss at 15,000 Hz for cassette. In this case, F = 15,000, W = 0.024, tan α = 0.0017453, and S = 1.875. Therefore, T = (0.017453 × 15,000 × 0.024) ÷ 1.875 = 0.3351032, so that

$$L = 20 \log \frac{\sin(180 \times 0.3351032)}{3.1415927 \times 0.3351032}$$

$$= 20 \log \frac{0.8687921}{1.0527576}$$

$$= 20 \log 0.8252536$$

$$= -1.67 \text{ dB}.$$

(Note that the answer appears as a negative, signifying a signal loss.)

To convert phase error into azimuth error requires a different formula:

$$\alpha = \arcsin \frac{P \times S}{360 \times D \times F} \qquad (2)$$

where
- α = Azimuth error angle in degrees,
- P = Phase error in degrees,
- S = Tape speed in inches per second,
- D = Distance between track centerlines, and
- F = Frequency in Hz.

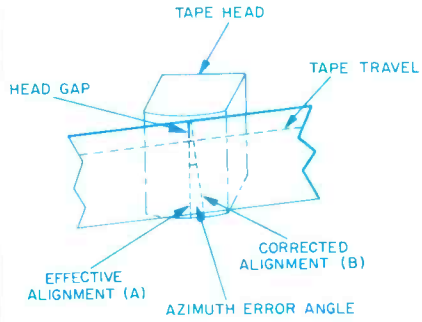


Fig. 3—Tape skew can effectively misalign a head positioned properly with relation to the tape deck. The effective alignment that results (A) is at an angle to the tape; repositioning the head produces corrected alignment (B).

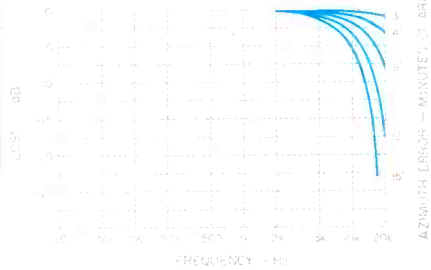


Fig. 4—Loss vs. frequency, as a function of azimuth error, for cassette tape.

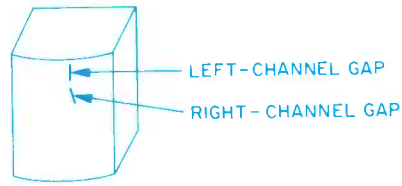


Fig. 5—Noncolinear head gaps (greatly exaggerated).

Compatibility in Tape Decks

HOWARD A. ROBERSON

It would seem that if the same alignment tape were used to adjust the playback heads on several three-head tape decks, and then each record head was adjusted for an exact match to its respective playback head, the recorded flux would have the same orientation to the tape on each deck. We might further conclude that a tape made with flat response on one deck could be replayed with flat response on a second deck.

Unfortunately, the situation is more complex than indicated. To get data on what really happens, I used a BASF Type II Alignment Tape to adjust the playback heads of three decks, all with separate record and playback head gaps. Two of these, the Nakamichi 582 and Tandberg TCD 3014, had separate record and playback head assemblies. The third, an Aiwa AD-M700, had a single head with separate record and playback gaps. In the Aiwa deck, therefore, the position of the record-head azimuth was automatically determined by the playback alignment with the test tape.

In the first tests, I made a recording of pink noise on the Tandberg TCD 3014 using Maxell XL II-S at 20 dB below Dolby level after the record head had been adjusted for the best response. The playback on the TCD 3014 was displayed and stored with a ⅓-octave real-time analyzer (Fig. 1, top). This same tape was then played back on the Nakamichi 582 (middle) and the Aiwa AD-M700 (bottom). All of the playback responses are quite flat over most of the range, but there are differences. The response on the Tandberg, which recorded the tape (top), is the flattest—as would be expected. The Nakamichi 582 playback (middle), however, displays a rising output above 2 kHz or so, which raises a question I'll answer a bit later. The response on the Aiwa AD-M700 deck would be considered disappointing, particularly in comparison with the other two decks. Immediately, it might be concluded that there was considerable alignment error, even though the AD-M700's head had been adjusted using the same test tape.

The second set of tests used the Nakamichi 582 as the recording deck, with a change to TDK SA-X tape, just to see if the tape skewing characteristics of a different cassette would affect the results. Figure 2 shows the very flat response at −20 dB with playback on the 582 deck (top). With playback on the Tandberg TCD 3014 (middle), however, the high-frequency rolloff is quite evident. The drooping response with the Aiwa deck is quite similar to that in the earlier figure, with a dB or so more rolloff.

Before drawing any conclusions, I ran a similar test set using the Aiwa AD-M700 as the recording deck, using XLII-S. The response in playback on the Aiwa deck is quite flat overall. The 8-dB drop at 20 kHz is a characteristic of this medium-performance deck. Playing this tape, the response on the Nakamichi 582 (middle) showed a rise above 1 kHz, while that on the Tandberg TCD 3014 (bottom) showed closer correspondence to the Aiwa deck results. Note that there is some vertical broadening of the 12.5-, 16- and 20-kHz filter-level indications for both the 582 and the TCD 3014—especially the 582. A separate check showed that the effect was caused by slight skewing of the tape on the Aiwa during recording. Because of the very short distance between the record and playback gaps of the Aiwa combination head, there were no skew-caused level variations in its playback.

An examination of the responses in

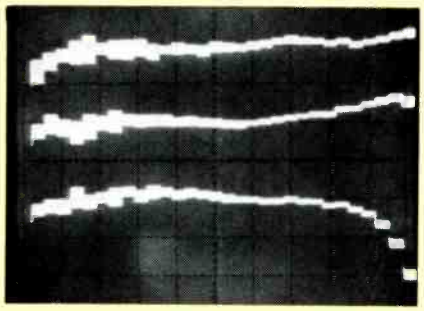


Fig. 1—Playback responses with recording made on Tandberg TCD 3014 cassette deck. Top, Tandberg; middle, Nakamichi 582; bottom, Aiwa AD-M700. (Vertical scale: 5 dB/div.)

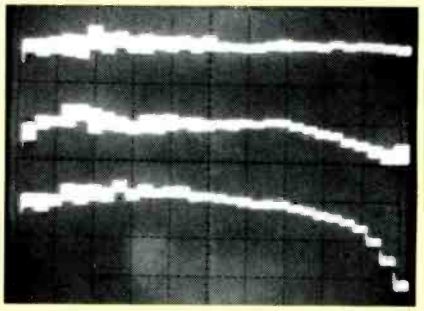


Fig. 2—Playback responses with recording made on Nakamichi 582. Top, Nakamichi; middle, Tandberg TCD 3014; bottom, Aiwa AD-M700. (Vertical scale: 5 dB/div.)

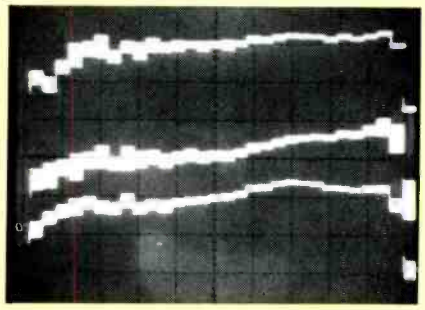


Fig. 3—Playback responses with recording made on Aiwa AD-M700. Top, Aiwa; middle, Nakamichi 582; bottom, Tandberg TCD 3014. (Vertical scale: 5 dB/div.)

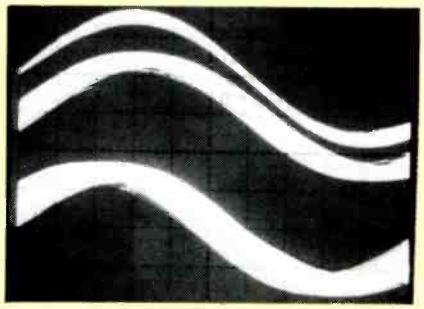


Fig. 4—Misalignment and jitter with 5-kHz test tone. Top, playback of reference track A on recording Nakamichi 582; middle, playback of trace B of 582, illustrating relative jitter; bottom, playback of same tape on Tandberg TCD 3014, showing alignment shift and jitter of track B relative to track A of TCD 3014. See text. (Horizontal scale: 30°/div.)

Figs. 1 to 3 along with some analysis, including reference to past experience, led me to these conclusions:

(1) The playback equalization of the Nakamichi 582 is relatively elevated at the higher frequencies compared to that of the Tandberg TCD 3014;

(2) The playback equalization and/or head response of the Aiwa AD-M700 rolls off compared to both of the other decks;

(3) The Aiwa deck uses "extra" record equalization to compensate for the roll-off in playback, and

(4) The alignment match between decks adjusted with the same alignment tape was fairly good, despite the equalization-caused response differences which might make things appear otherwise.

In confirmation of what some readers are already thinking, I must state that the playback equalization (70 μS for Type II), as given mathematically in international standards, is not followed exactly by the great majority of manufacturers. I won't take up space here to discuss the whole issue, but it can be noted that the Nakamichi playback is close to that for an ideal head, while the Tandberg's is closer to that for the IEC reference playback head.

Figures 1 and 2 reflect this relationship, with the Nakamichi recording rolled off on the Tandberg, and the Tandberg recording boosted on the Nakamichi. These response differences relate to equalization and *not* to azimuth error. Figure 4 illustrates what azimuth error might be found between these two decks. I recorded a 5-kHz tone on the Nakamichi 582, both tracks. In the playback, track A (top) was the 'scope sweep reference, and the broadening of the track B trace (middle) shows the jitter of B versus A. There was some amplitude variation on both tracks. The average position of its trace shows that B lags A by about 6° at 5 kHz, with 30° of total jitter. The phase error of 6° is equivalent to an alignment error of less than 1 minute of arc. The bottom trace is that of track-B playback of the same tape on the TCD 3014, with the 'scope locked to its track A. Here the jitter is higher, and B leads A by 20°, still just 2 minutes of alignment difference. So, a final word: Align heads carefully, but be aware of possible equalization discrepancies between decks.

(The distance between centerlines of the stereo tracks is 0.035 inch for cassette and 0.125 for quarter-track open-reel.)

To illustrate, an *Audio* review of a top-notch cassette deck stated that phase error measured 15° at a test frequency of 12,500 Hz. Thus P = 15, S = 1.875, D = 0.035, F = 12,500, so that

$$\alpha = \text{arc sin } \frac{15 \times 1.875}{360 \times 0.035 \times 12{,}500}$$

$$= \text{arc sin } 0.0001786$$

$$= 0.0102 \text{ degrees (or 0.61 minutes)}$$

So small an azimuth error would cause very minute azimuth loss, for example merely 0.03 dB loss at 20,000 Hz.

How Azimuth Loss Occurs

Assume that a sine-wave signal is recorded at 1⅞ ips on cassette tape. The recorded signal is equivalent to a series of bar magnets end to end, as in Fig. 6—north poles adjacent to north poles, and south poles to south poles. Each bar represents a half wavelength, and its poles correspond to the positive and negative peaks of the half wavelength. The higher the frequency, the shorter are the bar magnets because more of them must fit into each inch of tape. At the upper end of the treble range, say above 10,000 Hz, they become extremely short, on the order of less than 0.0001 inch. (At 10,000 Hz, a half-wavelength = 1.875/20,000 = 0.0000938 inch.)

At any given instant of playback, each edge of the head's gap contacts a given intensity and polarity of magnetic field produced by the bar magnets. Because the two gap edges contact different parts of a bar or of adjacent bars, most of the time each edge is at a different field intensity. Therefore most of the time a magnetic potential exists between the two edges. The potential constantly changes in intensity and polarity as the gap traverses the bar magnets, and the *changing* potential induces a voltage in the coil of the playback head.

As frequency rises and the bars become shorter, the difference in field intensity and polarity at the two edges of the gap increases, thereby increasing head output. Maximum output occurs when the distance between gap edges equals a half wavelength (one bar), with one gap edge contacting a north pole while the other contacts a south pole, resulting in maximum potential across the gap. Output falls rapidly as frequency increases further, reaching zero when an entire wavelength equals the distance across the head gap, since the potential will then always be equal at each gap edge. Hence, the importance of a very narrow playback gap for extended high-frequency response.

The greater the field intensity seen by each gap edge, the greater can be the magnetic potential between edges at various instants, and the greater can be the changes in potential, thus increasing head output. Contrariwise, if anything reduces the field intensity seen by the gap edges, this reduces head output.

Azimuth error performs such a reduction. When there is no azimuth error, in playback all parts of the left edge are in contact with the same polarity and intensity of magnetic field. That is, the upper and lower sections of the edge see the same field intensity as the center of the edge. But azimuth error tilts the edge with respect to the magnetic bar, so that the central, upper, and lower sections contact different magnetic intensities, which partially cancel each other. The same is true, of course, for the right edge.

To help visualize this, assume that the center of a gap edge is at the north pole of a bar magnet and thus sees maximum field intensity. But if the edge tilts, its top and bottom sections are no longer at the north pole and therefore are at points of reduced intensity. Accordingly the intensity seen by the edge as a whole is reduced.

This process doesn't work in reverse; that is, tilting the gap edge doesn't increase the field intensity seen by it. To illustrate, assume that the center of the edge is at the middle of a bar, where intensity is minimum. Now the top and bottom of the edge do see higher intensities than does the center of the edge. But the top and bottom incline in opposite directions, toward opposite polarities, so that these higher intensities cancel each other and leave the edge as a whole at minimum intensity.

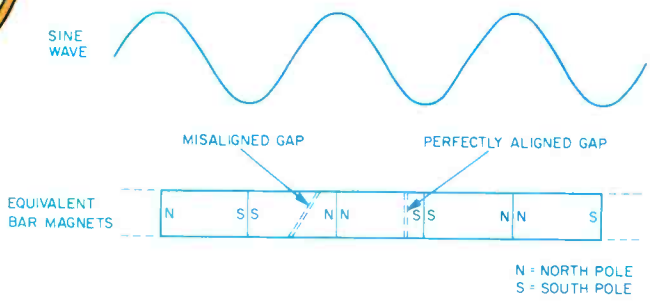


Fig. 6—How azimuth loss occurs: Recorded signals are essentially bar magnets of varying length. Head output depends on the difference in magnetic field bridged by the head gap—a difference greatly reduced when the gap is tilted to bridge areas of different flux.

Considering how short are the bar magnets at high frequencies, very slight gap tilt (azimuth error) will cause the top and bottom of a gap edge to ride very different field intensities, with substantial cancelling effect. To illustrate, assume a cassette player with an azimuth error of 9′, tilting the top of an edge to the left and the bottom to the right. Therefore the bottom of the edge is displaced 0.000063 inch to the right with respect to the top of the edge. (Displacement = sin α × gap length = 0.002618 × 0.024 inch = 0.000063 inch.) Next assume a frequency of 15,000 Hz, so that a half-wavelength, or one magnetic bar, = 1.875/30,000 = 0.000063 inch. Now assume that the center of the gap edge contacts a bar's north pole, where field intensity is maximum. Because the tilted edge in our example spans an entire magnetic bar, the top and bottom of the edge must be at midpoints of magnetic bars, where field intensity is minimal. Thus, the field intensity seen by the gap edge as a whole is quite substantially reduced.

At lower frequencies, where the recorded magnetic bars are longer, a given gap tilt causes the top and bottom of a gap edge to be displaced only a fraction of a bar relative to the center of the edge. Therefore the cancelling effect on field intensity seen by the edge is reduced, and azimuth loss is less.

The above discussion paves the way to our understanding why, for a given azimuth error and tape speed, the azimuth loss increases with track width. As the track width, and therefore gap height, is increased, the top and bottom of the tilted gap edge are displaced a greater distance along the tape path from the center of the gap. To illustrate: We noted earlier that at 1.875 ips an azimuth error of 9′ results in a displacement of the edge bottom relative to the edge top of 0.000063 inch when track width is 0.024 inch (cassette). When track width is 0.043 inch (open-reel), the displacement increases to 0.00011 inch. As already noted, the greater the displacement, the greater is the reduction in field intensity seen by the gap edge as a whole, increasing azimuth loss.

Minimizing Azimuth Error

From the foregoing it is obvious that great care must be exercised by all parties to the tape recording process in order to minimize azimuth error.

The cassette deck manufacturer must pay close attention to proper azimuth alignment of the head or heads used for recording and playback. This requires an accurate test tape on which a high frequency, such as 10,000 Hz, has been recorded with the gap of the record head (in the deck that produces the tape) exactly at a 90° angle relative to the direction of tape travel. The playback or record-playback head of the deck being aligned is then oriented for maximum output from the test tape. If the deck being aligned has a separate record head, it is adjusted, while recording and monitoring a high-frequency signal, for maximum output from the previously aligned playback head.

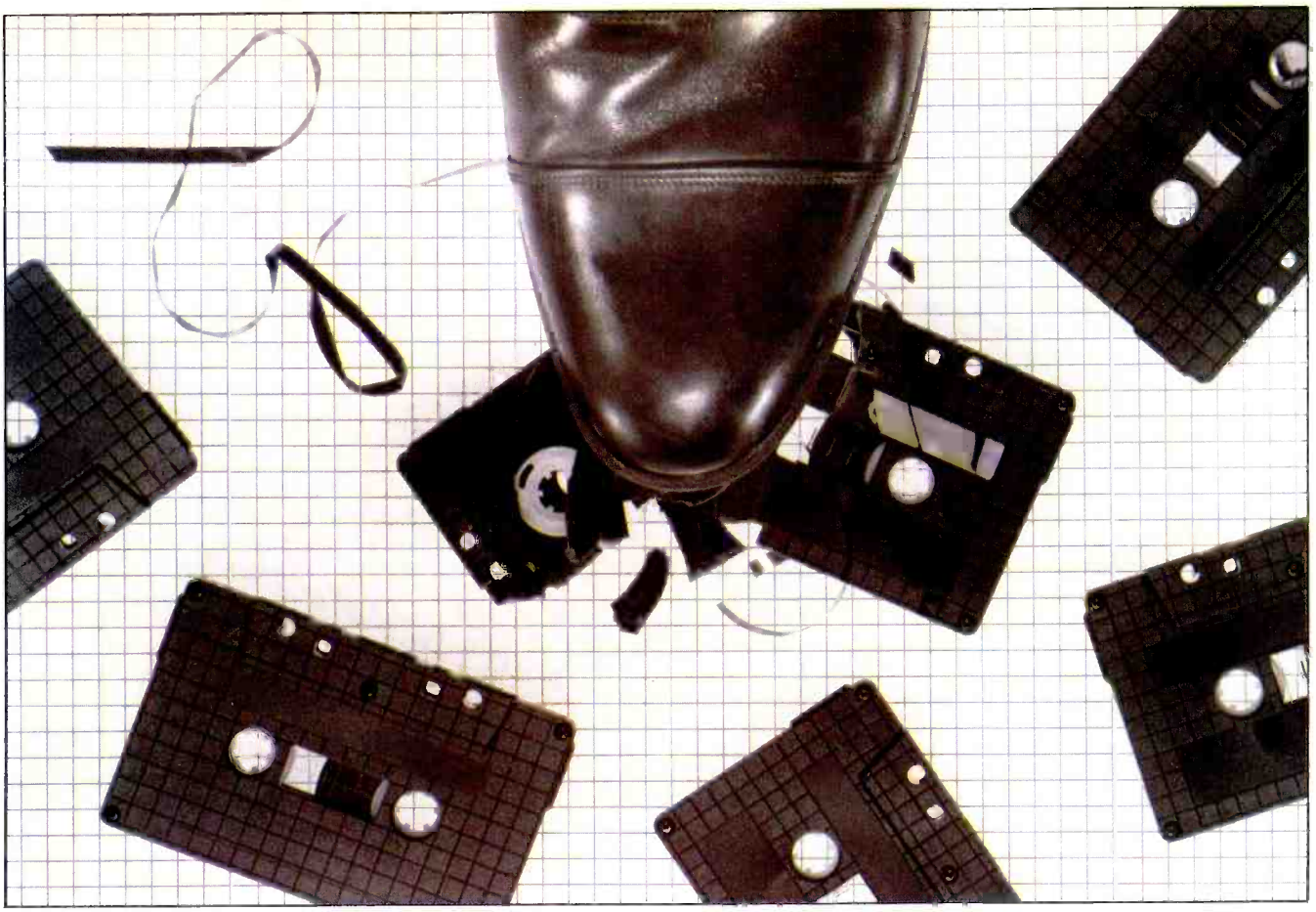
If head gaps are not colinear, so that correct alignment of one gap necessitates azimuth error of the other, an optimum position has to be found that achieves equal azimuth loss in both stereo channels. If there are separate heads for record and playback, optimization becomes more complex. And it is even more complex in the case of reversible decks which use heads with four gaps.

Production of an accurate azimuth alignment tape is not an easy matter and requires precise laboratory procedures. Even for test tapes made by companies of high reputation, it has been noted that somewhat different results may be obtained from tapes of different companies. However, these differences tend to be slight and are becoming slighter as new azimuth alignment tapes appear.

Care must be exercised by the deck manufacturer to properly adjust tape tension and thereby minimize tape slewing (a change in the angle of the tape with respect to the head). Toward the same end, the cassette deck must be designed so that the cassette is uniformly and securely locked in place.

Equal care applies to the cassette itself. It may appear to be a disarmingly simply affair but it is really a very sophisticated device that must be built with a high degree of precision in order to operate properly. Guides must be accurate and true, and the tape must be slit very accurately, in order to minimize slewing.

Reverse cassette operation presents an extra azimuth problem because the tape tends to slew differently when running from left to right than from right to left. One solution is to use a head with two gaps instead of four and rotate the heads 180°, with a separate azimuth adjustment (a stop screw) for each direction. Another solution is to turn the cassette over, as one turns the page of this magazine, so that the tape always runs in the same direction with respect to the heads. A third solution, used in the Nakamichi Dragon, is to continuously adjust the playback head azimuth *during operation*. This is achieved by dividing the gap for one of the playback tracks into two sections; as a tape is played, the phase difference between gap sections is constantly monitored, and azimuth is adjusted by a motor to minimize the phase difference and thereby minimize azimuth loss.



Photograph: Robert Lewis

CASSETTE TEST UPDATE: 12 FORMULATIONS

HOWARD A. ROBERSON

With the continuing introduction and updating of cassette tape formulations, it was just about inevitable that some manufacturer would deliver samples after the deadline for our "Mass Tape Test" (September 1983). Konica and TDK had that distinction, but the omission is being corrected here. There are two Konica Type I formulations, designated ML and GM-I, a Type II tape called GM-II and a Type IV, Metal. TDK introduced a new metal particle formulation, designated HX-S, which is unique in that it is designed to use Type II bias. The manufacturer claims greatly improved high-frequency MOLs, which normally aren't very good for Type II tapes.

This follow-up will also cover retesting of Radio Shack (Realistic) and Swire formulations. Radio Shack specifically questioned the results presented for their Supertape Hi-Bias tape, but provided samples for their entire cassette line. Retesting was conducted on the three formulations covered before, and the same tests were run on Realistic Low Noise, which had not been evaluated. Swire also felt that the results indicated the samples of their tapes were not representative and provided new samples for retest.

Test Methods

A brief word is in order to describe the evaluation leading to the results in the Table, response plots, and commentary that follow. All of the tests were made on a Nakamichi 582 deck. The bias for each tape was adjusted for best response at 20 dB below Dolby level, after adjusting the record

Most of the tapes showed little or no skew and were consistent in sensitivity, bias requirements and output level.

head for alignment with the playback head for that particular sample. The bias level was metered and referenced to the bias that secured best response with the IEC reference tape for the tape type under consideration. The record sensitivity was checked against the same reference tape. Because the frequency responses at −20 dB were so similar, they were not plotted. Those at 0 dB, or Dolby level, were, however, as they showed the limitations from high-frequency saturation.

The MRLs (maximum record levels) at a limit of 3% third-harmonic distortion were measured at 100 and 400 Hz and at 1 and 2 kHz. The 3% THD limit for higher frequencies was established using twin-tone IM techniques. The signal-to-noise ratio was measured with both IEC A and CCIR/ARM weightings, using the level for 3% distortion at 400 Hz as the reference. (The Table of results does not list the CCIR/ARM figures, as they were consistently just about 2.6 dB less than the dBA results.) Modulation noise was measured by recording a 1-kHz tone at +3 dB, notching out the tone in playback with a very narrow filter, and measuring the output noise after a bandpass filter of 500 to 1,500 Hz was inserted.

The output-level stability, dropouts and flutter were all measured on the playback of a recorded 3-kHz tone. The stability was examined with a 2-S/division sweep on a spectrum analyzer tuned to 3 kHz, while the dropout check used a sweep rate of 0.05 S per division.

Measurements

Table I lists the results of the evaluation of the 12 formulations. The arrangement is exactly the same as used in the earlier article, facilitating any comparisons that might be desired. Each of the 0-dB response plots has a 3% MRL curve added to help visualize the significance of the figures in the Table.

The brief comments below on each of the formulations are arranged alphabetically by brand within tape type. Most of the tapes showed little or no skew and had consistent sensitivity and bias. The output-level stability was usually quite good, and most of the samples showed average flutter.

Type I Tapes

Konica ML: Overall, the results would be classified as typical for a Type I tape. The analyzer display in the dropout test showed some roughness, but dropouts close to audibility were quite infrequent.

Konica GM-I: This is one of the better tapes in this category, with good MRLs, nice responses, high consistency, no skew, low noise, very good output-level stability and no dropouts, even of a minor nature.

Realistic Low Noise: This is a non-premium tape with low MRLs and higher noise than most Type I tapes. The consistency was quite good in most respects, but one of the samples which showed a little skew also had some output-level wandering (0.35 dB) and higher than average flutter.

Realistic Supertape Gold: Tests of the newer samples revealed that a good Type I tape had become better, with higher MRLs, lower noise, and improved output-level stability. Flutter was slightly better than average.

Swire Laser XL: The new samples evidenced general improvements. Especially worthwhile was the over 5-dB increase in MRLs from 100 to 2,000 Hz. Bias and sensitivity were much closer to the IEC reference tape. The samples had noticeable skew, however, and the output-level stability was just fair.

Swire Laser UHDI: The earlier tests of this formulation had shown an unusual distortion spectrum under some conditions, but the new samples did not have any such characteristic. The MRLs were fairly good across the band, and there was a slight improvement in the signal-to-noise ratio. The samples were very consistent, including their lack of skew.

Type II Tapes

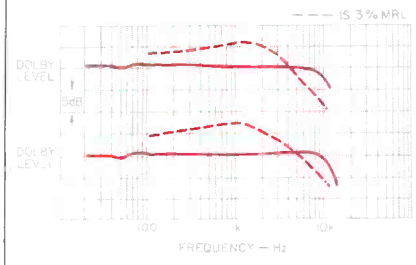
Konica GM-II: This is a good Type II tape, with good MRLs, low noise, no dropouts and excellent output-level stability. The samples had excellent

TABLE I

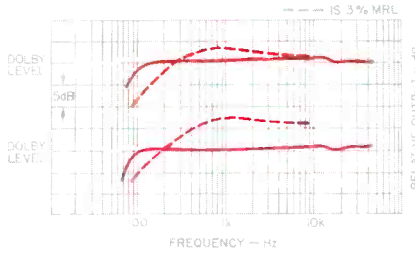
BRAND	DESIGNATION	TYPE	MAXIMUM RECORD LEVEL dB re: 400-Hz Dolby Level						S/N RATIO dBA	RESPONSE AT −3 dB (kHz)		MOD NOISE dB	BIAS dB	SENS dB
			HDL_3 = 3%				TTIM = 3%			0 dB Level	−20 dB Level			
			100	400	1k	2k	5k	10k						
Konica	ML	I	+ 3.6	+ 4.4	+ 5.1	+4.0	−3.8	−10.0	56.1	9.1	23.6	−44.6	−2.2	+0.4
Konica	GM-I	I	+ 4.4	+ 5.8	+ 7.1	+4.5	−1.2	− 7.5	58.4	10.5	23.4	−47.5	+0.3	−0.2
Realistic	Low Noise	I	+ 1.2	+ 2.3	+ 3.0	+1.9	−4.3	−10.3	52.7	9.0	22.9	−45.1	−2.1	+0.2
Realistic	Supertape Gold	I	+ 6.0	+ 6.6	+ 6.7	+4.6	−1.3	− 7.6	57.5	10.1	23.9	−47.5	−1.2	+1.0
Swire	Laser UHDI	I	+ 3.7	+ 5.0	+ 6.4	+3.2	−2.3	− 8.4	55.2	10.1	23.3	−48.3	−0.7	−0.3
Swire	Laser XL	I	+ 2.6	+ 3.9	+ 5.3	+3.3	−2.0	− 8.6	53.7	10.1	23.5	−47.1	−0.9	−0.5
Konica	GM-II	II	+ 4.3	+ 5.9	+ 6.7	+3.5	−4.5	−10.6	60.9	9.8	22.6	−49.2	−0.3	+1.0
Realistic	Supertape Hi-Bias	II	+ 4.4	+ 5.4	+ 5.7	+2.1	−5.1	−10.4	59.7	9.6	23.4	−47.1	+0.2	+0.8
Swire	Laser UHDII	II	+ 0.6	+ 1.9	+ 3.0	+2.1	−6.2	−11.1	57.0	9.3	23.9	−51.4	−0.1	−0.1
TDK	HX-S	II	12.0	25.8	+ 7.8	+8.7	+8.9	+ 7.0	− 1.7	− 6.4	60.6	−47.4	0.0	+3.5
Konica	Metal	IV	+ 6.8	+ 8.6	+10.1	+6.8	−0.5	− 5.9	61.2	12.9	25.1	−50.0	+0.1	−0.3
Realistic	Supertape Metal	IV	+ 9.0	+10.9	+11.4	+7.3	0.0	− 6.2	64.3	13.5	24.7	−49.9	+0.3	+1.5

As these tests demonstrate, you can expect continuing improvements and new names. Isn't it nice to have so many quality tapes?

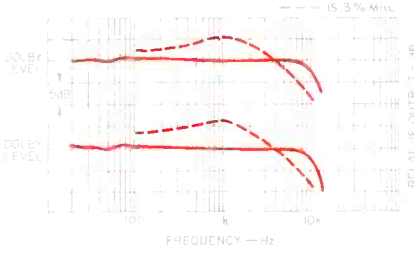
TYPE I



Konica ML (top) and GM-I

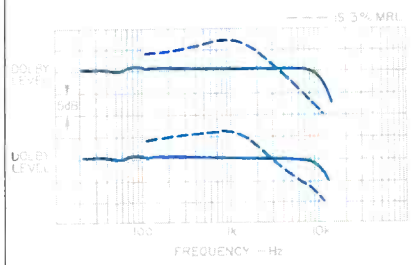


Realistic Low Noise (top) and Supertape Gold

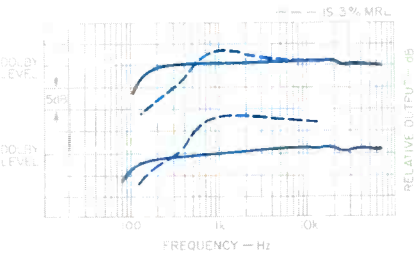


Swire Laser XL (top) and Laser UHDI

TYPE II

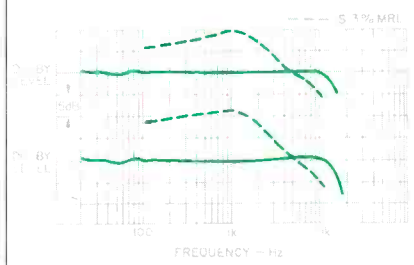


Konica GM-II (top) and Realistic Supertape Hi-Bias



Swire Laser UHDII (top) and TDK HX-S

TYPE IV



Konica Metal (top) and Realistic Supertape Metal

consistency of sensitivity, bias needs and lack of skew.

Realistic Supertape Hi-Bias: It was quickly apparent that results with the new samples were better than first reported. A reassessment of the earlier samples revealed that a reference-level error of 2 dB had been introduced inadvertently while doing low- and mid-frequency MRL tests with this formulation only. The new samples provided even better results, with good MRLs and low noise, as shown in Table I. There was little measured skew, also an improvement over the earlier report.

Swire Laser UHDII: The new samples of this tape were somewhat different from those tested before: Poorer low-frequency MRLs, better high-frequency MRLs, a lower signal-to-noise ratio and lower modulation noise. Overall, it remained one of the poorer Type II tapes.

TDK HX-S: The test results listed in the Table demonstrate that this formulation takes its place as the highest performing of all Type IIs, with the most extended responses at both 0 and −20 dB and the highest MRLs overall. The signal-to-noise ratio is very good, but not outstanding, and the modulation noise is a little high. The required bias was to the IEC reference, but the sensitivity was at +3.5 dB—not a problem if one compensates for it. There was outstanding consistency among all samples, including both sides.

Type IV Tapes

Konica Metal: This is a typical metal tape, showing extended responses, high MRLs and low noise. The consistency from sample to sample was very good, including no skew. The dropout display was a bit rough, but none of them got to the audibility threshold.

Realistic Supertape Metal: These new samples were in improved boxes with shrink-wrap, a change from the Radio Shack practice of using simple label seals. More important, however, was the increase in MRLs across the band, making this one of the better metal tapes. Its consistency remained one of the best for this tape type, and the low price adds to its appeal.

The evaluation of these 12 formulations demonstrated that the user can expect to see continuing improvements in products from tape manufacturers. TDK HX-S is an unusual addition to the tapes available, and for some decks, the lower bias requirements of this excellent formulation will be beneficial. And there will be new names appearing on those boxes as other firms hope for success in this competitive market. Perhaps this will increase confusion about *what* choice to make, but isn't it nice to have a number of quality formulations to choose from? A

1

REVOX B225 COMPACT DISC PLAYER

Manufacturer's Specifications

Frequency Response: 20 Hz to 20 kHz, ±0.6 dB.

Signal-to-Noise Ratio: Greater than 96 dB, 20 Hz to 20 kHz, unwtd.

Total Harmonic Distortion: Less than 0.006%, 20 Hz to 20 kHz.

Channel Separation: More than 90 dB, 20 Hz to 20 kHz.

Output Level: 2.0 V, fixed; 0 to 2.0 V, variable.

Headphone Level: 13 volts p-p, 35 mW into 600 ohms.

Number of Programmable Selections: 19.

Search Time For Any Location: Less than 4 S.

Wow and Flutter: Below measurable limits.

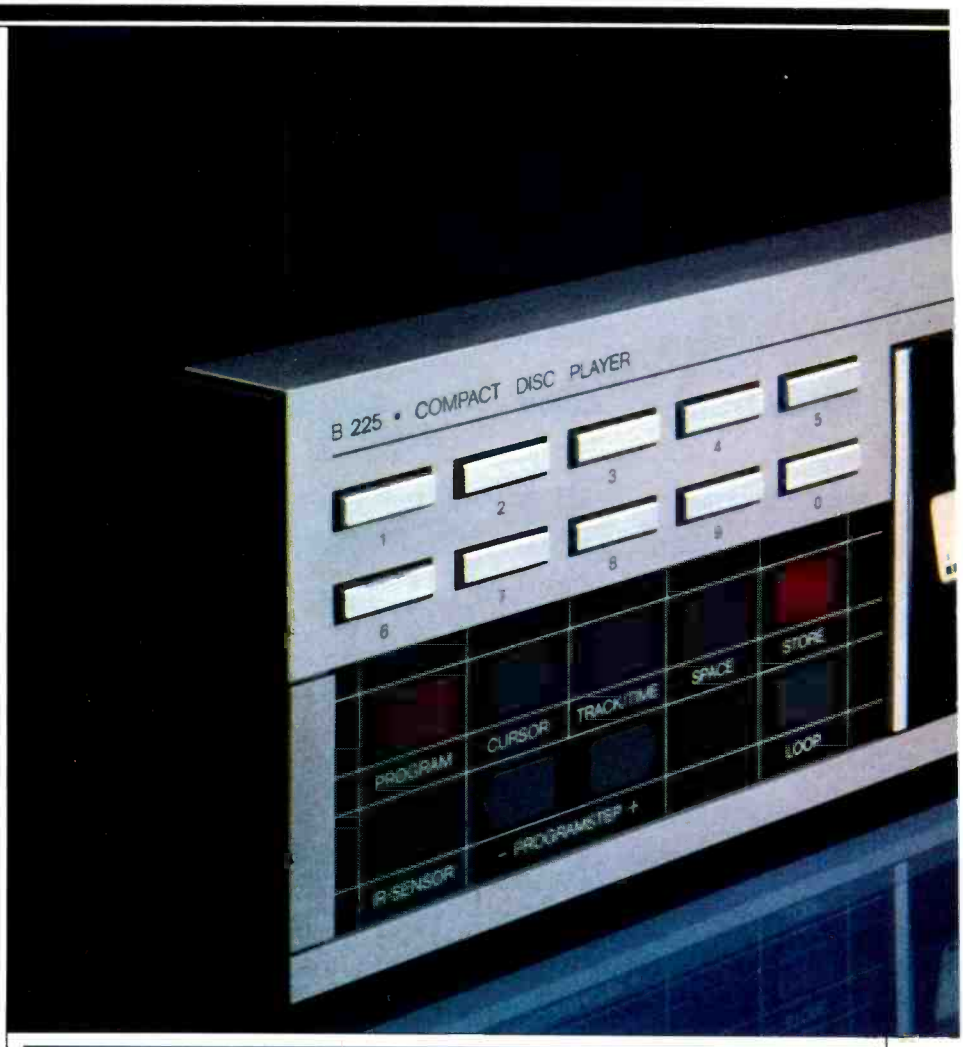
Power Consumption: 40 watts maximum.

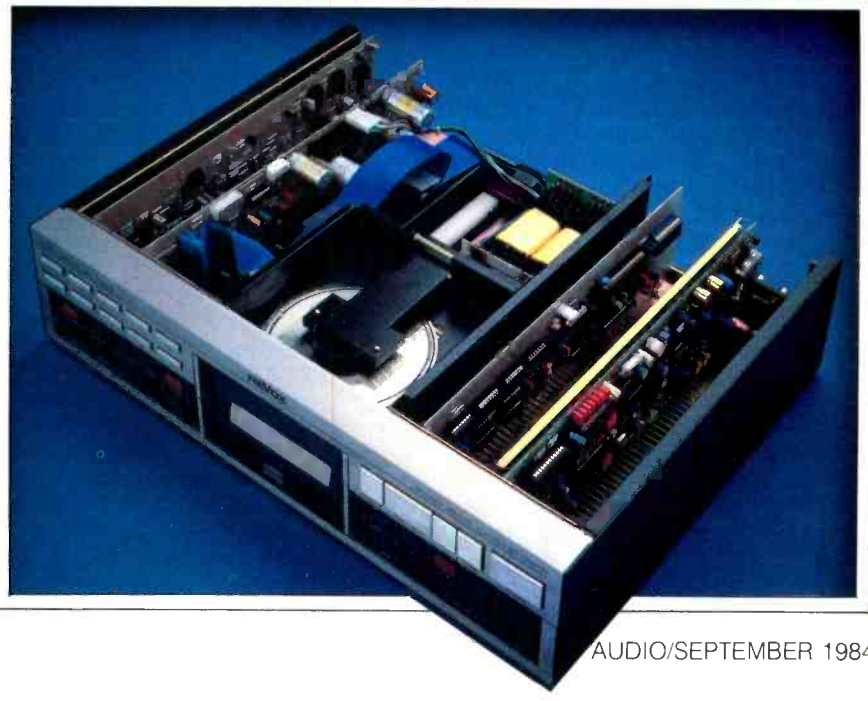
Dimensions: 17.75 in. (45.0 cm) W × 4.25 in. (10.9 cm) H × 13.0 in. (33.2 cm) D.

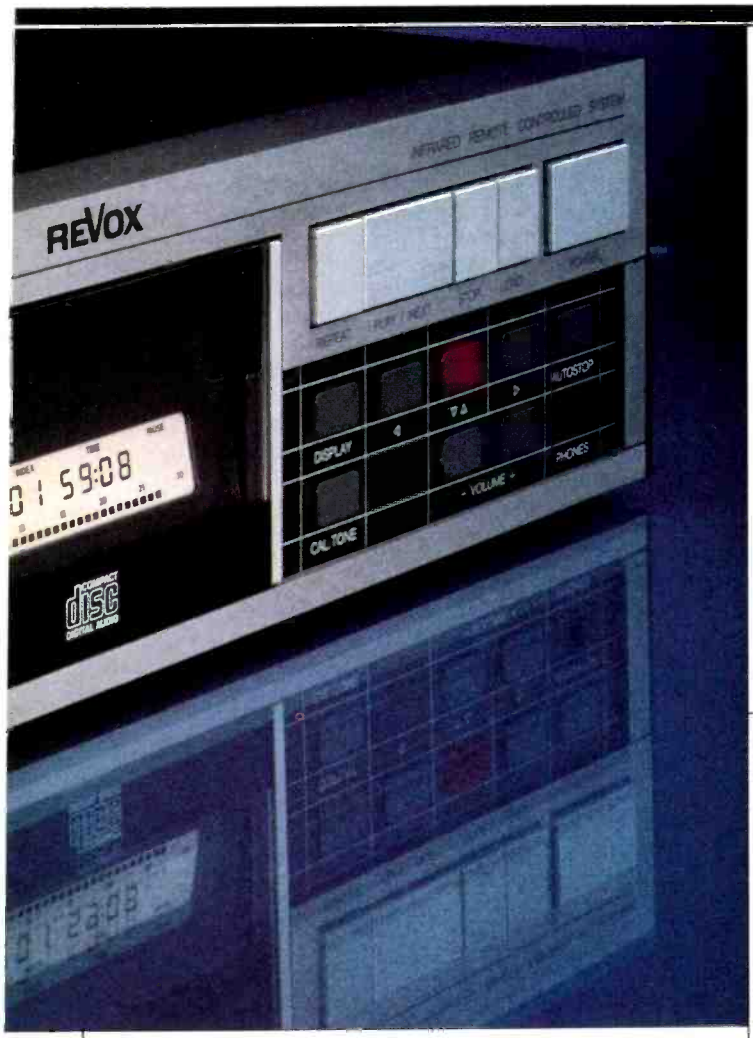
Price: $1,150.00.

Company Address: 1425 Elm Hill Pike, Nashville, Tenn. 37210.

For literature, circle No. 90







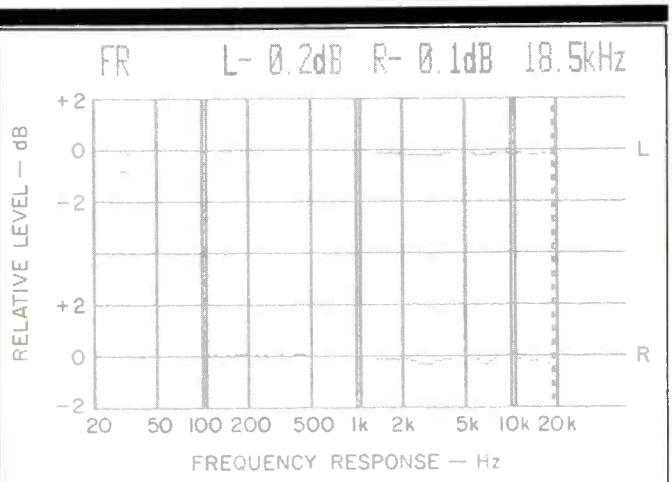


Fig. 1—Frequency response, left (top) and right channels, at 0-dB level.

It comes as no surprise to me that this first Compact Disc player to be built by Studer-Revox is one of the most sophisticated, rugged, yet easy-to-use units of its kind that I have ever tested. After all, Studer and Revox tape equipment is used in broadcast and recording studios throughout the world, and Revox products (the brand name used on Studer's consumer products) are regarded by many to have the same attributes as the company's professional components. What *did* surprise me was the suggested retail price of the unit. I had fully expected the Revox CD player to be among the world's most expensive as well as among the world's best. While it certainly lived up to the latter expectation, its price was no higher than that on some of the first-generation CD players which offered only a fraction of this unit's versatility.

The B225's programming facilities are unusually elaborate, and some are unique. Programs can be up to 19 steps long. Notice I said "steps," not "selections"—each step can include any number of consecutive selections, in their original order. Selections can be programmed by track number or by time from the beginning of the disc—or you can program the start of a selection one way and program its end the other way. Program memory is nonvolatile, so it will retain its contents even if you shut the B225 off or accidentally unplug it.

The three functions which Revox calls "special program steps" are even more unusual. Entering the "Loop" command as a program step makes the program repeat endlessly until stopped. (If pressed in normal play mode, the "Loop" button repeats the entire CD.) The program can pause automatically after any selection, until the pause key is pressed—and can also output the 1-kHz calibration tone to remind you that the program has paused. The player can even be set to turn itself completely off at the program's end! Even handier, perhaps, the program can be "paged" through for checking and then modified without erasing it or starting over.

On the technical side, the B225 follows the Philips system of four-time oversampling (at 176.4 kHz—see April, 1984 *Audio*), with both digital and analog filters, using digital filters specially designed for Revox by Dr. Roger Lagadec.

Control Layout

The first thing I noticed was the panel's logical layout. Often-used controls occupy the right third of the panel, while programming controls are grouped to the left. In the center is the disc drawer, with a multifunction display on its front surface.

The controls at the right include the "Power" switch, and a group of four keys: "Repeat," "Play/Next" (to start play or, if playing, move to the next track or next programmed step), "Stop," and "Load" (to open and close the drawer). Below are five more buttons: "Display" (which switches the display between time elapsed in the current selection and time elapsed since the beginning of the disc), keys to skip back or ahead and to pause or restart play, and an "Autostop"

I had expected Revox's CD player to be among the world's most expensive as well as among the world's best. But its price is not that high.

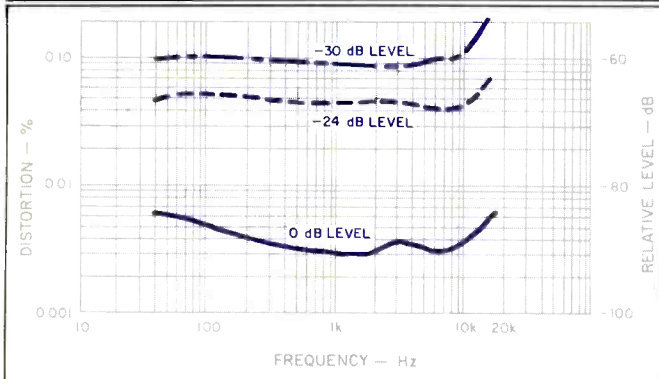


Fig. 2—THD vs. frequency at levels of (from top to bottom) −30, −24 and 0 dB.

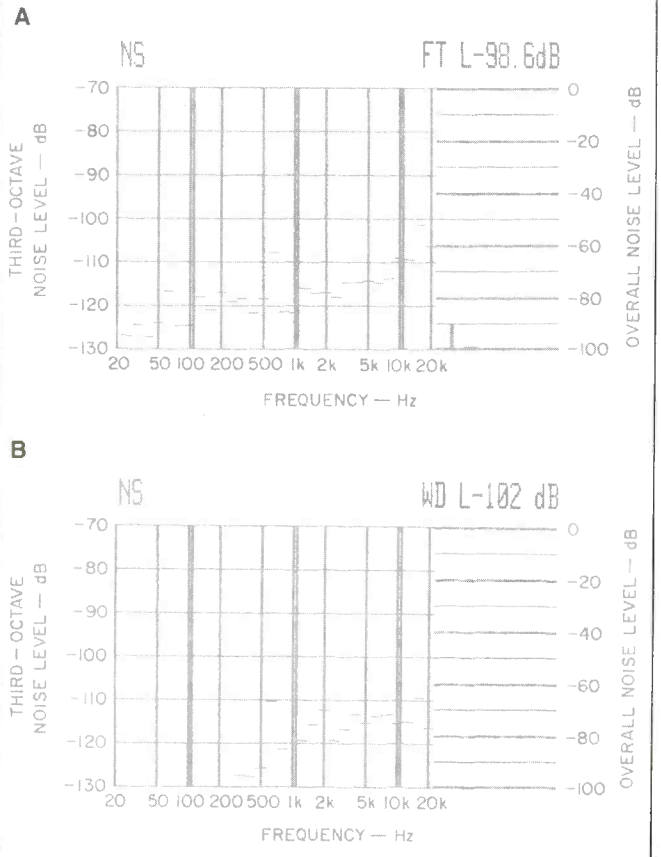


Fig. 3—S/N analysis, both unweighted (A) and A-weighted (B).

key (which makes the player pause at the end of each selection or program step, resuming when the pause key is pressed). At the bottom of this section are the "Cal. Tone" button (which sends a 1-kHz tone to the output jacks, at the maximum level possible from a CD, for adjusting tape-recorder levels) and the up/down "Volume" buttons (which control the adjacent headphone jack and the variable-level outputs on the rear panel).

The B225's display offers a wealth of useful information. In normal (nonprogrammed) play, it shows track and index number, time since the beginning of the current track (or since the start of the disc), and shows whether the "Pause," "Autostop" or "Loop" modes have been activated. If the player finds index signals on the disc, the word "Index" comes on the display, with the current index number just beneath it; there is no way of accessing selections by index number, though.

In programmed play, the display shows the word "Step" to indicate the programmed mode and shows the number of the step being executed. The next field of the display shows the track number or timing that started the selection, with the following field showing the track number or timing (if any) programmed as the selection's end point.

One display function remains the same in both programmed and normal play. When the disc is first loaded, a horizontal line of square bars appears along the bottom of the display, indicating how many selections (up to 30) are on the disc. These bars disappear, one by one, as the tracks they designate are played.

Several of the controls in the programming area at the left can be used for normal play as well. The 10 numbered buttons at the top of this section can be used for direct access to any given track in normal play, as well as for programming track number or selection time (from the beginning of the disc). The "Loop" button at the bottom left repeats the entire CD in normal play, or the entire program during programmed play. The others are for programming only. Pressing "Program" puts the B225 in program-entry mode, which can be done even while a disc is playing in normal mode. The "Store" button enters commands in memory. The "Track/Time" button switches selection start or end-point entry and display between track-number and elapsed-time modes. Start and end points can also be marked while the disc is playing, by pressing the "Mark" button as the desired points come by. Two additional buttons allow you to "page" through a previously entered program, forward or backward, to check or edit it. A "Cursor" key is used to move from field to field of the display when editing a program, or to switch, in elapsed-time programming, from minutes to seconds.

A sensor at the lower left of the panel receives infrared signals from Revox's optional B201 wireless remote-control unit ($125); a light behind the sensor panel blinks to acknowledge commands. The B201 commands the B225's "Play/Next," "Stop," skip-ahead, skip-back, and pause functions, plus direct numerical track entry. The B201 can also be used with Revox's B251 amplifier, B261 tuner, B710 Mk II cassette deck, and the B791 and B795 turntables. To keep the button count down to a reasonable number (38!), the remote does not provide separate buttons for the CD-

The B225's 20 programming steps can cover more than 20 tracks: Each step can include any number of consecutive selections.

player functions, but requires that a "*" key be pressed concurrently with each button when commanding the B225. If the remote is to be used only with the CD player, it can be modified so that the "*" key need not be pressed.

The rear panel of the B225 is equipped with fixed- and variable-level output-jack pairs, a power-cord receptacle and a multi-pin remote socket for connecting a wired remote control. Connecting such a remote automatically disables the infrared receiver.

Reading about all the B225's controls may perhaps intimidate you a bit—when I first read the owner's manual, before actually using the deck, I figured I'd need several hours to master everything. In fact, once I started dealing with this magnificent product, I was able to use and program it almost immediately—that's how well the panel is laid out, and how succinctly and clearly the controls are labelled.

Measurements

After marvelling at the extraordinary flexibility of this beautifully crafted machine, I got down to measuring its actual performance. As I have found again and again over the years, Revox's published specifications were unusually conservative. Figure 1 shows a plot of frequency response for both the left and right channels of the B225. The vertical scale is 2 dB per division, and the sweep, from left to right, extends from 20 Hz to 20 kHz. Frequency response was extremely flat, deviating by no more than ±0.2 dB. Harmonic distortion for maximum output varied from 0.003% to around 0.006%, depending upon the test frequency being measured. A plot of THD versus frequency up to around 10 kHz, at various recorded levels, is shown in Fig. 2.

Unweighted S/N measured 98.6 dB (Fig. 3A) while, with A-weighting, it increased to 102 dB (Fig. 3B). At maximum recorded level, IM distortion measured 0.0055%, increasing to 0.065% at −20 dB recorded level. Linearity was accurate to within 0.2 dB down to −80 dB. Stereo separation (Fig. 4) ranged from 80 dB at the low and high frequency extremes to around 89 dB at mid-frequencies.

Reproduction of a 1-kHz, digitally generated square-wave signal is shown in Fig. 5. The reproducec waveform is typical of that obtained with CD players that use digital filtering ahead of their D/A converters, as this one does. (The filters used here are Revox's own design.) Playback of a digitally generated unit-pulse signal was also typical of players using this type of filtering (Fig. 6). The 'scope photo of Fig. 7 shows negligible phase shift between a left-channel, 200-Hz test signal and a right-channel, 2-kHz one. It should be noted that the B225 has two independent D/A conversion circuits, which eliminate one source of time delay or phase differential between channels.

Use and Listening Tests

In their white paper on the technology of the B225, Revox claims the unit "doesn't mistrack, even in very stressful situations," thanks to its pivoting-arm laser assembly. As to error-correction, the paper claims that "The B225 plays all damaged records. It is the only CD player capable of this." The only restriction cited is that "Discs in very bad shape (broken, pierced, scratched all over the surface) will still be perfectly reproduced, but cannot be programmed."

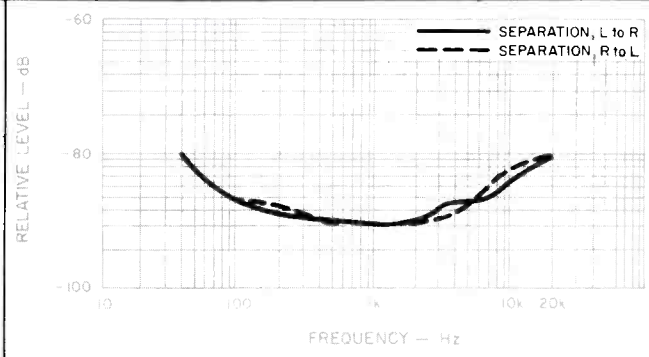


Fig. 4—Separation vs. frequency.

Fig. 5—Square-wave reproduction, 1 kHz.

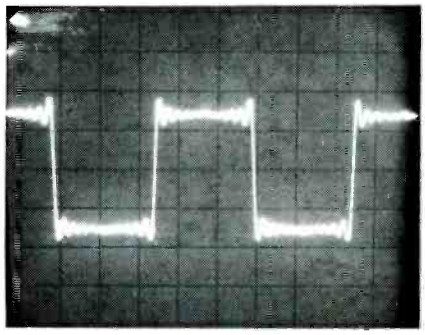


Fig. 6—Single-pulse test.

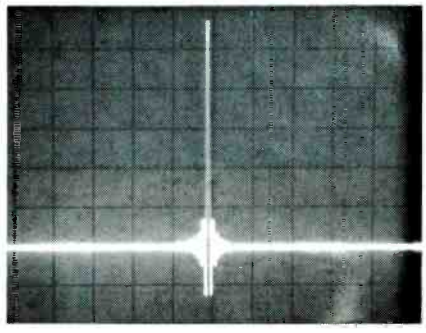
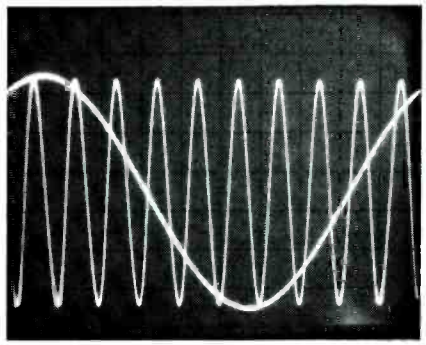


Fig. 7—Two-tone phase test (200 Hz left channel, 2 kHz right).



Revox claims the B225 can play even the most badly damaged Compact Discs. The only restriction is in programming.

Well, I wasn't about to break, pierce, or scratch all over their surfaces any of my favorite musical CDs to prove the point, and I suspect that even at Revox, copywriters can get to be a bit over-enthusiastic. This much I can say, with certainty, however. The Revox B225 had no trouble whatsoever playing through (and ignoring) all of the defects built into my special Philips test disc. That means that it was able to correct for dropouts extending to 900 microns in length, simulated dust or dirt spots 900 microns in diameter, and a long, semi-opaque simulated fingerprint smudge. I must also confess that I was a bit more brutal than usual in my "tapping tests" along the sides and top of this rugged unit, yet still I failed to cause any mistracking during these "shock tests."

If you are looking for a CD player that doesn't occupy very much space on your shelf or table top, this is probably not the unit for you. There are CD players around that are much smaller in size and lighter in weight. If, however, you are looking for a CD player that is more versatile in its programming capabilities than just about any other player available, you would do well to consider the long-awaited Revox B225 very seriously. I have been an admirer of Revox and Studer products for many years and have been privileged to visit the Studer factories in Switzerland and Germany and to meet and talk with the company's legendary founder, Dr. Willi Studer. Having had the pleasure of listening to Dr. Studer explain his philosophy of product design and quality, I expected nothing less than sonic and mechanical perfection from the company's first CD player.

I was not disappointed in the least. Sound quality was beyond reproach. I know that in the past I have repeatedly stressed that there is little audible difference between one CD player and the next. Nevertheless, I felt that the Revox B225 sounded cleaner; instruments seemed better defined during ensemble playing and in orchestral works. Stereo imaging was magnificent when I played some of my most recent CD acquisitions. I wondered whether my positive reaction to the sound of this player was purely psychological (stemming from my admiration for the engineering and layout of the instrument) or whether it was, in fact, the result of an audible difference between this CD player and others I have tested. I suppose I will never really know. The ease with which complex programming could be accomplished on this superbly engineered machine seemed a fitting accompaniment to the high technology involved in the actual playing and tracking of CDs. All in all, the Revox B225 is a superb instrument. I simply can't find anything to criticize, nor can I think of a single feature or control that I would have arranged differently. As is usual with Revox where new designs are concerned, it took the company quite a long time to come up with their first CD player. But it was certainly worth waiting for!

Leonard Feldman

Now, if you still want to pay more than $375 for a high-performance preamplifier, that's up to you.

"The construction of the GFP-1A is, to put it mildly, robust...The cabinet and chassis are made of steel... everything is on a single large circuit board, with an open, uncluttered parts layout and a minimum of point-to-point wiring. All of this indicates probable long-term reliability. Both on the test bench and as part of a hi-fi system, the Adcom GFP-1A left nothing to be desired. It has all the flexibility one could ever want combined with smooth, silent and bug-free operation. An excellent preamplifier at a very reasonable price."

Julian Hirsch in Stereo Review

"The GFP-1A gives us just about everything—in features, technology, and performance—that we've ever really wanted in a preamplifier. That response and distortion measurements are beyond reproach goes without saying... and the feel and appearance of the controls further inspire confidence. Had we not been delighted by what we heard through the GFP-1A, we would have been astonished. But the only real surprise was the price...which was modest relative to some of the high-tech preamplifiers to which its performance invites comparison."

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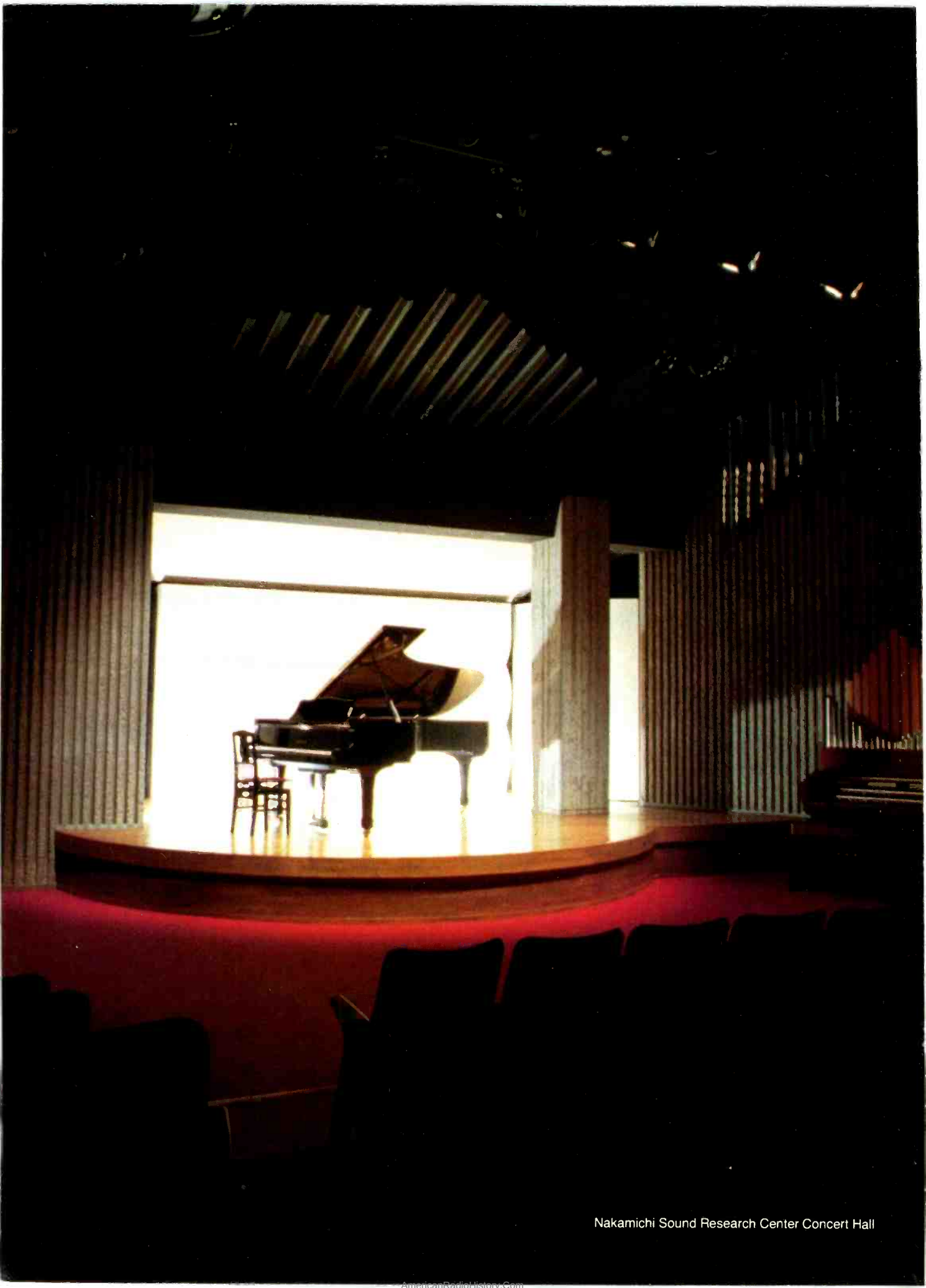

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In 1973 we shocked the world by introducing the Nakamichi 1000—the first "Discrete 3-Head" cassette deck—the first cassette recorder that *outperformed* the open-reel decks of its day.

In the past decade, Nakamichi has shattered one technological barrier after another with such innovations as NAAC, our Auto Azimuth Correction system, UDAR, our unique *Uni*directional Auto Reverse mechanism, and our exclusive Asymmetrical Dual-Capstan Diffused-Resonance transport, quite simply, the world's most *precise* tape drive.

As impressive as these technological breakthroughs are, they are merely means to an end—*sound purity!* Hearing is believing. Listen to *any* of our decks and you'll be convinced that Nakamichi Sound is in a class by itself—pure, clean, transparent, utterly refreshing, and quite unlike ordinary cassette sound.

Nakamichi Sound characterizes our entire line from the inexpensive BX-1 to the exotic DRAGON. When you pay less for a Nakamichi deck, you get fewer features—not inferior sound! Each Nakamichi design must pass the *ultimate* test—critical live vs. recorded listening in our Sound Research Center Concert Hall.

DRAGON Auto Reverse Cassette Deck

The world's first Discrete 3-Head Dual-Capstan Direct-Drive Auto-Reverse Cassette Deck. Nakamichi's unique Auto Azimuth Correction system—NAAC—guarantees 20-22,000 Hz response in *both* playback directions!

ZX-9 Discrete 3-Head Cassette Deck

The *perfectionist's* cassette recorder. Azimuth, bias, and sensitivity calibration controls for perfect recording on virtually any tape and our unique SLT direct-drive motor for flutter-free reproduction.

RX-505 Unidirectional Auto-Reverse Discrete 3-Head Cassette Deck

Our exclusive UDAR mechanism combines unidirectional performance with auto-reverse convenience. Discrete 3-Head recording and playback on both sides! The 2-Head RX-303 and RX-202 offer UDAR performance and many unique features.

LX-5 Discrete 3-Head Cassette Deck

Revel in the aesthetic luxury of the LX-5 and companion 2-Head LX-3. Tap the right panel to reveal the hidden controls, then sit back and enjoy the unique purity of Nakamichi Sound. A feast for the eyes and ears!

BX-150 2-Head Cassette Deck

Designed for those who appreciate simple virtuosity, the BX-150 and BX-100 demonstrate the sound purity that can be realized at an economical price. Compare them with decks costing much more. You'll be surprised!

BX-1 2-Head Cassette Deck

Think you can't afford Nakamichi Sound? Think again! The remarkable BX-1 costs less than $300, but outperforms decks at twice the price. Hearing is believing so audition one now and convince yourself!

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In Canada: W. Carsen Co., Ltd., 25 Scarsdale Road, Don Mills, Ontario M3B 3G7

2

TANDBERG TCD 3014 CASSETTE DECK

Manufacturer's Specifications
Frequency Response: 18 Hz to 20 kHz; to 23 kHz with metal tape.
Harmonic Distortion: 1%.
Signal/Noise Ratio: 74 dBA with Dolby C NR.
Separation: 40 dB.
Crosstalk: −60 dB.
Erasure: 80 dB.
Input Sensitivity: Line, 10 to 100 mV, adjustable.
Output Level: Fixed output, 700 mV; variable output, 0 to 4 V.
Flutter: 0.09% wtd. rms; ±0.12% wtd. peak.
Dimensions: 17⅛ in. (435 mm) W × 6-9/16 in. (166 mm) H × 13¾ in. (350 mm) D.
Weight: 21.6 lbs. (9.8 kg).
Price: $1,395.00.

Company Address: Labriola Court, Armonk, N.Y. 10504.
For literature, circle No. 91

The TCD 3014 is Tandberg's newest cassette deck and the latest addition to their 3000 series. The deck features advanced design, using discrete components instead of ICs wherever possible, phase-compensated amplifiers and high-grade capacitors. It has separate record and playback heads for best performance and monitoring while recording. To maximize performance with any tape, adjustments for bias, sensitivity and record-head azimuth can be made with controls on the TCD 3014's front panel.

The peak-reading meters are equalized to give better indication of maximum allowable levels before tape saturation. The TCD 3014 features Tandberg's patented Dyneq system (which automatically varies record EQ for best high-frequency recording) and Actilinear II (which increases the headroom of the record amplifier). This deck also includes both Dolby B and Dolby C NR.

The transport is built on a heavy aluminum baseplate for rigid and stable support of the four-motor, closed-loop, dual-capstan drive. The two reel-hub motors are slaved to provide constant tape speed, even in fast wind and cue and

review modes. The two capstan flywheels are not identical, to minimize resonances, and are belt-driven by the capstan motor. The fourth motor shifts the head assembly and performs other functions in a nonshock fashion, replacing the usual solenoid. A built-in microprocessor controls the normal transport operations as well as a number of memory and auto-wind functions. It also calibrates individual tapes for exact indications of elapsed time, even in fast forward and rewind. An optional, infrared remote control costs $150.

The TCD 3014's front panel is dominated by the projecting cassette compartment. Turning on the power (at the lower left) illuminates the meters (at the upper right) brightly, while the counter display (upper left) shows "0000" after warming up for a few seconds. A red light above the "Release" button (furthest left of the six large, round transport-control buttons) shows that the transport is unlocked, for easy insertion of a cassette. In all other modes, including stop, the tape is snugly held in place until "Release" is pressed again.

The play and fast-wind functions require only a touch of the appropriate buttons. Recording can be initiated from either play or stop mode, but only if the "Rec. Preset" lever (just beneath the "Record" button) is switched on—a nice touch that helps prevent inadvertent erasures. The recording indicator, just above the button, flashes when the preset is on and glows when the deck is recording. The 3014 is unusual in that it not only allows punch-in recording but also can be switched back into play mode without stopping the tape—a definite nicety. Another nice touch is that the recording indicator will not light or flash if the cassette's erase-prevention tabs have been removed, showing immediately that the tape cannot be recorded unless the holes are covered again.

The "Memory" ("Stop/Off/Repeat") switch works with the "Set" button just below "Release." With the "Memory" switch at "Stop," the "Set" button resets the counter to zero, to mark the automatic stop or rewind point. And with the "Memory" switch at "Repeat," the "Set" button records the displayed counter setting as the automatic start point.

Pressing "Stop" and "Set" together switches the counter readout between conventional counting and elapsed-time display. The time display is calibrated to match C-90 tapes, but pressing both "Release" and "Set" recalibrates it for the tape length actually in use. The calibration includes automatic rewinding to the beginning, playing two short sections of tape, and rewinding back to the start of the tape again—accomplished in about 20 S plus any rewind time needed. I liked the combination of memory and counter features, especially the elapsed-time readout, which keeps its calibration even in fast winds.

The fast winds have constant tape speed for controlled tape tension. The winding speed is 60 times play speed, so that 1 S of wind equals 1 minute of play anywhere along the tape. Winding speeds are reduced by holding the corresponding button in, and the tape can be shuttled back and forth easily by rocking between the two fast-wind buttons; the tape stops if both are released at once.

The cue and review modes, at 20 times normal speed, are locked in by touching the "Play" button while holding either fast-wind button down. Here, too, the tape can be shuttled.

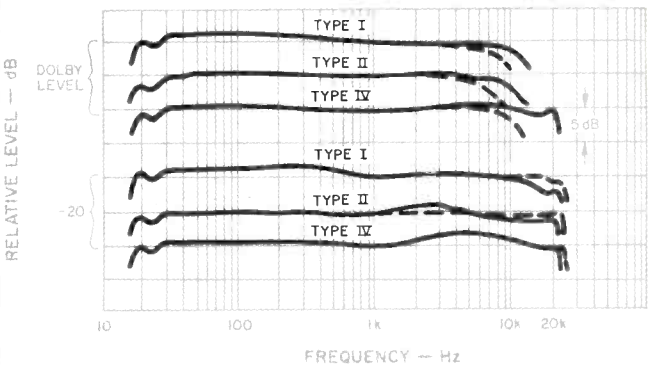

Fig. 1—Frequency responses with (solid lines) and without (dashed lines) Dolby C NR, using Type I (XL I-S), Type II (XL II-S) and Type IV (MX) tapes, all from Maxell.

Pressing the "Stop" button during a fast wind starts the auto search function, which skips ahead or back for up to nine selections, depending on how many times the "Stop" button is pressed.

Input levels are set by a large-knobbed "Master Control" and a center-detented "Balance" pot. I prefer this arrangement to the usual separate channel pots, particularly when they are the dual-concentric type with high friction. The 3014's master pot has the added conveniences of an adjustable reference-level indicator with detent and accurate decibel scaling (relative to 12 o'clock) around its periphery.

At the top of this panel section are the brightly illuminated, peak-responding level meters, which have white scales below zero (250 nWb/m, about 2 dB above Dolby level) and red above that. Each meter has a second scale, for Type IV (metal) tapes, just below the first one. Its zero is 6 dB above Dolby level—at 400 nWb/m. The white meter needles are easily seen against the meter faces. The infrared receptor for the remote control is to the right of the meters.

Along the bottom of the panel, to the left of the "Balance" pot, are the switch for "Dolby NR" selection, the "Output" level pot, and a rotary "Monitor/Test" switch. This has the usual source and tape positions, plus positions for 15-kHz and 315-Hz test signals. These signals are used when making record-head azimuth, bias, and tape-sensitivity ("Record Current") adjustments. The controls for these adjustments are to the left of the cassette well.

The 15-kHz test tone is used for azimuth adjustment, which is gauged by reading playback-head output on the meters while turning the "Azimuth" knob. When the meters peak, the record head is properly aligned to the playback head for that tape, even if the tape has some skew. Tandberg recommends doing this for every recording.

For other recording adjustments, the azimuth is set and the tape type is selected by using the three-position toggle switch above the "Azimuth" control. These steps must be taken before the bias and sensitivity controls are adjusted. This must be done with a small screwdriver, as these controls are recessed behind the panel. Bias is correctly set

The 3014 not only allows punch-in recording, but can be switched back into play mode without stopping the tape—a nicety.

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

	With Dolby C NR				Without NR			
	Dolby Lvl		−20 dB		Dolby Lvl		−20 dB	
Tape Type	Hz	kHz	Hz	kHz	Hz	kHz	Hz	kHz
Maxell XL I-S	17.0	13.9	17.0	23.6	17.0	10.2	17.0	25.2
Maxell XL II-S	18.3	11.8	17.0	22.5	18.4	7.7	17.0	24.7
Maxell MX	17.4	22.0	17.1	24.0	17.4	11.3	17.1	25.1

Table II—Miscellaneous record/playback characteristics.

Erasure At 100 Hz	Sep. At 1 kHz	Crosstalk At 1 kHz	10-kHz A-B Phase Error*	10-kHz A-B Phase Jitter	MPX Filter At 19.00 kHz
56 dB	56 dB	−105 dB	20°	25°	−30.3 dB

*After record-head adjustment.

Table III—400-Hz HDL_3 (%) vs. record level (0 dB = 200 nWb/m).

		Record Level						HDL_3 = 3%
Tape Type	NR	−10	−8	−4	0	+4	+8	
Maxell XL I-S	Dolby C	0.14	0.20	0.36	0.60	1.3		+7.0 dB
Maxell XL II-S	Dolby C	0.09	0.17	0.40	1.1			+3.7 dB
Maxell MX	Dolby C	0.04	0.04	0.11	0.40	1.1	3.0	+8.0 dB

when the output-meter readings for both the 15-kHz and 315-Hz test tones are equal. Record current is correctly matched to the tape's sensitivity when the meters read zero for the 315-Hz tone. These adjustments assure the best performance possible and good Dolby-NR tracking. Individual bias and sensitivity pots are provided for each channel and for each of three tape types.

The headphone jack is right under the "Azimuth" knob, a position that might lead to an inadvertent azimuth error when attempting to change listening level (though I must say I didn't do that during testing). The "Timer" switch ("Play/Off/Record") also seemed somewhat out of place to me, being below the "Stop" button on the right side of the panel.

There are the expected pairs of phono jacks on the back panel, but with a difference: The inputs have adjustable sensitivity from 10 to 100 mV, and there are two sets of outputs. One set has a fixed level of 700 mV for meter zero, while the other is controlled by the front-panel pot, anywhere from 0 to 4 V for the same meter reading. These features add greatly to the deck's flexibility in interfacing with other equipment. The deck has automatic sensing to set EQ in playback, but there is a little pushbutton switch on the back panel to get 70 μS for older Type II tapes which lack sensing holes. The multiplex filter switch is also back here, which could be inconvenient for those who record from FM units with poor pilot-tone suppression.

The top and side cover has pads on its inside surface to clamp and steady the three vertical p.c. boards (which appeared to be for the microprocessor and the Dolby NR circuitry). One of the two horizontal mother boards has power-supply, bias and motor-control circuits, while the other holds amplifier circuitry. Adjustments are labelled with parts numbers and function. The soldering is excellent, and intercard connections are made with multi-conductor cabling. The parts quality is also excellent, and the capacitors are the highest quality I have yet seen in a deck. I was impressed by the rugged transport support from a solid die-casting and the rigid U-channel box chassis, quite amenable to the use of the optional rack adaptors.

Measurements

The playback responses were within ±1 dB for both equalizations, one of the best results I have ever measured. Playback-level readings for such standard flux levels as 200 nWb/m were pretty accurate. The range of the record-current and bias-current adjustments was well beyond that required by any present-day tapes, and excellent performance could be secured from many of them. I did, however, use the supplied tapes (Maxell XL I-S, XL II-S, and MX) in my lab tests.

Swept-frequency responses were run with and without Dolby C NR for the usual three tape types both at Dolby level and 20 dB below that. As Fig. 1 and Table I show, the responses at −20 dB were well extended and flat within ±1.5 dB from 20 Hz to 20 kHz for most cases, including those with Dolby C NR. The benefits of Dolby C NR at higher levels are evident for all three tape types.

Table II lists some measured record/playback properties. At 100 Hz, erasure of metal tape was just fairly good (56 dB)—but it was an outstanding 94 dB at 1 kHz. Crosstalk was so low (−105 dB) that it was nearly impossible to measure. The tests of third-harmonic distortion versus level (Table III) showed that the Tandberg deck utilizes metal tape's potential very well. The low-distortion results are reflected in the signal-to-noise ratios given in Table IV, all excellent, although the Type II figures seem relatively low. Table V lists the HDL_3 figures for MX tape with Dolby C NR from 30 Hz to 6 kHz at −10 dB. The distortion is certainly

The controls for bias and sensitivity are recessed behind the panel, so a small screwdriver must be used to make these adjustments.

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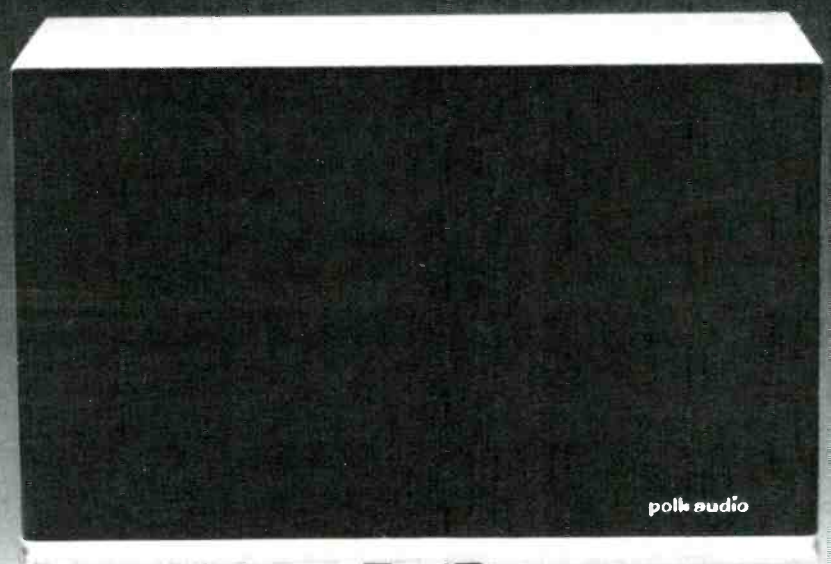

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I particularly liked the elapsed-time counter, the record preset switch, and the smooth high-speed winding.

low in mid-band, and the rises at the frequency extremes are quite moderate. It does appear that Dyneq and Actilinear II do provide benefits.

Various input and output characteristics are listed in Table VI. The line-input levels shown are for the maximum and minimum sensitivity settings of the level-set pots on the rear panel. The line-output figures listed are both for meter zero: The 4.3-V figure was the maximum from the variable output, which could be set at any value down to zero, while the 720-mV figure is from the fixed-level output. A very high level was delivered to all headphones tried. The master input-level pot sections tracked within 1 dB over a 65-dB range, outstanding performance. The output-level pot tracked better than most, both channels within 1 dB of each other for 50 dB of attenuation. The deck's input and output polarity were the same in both "Source" and "Tape." Checks of the nondefeatable subsonic filter indicated a response down 3 dB at 16 Hz, −10 dB at 10 Hz, and −20 dB at 6 Hz—useful to remove record-warp contributions. Bias in the output was quite low during recording. The waveforms for the 315-Hz (304-Hz actual) and 15-kHz (14.6-kHz actual) test tones were fine for their intended purposes.

The peak-responding meters are truly that, for they reach full deflection, within 1 dB, with a 2-mS tone burst and rise the correct 6 dB when the tone burst is offset so its peak (or bottom) value, rather than its middle value, corresponds to 0 V. Very few recorder meters show such peak levels correctly. The meters also had a good 20-dB decay time of 1.9 S. The meter-scale calibration was very close relative to zero, with most points within 0.2 dB. In "Release" mode, the meter frequency response was 3 dB down at 19 Hz and 45.6 kHz. In "Stop" (or play or record modes), the response showed the effect of record equalization—about 3 dB of boost at the lowest frequencies, increasing to 7 dB at 15 kHz.

The playback of a recorded 3-kHz tone showed barely measurable speed variations when line voltage varied anywhere from 110 to 130 V. The record/playback flutter was very low: 0.035% wtd. rms and ±0.05% wtd. peak. Tape play-speed deviations over time stayed within ±0.01%. Wind/rewind was smooth but fast, taking just 38 S for a C-60 (one way) and ending with a nonshock stop. Tape slack was taken up before tape drive began. All changes in mode required 1 S or less.

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

	IEC A Wtd. (dBA)				CCIR/ARM (dB)			
	W/Dolby C NR		Without NR		W/Dolby C NR		Without NR	
Tape Type	@ DL	HD=3%	@ DL	HD=3%	@ DL	HD=3%	@ DL	HD=3%
Maxell XL I-S	65.8	72.5	51.1	57.3	67.6	74.3	49.2	55.4
Maxell XL II-S	67.2	70.7	53.4	56.0	69.5	73.0	51.4	54.0
Maxell MX	67.1	74.6	53.0	59.5	70.1	77.6	51.8	58.3

Table V—HDL_3 (%) vs. frequency at 10 dB below Dolby level.

		Frequency (Hz)							
Tape Type	NR	30	50	100	400	1k	2k	4k	6k
Maxell MX	Dolby C	0.22	0.08	0.09	0.04	0.03	0.08	0.16	0.47

Table VI—Input and output characteristics at 1 kHz.

Input	Level		Imp.,	Output	Level		Imp.,	Clip (Re:
	Sens.	Overload	Kilohms		Open Ckt.	Loaded	Ohms	Meter 0)
Line	8.8 mV	530 mV	155	Line	4.3 V	4.3 V	102	+17.3
	83.0 mV	5.5 V			720 mV	687 mV	510	
				Hdphn.	4.2 V	2.2 V	45	

Use and Listening Tests

The owner's manual provides good basic instruction, but it would benefit from greater detail. On the other hand, there is a quick-reference guide card, with the microprocessor functions covered on one side and record-optimization adjustments on the other—a handy reminder to keep next to this Tandberg deck.

Tape loading is simple—just push the cassette in. Removal is just as simple, but the deck must be in "Release." Access for cleaning or demagnetizing the tape path is excellent, and a push-in dust cover helps keep dirt out of the tape well when the deck is not in use.

I particularly liked the 3014's elapsed-time counter, the record preset and the smooth, high-speed winding. With some practice, most of the special button pushing, such as "Record" plus "Stop" for record-mute, seemed quite logical. Going into "Record" and back to "Stop" generated soft clicks which were just out of the tape noise with Dolby C NR. Setting levels was very easy with the meters, thanks to their excellent dynamic response and their high visibility under any lighting condition. I decided there was validity in the Tandberg approach of having the meters display the input level during recording even with the output monitor set for "Tape." With level-monitoring of the source signal, there is better indication of momentary peaks that might be reaching the tape saturation level.

The wireless remote control worked very well, and it was not necessary to point it exactly at the receptor window on the deck. Its range appeared to be at least 30 feet.

Sometimes during the listening tests, I felt that I could pin down specific differences between the sounds of source and playback, but when the in/out levels were very closely matched, it became difficult to tell. Discs for the tests included the dbx-encoded Nautilus release of Tim Weisberg's *Tip of the Weisberg* and the Mobile Fidelity release of the Beethoven Ninth Symphony recorded for London by Sir Georg Solti and the Chicago Symphony Orchestra and Chorus. It was easy to relax and enjoy the Tandberg deck: The sound was detailed, but also sweet.

The 3014 does not have a sophisticated music-selection programming mode, but it has many other features for the serious user: A rugged transport for long-term reliability, elapsed-time metering, fast winding with low tension, excellent level metering, and facilities to match any tape that might be used. These and other niceties, in combination with its excellent performance, make the Tandberg TCD 3014 worthy of consideration by critical users, including comparison to other decks costing much more.

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3

NAKAMICHI TD-800 CAR STEREO

Manufacturer's Specifications

FM Tuner Section

Usable Sensitivity: 20 dBf.
50-dB Quieting Sensitivity: Mono, 26 dBf.
S/N Ratio: Mono, 65 dB.
THD: Mono, 0.08% at 1 kHz; stereo, 0.13% at 1 kHz.
Frequency Response: 30 Hz to 15 kHz, ±3 dB.
Alternate-Channel Selectivity: 60 dB.
Capture Ratio: 1.5 dB.
Image Rejection: 65 dB.
I.f. Rejection: 80 dB.
Stereo Separation: 35 dB at 1 kHz.

AM Tuner Section

Sensitivity: 36 μV.
Selectivity: 20 dB.
Image Rejection: 50 dB.
THD: 2.0%.

Preamplifier Section

Frequency Response: 10 Hz to 50 kHz, ±1.0 dB.
Output Level: 1.1 V.
Output Impedance: 870 ohms.
THD: Less than 0.005%.
Tone Control Range: Bass, ±18 dB at 40 Hz; midrange, ±10 dB at 200 Hz; treble, ±12 dB at 20 kHz.

General Specifications

Dimensions: Main unit, 7-1/16 in. (17.9 cm) W × 2-1/16 in. (5.2 cm) H × 7-3/16 in. (18.3 cm) D; Additional electronics enclosure, 7⅛ in. (18.1 cm) W × 2 in. (5.1 cm) H × 5¼ in. (13.3 cm) D; Azimuth Fine Tuning Control, 2-11/16 in. (6.8 cm) W × 2½ in. (6.4 cm) H × 2-13/16 in. (7.1 cm) D.
Weight: Main unit, 5½ lbs. (2.5 kg); additional enclosure, 1 lb. 12 oz. (0.80 kg); azimuth control unit, 2 oz. (57 g).
Power Requirements: 13.2 V d.c. (10.8 to 15.6 V allowable), 3 A maximum; negative ground.
Price: $890.00.
Company Address: 19701 South Vermont Ave., Torrance, Cal. 90502.
For literature, circle No. 92

Since it comes from Nakamichi, I expected this car stereo's cassette mechanism to be superb; what I didn't expect was that its frequency-synthesized tuner section would be equally so. Nor did I expect so many features and so rugged a transport as I found in this small package—or, rather, set of packages, since the TD-800 is a three-piece unit. Beside the main chassis, with the tape transport and controls, there's a remotely situated azimuth control (in a small enclosure, which can be removed for installing the control in the dash) and a hide-away box which holds the tuner circuitry, the antenna input, and other overflow components.

The azimuth adjustment is in recognition of the fact that tapes played on any car stereo (save for the one or two models which record) will have been recorded on other machines. Since there is no way of knowing that recorder's azimuth alignments, the TD-800 lets the user adjust azimuth for optimum high-frequency playback response from each recorded tape. A lovely idea—I wonder why no one else ever came up with it.

The TD-800's second unusual feature is its slide-out tape-transport mechanism, shared with the TD-1200. This saves space while allowing the use of a high-inertia flywheel and a Nakamichi-developed linear torque motor. When the tape ends or the ignition is shut off, the pinch roller releases and the drawer unlocks, but does not move out; if the ignition is turned on again and the tape hasn't ended, play resumes.

Control and Panel Layout

On both control shafts, two concentric ring controls surround a triple-duty knob. On the left, these are "Bass," "Treble" and a "Volume" knob which also turns the tuner on or off, if pushed, and becomes a mid-bass tone control (centered at 200 Hz) when pulled. All three tone controls have center click-stops. On the right, the outermost control selects "AM," normal FM, "Hi-Blend" or "Mono"; it surrounds the front/rear "Fader." Twisting the center knob a little tunes up or down the dial until you release it; pushing the knob triggers the auto-seek circuits, which find the next station up the dial, and pulling the knob engages the "Balance" control.

The nosepiece (the front of the tape drawer) holds the five preset tuning buttons and their indicator LEDs (when a preset is selected, its LED glows brighter), the nicely out-of-the-way "Memory" button, the station display and stereo-FM light, and the tape controls and indicators. These include the large tape-play button and the smaller buttons for fast-forward, rewind and stop/eject. At the top of this panel section lie the "EQ" ("70/120") button, the tape motion and "Repeat" indicators, and the "NR" button (which cycles, push by push, through Dolby B, Dolby C and off). The Dolby B NR works on FM too—and the station memory records whether you want it on or off for any preset station. Below the "NR" switch is the "Auto Repeat" button, which automatically rewinds and replays the tape.

The azimuth control has 31 click-stop settings, each of which alters the angle of the playback head by about 2.6 minutes of arc. To set it, you adjust it slowly while listening for maximum treble from your tape. It may help to temporarily boost the treble control while doing this.

Tuner Measurements

In mono, FM usable sensitivity measured a very low 12 dBf, far better than the 20 dBf Nakamichi claims. Only a 17.5-dBf signal was required for 50-dB quieting, well below the claimed 26 dBf.

In stereo, usable sensitivity measured 13 dBf, almost as low as in mono, because the automatic high-blend circuit cuts stereo signals almost down to mono to minimize noise. This accounts for the unusual shape of the stereo noise versus input curve (Fig. 1): As signal strength decreases, noise begins to rise, then starts decreasing, as the auto blend takes over. Strong-signal (65-dBf) S/N was nearly as high for stereo (68 dB) as for mono (70 dB).

Figure 1 also shows that distortion at 1 kHz is very low for strong signals, both in mono (0.064%) and in stereo (0.08%)—expected in top-quality home tuners, but rare in car units. Figure 2 shows that distortion is not only low at mid-frequencies but remains relatively low at the frequency extremes.

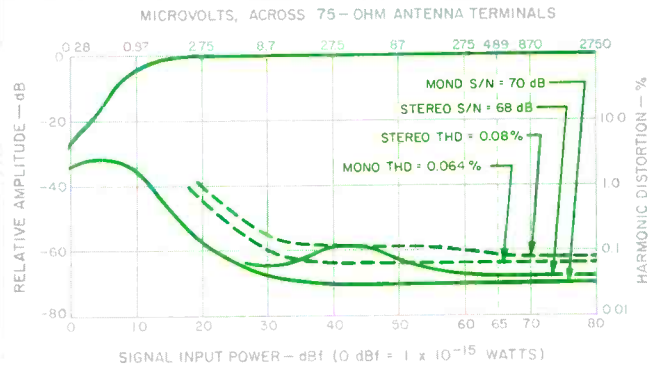

Fig. 1—Mono and stereo quieting and distortion characteristics, FM section.

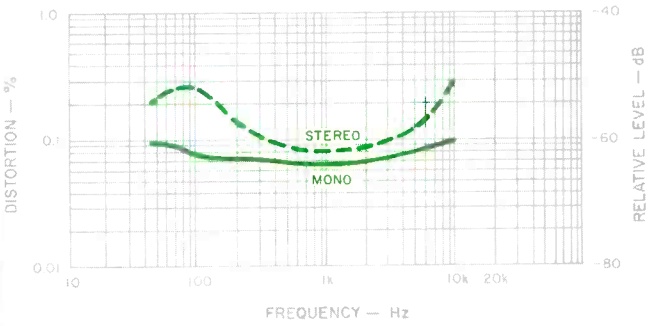

Fig. 2—THD vs. frequency, FM tuner section.

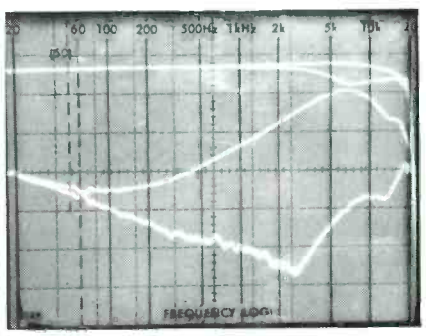

Fig. 3—FM frequency response and separation. From top to bottom: Response without high-blend and with high-blend, separation with high-blend and without high-blend.

A spectrum analysis of tuner frequency response versus stereo separation (Fig. 3) shows that, with the high-blend off, the separation (lower curve) was 46 dB at 1 kHz, 36 dB at 100 Hz, and 32 dB at 10 kHz. As you would expect, with high-blend on, separation decreases as frequency rises, reducing to around 22 dB at 1 kHz and to about 10 dB at 10 kHz, with a slight frequency-response aberration at the treble end. Figure 4 shows crosstalk and distortion products for a 5-kHz modulating signal. Capture ratio measured 1.5 dB. Selectivity and image rejection both measured 65 dB, SCA rejection was 68 dB, and i.f. rejection measured 85 dB.

I would not characterize the AM tuner frequency response

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Nakamichi may bill the TD-800 as a unique tape player, and it is. But its FM performance is uniquely good, as well.

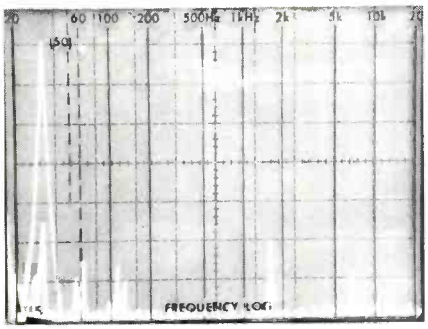

Fig. 4—FM stereo crosstalk and distortion components for a 5-kHz signal (with linear sweep, 5 kHz/div., ignore frequency notations on 'scope face).

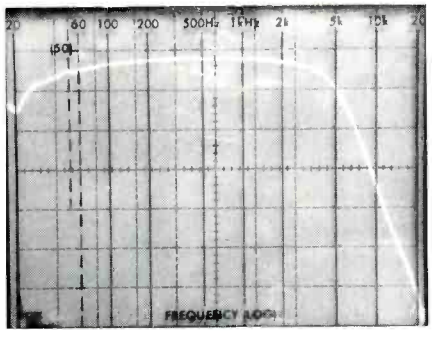

Fig. 5—AM frequency response.

(Fig. 5) as "high fidelity," but it is far better than that of most home tuners and receivers. It's a good compromise between reasonable response and overly wide AM bandwidth, which can cause whistles and noise.

Tape Player Measurements

Nakamichi's concern for correct azimuth is shown by the automatic adjustment in the Dragon home deck and TD-1200 car player. In the TD-800, azimuth adjustment is manual, but still easy when listening to any recording with good treble content. I was impressed by the difference it made. With the azimuth control deliberately misadjusted (by just one click stop!), frequency response (Fig. 6A) was down 10 dB at 20 kHz. With the control at its optimum setting (which was at the midpoint of the control, I am happy to say, for my test tape), response (Fig. 6B) was down only 0.6 dB at 20 kHz, and substantially flat beyond that!

Since azimuth misadjustment also causes phase errors that increase with frequency, I compared the phase of the left and right playback channels, for test signals of 2.8, 5.7, 11.8 and 15.8 kHz. Figure 7 shows phase error with the azimuth control deliberately misadjusted by one click stop, yielding an error of −176° at 15.8 kHz; a one-click misadjustment in the opposite direction changed the error to +108°. This wide error range is for a total playback-head swing of only about 5.6 *minutes* of arc, less than 0.1°. With the control optimized for this tape (Fig. 8), phase error at 15.8 kHz becomes a negligible 4°!

Wow and flutter measured only 0.045%, wtd. rms (Fig. 9). The chief wow component, 8 Hz, contributed 0.024% to the overall figure.

Tape speed was off by approximately 0.279%. Altering the d.c. supply voltage to the TD-800 from 12.0 to 14.0 V, I observed virtually no shift in speed.

While S/N for a tape player depends on the tape used, I still wanted to see what difference Dolby B and C NR made for each major tape type. With a Type I tape (TDK AD-X), A-weighted S/N (relative to 200 nWb/m recorded level) measured 56.0 dB without NR, 65.5 dB with Dolby B, and 70.5 dB with Dolby C NR. With a Type II tape (Maxell XL IIS), the figures were 59 dB without NR, 67.5 dB with Dolby B, and 73.5 dB with Dolby C NR. With a metal tape (Maxell MX), the figures were 58, 66.5 and 73.0 dB, respectively.

Output levels of the preamp section were 1.34 V for an FM signal at 100% modulation and 1.1 V for a cassette with a mid-frequency signal at a level of 200 nWb/m. Figure 10 shows the action of the three tone controls.

Use and Listening Tests

In my own listening tests, with the unit connected to my laboratory reference amp and speakers, I found the 200-Hz mid-bass control particularly effective in filling out program material which lacked solid upper bass or, combined with

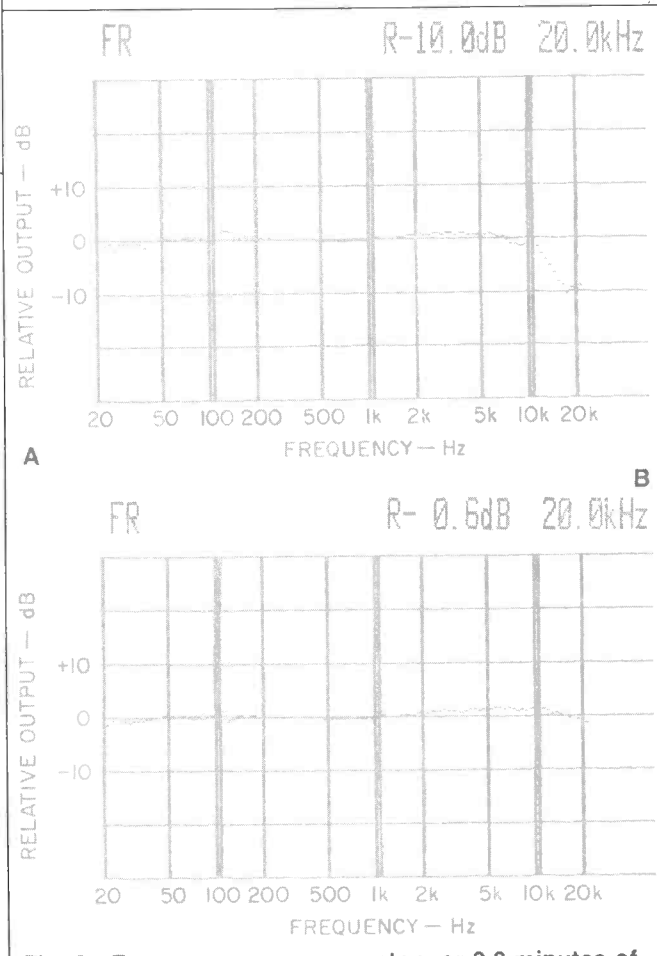

Fig. 6—Frequency response with azimuth misadjusted by one click stop, or 2.6 minutes of arc (A), and when properly adjusted (B).

On the road, I consistently picked up many more stations, far more clearly with the Nakamichi than with my reference system.

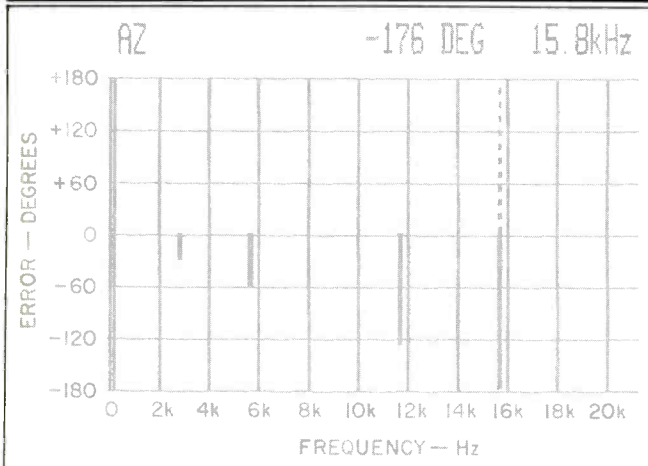

Fig. 7—How phase error between channels increases with frequency with azimuth misadjusted by one click stop. Test signals shown are 2.8, 5.7, 11.8 and 15.8 kHz.

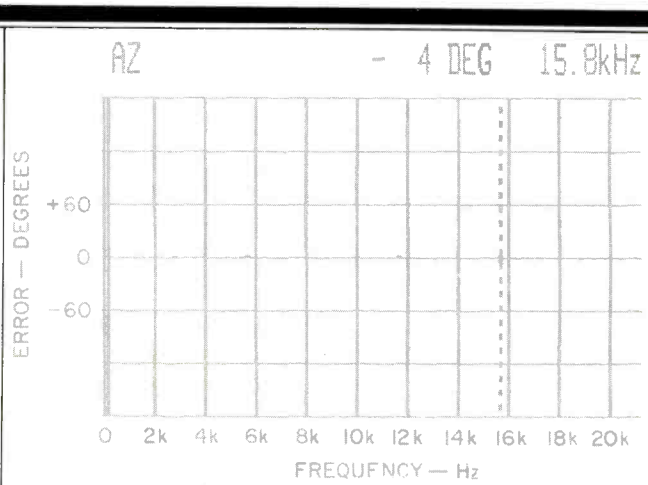

Fig. 8—Same test signals as Fig. 7 with azimuth control setting optimized for the test tape.

moderate use of the regular bass control, in producing a loudness-compensation curve for low-level listening.

The Nakamichi TD-800 is, without a doubt, one of the finest tuner/tape deck combinations ever offered to the music-loving driver. That little azimuth control makes such a difference in tape reproduction that you may well wonder how you ever got along without it—and wish you had it in your expensive home deck.

As to FM performance, while I cannot tell you how the TD-800 deals with such on-the-road problems as multipath and signal fading, I can tell that, given a signal of even moderate strength, the tuner performed beautifully when in a fixed location. Had I not known otherwise, I would have guessed, just from listening, that it was a top-quality home tuner and not the little package that it is. *Leonard Feldman*

Behind the Wheel

Installing the TD-800 is complex, but the pieces are small enough and the cables long enough to give the installer some flexibility, and the instructions are excellent. The main unit is fairly large, however, and will not fit every car's dash.

The slide-out transport will make loading harder in those few installations where the deck slants up or some projection overhangs the drawer. But it also frees up panel space for the many controls, makes head-cleaning easy, eliminates the need to eject the tape when the deck shuts off, and will simplify untangling tape snarls, if there are any. I'd prefer a stronger spring to move the drawer out or an easier way to grip it, however.

The TD-800's panel looks daunting, but its layout is basically conventional. The tape play button moves at an odd angle, but is nicely big. The mid-bass control is hard to engage and has an oversoft detent, but the manual implies it's mainly meant for "set it and forget it" acoustic compensation. The LED indicators for tape EQ and Dolby NR setting were invisible by day, alas.

At night, the tape-EQ and sometimes other LEDs glowed

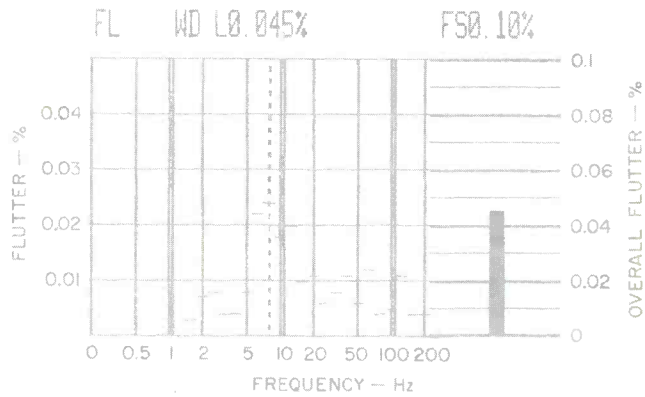

Fig. 9—Wow-and-flutter analysis.

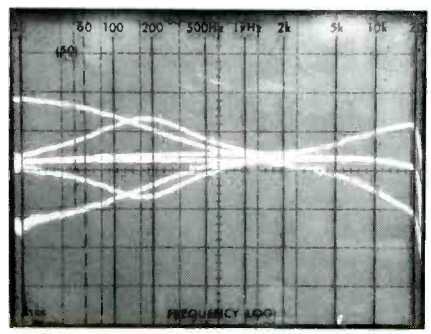

Fig. 10—Tone control characteristics; note mid-bass control.

The new Kyocera DA-910 Remote Control Compact Disc Player.

Stops vibration in its track.

How? With ceramics technology—Kyocera's innovative method of ensuring steady laser tracking—immune to vibrations. The bottom line: total purity of sound.

Why ceramics? They're rigid and inert, so they provide uncommon stability and resistance to mechanical vibrations from audio feedback. They're non-ferrous, so there are no chassis eddy currents to cause electrical hum.

The handsome ceramic-compound resin base of the DA-910 CD player is actually the chassis—supporting and housing all components and isolating vibration. Resonance from the cabinetry is almost non-existent.

But Kyocera doesn't stop there. Digital audio's technical requirements demand unprecedented circuit capability so we use fine ceramics throughout to further conquer vibration. For example, all discrete hi tolerance audio components and the 3rd order Besselle analog filters are ceramic encased.

There are other material differences. Instead of an ordinary laminated E frame, we use a solid ferrite cutlass core power transformer to cut eddy currents, minimize flux leakage and improve voltage regulation. And instead of ferrous metals, we use 100% aluminum and zinc chassis construction including a diecast laser head and a precision disc drive mechanism.

What else does the DA-910 offer?

- Infrared wireless remote control system.
- Three separate power supplies to allow complete isolation to critical circuits.
- Direct coupling (audio stages) for excellent low frequency response.
- Floating horizontal motorized disc loading to further improve stability and accuracy from external feedback.
- Separate digital to analog conversion for left and right channels.
- 176.4 Khz quadruple over-sampling technology.
- Quality digital and improved analog filtering for superior phase distortion performance.
- Full feature programmable keyboard entry.

Even before Kyocera added ceramics, the DA-910 CD player provided remarkable purity. With ceramics, the results are truly astounding. Put it to the test at a selected Kyocera dealer now.

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The TD-800 is, without a doubt, one of the finest tuner/tape deck combinations ever offered to music-loving drivers.

even when the unit was off, a nice touch; with the tuner on, more LEDs visually locate the preset buttons and show which has been selected. It was too easy, especially in the dark, to confuse the fast-forward and rewind buttons, but indicator LEDs made it clear what the deck was actually doing.

The azimuth control proved its worth when I randomly tested 16 tapes and found their proper azimuth settings ranging from +6 to −11 (including an 8-click variation between sides of one tape). But I probably wouldn't be able to use it much while driving, except with badly misaligned tapes. I also found it useful in rolling off the highs on very hissy tapes, since it works more steeply (Fig. 7A) than the treble control.

On the road, tape performance was exceptional. I heard no flutter on bumpy roads, and the sound was clear and clean, even with metal tapes recorded to their limit.

The real eye-opener was FM performance. According to the specs, the TD-800 should be no match for my reference system's tuner; in practice, the 800 runs rings around it. On the highway, I consistently picked up many more stations, far more clearly, with the Nakamichi. (In one far-fringe location, the TD-800 picked up 14 stations well, 12 stations fairly well, and eight stations poorly, while my reference system got two good, three fair, and three poor ones.) In high-multipath city driving, both units were pretty good; the TD-800's manual mono setting helped more, here, than its manual high-blend control. On AM, the TD-800 picked up very few more stations than my reference unit, but sounded substantially clearer on the strong ones.

Nakamichi may bill the TD-800 as a unique tape player, which it is. But as an FM tuner it is, while not technically unique, still uniquely good. Overall, sound clarity proved to be the unit's major virtue—not just in tape playback (where the azimuth control system had led me to expect it) but in FM and AM as well. *Ivan Berger*

Department of Further Amplification

The Perreaux preamp, tested in our July issue, was in a seriously underbiased condition—0.4 mA instead of the specified 18 mA. This may well have affected the listening tests and possibly several of the measurements. Where and how this underbiasing occurred, neither the maker, the importer nor *Audio's* office staff and reviewer know. Graciously, the importer has offered to take the lumps for the condition of the preamp, since they provided no schematic which would have disclosed the proper level. Not providing details of the circuitry is understandable since many of the Perreaux techniques are proprietary. On the other hand, *Audio* might well have asked about such a peculiar situation in a preamp we otherwise saw as a good attempt at state of the art. Our sample seemed in good working order when tested.

The results of the repeat listening tests and measurements will appear together with some comments about preamp design criteria and testing by Peter Perreaux. Specifically addressed will be the RIAA circuitry, correlation of sonic attributes such as "air," "space," and the stereo stage with square-wave response and phase testing, and, finally, the SM2's grounding techniques and goals.—*E.P.*

The new Kyocera PL-701
Full Automatic
Belt Drive Turntable

Steady as a rock.

To avoid turntable rumble, hum and howling, stability is all. Steadiness of the needle in the groove—and in the platter rotation.

Kyocera's solution: It starts with ceramics. This unique material provides uncommon stability and isolation of mechanical and electrical feedback. The result is a performance that is virtually free of vibration and resonance.

A rigid ceramic-compound resin forms the subchassis of the PL-701. To further eliminate vibration, this subchassis is suspended by three springs within a sturdy wood base. The base has four adjustable shock-mounted feet. This dual-isolation foundation supports the platter and arm. For even greater stability and uniform rotation, the platter weighs in at 3.3 lbs. Add an advanced two-motor belt drive system to eliminate motor vibration and you have a turntable that is truly—steady as a rock.

Other features:

- Straight aluminum tubular low mass tonearm with removable carbon fiber shell.
- Micro-computer electronic sensing non-friction tonearm control.
- Stabilizer (.7 lb) with built-in two-speed stroboscope.
- Wow and flutter of 0.03%.
- Signal-to-noise ratio of 70 dB (DIN-B)
- Tinted dust cover and convenient soft-touch front panel controls.

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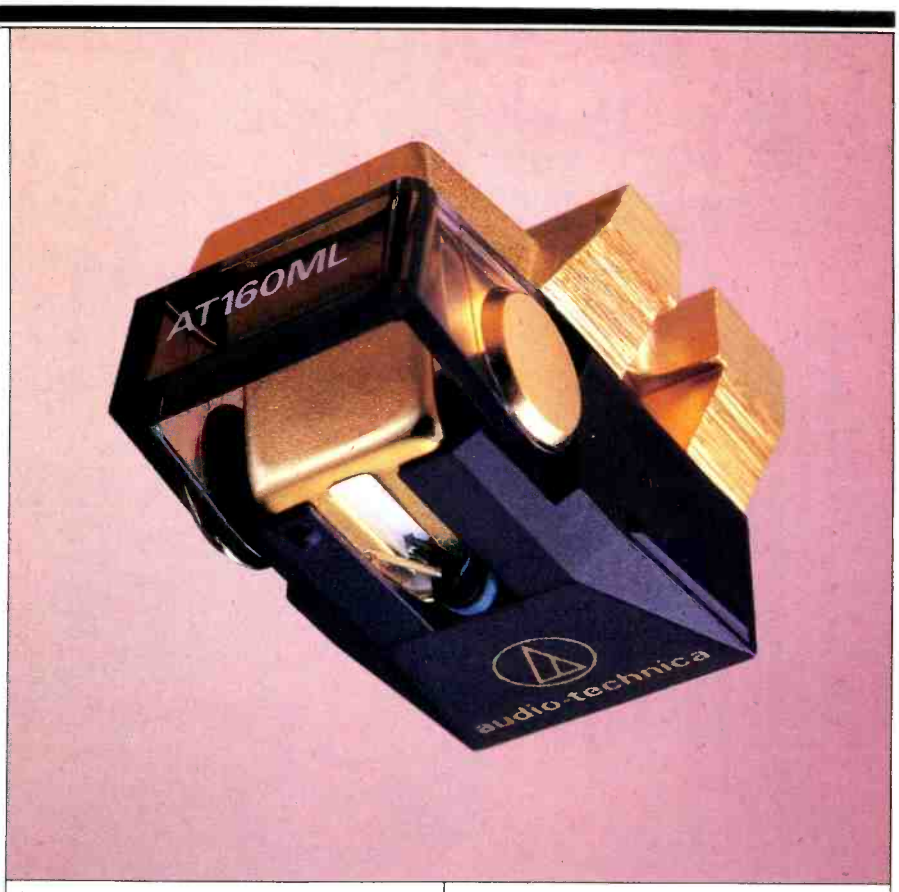
4

AUDIO-TECHNICA AT160ML CARTRIDGE



Manufacturer's Specifications
Type: Moving magnet.
Stylus: MicroLine, nude-mounted, grain-oriented, square diamond.
Frequency Response: 5 Hz to 35 kHz.
Channel Balance: Within 0.5 dB.
Separation: 31 dB at 1 kHz, 21 dB at 10 kHz.
Recommended Vertical Tracking Force Range: 0.08 to 1.8 grams.
Tracking Ability: 90 microns at center vertical tracking force (VTF), 100 microns at upper VTF.
Output: 5 mV at 1 kHz and 5 cm/S.
Recommended Load Impedance: 47 kilohms and 100 to 200 pF.
Vertical Tracking Angle: 20° (IEC/DIN standard).
Cartridge Weight: 8.1 grams.
Price: $275.00.
Company Address: 1221 Commerce Dr., Stow, Ohio 44224.
For literature, circle No. 93

The AT160ML cartridge, introduced in early 1984, succeeds the AT155LC as the top of Audio-Technica's moving-magnet line. While the 155 remains in the line, the 160 sports several important developments—reduced cantilever mass, the new MicroLine stylus shape, and an improved stylus guard. The cartridge comes in an attractive plastic case with a universal headshell and an assortment of accessories. The case itself will display and store two cartridges in universal shells. The case's back can be removed for access to the accessories, which include an overhang gauge, a left/right inclination gauge, two brushes (the usual stylus brush and a special one to reach the recessed contacts in a universal tonearm mount), an Allen wrench for unlocking the headshell azimuth adjuster, a flat-bladed screwdriver, and the usual mounting hardware. All in all, this is an unusually complete and very well thought-out set of accessories, which nicely complements a top-of-the-line phono cartridge.

The AT160ML is one of the first cartridges on the market to use the new MicroLine stylus design (see Fig. 1). To produce this radically new tip shape, the square, grain-aligned diamond stylus is cut away at the edges of the normal contact area to form a microscopic ridge, which rides at 90° to the record groove. This shape allows more vertical contact than is possible with almost every other design, and only one or two other designs compare in this regard. In addition, since the front and back sides of the ridge are parallel, the shape of the footprint area contacting the record groove wall does not broaden as the stylus tip wears. It also appears likely that discs will be worn at a slower rate, particularly discs which are hard to track because of their high velocities. Further, not only will new records be tracked better, but older discs, ones with moderate amounts of wear confined to specific levels of the groove wall, will be reproduced better. While it might fairly be said that all of these benefits could be claimed by the successively more radical generations of stylus tips, there can only be one "Best Tracking Cartridge" at each point in time. Certainly, Audio-Technica's AT160ML is an extremely strong contender for that crown at present.

The cantilever is 0.3 mm in diameter and, like its predecessor in the AT155LC, it is made of beryllium, one of the lightest and stiffest metals. In the AT160ML, it is gold-plated, as part of an effort to flatten frequency response by control-

The new Kyocera A-910 Integrated Amplifier.

Pure power without bad vibes.

The key is Kyocera ceramics technology—a superior new way to virtually eliminate mechanical and electrical vibrations that impede dynamic performance.

It starts with a handsome ceramic-compound resin base (actually the chassis) that supports all components. Because ceramics are rigid and inert, they provide vibration-free stability immune from volume and frequency irregularities. Because ceramics are non-ferrous, there are no eddy currents—so there's no electrical hum. Result: a chassis with practically no mechanical and electrical impurities.

In addition, fine ceramics encapsulate critical components throughout the circuitry to further isolate vibration. Kyocera also uses a heavy duty cutlass core power transformer to reduce eddy currents, minimize flux leakage and improve voltage regulation.

There are many other features that distinguish this extraordinary integrated amp:

- Rated a full 150 watts per channel into 8 OHMS at 0.02% THD from 20-20,000 HZ.
- New MM/MC equalizer with ultra low noise and input impedance transistors.
- Heavy duty high speed 80 MHZ power amplifier design incorporating parallel triple push pull final stages with MOS FET drivers.
- Single stage push pull amplifier circuitry for improved signal to noise ratio and wide band frequency response.

Kyocera's matching PLL Quartz synthesized AM/FM Stereo T-910 Tuner.

- Non-ferrous ceramic-compound resin base with adjustable feet.
- Fluorescent digital display (low noise type).
- Dynamic noise reduction circuitry for improved weak signal reception.
- Programmable 16 station pre-selects.
- Narrow or wide IF bandwith programmable selection.
- Two FM antenna—programmable selected.
- Multiplex decoder with pilot and birdie noise cancelling circuit.

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The AT160ML's new stylus tip, dubbed the MicroLine, offers better vertical contact with the groove throughout the stylus life.

ling and reducing resonances. Audio-Technica uses what they term a Vector-Aligned Dual Magnet system, which positions two tiny cylindrical magnets in the shape of a "V" to match the angles of the left and right groove walls on a stereo record. These magnets are arranged between the laminated pole pieces, which are para-toroidally wound to reduce sensitivity to hum. Immediately to the rear of the magnet and pole-piece assembly, and located at the fulcrum, is the radial damping ring, which AT tells us is individually hand-tuned. Such hand-tuning, incidentally, can do a good deal for a cartridge's response. In a cheaply made cartridge, hand-tuning can bring the unit within spec; in high-end cartridges like the AT160ML, hand-tuning will bring the response within very fine tolerance.

Measurements

After measuring an inductance of 565 mH and a resistance of 760 ohms, I mounted the AT160ML in the tonearm of the recently introduced AR Turntable and aligned it using Telarc's Omnidisc. The AT160ML weighs 8.1 grams, which is at the heavy end of the range for today's cartridges, and what with the additional weight from screws, nuts, and so forth, I found that the AR's counterweight was not heavy enough to balance the cartridge. I therefore machined an additional mass for the arm and proceeded with the tests.

As is the practice of this magazine's reviewers, measurements are made on both channels to assure accuracy, but only the left channel is reported unless there is significant variation. During the test period, temperature was 70° ±2° and the relative humidity ranged from 50% to 70%. The following records were used in making the measurements reported here: CBS STR-100 and STR-112; JVC TRS-1007; Deutsches HiFi No. 2, and Shure Brothers TTR-103, TTR-110, TTR-115, and TTR-117.

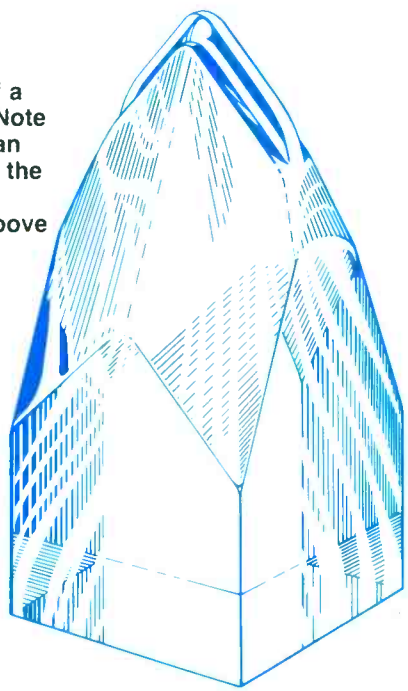


Fig. 1—Drawing of a MicroLine stylus. Note how the shape is an attempt to contact the maximum vertical distance of the groove wall.

The tracking force found to be optimum was 1.5 grams, and the anti-skating force was set to 1.8 grams, again the optimum setting. The load resistance was 47 kilohms and the total load capacitance was 200 pF. As one might expect with a relatively heavy cartridge such as this one, the low-frequency arm-cartridge resonance (12-dB rise of 6.5 Hz) was at a lower frequency than one would optimally prefer. This is within the warp-wow frequency region and should be of concern to those who play significant numbers of warped discs. The peak would be lowered by use of a tonearm with a well-engineered decoupled counterweight.

The AT160ML's frequency response (see Fig. 3) was within 1.5 dB from 40 Hz to 20 kHz, using the CBS STR-100 test record. Using the JVC TRS-1007 test record, the channel-to-channel separation at midrange frequencies was a bit over 30 dB, decreasing smoothly to about 23 dB at 10 kHz, and to 15 dB at 20 kHz.

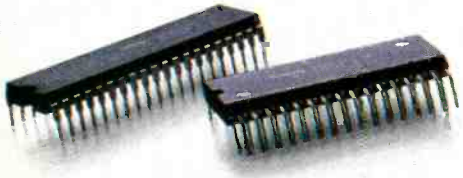
Static vertical compliance was 42×10^{-6} cm/dyne, while dynamic vertical compliance was 9.2×10^{-6} cm/dyne. The lateral compliance was found to be 8×10^{-6} cm/dyne. The vertical tracking angle was found to be approximately 20°, using an optical readout system. Output was found to be 5.3 and 5.8 mV (1.50 and 1.64 mV/cm/S) for the left and right channels respectively, for a channel balance within 0.22 dB.

Figure 4 shows the square-wave response as obtained with the CBS STR-112 test record. An expanded 'scope trace revealed the rise time to be 18 μS with the normal load of 47 kilohms and 200 pF. Increasing the capacitive load to 700 pF increased the rise time to 22 μS; 700 pF is probably outside any real-world conditions. The cartridge is well damped, showing only one cycle of sonic-region oscillation during square-wave tests, the last half cycle being rather small. This is followed by ultrasonic oscillations at a frequency of about 37 kHz, which are on the test record, probably as a result of cutterhead assembly ringing.

Using the 3.54 cm/S, 45°, 1-kHz signals from the CBS STR-100 test record, the total harmonic distortion was found to be 1.3%. IM distortion, using CBS STR-112 (400/4000 Hz, 4-to-1), was: Lateral (+9 dB), left 0.9%, right 1%; vertical (+6 dB), left 1%, right 1.2%.

Tests of tracking ability showed that the AT160ML is outstanding in its ability to handle highly modulated discs. The cartridge easily tracked the highest vertical and horizontal 300-Hz bands of the Deutsches HiFi No. 2 test record. The recorded levels from the correction table are 55.4 microns (0.00554 cm) at 10.32 cm/S at +5.86 dB, and 114 microns (0.0114 cm) at 21.5 cm/S at 12.10 dB, respectively. The cartridge was also able to track the highest (+18 dB) 300-Hz lateral and highest (+12 dB) 300-Hz vertical bands of the CBS STR-112; the +18 dB band approximates the highest levels found on commercial recordings. With Shure's TTR-103, some slight mistracking was evident on the highest level of side 1, band 8, which is composed of 1 and 1.5 kHz, mixed at equal levels and recorded at 40 cm/S peak velocity. The AT160ML successfully tracked this disc's previous band, which was recorded at 31.7 cm/S peak velocity. The cartridge also tracked all bands of Shure's

TO CREATE A BETTER DISC PLAYER, WE TURNED TO A HIGHER INTELLIGENCE.



Yamaha's proprietary LSI technology provides audibly superior playback and added programming power.

Introducing the CD-2 compact disc player. And the brains that set it above all other compact disc players.

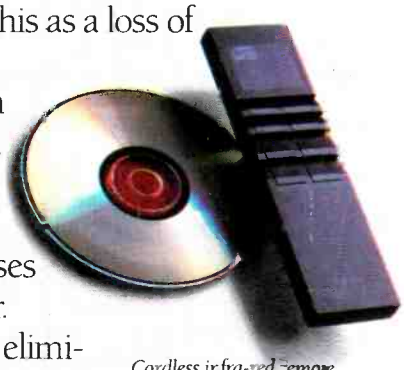
We're referring, of course, to our proprietary LSIs (Large Scale Integrated circuits). And the approach they use to process digital signals.

Most CD players convert the digitized signals at a standard sampling rate of 44.1kHz. So they are forced to use a very sharp 50db/octave analog filter to cut off the unwanted frequencies above 20kHz generated by the 44.1kHz carrier signal.

This process creates phase anomalies which degrade the harmonic structure of your music. You hear this as a loss of dimensionality.

So we came up with an intelligent solution. Our YM-2201 LSI. It doubles the sampling rate to 88.2kHz and uses an on-chip digital filter.

This over-sampling eliminates phase distortion and maintains the harmonic integrity of your source. With no loss of dimensionality. You can actually hear a more natural, spacious sound from your discs.



Cordless infra-red remote control is standard equipment.

A related benefit of our proprietary LSI technology is user convenience. You can choose from three different playback modes. Program the random-access memory system in moments. And search for selections (or individual passages within a selection) at the touch of a button.

To match your decor and other components, the CD-2 is available in silver and black (both standard component size).

You also get wireless infra-red remote control. Our 3-beam laser with LSI-based servo-control for extraordinary tracking accuracy. And a sleek, component-sized package.

What's more, if you don't require the CD-2's random access programming, or a remote, you can enjoy all this sound-improving technology in the CD-X1. At an even lower price. (CD-2, $599*; CD-X1, $499*)

So visit your Yamaha dealer today. And hear for yourself why our CD-2 is the most intelligent way there is to listen to compact discs.

YAMAHA

*Suggested U.S.A. retail prices

Yamaha Electronics Corporation, USA, P.O. Box 6660, Buena Park, CA 90622

Frequency response was within 1.5 dB from 40 Hz to 20 kHz, while separation was above 30 dB through the midrange frequencies.

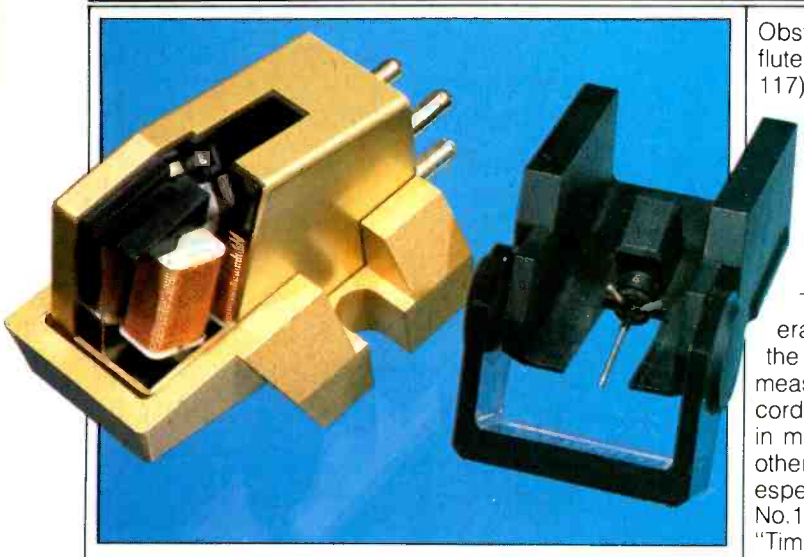


Fig. 2—This large-scale model shows how the coils in the AT160ML are arranged.

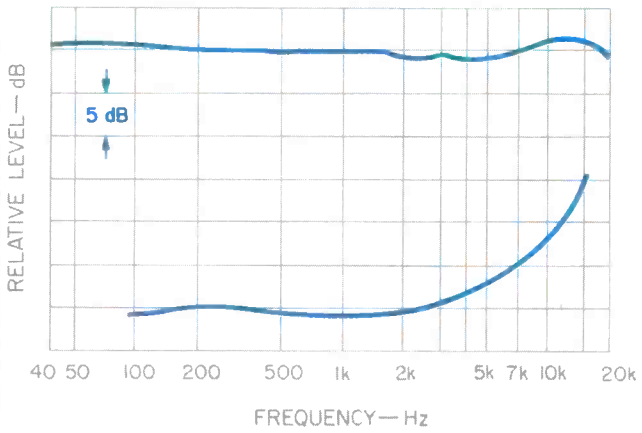


Fig. 3—Frequency response from CBS STR-100 and separation from JVC TRS-1007.

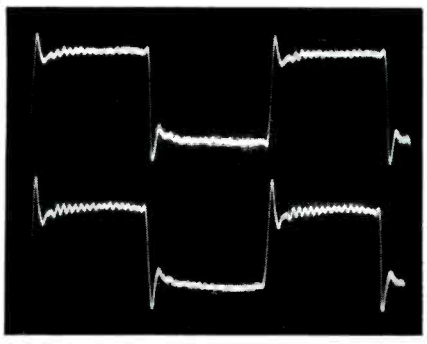


Fig. 4—Response to 1-kHz square wave from CBS STR-112.

Obstacle Course Era IV (TTR-115) except for level 5 of the flute and harp test. Shure's Era V Obstacle Course (TTR-117) contains a complex signal composed of 200 Hz, 2.1 kHz, and 17 kHz; all six bands on this disc were tracked without audible mistracking or waveform distortion being visible on the 'scope. An X/Y plot revealed good linearity and phasing between the two channels.

Use and Listening Tests

The Audio-Technica AT160ML was used to audition several digitally mastered and direct-to-disc recordings, using the same AR Tonearm and AR Turntable with which the measurements are performed. In addition to the three recordings from Delos and the Mobile Fidelity disc mentioned in my March 1984 review of the Micro-Acoustics 630, two other sampler discs were used for auditioning and are to be especially recommended. These are Opus 3's Test Record No.1, "Depth of Image" (79-00) and Test Record No. 2, "Timbre" (80-00). (Available from Scandinavian Sounds, P.O. Box 3656, San Clemente, Cal. 92672.) These recordings contain superbly recorded music and require no instruments for the evaluation of one's system. (*Editor's Note:* We have been using this disc pair around the office for some months, principally to check loudspeaker voicings as a preliminary to full-scale reviews. Frankly, we're in love with them. They contain virtually every sort of music one might wish—vocal, organ, piano, guitar, violin, both solo and in groups. I can't think of any cut that isn't acoustic, rather than electric, and natural, rather than colored.—*E.P.*)

As its uniform frequency response would suggest, the AT160ML presented a neutral, unrestrained sound over a wide range of recorded material. This included the broad variety of types presented by the Opus 3 records, particularly the massed choirs, plucked strings, and percussive sounds, such as drums and finger-cymbals. Highs were unrestrained and possessed a sheen, but not to the point of excessive brightness. The midrange was natural, and the bass was solid. With the misshapen discs I use to test for warp-handling ability, a small amount of warp modulation of sustained mid-frequency notes was heard. This check of arm-cartridge interaction with record warp is worst-case testing, since there seldom is a need or desire to play such severely warped discs and a good decoupled tonearm can reduce such modulation to inaudibility.

The imaging of the AT160ML was good. The left-to-right stereo stage was stable, with individual instruments and soloists maintaining their positions. Front-to-back imaging was similarly good, particularly with the Gitarrkvartetten handling of J. S. Bach's "Invention No. 14" on the Opus 3 "Depth of Image" disc.

To sum up, then, the Audio-Technica AT160ML is not an inexpensive cartridge since it lists at $275, but it is reasonably priced considering its level of performance. One particular appeal will be to those who wish to upgrade to a cartridge possessing one of the newest and best-tracking stylus shapes. The AT160ML is also a cartridge with good linear frequency response, excellent separation, and superior tracking ability. In short, it's a strong contender for state-of-the-art.

George Shellenberger

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YAMAHA NS-2000 LOUDSPEAKER

Company Address: 6600 Orangethorpe Ave., Buena Park, Cal. 90620.
For literature, circle No. 94

The Yamaha NS-2000 speaker system is definitely a high-end product. It costs $2,900 per pair, and combines a greatly improved form of the beryllium dome midrange and tweeter technology which Yamaha pioneered in the NS-1000 with a true all-carbon-fiber woofer cone. These drivers are placed in the most solidly built enclosure that I have ever encountered in a box speaker. Each unit weighs 103 pounds, although it measures only 17⅝ × 29⅝ × 15⅞ inches.

The main change in the new beryllium drivers is greatly improved dispersion. The 13-inch carbon-fiber woofer is made of formed sheets to allow Yamaha to avoid any blend of the carbon and other materials, and this woofer is said to have very similar sound propagation properties to the beryllium 3½-inch midrange dome and 1-3/16-inch tweeter. All drivers have comparatively high flux and seem to be very well made, indeed.

Careful attention is paid to minimize cabinet and mounting diffraction effects. The crossover is a fairly complex 12 dB/octave system, operating at nominal frequencies of 500 Hz and 6 kHz, and uses good components. Separate level adjustments are provided for the midrange and tweeter.

The cabinet finish is superb, as well as being nonresonant. The speaker does, however, need a custom-made stand to raise its tweeter to ear height. Suitable speaker stands are available from the Chicago Speaker Stand Co. (4701 W. Armitage Ave., Chicago, Ill. 60631) for $75 and raise the units 8 inches off the ground. The speaker connections are the clip-in types.

The sound of the speaker is highly dependent on adjustment of the midrange and treble controls. I found it excessively bright until the treble control was set below 10 o'clock and the midrange control below 11 o'clock. It is also essential to keep each speaker about 18 inches from the rear wall and 24 inches from either side wall to get the flattest response in most rooms, as well as to use stands to raise the speaker so the tweeter is ear height. Keeping the backs parallel to the wall seems to provide better imaging and sound-stage depth than a toed-in (drivers pointed toward the listening position) placement.

As is the case with most acoustic-suspension designs, the NS-2000 provides its best bass response and control with the high damping factor and low impedance drive capability of the better transistor amps. For example, the Robertson Forty Ten and Sixty Ten did notably better in controlling the bass than the conrad-johnson Premier Four or Audio Research D-160B.

Even with such amplifiers, there is limited deep bass below 50 Hz. The mid- and upper-bass, however, is excellent. The NS-2000 is fast, flat, detailed, and well controlled to any power level a sane listener could desire. This is not an organ buff's speaker, but no drummer, pianist or bass player is likely to criticize its performance. This is saying quite a bit, even given the demanding competition in the NS-2000's price range.

The midrange is equally clean, but not as flat, and there are some slight sonic problems around the crossover frequency of 500 Hz. The NS-2000 lacks its usual coherence at this point. There also is a slight upward tilt in the upper midrange which cannot be eliminated by the midrange or treble controls. The speaker's specifications indicate that this is around 2 kHz, but it sounds slightly higher. The blend between midrange and tweeter is excellent, and considerably better than in most high-end speakers.

The NS-2000s have a musically natural midrange and treble, with a slight tinge of brightness. This is not noticeable on good, well-balanced recordings—in fact, it helps create the impression of "life," that one is sitting near the performance. It can, however, be slightly hard when the material is bright or miked too close. The upper strings and female voice can be particularly revealing in this regard.

The NS-2000s are not the ideal speakers for a phono cartridge with a rising high end or for hard transistor electronics. A flat or slightly downward sloping cartridge is preferable. The speed and detail of the Yamaha NS-2000s make them a good match with tube electronics or those transistor electronics which are detailed and mu-

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Yamaha's NS-2000 speakers clearly merit, if not demand, excellent high-end components.

sical, rather than those which are aggressive and bright.

They worked very well with the new Hafler and PS Audio equipment and the "softer" tube electronics—such as the conrad-johnson or earlier Audio Research products. You may, therefore, have to make some minor tradeoffs between the merits of transistors for the bass and tubes for the midrange and treble.

Imaging and sound-stage depth are very good, but not excellent. The NS-2000s offer a wide, stable sound stage, good dispersion over a wide range of listening positions, and considerable depth. They do not, however, match the ability of the Quad ESL-63s or Thiel CS-3s to both place an instrument in a precise and stable manner and then give it the harmonic detail or air that make it sound natural.

The Yamaha NS-2000s do, however, have outstanding dynamics and power handling, which helps them provide very good sound with piano and percussive instruments. They outperform the Quads and Thiels in this respect, although the difference between them and the Thiels is limited. Further, the Yamahas are much less sensitive than the Quads and other dipole speakers to rear wall conditions, and this helps eliminate bass anomalies and center-fill problems.

Whether they are the best pair of near-$3,000 speakers in the world is impossible to answer. They are a definite design success, and a considerable advance over the NS-1000M, which was the first speaker to prove to me that Japan could also make great loudspeakers. The NS-2000s clearly merit, if not demand, excellent high-end components.

Much will depend on your preferred listening position and style. I would describe these speakers as putting you close to the music in a modern hall: They are accurate, detailed, and musically natural, with good staging and the ability to disappear behind the music.

Put it this way: They are good enough, even at their high price, to be worth extended auditioning with the proper matching components. I even felt it was well worth lugging 206 pounds of speakers into my living room. A very good listen!

Anthony H. Cordesman

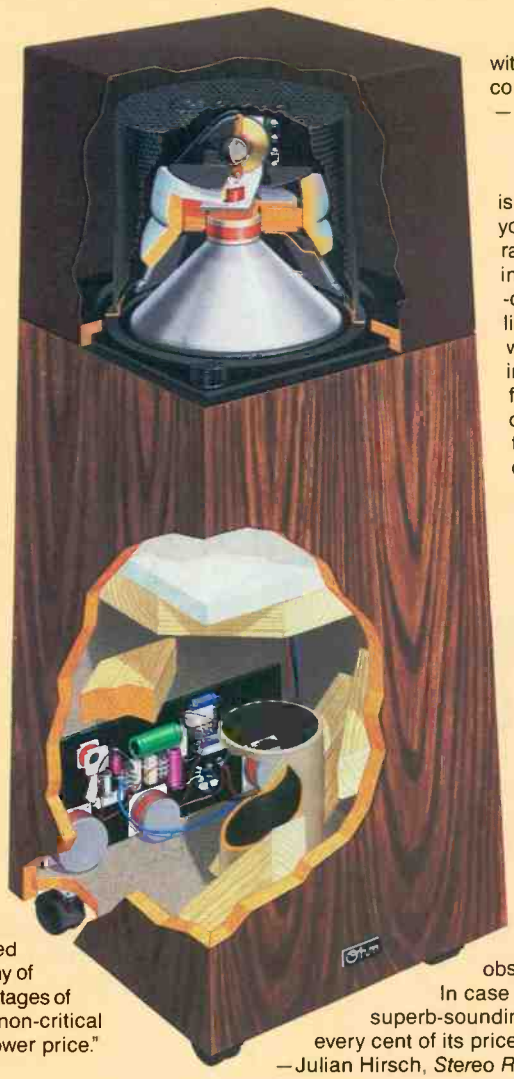
Experts Experience Superb Sound of Ohm Walsh 4

Experience the Innovation

"As close to genuine innovation as anything we have seen in this broad class of (dynamic) speakers, is the cylindrical diaphragm devised by the late Lincoln Walsh (1903–1971). It resembles a megaphone standing on its wide end — a huge inverted ice cream cone, if you will — with the voice-coil perched at the apex.

Why this design? For one thing, it produces uniform power dispersion omnidirectionally, a technique that is credited with achieving excellent phase linearity and sonic 'coherence,' contributing both to clarity and to a good stereo image."
— Norman Eisenberg, *Ovation*

"Ohm claims that the Walsh driver does not operate as a piston — the usual design goal for a conventional speaker — but rather as a transmission line that progressively delays the propagation of different frequencies so that a coherent cylindrical sound field is radiated. Some years ago, when we tested the original, Ohm F speakers, we were able to verify that claim to our satisfaction. Although the Walsh 4 is a modified form of that system, it retains many of its qualities, with the added advantages of a reasonably high sensitivity, non-critical room placement, and a much lower price."
— Julian Hirsch, *Stereo Review*



Experience the Power

"(Ohm) has now at last gone all the way with the new Ohm Walsh 4, which boasts all the notable virtues of the earlier model but extends the bass to 32 Hertz. This allows it to conjure up with almost tactile impact the deep shudder of a low C played on an organ pedal or the wallop of a bass drum. With a stupendous power capacity of 500 watts, the Ohm Walsh 4 accommodates with apparent ease even the most hair-raising sonic peaks contained on the new laser disks."
— Hans Fantel, *The New York Times*

Experience the Sound

"Listening to a pair of (Walsh) 4s reproducing music is the real clincher. You are hardly into a recording before you sense that you are listening to a performance rather than to one being reproduced by machinery. This impression — which one may get from a few other top-quality speakers — does not lessen with prolonged listening. The full musical spectrum is easily spanned with authority and fine tonal balance. Detailing of inner instrumental choirs is excellent, and so too are the fuller splashes of massed ensemble effects. Titanic dynamic impact comes across when required, yet there there is no tonal dropout of the subtle nuances of chamber music. Transients come across properly crisp and forceful, but not 'over-etched' to the point of unnaturalness."
— Norman Eisenberg, *Ovation*

"The Ohm Walsh 4 is as smooth and natural sounding as its excellent frequency-response measurement suggests. It provides a full stereo stage of sound at almost any position in the room, including a distinct quality of depth resulting (presumably) from sound reflections off the rear and side walls.

Ohm makes much of the imaging qualities of this speaker, and it certainly lives up to those claims. A demo record produced by Ohm provides convincing evidence that the Walsh 4, playing a variety of commercial music recordings, is capable of generating distinct spatial images that are apparent from almost any position in the room. For example, Leroy Anderson's musical typewriter moves with the impressive smoothness between the speakers, with not a trace of the vague, uncertain, or erratic position shifts that we observed with some other speakers.

In case I have not made the point sufficiently clear, this is a superb-sounding speaker — not inexpensive by any means, but worth every cent of its price.
— Julian Hirsch, *Stereo Review*

For information on Ohm Walsh speakers, and details on how you can buy directly from Ohm, write or call toll free, today.

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Specifications	Ohm Walsh 1	Ohm Walsh 2	Ohm Walsh 4
Frequency Response	48 Hz to 18kHz ±4dB	45Hz to 16kHz ± 4dB	32Hz to 17kHz ± 4dB
Weight	24 lbs.	29 lbs.	63 lbs.
Sensitivity	87dB at 1 meter with a 2.83 volt input	87dB at 1 meter with a 2.83 volt input and all controls at maximum	87dB at 1 meter with a 2.83 volt input and all controls at maximum
Finish	Genuine walnut veneer	Genuine wood veneer, walnut and oak standard. Scandinavian rosewood and black or white lacquer on oak finishes available on special order.	Genuine wood veneer, walnut and oak Scandinavian rosewood and black or white lacquer on oak finishes available on special order.
Inputs	Press connectors accepting "banana plugs" or bare wire up to 12 gauge	Press connectors accepting "banana plugs" or bare wire up to 12 gauge	Press connectors accepting "banana plugs" or bare wire up to 12 gauge
Controls	None	2 — low and high frequency each with 3 positions	3 — low, high and perspective each with 3 positions
Power requirement on Music	20 watts minimum/90 watts maximum	30 watts minimum/120 watts maximum	50 watts minimum/500 watts maximum
Impedance	8 ohms	4 ohms	8 ohms
Price per Pair	Under $595	Under $995 Depending on finish	Under $1895 Depending on finish

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MICHAEL TEARSON
JON & SALLY TIVEN

FIRE THE BOSS

Born in the U.S.A.: Bruce Springsteen and the E-Street Band
Columbia QC38653.

Sound: B – Performance: C

Bruce Springsteen has come to the point in his career most artists eventually reach, and his coming to grips with his situation has produced a simply mediocre piece of work. Most of those idols Springsteen revered have either passed on or have been dwarfed by Bruce's fame. Bruce is alone on his mountaintop, seemingly flanked only by yes-men, stacks of records, and the E-Street Band. Unfortunately, Mr. Springsteen isn't exactly the deepest of thinkers and, having shed most of his influences, his recent introspections result in an album of relatively little consequence.

From the title track—yet another rewrite of "Cadillac Ranch" with an additional debt to Keith Richards—to the pseudo-moderne synths of the single "Dancing in the Dark," Springsteen shows himself to be anything but The Boss. His bravado of old is replaced by a desperation without reason, a nostalgia that reads more like a reactionary streak than common sense. The Great White Hope of '70s rock has become a has-been. In refusing to move forward with musical trends, Bruce Springsteen displays an alienation from his first love—the world of rock 'n' roll.

Some of this is due to Springsteen's own mid-career crisis. How long can you go on singing about cars, girls, the road, the night, and the glories of rock 'n' roll once you pass 30? But no, Bruce's shrine is his record collection, and there are no greater glories than to try to rekindle some quasi Woody Guthrie "We Are the Common People" stance. The record sounds pompous, as if it *should* mean something, but, upon close inspection, it resembles warmed-over Meatloaf. The new Bob Dylan has turned into the New Elvis—flanked by his impenetrable Jersey Mafia, and no signals get through that aren't specially groomed. These tracks were originally intended for release before *Nebraska*—an album of infinitely more power and honesty than *Born in the U.S.A.*—and it's easy to see why they were delayed. The words are hollow, the melodies retreads, the arrangements border on self-parody. Welcome to the unveiling of The Emperor's New Album. *Jon & Sally Tiven*

(*Reviewer's Note:* There is something a bit unusual about the packaging of *Born in the U.S.A.* which may be of note to *Audio* readers. The album's innersleeve is ¼-inch wider than usual, making it impossible to insert the sleeve with the open side out without mangling it. This may well help some people take better care of the album, and as such it is a fine, off-the-wall idea.—*Michael Tearson*)

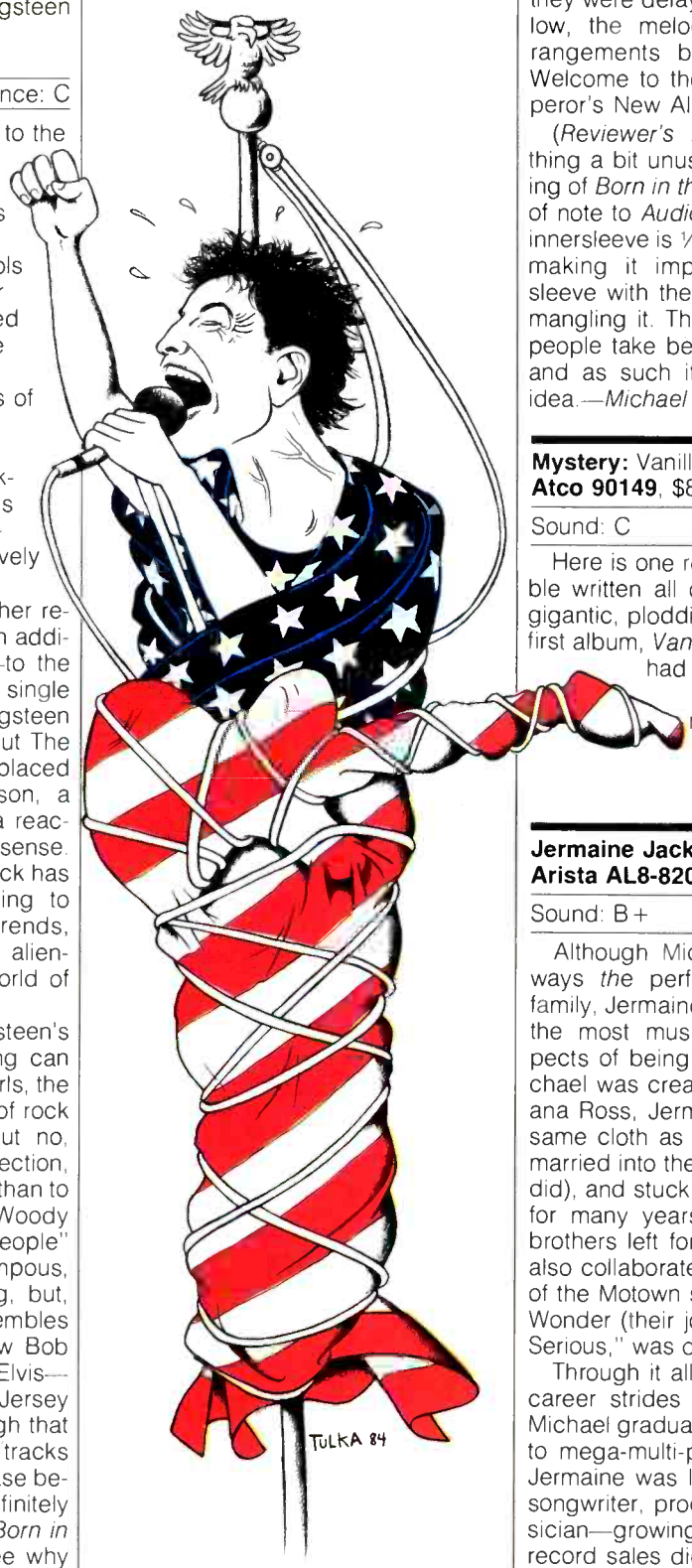

Illustration: Rick Tulka

Mystery: Vanilla Fudge
Atco 90149, $8.98.

Sound: C Performance: D –

Here is one reunion that has inevitable written all over it. *Mystery* is one gigantic, plodding turkey. So was their first album, *Vanilla Fudge*, but that one had the innocence of youth going for it. As a wise man sang, "The original is still the greatest."
Michael Tearson

Jermaine Jackson
Arista AL8-8203, $8.98.

Sound: B+ Performance: B+

Although Michael Jackson was always *the* performer in the Jackson family, Jermaine embodied the spirit of the most musically adventurous aspects of being a Motown artist. If Michael was created in the image of Diana Ross, Jermaine was cut from the same cloth as Marvin Gaye. He even married into the Gordy clan (as Marvin did), and stuck with the Motown family for many years after the rest of his brothers left for greener pastures. He also collaborated with many members of the Motown stable, including Stevie Wonder (their joint venture, "Let's Get Serious," was quite compelling).

Through it all Jermaine made minor career strides while younger brother Michael graduated from platinum sales to mega-multi-platinum. All the while, Jermaine was learning his trade as a songwriter, producer, singer, and musician—growing as an artist even if his record sales didn't reflect it. When he

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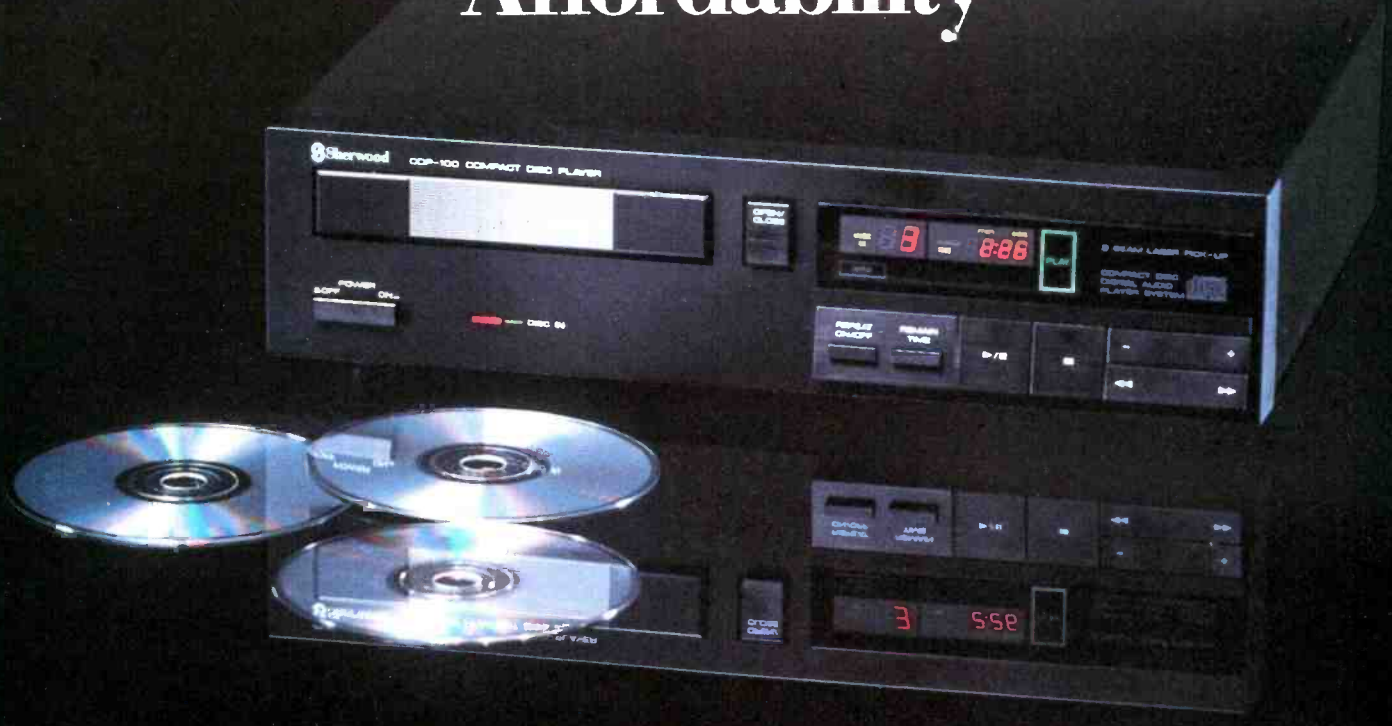

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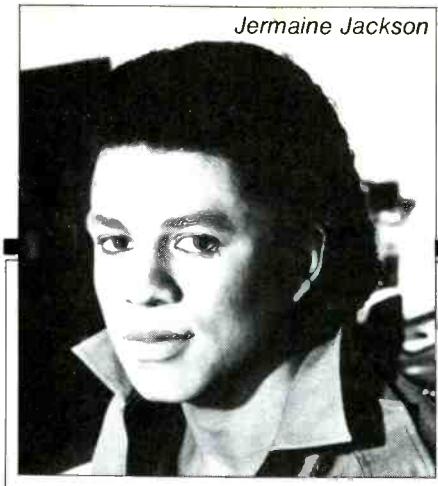

Jermaine Jackson

All in all, a very impressive album from a very talented man. Jermaine Jackson will obviously grow more as a writer in the future.

finally cut his ties with Motown, his bid for stellar sales was this record which, in many ways, is the culmination of his woodshedding. Jermaine produced most of it (with help from Michael Omartian and arranger Michael Sembello), wrote little of it, and sang his arse off on it. Although it seems to have been created in a spirit-of-*Thriller* atmosphere, Jermaine manages to come off as his own man. His debt to Marvin as a singer is acknowledged in the liner notes and in the grooves as well—the cool timbre and attack ring that familiar emotional bell. The songs and production style aren't quite as personalized as the vocalizing—Jermaine is aiming at a wider audience than was Mr. Gaye—but he knows well that one needs several "Ain't Nothing Like the Real Thing's" to legitimatize his *What's Goin' On*. His album is humbler than *Thriller*, but its high moments (such as "Dynamite" and "Tell Me I'm Not Dreaming") easily equal anything on *Thriller*. And brother Michael's duet with Jermaine is more adventurous, phrasing-wise, than one would expect. All in all, a very impressive album from a very talented man. Jermaine will obviously grow more as a writer and auteur in the future, and his approach can only improve as he takes a firmer grip on his artistic direction.

Jon & Sally Tiven

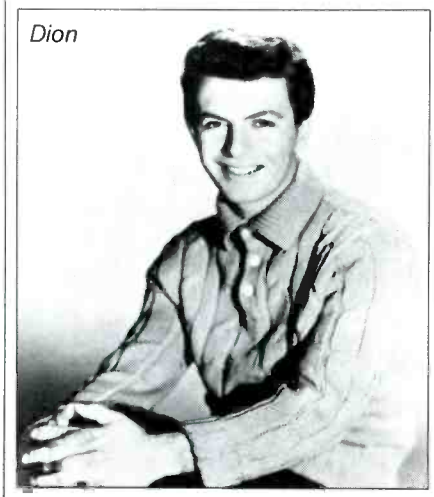
24 Original Classics: The Everly Brothers
Arista AL9-8207, two-record set, $9.98.

24 Original Classics: Dion and The Belmonts
Arista AL9-8206, two-record set, $9.98.

Sound: C+ Performance: A

Both of these sets are "best of" collections, gathered from the full span of two illustrious careers, and include selections from all of the record companies the artists recorded for. It's the first time either artist has enjoyed such complete coverage. Both sets do what retrospectives are supposed to do and so often don't: They cover the whole range of an artist's career and give it perspective.

The Everly Brothers are an act I hold especially dear, and their collection is


Dion

as good as anyone could hope for. Sides one and two cover the brilliant early years on Cadence, while three and four cover the Warner Bros. years with one early 1970s RCA track. From the raw energy of youth to the recorded polish of accomplished studio work, *24 Original Classics* shows the full range of Don and Phil Everly, from rockers through some of the most sublime ballads ever. It is all here.

The Dion set is similar in execution with two sides covering the early years on Laurie, 1958 to 1963. These include the Dion and The Belmonts hits, Dion's subsequent solo successes plus The Belmonts' 1961 hit, "Tell Me Why." Side three covers Dion's tenure at Columbia, where Mitchell Cohen's notes point out he was handled as poorly and inappropriately as Aretha Franklin was at the same time and by the same label. Side four begins with Dion's 1968 comeback smash, "Abraham, Martin and John" and its wonderful flip side, "Daddy Rollin' (In Your Arms)," and continues through his Warner Bros. years, concluding with a track licensed from Lifesong.

Sound on both sets is surprisingly good on the early songs with little noise and unexpected clarity that wavers only on the Columbia side of the Dion set. The Everly Brothers' Cadence material receives its best reproduction in several reissue attempts.

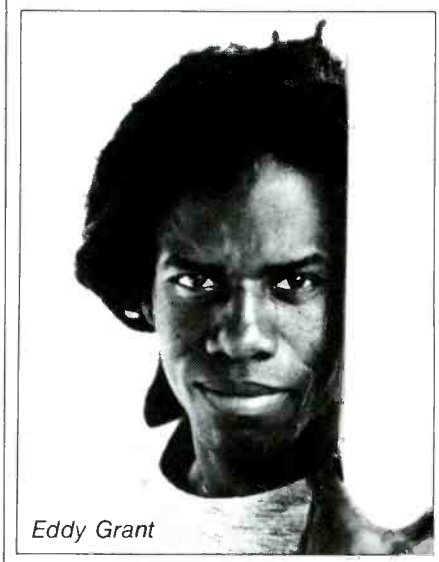
To say I prefer the Everly Brothers collection only reveals my own preferences. Both acts are important ones in the history of rock 'n' roll, and each deserves this attention. Your favorite song by The Everly Brothers or Dion is almost certainly included as well as some excellent stuff you may have forgotten or never knew before.

Michael Tearson

Going for Broke: Eddy Grant
Portrait FR 39261.

Sound: B Performance: B+

After the 1983 breakaway summer success of "Electric Avenue" from his *Killer on the Rampage* album, Eddy Grant is back with more music ideal for warm weather. Standouts on *Going for Broke* include "Boys in the Street," "Telepathy," and "Romancing the Stone," which was omitted from the


Eddy Grant

soundtrack of the hit movie at the last possible moment before release. Each side includes a slow song to help the pacing.

Eddy plays all of the instruments except the horns, but the album feels much livelier than your usual one-man band. Part of the "why" is that Grant uses only a little synthetic percussion so that a true "live" feeling is still there. *Going for Broke* is a good solid album.

Michael Tearson

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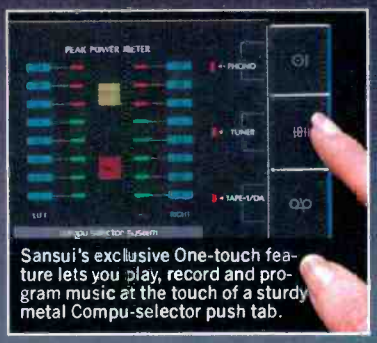

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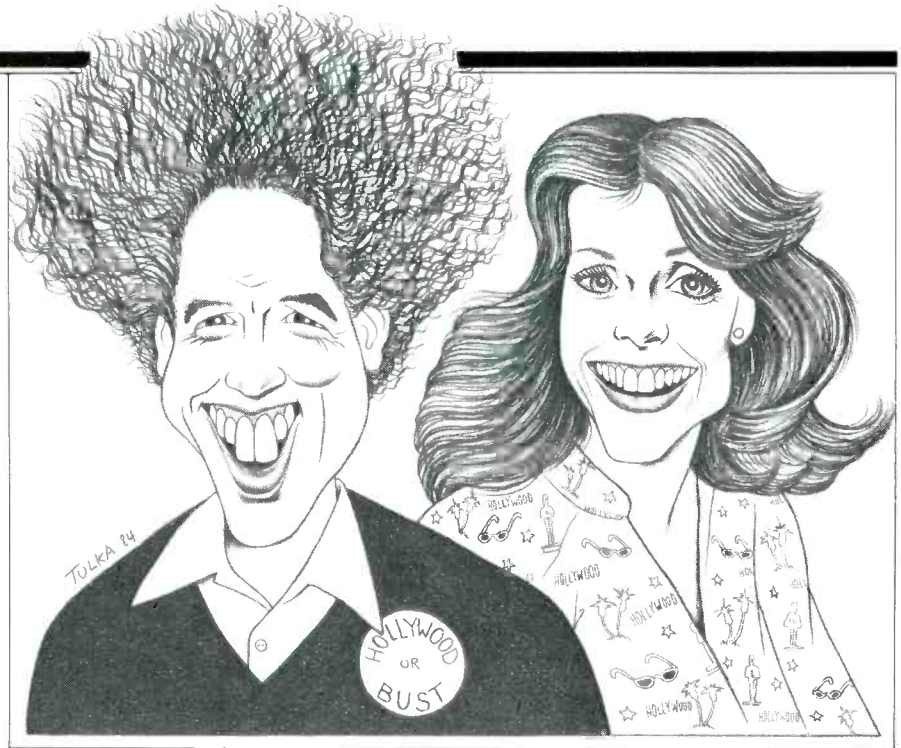

Illustration: Rick Tulka

As virtually every audiophile knows, in 1970 Sheffield Lab resurrected an old technique, direct-to-disc recording. By combining this with the sophisticated devices of modern disc-cutting technology, Sheffield created a recording medium of the highest fidelity. Using a brilliantly conceived microphone setup with proprietary tube microphones, their first direct-to-disc recording, *Lincoln Mayorga and Distinguished Colleagues*, was a sonic blockbuster that became an instant hit as a demonstration disc.

In the intervening years, Sheffield has built up a small, but very impressive catalog of direct-to-disc recordings and a well-deserved international reputation for sound of the highest fidelity. Sheffield's co-owners, Doug Sax and Lincoln Mayorga, have steadfastly continued to record in the direct-to-disc medium, but in virtually all of their recordings, they have been wise enough to record two-channel, stereo analog tape reference masters at the same time. In the last few years, some of their productions have been recorded digitally as well. The use of digital recording by Sheffield Lab may seem surprising in view of the fact that Doug Sax has become one of the most outspoken critics of digital recording. (See the interview with him in the January, 1984 issue of *Audio*.) Whatever his antipathy to digital recording, you can be sure Doug felt it was prudent to make digital reference recordings as a hedge towards future developments.

Needless to say, the analog and digital tape masters that he had made were a great asset with the advent of the Compact Digital Disc. No matter what reservations Doug might have about CDs, he could hardly have been expected to ignore their strictly business aspects. With the superior sound of his Sheffield Lab recordings, it was an obvious move for them to produce Compact Discs. By the time you read this, 11 Sheffield Lab recordings will have been issued on Compact Disc.

I received advance CDs of *Growing Up in Hollywood Town*, and *West of Oz*, featuring one of Sheffield's most famous artists, the multi-talented Amanda McBroom. In the direct-to-disc format, both of these recordings are much favored by audiophiles for demonstration and test purposes. This is especially true of the "Amanda" cut on the *Growing Up* album, where there are interesting percussion effects including two bass drum thwacks of great impact and very heavy Fender and synthesizer bass.

I want to state straight away that these first Sheffield Lab Compact Discs are superb, and among the best I have heard thus far.

I was most interested in making a comparison between the original direct-to-disc recordings and their CD counterparts. The *Growing Up In Hollywood Town* CD was derived from an analog master tape and had the obvious advantages of noiseless surfaces. The lovely, clear, clean voice of Amanda McBroom was beautifully reproduced from the CD and the direct-to-disc recording. Technically, there was little to choose between them. In fact, the CD and the direct-to-disc album sounded remarkably similar. However, careful auditioning did show points of superiority in the sound of the direct-to-disc recording. The transient attack on piano, cymbals, guitars and drums was much sharper, faster, and more cleanly delineated than on the CD. The aforementioned big bass drum thwacks in the "Amanda" cut had a decidedly lower extension in bass response and more impact. This is understandable since a good, properly adjusted Neumann or Ortofon cutterhead has better low-frequency response than a typical analog tape machine.

When the *West of Oz* album was recorded direct-to-disc, the simultaneous reference tape was digitally recorded. In this case, the sound of the CD and the direct-to-disc recording are almost identical. In matters of transient attack, the digital sound of the CD and the DD album are equally matched. In terms of bass response, a digital recorder can equal or surpass the performance of a disc cutter-head. Thus, the bass response of the CD and DD recording is just about equal. As for the attenuation of reverberant information, which some people allege is a fault of the digital recording process, at least in this particular comparison, I could not perceive any difference. Just as a point of reference, I used both a Magnavox CD100 player (as a representative player of the European oversampling decoding technique) and a Technics SL-P10 player (typical of

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The recordings on this Dylan CD are flat and characterless, with little or no sense of depth. The instruments tend to lose their individuality.

Japanese 16-bit, linear decoding). For playback of the direct-to-disc recordings, I used a Sota Star Sapphire vacuum turntable with Sumiko's "The Arm," the really excellent Alpha I phono cartridge, and the superb, but much more expensive, Kiseki Agaat Ruby phono cartridge.

Viewing these Sheffield Lab CDs strictly on their own merits, they are both a sonic and musical delight. Amanda McBroom is a remarkable performer. The beautiful quality of her voice is aided by her great projection, deft delivery, sense of timing and masterful phrasing. She is also well represented as a composer on these two CDs. On *Growing Up In Hollywood Town*, she very expressively sings the plaintive and poignant "The Portrait"; her most famous piece, "The Rose," and the audiophile's delight, "Amanda." On *West of Oz* she sings the uptempo "Not Gonna Say I'm Sorry" and the saucy and impudent, "Reynosa." She is equally effective in other composer's songs, whether the mood be rock 'em-sock 'em, or tender and lyrical. We must not forget Lincoln Mayorga's fine piano contributions and orchestral arrangements here.

The utterly clean, dynamically exciting sounds we have come to expect from Sheffield Lab recordings has been most successfully transferred to these CDs.

When I engineered the direct-to-disc recordings of classical music for Crystal Clear, I also recorded analog or digital, and, in some cases, made both types of reference tapes. I can only hope that if these recordings are eventually transferred to CD, they will fare as well as these fine examples from Sheffield Lab. *Bert Whyte*

Bob Dylan's Greatest Hits
CBS CK 9463.

The digital medium can do just so much to improve upon older analog recordings. The digitalized version of *Bob Dylan's Greatest Hits* only serves to point up the shortcomings of the technology applied to these recordings back in the '60s.

Although the musical material here is treasurable both for its entertainment value and for its place in the history of modern popular music, the recordings themselves are flat and characterless. They have little or no sense of depth, and in the few cases where instruments are massed in any number, they tend to lose their individuality. This is most noticeable in the classic "Subterranean Homesick Blues," in which Dylan's snappy vocal compendium of social ills and foibles careens headlong over a great marsh of sound from which occasionally emerges his clean spunky harmonica or a clear electric guitar riff. Keep in mind, this is not a complaint about the arrangement—a jangly, energetic flight of early electric Dylan which would be grand to hear decently reproduced exactly as it was played in 1965.

Much of this album is early acoustic Dylan, the Hibbing minstrel, his guitar and harmonica captured flat and unaccompanied on tape. Some of the tape hiss has been cleaned up (although some is still audible, as on "Blowin' in the Wind"), and it is good to have a CD of this stuff instead of the beaten-up, candle-wax marred vinyl grooves many of us have been hauling around in our collection since our folkie days.

I have a few complaints about the packaging, though. These are indeed *some* of Bob Dylan's greatest hits, but this collection is by no means comprehensive. Originally put together way back in 1967, this album represents only his acoustic folk period ("Blowin' in the Wind," "It Ain't Me Babe") and his early transition into folk-rock ("Mr. Tambourine Man") and electric instrumentation ("Subterranean Homesick Blues," "Like a Rolling Stone"). The front-cover art, picked up from the analog disc jacket, mis-sequences a few of the cuts. CBS might have taken the time to correct this ancient error. CBS also chose to provide zilch in the recording information department. Even minimal information on which album each selection was taken from and the year of each song's original recording have been neglected. Of course, there is no indication of the musicians and producers involved either. This is pretty sloppy packaging, and it insures that the *Bob Dylan's Greatest Hits* CD is for the hard-core Dylan fan or pop historian cum collector only. *Paulette Weiss*

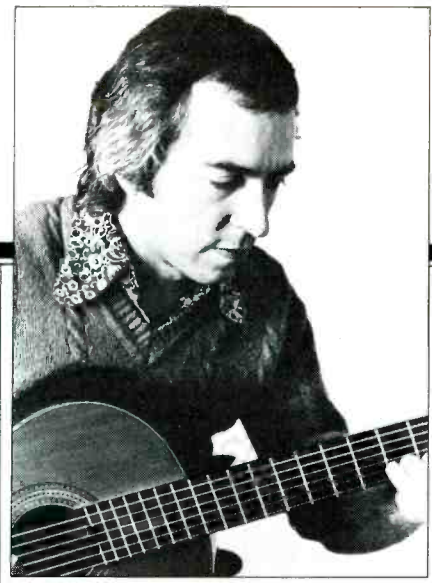
Tchaikovsky: Symphony No. 4. The Cleveland Orchestra, Lorin Maazel. **Telarc CD-80047.**

Lorin Maazel made recordings of the six Tchaikovsky symphonies with the Vienna Philharmonic Orchestra for London/Decca some years ago that established him as one of the premier interpreters of Tchaikovsky's music.

His reading of Tchaikovsky's Fourth Symphony, on this Telarc CD, reveals little change from his London recordings. Tempos are a shade faster, and the boisterous finale is even more brilliant and exciting. Otherwise, his performance is as refined and neatly structured as before, including his very lyrical second movement. The Vienna Philharmonic had a somewhat warmer sound than the Cleveland Orchestra has here, but the Clevelanders excel in their precision and execution in ensemble playing. Their superiority is clearly evident in the way they traverse the difficulties of the pizzicato section in the third movement.

Recorded in Masonic Auditorium in Cleveland, Telarc has given us a full-bodied, highly detailed sound with warmly spacious acoustics. A good sense of depth is apparent, as are excellent inner balances. The frequent trumpet fanfares and answering French horn fanfares of the first and fourth movements are particularly brilliant and well projected. String tone is

John Williams gives a virtuoso performance. The overall sound is clean but marred by wiry strings and an over-isolated guitar.



John Williams

smooth. The explosive opening of the fourth movement shows off the power and impact of the bass drum. In the opinion of many, this is one of Telarc's best recordings. I would have to concur. *Bert Whyte*

The World of the Harp. Susann McDonald playing the concert, Paraguayan, and Irish harps.
Delos D/CD 3005.

Seventeen works, most of them fairly short, are on this disc. As its name implies, this release is something of a guidebook to the instrument and its unique colors. While not as demanding as the piano, the harp has never really been well served by the LP, with its inherent noise level and low-frequency aberrations. On CD there is none of that, and the music seems to float out of the loudspeakers with no effort at all. Amazingly, one can almost imagine the harp right in the listening room.

There isn't much substance to the solo literature for the harp, most of it having been written by harp virtuosos. Generally, the transcriptions fare better. Taken altogether, there is almost too much richness of sound to be taken in one sitting. Things are bound to cloy, no matter how fine the player may be.

The brief excursions to Paraguay and Ireland are a good tonic.

John M. Eargle

Susan McDonald

Rodrigo: Concierto de Aranjuez; Villa-Lobos: Concerto for Guitar. The English Chamber Orchestra, Daniel Barenboim; John Williams, guitar.
CBS MK 33208.

On this CD we have the well-known "Concierto de Aranjuez" of Rodrigo, with the haunting second-movement adagio that is so famous in its own right, along with the rarely performed "Concerto for Guitar" by Villa-Lobos.

John Williams gives us a virtuoso performance of these works, and his fingering and clean, articulate touch are something to marvel at. Daniel Barenboim and the English Chamber Orchestra furnish a well-played, entirely sympathetic accompaniment to Mr. Williams' guitar. The overall sound is quite clean, but is flawed by the wiry sound of the high strings. Also, while the sound of John Williams' guitar is clean and resonant, it is recorded as if it were in an isolation booth. The surrounding orchestra is heard with a nice spacious ambience, but the guitar appears to be in a different and rather dry-sounding acoustic space. One appreciates that the output of an acoustic guitar is low, and could easily be swamped by the weight of the orchestral sound, but this problem can and has been solved in other recordings of these works, without recourse to such extreme isolation of the guitar as heard here. *Bert Whyte*

Rise: Herb Alpert
A&M CD 3714.

Although Herb Alpert, head honcho of A&M Records, long ago left the Tiajuana Brass behind, perhaps in some picturesque cantina to drown their sorrows in tequila, he still retains an affectionate "south of the border" quality in his music. On *Rise*, his 1979 A&M release, he lifts his trumpet in tribute to Spain and Mexico on Rodrigo's "Aranjuez," Sinfield and Brooker's "Angelina," and on Alpert's own "1980."

Now Alpert is a naturalized citizen of the recording studio: Here he is very much at home and shows no hesitation in using every one of its rich resources. *Rise* contains eight selections featuring massive and intricate instrumentation, with additional audio and musical wizzardry provided by a host of established music business names.

All cuts here were originally recorded digitally, then transferred to analog for editing, and once again digitized for this format. The results are quite impressive. With coproducer Randy Badazz and associate producer Andy Armer, Alpert goes for the big effect, laying on banks and banks of instruments to showcase his Latin-flavored horn. A magnificent sense of aural space is created here, though it is an artificial space, not one which reflects the actual location of instruments in an orchestra. Alpert's horn is almost always the center of attention, although the mix often places it in the background. As though from a distance, Alpert's trumpet or flügelhorn shines through the masses of sound, floating in a bright pool of reverb at the center of great swirling clouds of instrumentation.

The production and arrangements are extremely lavish. For the precise musical accent, Alpert and cohorts choose any instrument that might best serve their purposes, whether it is a slide steel guitar, a marimba, or even a balalaika. The variety of sounds elicited from excellent musicians like Tom

Herb Alpert

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Under Cover shows what a hot little CD can do to capture the spirit of sleazy rock 'n' roll at its best.


The Rolling Stones

Scott, Joe Sample, and Michel Colombier tests the CD's full-range accuracy of reproduction. From crisp bongos to delicately chiming triangles, from full orchestral strings to synthesized bass bottoms, these arrangements clearly display the superiority of digital technology over analog. The total lack of distortion, even at very high volume levels, is extraordinary. One particularly impressive effect is a short run of ear-testing-type high notes on "Angelina," a gentle little "south of the border" tune. These piercingly high notes, produced either on the slidesteel or on a synthesizer, are just within the range of the human ear, and they add an almost subliminal musical dimension to an otherwise unremarkable piece of music.

The material on *Rise* goes from grandiose Spanish-style epics, like "1980," to the light funk of "Street Life." Despite all the lavish instrumentation and the constantly shifting patterns within each arrangement, this is generally very easy stuff to listen to, featuring pretty, almost bland melodies, which are not at all as taxing as you might expect from the complexity of their underpinnings. It's a case of the parts being greater than the whole.

If you'd like to blast your guests out of their seats and straight into the bullring with a powerful brass fanfare, then crank up your volume control knob and let 'em have "1980" full force. Otherwise, just pass around the tequila and salt and put *Rise* on for background atmosphere. *Paulette Weiss*

Ravel: String Quartet; Bartok: String Quartet No. 3. Sequoia String Quartet. **Delos D/CD 3004.**

The lushness of both playing and recording here benefit the Ravel quartet. By comparison, the same soft-edged sound takes away some of the essential incisiveness of the Bartok. Yet both works are superbly played by the Sequoia String Quartet, who, in the several years since this digital recording first appeared, have grown in musical stature.

For most listeners, a bonus in this recording will be the total lack of edginess in the pickup of the ensemble. The mellow B & K omni microphones saw to that. *John M. Eargle*

Under Cover: The Rolling Stones **Rolling Stone CP35-3087.**

The Rolling Stones like their rock 'n' roll lowdown and dirty, and in many ways their production values consciously reflect this. Stones albums have plenty of muddy instrumental stretches; the guitars of Keith Richards, Ron Woods and, very occasionally, of Mick Jagger himself often blend in murky interchanges, which are further muddied by the use of fuzztone and the boys' raucous, uninhibited vocal choruses.

So why bother with a CD? Although *Under Cover* is no exception to The Stones' pattern, it shows off what a hot little CD can do to capture the spirit of sleazy rock 'n' roll at its best. The clarity of this analog-to-digital master recording reaffirms that The Stones and their producers, Chris Kimsey and the Glimmer Twins (actually Mick and Keith), have consciously opted for this swampy sound. When aural clarity is deemed necessary, significant effects or passages cut through the murk like a hungry 'gator razoring through the bayou.

Special percussion and electronic touches punctuate these 10 selections with eye-opening impact. For instance, the title cut, The Stones' most political song in many years, explodes out of the CD silence with a clear burst of simulated machine-gun fire. "Under Cover's" follow-up percussion (the "thonk" of claves in the right channel, Charlie Watts' speeding-train drum and cymbal figure in the phantom center), its big rich bass and sweep of electronic wash, the odd tin-roof drum rumble in the left channel, and Mick's voice entering at mid-ground center are all reproduced faithfully. Their widely disparate textures are almost physically palpable on this digital recording. The now-notorious "She Was Hot" contains healthy doses of fuzztone guitar and other aural obfuscation, yet when Mick's voice, sinister and sensuous, half whispers "she was hot" in both left and right channels with an upfront hissing intimacy, it becomes very clear that these producers knew just what they were doing.

This is a hard-driving album, and though it doesn't push the outer reaches of the CD's ability to handle high-end frequencies, it certainly gives the low end a workout. Most of these cuts have a good, thumping rock-dance beat, with lots of drums, including big, bottom-heavy babies that appear with liver-quivering presence in "Too Tough" and "Tie You Up (The Pain of Love)." Bill Wyman's bass gets its low licks in too, loping along on "Under Cover" and "Feel on Baby." No distortion here, no matter what the volume level. The high end gets a bit of mild exercise from the hot horn of the backup group, CHOPS, on "Too Much Blood," and The Stones' occasional screams and glass-shattering falsettos pierce the murk with nerve-tingling precision.

My reviewer's copy of *Under Cover* is a Japanese import, featuring an album-jacket booklet with full information on the disc. The U.S. release is now available, presumably minus the translation into Japanese. Get it. *Under Cover* is a powerful Stones album, carrying their two-decade-old obsession with sex and violence into the '80s. It is excellently produced and engineered, and the digital mastering process allows the listener to wallow in the aural and moral muck The Rolling Stones choose to play in. *Paulette Weiss*

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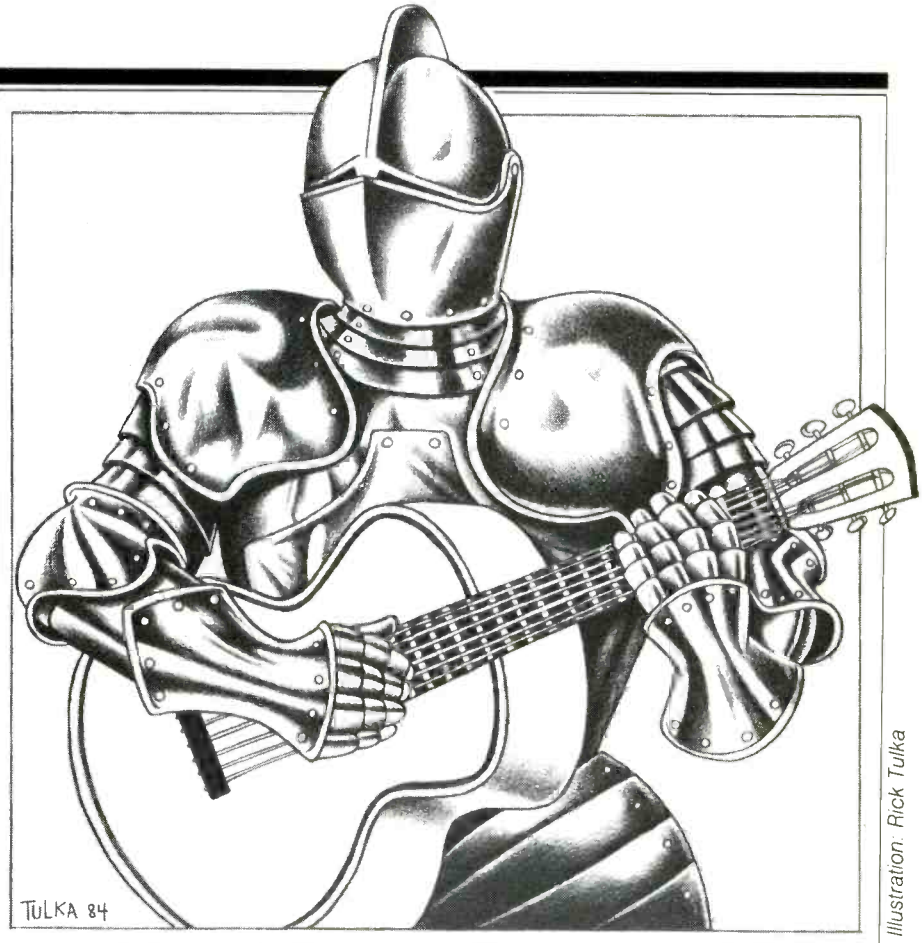

Illustration: Rick Tulka

Sir John—a Lot of Merrie Englandes: John Renbourn
Lost Lake Arts LL-0084, $9.98.

Sound: A Performance: A+

Windham Hill Records established their Lost Lake Arts subsidiary to bring back into circulation gems that have become otherwise unavailable. John Renbourn's 1968 masterpiece, *Sir John,* is the fourth in the series. He was then a member of Pentangle, that seminal fusion of English traditional folk song with jazz ideas greatly influenced by Charles Mingus.

Sir John is entirely instrumental and unbelievably beautiful. Selections range from Booker T and The MGs' "Sweet Potato" and Charles Lloyd's "Transfusion" to William Byrd's "The Earle of Salisbury," which dates from Elizabethan times, and the traditional, "The Trees They Do Grow High." The rest is original material which falls within these wide parameters.

Renbourn's stunning acoustic guitar is properly the center of the sound. He is joined, as occasion warrants, by Ray Warleigh on flute and fellow Pentanglan Terry Cox on African drums, finger cymbals and glockenspiel. On "Morgana," the lengthiest piece here, the ensemble is augmented by David Monroe on recorders and Roderick Skeaping on bass viol for a medieval fantasia.

Sir John has been a treasured companion for the 16 years since its original issue and a perennial on my "desert island collection of records I would never do without. The reissue is definite cause for celebration. With the brilliant job the sonically concerned folk at Windham Hill have done remastering the record, the reissue is clearly superior to the original. It is fun listening technically to the mallet striking the glockenspiel in "The Earle of Salisbury," the wind in the recorders in "Morgana," the thump of hand on drum in the finale, "Seven Up."

Best of all, Renbourn's guitar has splendid detail. He is a wonderful guitarist who plays as fast as anyone, but he's also one of those rare musicians who know how to play slowly, intricately, and precisely.

Congratulations and thanks to Windham Hill for *Sir John a Lot of.* This is what recorded sound on vinyl is supposed to sound like. My sources tell me that they also have the rights to Renbourn's companion album, *The Lady and the Unicorn.* I hope release of that gem will follow as soon as possible. *Michael Tearson*

Norman Mackenzie at Trinity Cathedral. Norman Mackenzie, organ.
Direct-to-Tape DTR-8215, PCM digital cassette (Beta and VHS), $29.50.

Ron Thomas: Digital Demo for Bob.
Direct-to-Tape DTR-8217, PCM digital cassette (Beta and VHS), $25.00. (Both also available on open reel, cassette and Beta Hi-Fi Audio from DTR, 14-D Station Avenue, Haddon Heights, N.J. 08035.)

Direct-to-Tape Recording Company specializes in recorded tape in a variety of formats, including Sony's PCM-F1 Beta. Currently, all of their recording is done digitally, so creating clones of the edited master in Beta F-1 format is as simple as making a cassette in your own home. Recently, I have had the pleasure of listening to a couple of DTR's Beta format recordings.

Norman Mackenzie presents a program of organ music from Trinity Cathedral in Trenton, N.J. The organ, originally a Möller, but now the product of several rebuildings, is thoroughly in the French style, with its gutsy trompettes and varied mutation stops. The program consists of early works by de Grigny and Soler, continuing into more modern times with works by French organ masters Gigout and Duruflé. Mackenzie's playing is accurate and has plenty of the panache which this music needs. The recording is a model of its kind—absolutely stunning! The organ is heard fairly close in, but there is enough reverberation to envelop the sound to the required degree. The French-style chorus reeds, heard with no trace of break-up or time-base distortion, have the impact of the real thing. This recording will measure your system, both as regards dynamic range and low-frequency extension. Recommended without question.

The Bob referred to in Ron Thomas'

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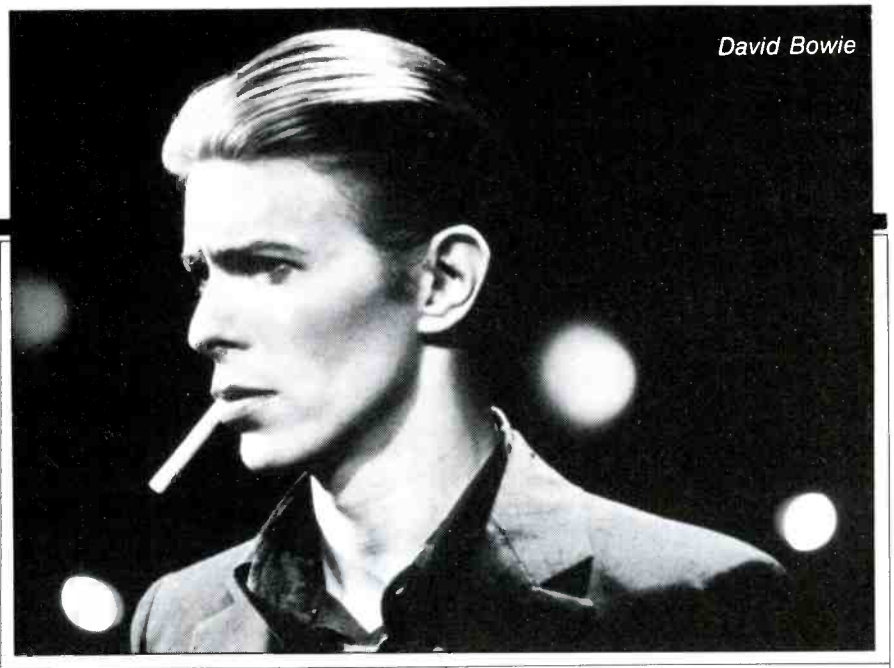
David Bowie

Digital Demo for Bob refers to Bob Sellman, who is the engineer and producer for the company. While agreeing that the sound of Thomas' bluesy piano is quite natural, I must confess that I am not taken by the program of his own compositions. Again, as with the organ, it is a revelation to hear the piano with not a trace of distortion or wow.

How do these recordings differ from Compact Discs? Not at all, I would say. The digital standard employed in the F-1 system is virtually the same as that used in the CD, so, minor player differences aside, these recordings sound very much as though they would if they were available on CD. The fact is that a great deal of the Direct-to-Tape catalog, because of its specialized nature, will never see the light of day in CD form.

Only the packaging is less than fully professional. Notes are minimal and are the product of a difficult-to-read dot-matrix printer. It could simply be that, with so few orders in the F-1 format, the company has not been able to justify anything better.

Most of the DTR catalog is classical, with an emphasis on Baroque forms. There is lots of organ music, with lutes, recorders, and harpsichords not far behind. The pop/jazz portion of the catalog is presently quite small.

If you are a tape enthusiast and appreciate the benefits of Dolby or dbx noise reduction, you should certainly contact DTR and ask for a copy of their current catalog. *John M. Eargle*

Let's Dance: David Bowie
Mobile Fidelity MFSL 1-083, $15.98.

Sound: B– Performance: B+

Months after its chart domination is over, David Bowie's *Let's Dance* is now available in audiophile format, which throws a whole new light on the record. Is a dance record worthy of this sort of treatment? Is the recording of a high enough quality to make a high-grade mastering/pressing job noticeably better? And how good an album was this in the first place?

Last question first—this was a number one album because a couple of the tracks captured the mood of the nation/world at the time of its release, because Bowie once again was in vogue, and because he was on a label that was willing to go out on a limb to make him happen. As everyone (ABC, most notably) was being successful mimicking him, it was of the utmost importance that Bowie reestablish his presence, thus a massive promotion and tour, unlike anything Bowie'd done in years, coincided with this record. But after all the dust has settled in the grooves, *Let's Dance* is not a great album as such, what with only two of the five new Bowie songs worthy of a second listen ("China Girl" was on an Iggy LP, "Cat People" appeared on the soundtrack of the movie of the same name in a superior form, and "Criminal World" is a cover tune). The two tunes that rate, "Modern Love" and the title track, are meritorious more for their incessant dance groove (courtesy Nile Rodgers, who produced) than for content. So this come-back album for the thin white duke could have stood a little more weight, and in retrospect its success is more remarkable than its music.

As for the sonic quality, the richness of the gated reverb on the snare is mighty pleasing, but overall this pressing seems a little top-heavy. The recording was made more with radio and the dance floor in mind than the home listener. Perhaps the best test of this master recording would be in Studio 54, but they wouldn't allow us to use their premises as a listening room. Suffice to say that this has more dynamic range than the conventional pressing, but it still could use a bit more low end. Either way, we're not talking about an earthshaking classic—perhaps purchasing the 12-inch versions of "Let's Dance" and "Modern Love" would prove to be of ultimately greater sonic worth (wider grooves, less chaff) to the diehard Bowie audiophile.

Jon & Sally Tiven

Moby Grape
San Francisco Sound SFS 04830-PB, digital, boxed-set, $50.00; **SFS 04830-3,** vinyl LP, $9.98; **SFS 04830-PD,** picture disc, $20.00. (Available from San Francisco Sound, P.O. Box 4011, Malibu, Cal. 90265.)

What a visual stunner this rainbow-boxed set of brightly colored picture discs is! These six pretty babies, each differently hued, are 12-inch, 33⅓-rpm singles containing one cut per side. A brightly colored picture disc as well as a standard black-vinyl LP are also available.

The sound within is a technicolored spectacular as well; all is digitally recorded, and the aural fidelity is remarkable. The dynamic range is impressive. Aural textures are exquisite; a brush stroked over a cymbal stands out in sandy, grainy contrast to the smooth metallic ping of that same instrument tapped by a wooden drumstick. The lowest bass run is solid, with no distortion, and the highest scream of an electric guitar is reproduced with piercing accuracy. Presencing and spatial relationships are also handled beautifully.

But, is this carefully numbered, limited-edition set one for your collection, despite the hefty price tag? Nope; the pot o' gold at the end of this particular rainbow turns out to contain sheer dross. The music, so stunningly presented visually, is colorless, trite, repe-

Although the musicians on Moby Grape still have great chops, they have nothing but their own brand-new material to work with.

titious, and hardly worth your time and money.

Another blight on the rainbow is the excessive amount of surface noise on the standard LP, audibly present despite the proud claim on the shrink-wrap label of "finest quality vinyl for absolute fidelity." As for the picture discs, forget about actually putting these colorful cuties on your turntable if good sound is important to you; these surfaces play with all the quiet dignity of an IRT express roaring into Penn Station at rush hour.

As for packaging, there are no cardboard or foam reinforcements between the six discs in the box to prevent warping, an oversight in view of the obvious care taken in producing the set. Otherwise, the box is quite sturdy and each disc is well-protected by a heavy, clear-vinyl sleeve.

Although technically the instrumentalists still have great chops—the guitar work shines as brilliantly as in the old days—they have nothing but their own brand-new material to work with. And *it* sounds time-worn and dull. "Silver Wheels," for instance, is an attractive enough country-rock tune with some lovely guitar interplay, but by now this road has been too often travelled by the likes of Poco, The New Raiders of the Purple Sage, and early Eagles. Moby Grape's attempts at rock and boogie tunes—"Suzzam," "Too Old to Boogie," "Think It Over"—run a handful of repetitious riffs into the ground and go nowhere. There are a few special effects ("Queen of the Crow") and some interesting monochromatic twists ("Sitting and Watching"), but, in general, there's little here to justify the physical extravagance of this presentation.

The Grape has had bad fortune before in its balance of talent and packaging. Their first LP, released in 1967, was also called *Moby Grape*. It featured their classic three-guitar lineup, tight vocal harmonies, and well-structured songs that ventured into the blues, psychedelia, and early country-rock. Unfortunately, the hype Columbia Records saddled them with at that time weighed the Grape down and limited their fame to the San Francisco area.

The original band—Jerry Miller, Peter Lewis and Skip Spence on guitars, Bob Mosley on bass, and Don Stevenson on drums—broke up and reformed several times over the past 17 years. The albums they produced were of little consequence despite their "legendary" reputation. The present lineup substitutes Grisha Dimant for long gone Skip Spence and adds Richard Dean on keyboards and Lorenzo Biancalana on vocals. However, nothing they do can lift the Grape out of the pits.

Moby Grape was an innovative band in the '60s. Unfortunately, yesterday's fresh fruit is today's fuzzy green thing jammed in the back of the refrigerator. This collection is for avid collectors and die-hard Moby Grape fans only.

Paulette Weiss

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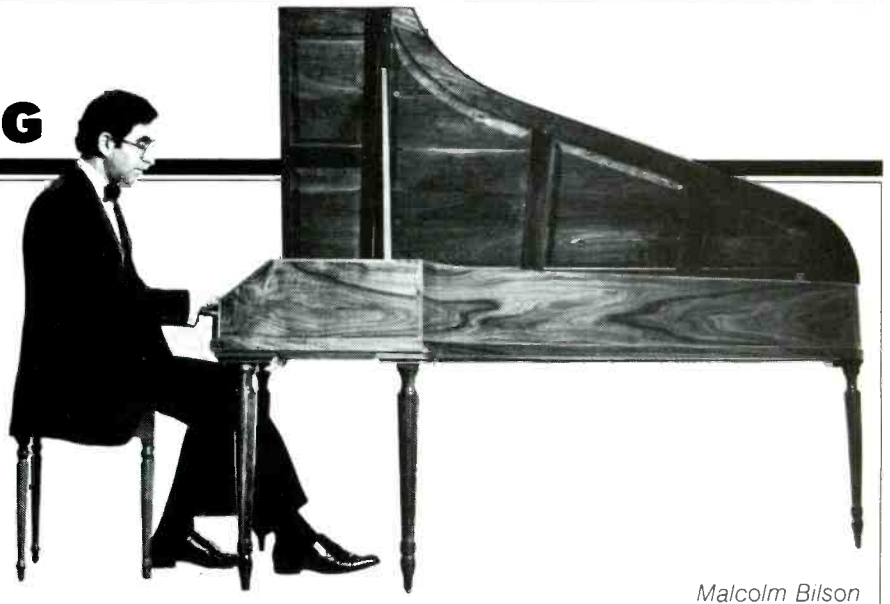


Malcolm Bilson

Dvořák: "New World" Symphony. The Chicago Symphony Orchestra, Sir Georg Solti.
London 410 116-1, digital, $11.98.

I cringe to think of the opening impact of this recording in its CD form! Even the LP's beginning is likely to jolt you. It begins (as Dvořák intended) so softly and gently that you will reach for your volume control, bemused: Is something wrong with the LP? Why so faint? Then, *wham*, comes the loud music, and down goes the volume control again. The LP surfaces are so quiet, especially in the usually audible low-bass rumble, that its impact is not too different from CD's. The whole dynamic range of the music is there.

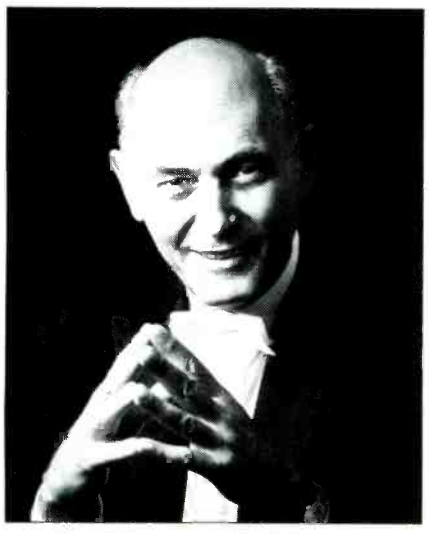
Dvořák and a zillion others wrote for live performance in numerous Carnegie Halls. The live volume was absolute and preset. If the violins played so you could scarcely hear them for audience coughs and rustles and creaks, at least you *knew* they were exactly as soft as they sounded, no more, no less. Not so in recording! I suggest that, at least for CD, some sort of predetermined level information be put on each disc to avoid jarring.

This "New World" is super-high-tech, both in the recording and, curiously, in the playing. The performance is hard virtuoso, faultlessly accurate, ruthlessly loud and forceful in the big places. I like it for its nowness, its 1980s modernity—this is no sonic nostalgia voyage back to the '90s of the old century! Far from it. Even the soft parts are on the taut side, if beautifully played in every detail. Very cool, in every sense, old and recent.

The sound of London's Orchestra Hall has a faintly metallic ring to it, not to my liking though it suits the hard performance. Why? I wasn't there, can't say. I expect that a Romantic work like this could, even in that same hall, have a velvety ambience.

Yes, there are new levels of sheer fi to be heard on this and similar recent digital recordings, whether via CD or LP. It shows—you will notice it instantly. I interpret the difference as simply an even cleaner sound than all the clean sounds of the past—what else? Clean overtones and instrumental color; more significantly, ultra-clean quick transients, razor-fast and sharp. You can hear these differences on most older equipment—it's all relative. Improve just one part of the audio chain and all the rest seems to improve too. Most of the time, anyway.

Sir Georg Solti



Mozart: Music for Two Fortepianos. Sonata in D, K. 448; Fugue in C Minor, K. 426; Larghetto and Allegro in E Flat. Malcolm Bilson and Robert Levin.
Nonesuch 78023, $8.98.

The fortepiano is so named for convenience today, to distinguish it from the pianoforte, our modern instrument out of the late 19th century; it is the piano from its beginnings through the first part of the 19th century and the early Romantic period. The modern redevelopment of this old instrument (in a variety of forms) followed straight after the earlier revival, first, of the harpsichord and, later of the "Baroque" or "Classic" organ. All of these were put into operation for the music originally intended to be heard on them in one of two forms: The original old instruments, restored, or, alternatively, modern "exact" copies, rigorously derived from older models.

It is a pair of these last that we have here, and the usual special question arises concerning any stringed instrument—*is this the way the old ones sounded when they were new*? Not so easy to say! As much tinkering can be done with an old piano as with any vintage amplifier, including, of course, the temptation to add modern "improvements." They do sneak in, inevitably, and why not? Do we have to make all the mistakes our forebears made, when we now can do better? Or can we?

Certainly the sound of these two new fortepianos (modelled on specific old ones) is nearer to what Mozart presumably heard than to the sound of any modern pair of pianos. But there isn't that much difference here. These two instruments sound in the treble very much like a modern instrument, only a little brighter; and the metallic, clanky bass of the old fortepianos, harpsichord-like, is minimized.

That, for my ear, is a shame—but am I right? I love the older bass sound, the harpsichordish twang, as I have heard it in many recordings of restored old instruments and even in a live example, on which I myself did a bit of playing. There is another recording of the two-piano Mozart "Sonata in D," featured here, which was played on two original instruments in Vienna, supposedly restored. The sound is utterly

unlike that of these modern copies and, again, for my ear much more interesting. Am I crazy?

The problem is—are even the restored pianos just "old pianos" and sounding that way? Are the creaks and groans and clanks, the tinny highs and brassy bass, merely symptoms of age, just as they might be in a well-worn, old-timey jazz upright, the sort that sounds as if it had thumb tacks in its hammers? Who knows? I don't. I just enjoy that noise a lot.

The modern fortepianos are relatively colorless and cool. Perhaps that is right. At least there is no overwhelming big blur, as too often occurs via the contemporary piano, or that artificially "little" sound that so many pianists produce in an attempt to put Mozart in his place. There is heft here, and energy, and clarity too. As for performance, these two pianists race like the wind and I don't like it much. Why such a hurry? The music gets to be mechanical sounding, especially in the difficult "Fugue in C Minor," which sounds like the "Grosse Fuge" of Beethoven, all harsh and rattlingly loud.

Brahms: Hungarian Dances. Royal Philharmonic Orchestra, Walter Weller. **London Jubilee 411 703-1 LJ,** $6.98.

The steady spate of lower-priced reissues, always improved in quality and, "now more than ever," currently huge, is due perhaps to the appearance of the expensive CD and all the varieties of digital recording. London's Jubilee label should offer many nice goodies for just over half the cost of a disc on the parent's digital label. This one, however, is strictly so-so—not because of age or recording quality but because of the strangely distant and confused mike pickup and the interpretation of the dances.

We all know how the so-called "Hungarian" music of the 19th century, actually derived from gypsy café music, tends to start slow and then increasingly speed up. Okay—but this conductor whips up such a speed that the music, especially in a confusing reverb, is simply unintelligible, the details smeared and the fine points lost in the shuffle. It seems to be worst in the very familiar dances, four or five of 21. The others fare little better.

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Maestro Cleve is a knowledgeable Mozart conductor, with an excellent sense for phrasing and rhythm in this not-so-simple music.

Mozart: Symphony in E Flat, K. 161a; Piano Concerto No. 17 in G, K. 453. Midsummer Mozart Festival Orchestra, George Cleve; Lilian Kallir, piano. **Sonic Arts LS 40,** digital, $17.98.

This digitally recorded series, recorded "live in concert," has some intriguing aspects that brought me back for a third time, after trying two earlier releases, one of which was quite acceptable, the other full of almost unbelievable faux pas, both musical and in the technical production.

Aside from the deliberately intended audience noises, which will surely annoy some listeners (after the umpteenth playing!), this one comes through very acceptably, if with some musical reservations. Lilian Kallir is an assured and highly competent Mozart player with a fine sense of proportion and style and so you are assured of the best in the piano solo. George Cleve is a knowledgeable Mozart conductor, too, with an excellent sense for phrasing and rhythm in this not-so-simple music (Mozart may "sound easy" but it isn't!). Thus, in interpretation, you will not find any better Mozart, and much that's worse, even among Great Performers.

The one musical weakness in this series is in the string department—particularly noticeable in a one-time "live" recording. Maestro Cleve keeps these players on a stylistically good track but he cannot make them into a viable ensemble. There are entirely too many sour notes, blurred fast passages, just plain incompetent performing, concert or no. I have heard plenty of "festival orchestras" of this sort, not to mention more permanent playing organizations, enough of them to know that there are hundreds and hundreds that do a better, more accurate job in a live performance.

Frankly, I am not one to go along with the current reaction towards "live" recordings, though they can often be superb if all goes ideally well. It seems to me that the idea, right now, is a bit suspect, though understandably so. It isn't exactly a coincidence that the "live" digital recording requires no expensive digital editing, or at least a minimum at beginnings and endings; there are no time-consuming retakes, no hours and hours of studio or hall time, etc. In "live" recording we take what gets played—once—and that's it. Very economical, you must admit. Especially when the resulting LP sells for $17.98. (Telarc has reduced its similar digital-LP price to $12.98.)

You'll find nine other current LP versions of this Mozart piano concerto and two of the little symphony in E Flat, usually known as K. 184 but in the revised "K." listings as K. 161a.

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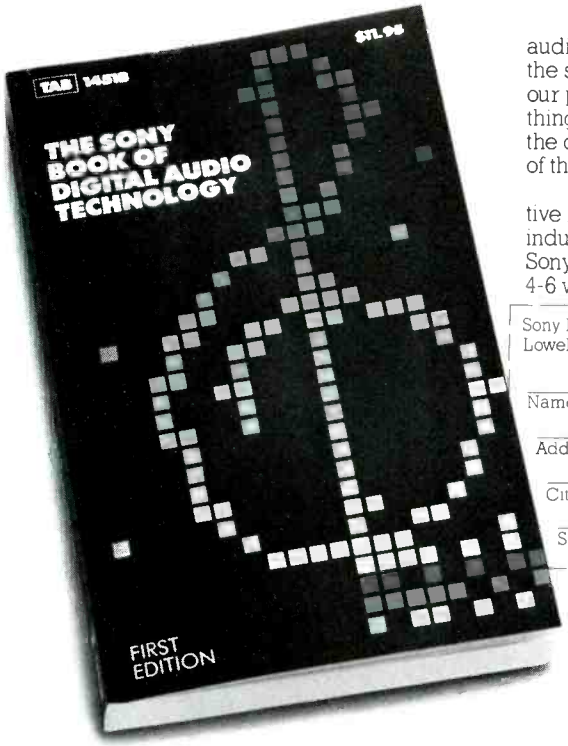

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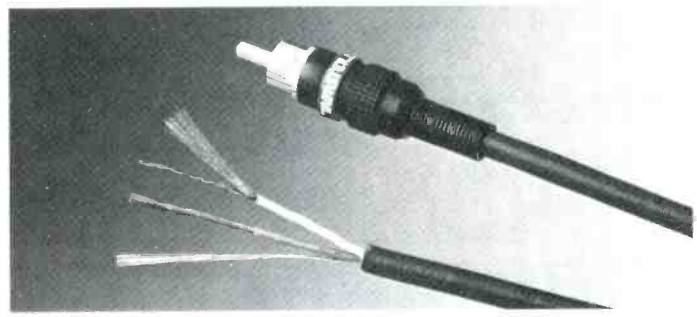

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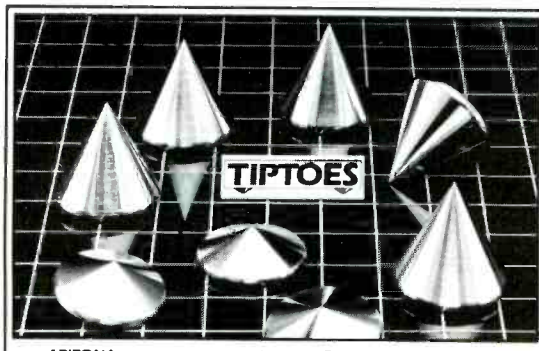

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TRANSCENDENTAL AUDIO LTD. offers you the best low frequency reproduction you're likely to hear—a JBL subwoofer. The JBL system is designed to reproduce the lowest octave, the one missing from most full-range systems. And the difference it makes is dramatic. Hear for yourself at Transcendental Audio, 773 Niagara Falls Blvd., Amherst, NY.

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SOUTHEAST

CUSTOM SOUND INVITES you to stop by and discover the missing octave—the truly deep bass that gives music its foundation. We feature JBL subwoofers—the world's best. JBL subwoofers restore that missing octave, and once you hear it you won't want to live without it. Custom Sound in Athens, GA (404) 549-4844; in Augusta (404) 738-8181; and in Montgomery, AL (205) 279-8940.

EVEN IF YOU HAVE exceptional full-range speakers, you're probably missing most of the lowest octave. It takes a JBL subwoofer to bring out the lowest notes in today's top recordings and let you hear them at proper volume levels. Hear what this remarkable JBL subwoofer can do—come to Mac's TV and Audio Showcase in Morganton, NC (704) 437-2494.

IF YOU DON'T HAVE a JBL subwoofer, you're missing your bottom octave. We didn't realize how much low frequency information is on today's top recordings until we hooked up our JBL subwoofer. This system made a tremendous difference, and once you've heard it, you won't live without it either. We have JBL on display at Todd's Stereo Center, Greenville, NC (919) 756-2257 or 756-2293.

LEE HARTMAN & SONS is the place to go when you want the best in bass. We have the JBL subwoofers, outstanding systems that reproduce the lowest octave with clarity and power. Even the best full-range systems can benefit—and the difference is dramatic. Hear for yourself at Lee Hartman & Sons, 3236 Cove Rd., Roanoke, VA.

ONCE YOU'VE HEARD a JBL subwoofer system, you won't want to live without it. A JBL B380 or B460 will let you hear the bottom octave, the octave missing from most full range speaker systems. And the sound is crisp and tight. Hear JBL subwoofers at Melton's Pro Sound in Atlanta (404) 873-4484. Also in Doraville, GA.

SOUTHWEST

HI-FI SALES OF MESA wants to introduce you to true low frequency reproduction, the kind you can't get from most full-range systems. But you can get it from a JBL subwoofer. The JBL B380 and B460 will let you hear the deep bass that's on today's top recordings, and hear it with clarity and accuracy. Hi-Fi Sales, 810 W. Main, Mesa, AZ.

JERRY'S CONCEPTS in Home Entertainment Environments now brings you the ultimate in low frequency reproduction—the JBL subwoofer system. Yes, JBL makes the best subwoofers around—the only ones we know of that deliver clean, natural deep bass. Even the best systems can benefit. Jerry's Concepts in Phoenix (602) 263-9410.

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The **LUXMAN** TX-101 tuner, with 16 f.m. presets plus 8 a.m. presets, offers excellent reception and musical quality that is *outstanding* for $350.

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The leading high-end audio publications are now describing the **THIEL** model **Cs3** loudspeakers ($1,950/pair) as "SUPERB!" and "FANTASTIC!" We, ourselves, have had a few words to say about the Cs3, and we've been saying them for about a year now (well in advance of *all* the magazines). If you haven't yet heard the Cs3, we have a very rare treat waiting for you.

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MIDWEST

ANY STEREO SYSTEM, no matter how good, can benefit from a JBL subwoofer. These are the best subwoofers we've heard; they reproduce the lowest octave with clarity and depth. And the midrange of the stereo speakers is cleaner too. Hear how a JBL subwoofer will improve your system, at Meyer Television and Audio in Edwardsville, Il (618) 656-4620.

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B&B APPLIANCE will HELP your stereo system reach new lows—with a JBL subwoofer. The JBL B460 and B380 will let you hear all the low bass that's in today's best recordings—and when you hear it, you won't want to live without it. Hear these remarkable JBL subwoofers at B&B Appliance in Middleburg Heights, OH (216) 842-5600, and in Cleveland (216) 261-5600.

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DIGITAL SIGHTS AND SOUNDS features new lows in audio—the best subwoofers we've ever heard. And they're from JBL! The JBL subwoofers reach down and bring back the bottom octave that's missing in just about all full-range systems. You owe it to yourself to hear what we're talking about. Digital Sights & Sounds, 783 Bethel Rd., Olentangy Plaza, Columbus, OH.

GOURLEY PRO AUDIO now has the world's best subwoofers—from JBL! The JBL B380 and B460 bring you the bottom octave that's missing from most full-range systems. Today's best recordings really benefit from a JBL subwoofer—the difference is dramatic! Hear JBL at Gourley Pro Audio, 400 N. Main, Sioux Falls, SD.

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PARAGON SOUND can help you find the missing octave—the low bass that adds drama and impact to your music. Come in and listen to a JBL subwoofer system, the best we know of. Today's best recordings have plenty of low frequency content, and a JBL subwoofer will let you hear all of it. Paragon Sound, Toledo, OH (419) 882-1010.

QUITE A CHALLENGE, but there is a way to add the lowest octave to your stero system. Hear a JBL subwoofer, and you'll be amazed at the clarity and power it adds to even the best full-range systems. Once you hear it, you won't want to be without it. Come to Stereo Center, Flint, MI (313) 239-9474.

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SO YOU THOUGHT SUBWOOFERS were only for reproducing cannon shots? When you hear the JBL subwoofers, you'll find out how much one of them can add to any good recording. In fact, when you hear what really good bass actually sounds like, you'll wonder how you ever got along without one . . . even if you don't like cannon. Sound World in Appleton, WI (414) 733-8539 and in Green Bay (414) 499-4519.

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DEEP BASS THAT'S REALLY crisp and clean? You bet, when you have a JBL subwoofer. Audition the JBL B380 at the Sound Wave in Pocatello and you'll hear how much bass there really is in today's best recordings. Only JBL can give you the bottom octave with such clarity and power. Hear it at the Sound Wave, 416 S. 5th Ave., Pocatello, ID.

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ROCKY MOUNTAIN HI-FI WANTS to help you find the missing octave in your stereo system—the lowest octave. Most full-range systems simply can't reach that low. But a JBL subwoofer can. These are the best subwoofers we've ever heard, and adding one to your system will make a dramatic difference. Rocky Mountain Hi-Fi in Great Falls, MT (406) 761-8683.

THE SOUND TRACK NOW OFFERS the world's best subwoofers—JBL! That's right, JBL. The B380 and B460 reproduce the lowest octave, the one missing from most systems. From thunderous crescendos to delicately played tympani, a JBL subwoofer brings out the best in your best recordings. The Sound Track, Boise, ID (208) 375-5530.

WEST

FIDELITY SOUND OF ORANGE wants you to hear low frequency sound so good you won't believe it's from a speaker system. But it is—and from a JBL subwoofer system. There's really no other way we know of to get true deep bass. The JBL subwoofers are the best around. Hear them at Fidelity Sound, Orange, CA (714) 997-3030.

GRAMOPHONE SHOP, INC. now offers the world's best subwoofers—and they're from JBL! That's right—JBL's subwoofers deliver the truest low bass reproduction we've heard. Today's best recordings demand these systems, and so will you when you hear them. Come in now—the Gramophone Shop in Denver (303) 744-1283.

HARMONY STEREO CAN SHOW YOU how to take your stereo system to new lows—with a JBL subwoofer. Today's top recordings have lots of good low frequency information, and it takes a JBL subwoofer to let you hear it as it ought to be heard. So for clean, powerful bass, hear JBL at Harmony Stereo in San Francisco (415) 661-2525.

KUSTOM HI-FI IN BURLINGAME wants to introduce you to the best in low frequency reproduction—a JBL subwoofer. From cannon to contrabassoon, a JBL subwoofer gives you all the power—and the detail—that's present in the lowest octaves. We wouldn't live without it. And we think you'll feel the same way. Kustom Hi-Fi, 220 California Drive in Burlingame, CA.

LISTEN UP BRINGS NEW LOWS to the mile-high city—subwoofers from JBL! JBL makes the best low frequency loudspeakers around, and the B380 and B460 subwoofers are what you need to hear the bottom octave that's missing from just about all full-range systems. Hear what we're talking about at 685 S. Pearl St. in Denver.

AUTHORIZED DEALERS

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MATEO HI-FIDELITY is now featuring the ultimate low in stereo sound—a JBL subwoofer system. JBL makes the best low frequency loudspeakers in the world, subwoofers that cleanly reproduce the bottom octave that's missing from most stereo systems. Today's best recordings demand equipment of this caliber. Mateo Hi-Fidelity, San Mateo, CA (415) 573-6506.

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PERFECTION in audio reproduction is hard to find . . . but you should listen to a JBL subwoofer system. With today's fine signal sources, you'll hear the lowest octave the way it should be heard. A JBL subwoofer will improve any stereo system. Hear what it can do at Serra Stereo in Colma, CA (415) 992-5018.

STEREO SHOWCASE NOW FEATURES an indispensable part of the ultimate stereo system—a JBL subwoofer. JBL makes the best low frequency loudspeakers we know of, and you won't believe how good the sound is until you've heard one. The impact is stunning. Hear for yourself at Stereo Showcase in Vallejo, CA (707) 552-1515, and in Sacramento (916) 483-5141.

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UNLESS YOU HAVE A JBL SUBWOOFER, you're probably missing out on hearing the lowest octave. From cannon to contrabassoon, there is a lot of music down there, and it takes a JBL subwoofer to reproduce it with the clarity and power of the original performance. Hear JBL at Metro Stereo, Fresno, CA (209) 221-0500. Also in Visalia.

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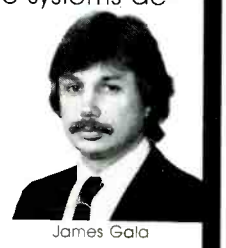
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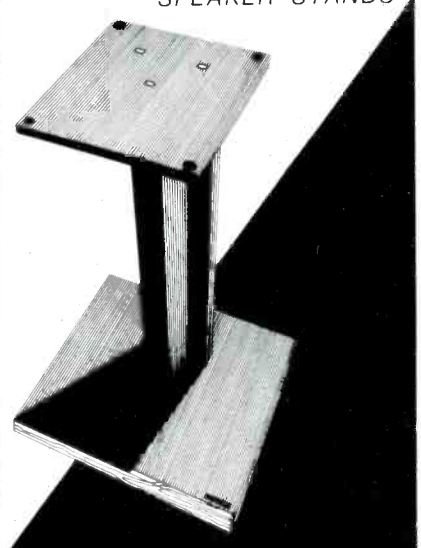

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Dimensions	160mm/6¼" Dia., 67mm/2⅝" Depth
Mounting Depth	53mm/2⅛"
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Front Grill	Integral metal grill

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Ferrofluid Cooling/Damping	Yes
Impedance	4 ohms
Sensitivity 1W/1M	92 db.
Magnetic Structure Weight	2.3 lbs./1.05 Kgs.
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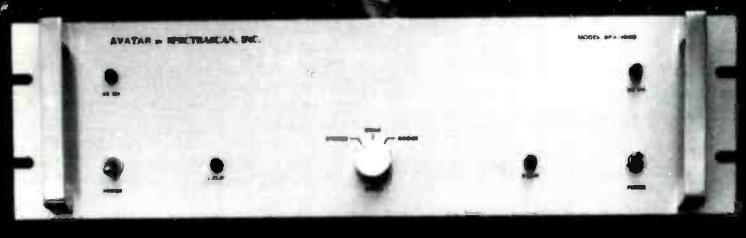

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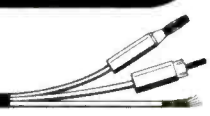

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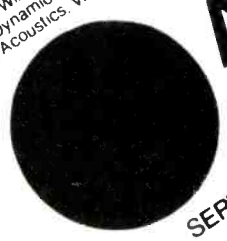

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