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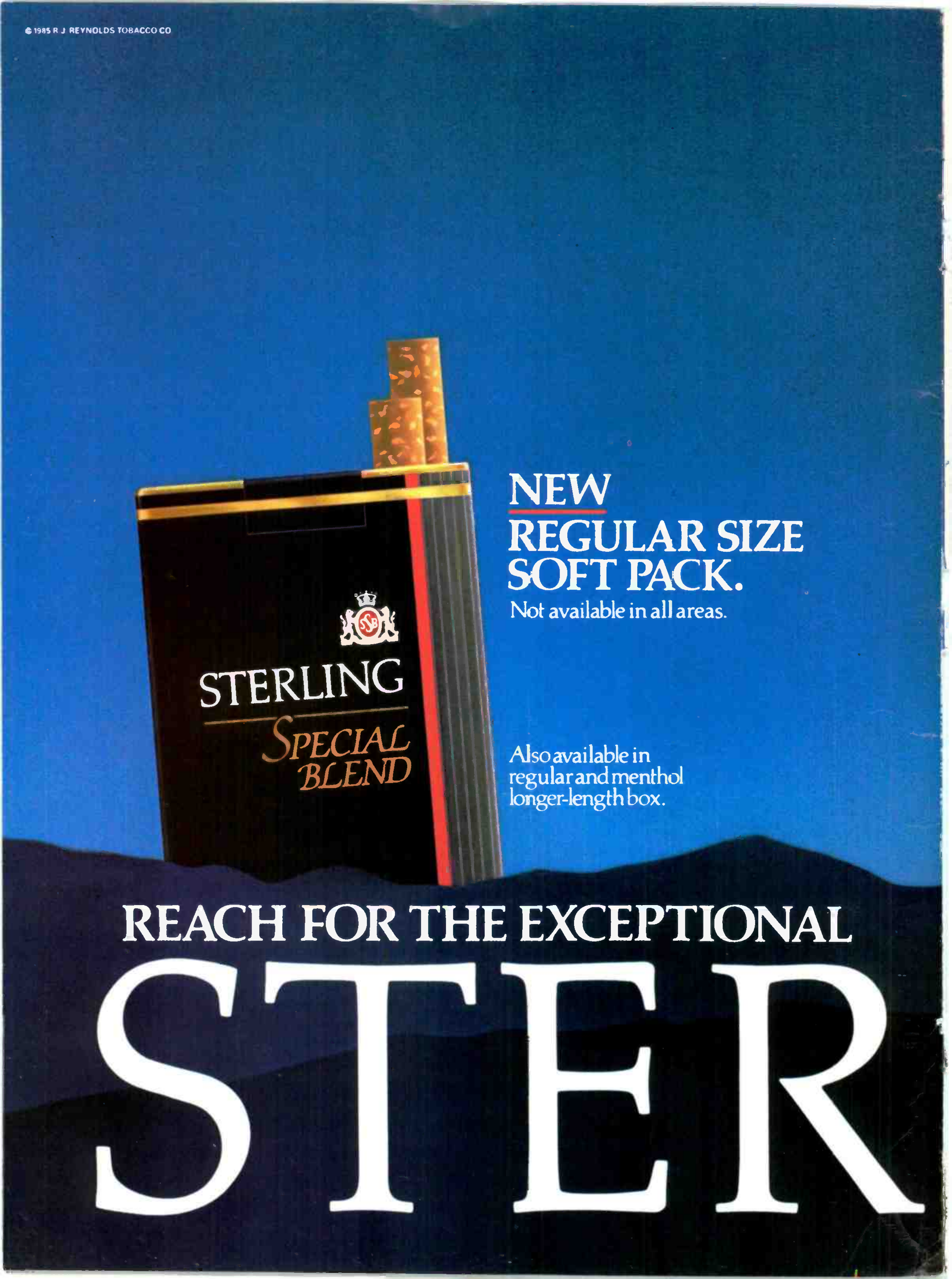
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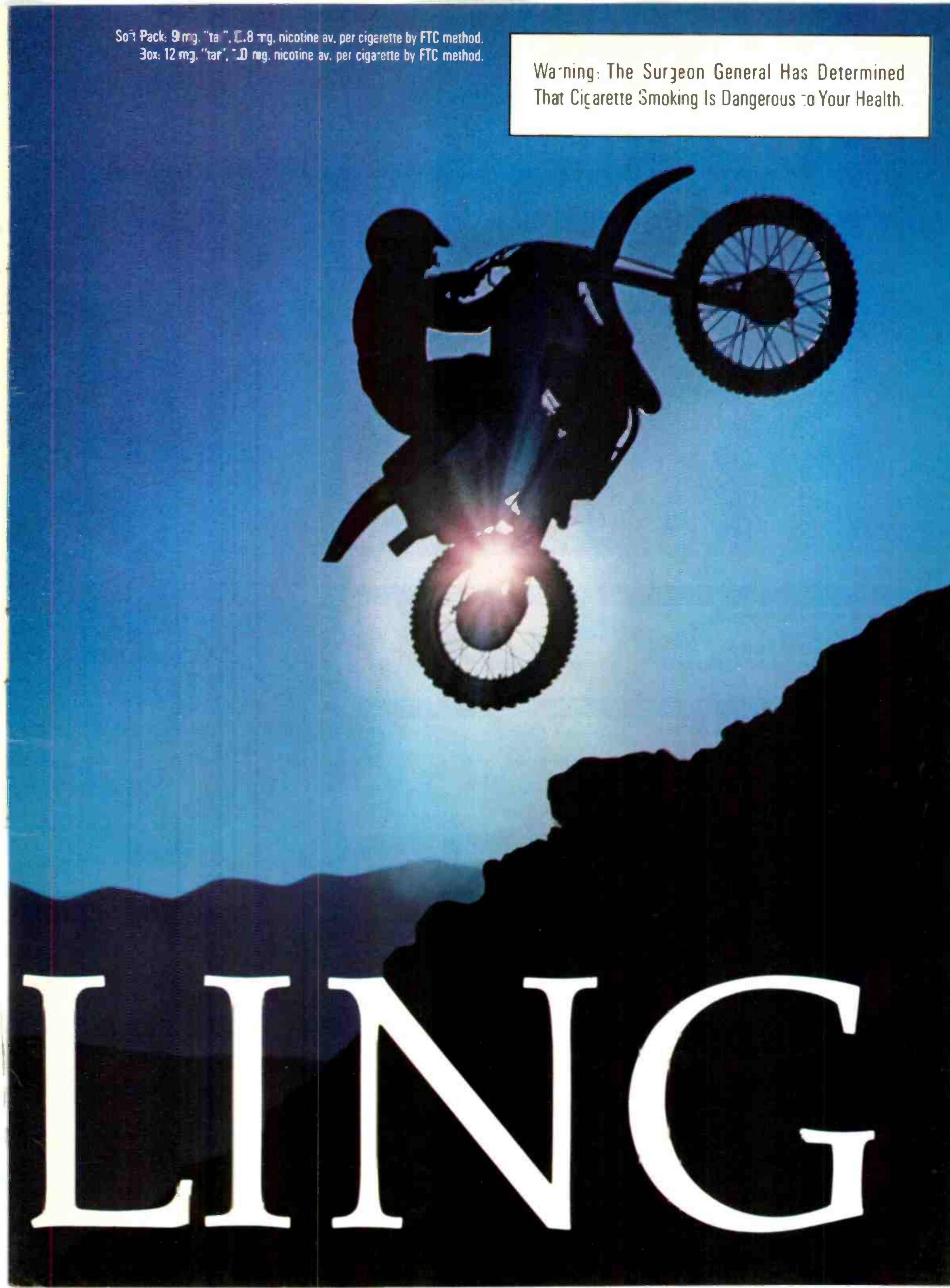

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Audio

JULY 1985 VOL. 69, NO. 7

See page 34

See page 58

FEATURES

THE AUDIO INTERVIEW: CLIVE DAVIS	Ted Fox	28
THE MAGIC SPEAKER FROM ACOUSTIC RESEARCH	Kenneth L. Kantor	34

EQUIPMENT PROFILES

REVOX B215 CASSETTE DECK	Howard A. Roberson	44
SONY CDP-650ESD COMPACT DISC PLAYER	Leonard Feldman	56
SONY DAS-702ES D/A CONVERTER	Leonard Feldman	58
PROTON 440 TUNER	Leonard Feldman	70

MUSIC REVIEWS

COMPACT DISCS		76
CLASSICAL RECORDINGS	Edward Tatnall Canby	86

DEPARTMENTS

AUDIOCLINIC	Joseph Giovanelli	6
TAPE GUIDE	Herman Burstein	10
BEHIND THE SCENES	Bert Whyte	12
DIGITAL DOMAIN	Ken Pohlmann	16
ROADSIGNS	David L. Clark	19
AUDIO ETC	Edward Tatnall Canby	22

See page 12

See page 16

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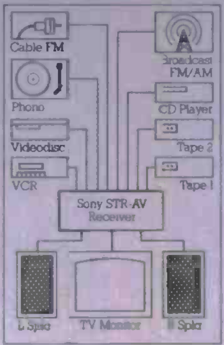

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AUDIOCLINIC

JOSEPH GIOVANELLI

Slide vs. Rotary Volume Controls

Q. I have a question concerning slide-type versus rotary volume controls, especially with regard to playing phonograph records. I have to set the slide-type volume control on my receiver as high as "8" when playing records. On my former receiver (which had a rotary control), the volume was set only to "4" when playing records.

What goes on here?—Richard W. Kopsch, Rochester, N.H.

A. The volume setting needed to produce a given sound level has nothing to do with the kind of volume control employed. What is involved is the sensitivity of the phonograph section of the equipment and the output available from the cartridge. The lower the cartridge's output or the phono preamplifier's sensitivity, the higher the volume control must be advanced to produce satisfactory output.

If you are using the same phonograph cartridge you used when you had the receiver with the rotary volume control, then the difference in volume-control setting must be due to lower sensitivity in the new receiver's phono section, or lower overall voltage gain in the new receiver.

It is also possible that the new receiver has less overall voltage gain than your former receiver.

The only way that I can envision the volume control as a direct factor in your cause would be if the tapers of the two controls under discussion were different. By "taper," I mean a given amount of d.c. resistance versus the setting of the control. If you notice that most of your volume control's action occurs near its maximum setting, then taper is the likely cause of the difference we have discussed.

To demonstrate that the setting of the volume control has nothing to do with available acoustical power, assume that you change loudspeakers to less efficient models. Under these circumstances, you must advance the volume-control setting to compensate for the lower efficiency if you are to obtain the same acoustical output from each pair of loudspeakers.

While on this general subject, I am constantly asked about volume-control setting as an indicator of power output. I think you can see from the foregoing discussion that this can only be done where the input signal level is known; you would then have to do a handmade calibration chart of volume-control settings versus power output. This is not practical in the real world because input signals vary from one phonograph record to another and from one FM station to the next, etc.

The best you can hope to do is know enough about the particular "feel" of your control that you more or less know how loud a sound you will get from any setting of the volume control.

Relative Tweeter and Woofer Power

Q. In a loudspeaker system, must the tweeter and midrange drivers have the same maximum power rating as the woofer, or can they be rated lower?—Name withheld

A. The woofer consumes most of the power required by the speaker system as a whole. The midrange driver requires less power and the tweeter, still less.

There are some imponderables involved here: If you demand lots of highs and midrange, the amount of power the midrange and tweeter will require will rise considerably above what would be needed for music played with a flat response.

Vibration and Unwanted Phonograph Output

Q. I have a problem with my music system. If I tap the turntable, noise can be heard from my speakers. My audio dealer suggests that I upgrade to a better turntable.—John DeRosa, Mattapan, Mass.

A. I cannot imagine any turntable which, if tapped when the tonearm is placed on a phonograph record, will not produce a "thump" in the loudspeakers. The turntable is set into vibration, imparting a relative motion between the disc and the stylus. Like any such relative motion, this will be picked up by the cartridge and interpreted by your system as an audio signal. Turntables do vary in their sensitivity to external vibration, but you would have to own a turntable assembly made of concrete to prevent vibration pickup altogether. Try comparison tap tests on turntables in your dealer's showroom to see if your table is more or less vibration-sensitive than average. Tap the top, front and one side, as sensitivity may vary in each direction.

The only times I can think of when this becomes a problem are when the floor or wall supporting the table is shaky, or when the table is close enough to the speakers to suffer from acoustic feedback. This occurs when the speaker's vibrations shake the turntable or record, causing a signal which comes back through the speakers to shake the record even more. In extreme cases, it will not only mar your enjoyment of the music but can damage your speakers and/or amplifier.

Erratic Turntable Speed

Q. Occasionally, when playing 45-rpm records, my turntable will slow down considerably and then go back to normal. How can I correct this problem?—David Abbou, Alexandria, Va.

A. A number of things can cause your problem. The one which plagued me was a dirty pitch control. Once I cleaned it with suitable contact cleaner, there was no more erratic speed. Along similar lines, perhaps the 45-rpm switch contacts are in need of cleaning.

If these relatively simple fixes don't work, you should look for cracked circuit foils, poorly soldered connections, defective circuit components and the like. Look at those components which are associated only with the 45-rpm speed. If, however, there is a common IC involved, you must take this into account.

Obviously, before getting into any of these procedures, check your warranty; you may be best served by having the factory make the necessary repairs. If you plan to do the work yourself, be sure to obtain a service manual before you really dig into the circuitry.

(*Editor's Note:* It also pays to check any mechanical components which relate to speed changing. Problems such as this can be caused, among other things, by belts or idler wheels not properly contacting their drive pulleys when switched to certain speeds.—*I.B.*)

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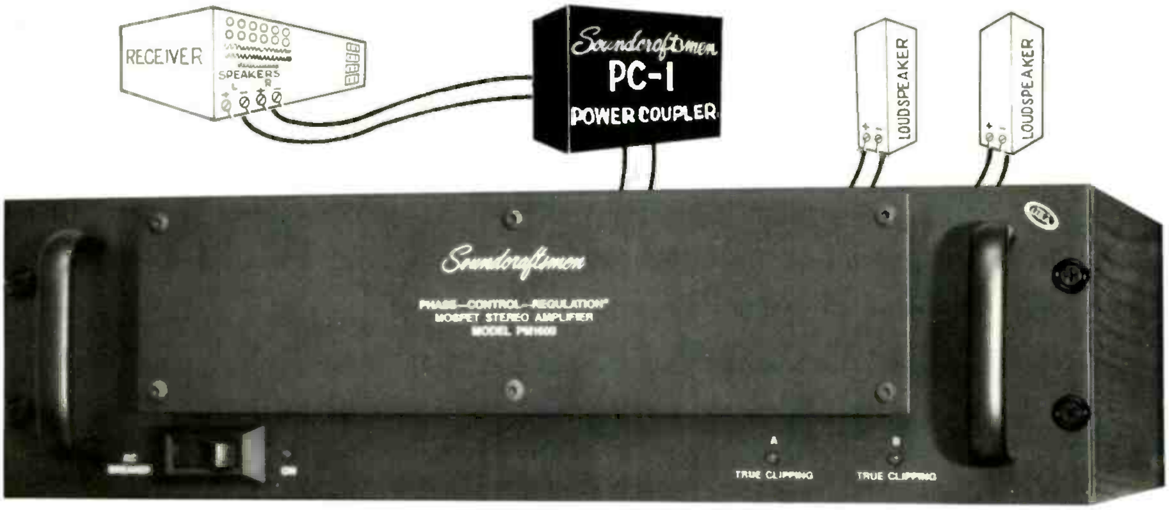

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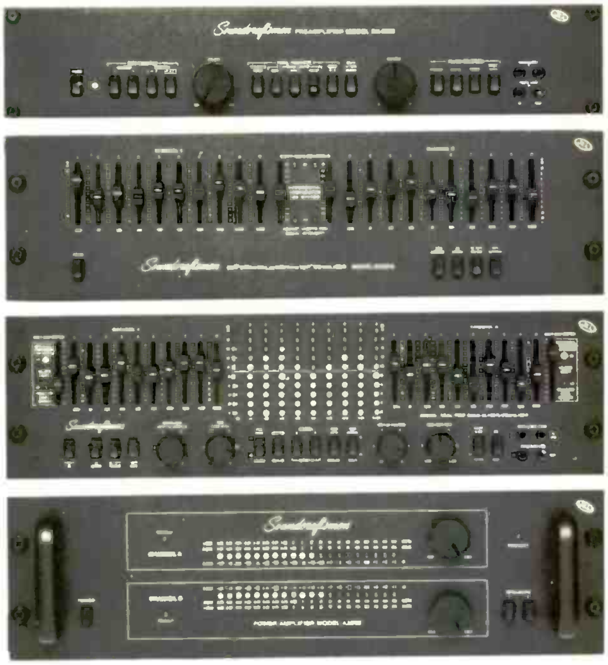

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TAPE GUIDE

HERMAN BURSTEIN

Fast or Slow Deck

Q. *I recently purchased a new cassette deck and kept my old one for dubbing purposes. When a tape recorded on my old deck is played on the new one, it sounds as though the new deck is running slow. I don't know whether my new deck is running slow or my old deck runs fast.*—Michael J. DeVoge, Conneaut Lake, Pa.

A. Cassette decks are usually within 0.5% or so of exact speed, in either direction; occasionally, they deviate by more than 0.5%. Inasmuch as 0.5% deviation represents but a fraction of a semi-tone (about a 6% change in pitch), most people cannot hear the difference. If one deck is running fast and the other slow, the total deviation could be 1%, still not apparent to many. The fact that you hear it indicates either that you have an unusually good sense of pitch or that one or both of your decks is running unusually fast or slow.

Perhaps you can tell by playing a commercially prerecorded tape on each deck. If you are still in a quandary, I suggest that you take the new deck to an authorized service shop to have its speed checked. Since this deck is new, it should be within its warranty period for free service. If the deck turns out to be exceptionally slow—by well over 0.5%—you should be entitled to repair or replacement.

Demagnetizing: What and When?

Q. *If a tape deck contains separate record, playback and erase heads, do they all have to be demagnetized, or just the playback head? How often? And how often should they be cleaned?*—Eugene L. Bershad, Freehold, N.J.

A. All heads should be demagnetized. So should other metal parts that come in contact with the tape, such as the capstan.

Frequency of demagnetization depends a good deal upon the deck's circuitry and on the materials that the heads are made of. The usual recommendation is to demagnetize after about every 8 to 16 hours of use. Some readers claim they have never demagnetized despite long use yet hear no ill effects, or that they hear no improvement after eventually demagnetizing. Still, precautionary demagnetization does no harm if done carefully. Make sure to avoid abrupt appearance or disappearance of the magnetic field produced by the demagnetizer when in close proximity to the deck.

An interval of about 8 to 16 hours of use is also recommended by many with respect to frequency of cleaning. However, more frequent cleaning is necessary if there is a buildup of tape oxide on the heads, capstan, etc. It is wise to check with the deck manufacturer as to his recommendations concerning frequency of demagnetization and cleaning.

Noise—White and Pink

Q. *What is white noise and what is pink noise, and how is pink noise used?*—Don Davis, Lawndale, Cal.

A. Both white and pink noise consist of random mixtures of sound frequencies distributed throughout the audio range. However, this energy is distributed differently in each noise type. White noise has equal energy at every *frequency*; as a result, its energy doubles with each octave. This is because there are twice as many frequencies in the octave from, for example, 400 to 800 Hz as there are in the octave from 200 to 400 Hz. Pink noise has equal energy in every *octave*. This is achieved by applying a cut of 6.02 dB per octave as frequency rises. Pink noise is commonly used for audio testing and calibration, such as when using a graphic or parametric equalizer to flatten the response of a speaker system in a specific environment.

Automatic Tape Calibration

Q. *Do cassette decks with automatic tape-calibration circuits (adjustment of bias, equalization, and sensitivity) achieve accuracy as great as do decks with user-adjustable controls? In other words, how good is the job these automatic circuits perform in matching the deck to the tape?*—Freeman Matthews, Columbus, Ohio

A. Automatic calibration circuits in general do at least a very good job, and in many cases an excellent one. To date I have not come across any that perform less than commendably. On the other hand, there have been some cases where manual adjustment, or the fixed adjustment for each of the four basic tape types, has produced results slightly superior to those of automatic calibration.

By now automatic calibration, performed by microprocessors, has been around long enough so that the bugs have been eliminated and these circuits can be trusted to produce results satisfactory to most users.

High-Speed Dubbing

Q. *Does high-speed dubbing usually produce better or worse sounding recordings?*—Mitchell Young, Montgomery, Ala.

A. High-speed dubbing tends to produce worse recordings than those made in real-time (at normal operating speed) unless special precautions are taken. There are such problems as the ability of the electronics and heads to handle elevated frequencies (for example 15 kHz becomes 30 kHz if speed is doubled), ability of the record head to handle the correspondingly elevated bias frequency, and proper adjustment of equalization to deal with this frequency shift. Therefore, we find that the best commercial dubbings are made in real-time, although this necessarily adds to production costs.

Hear, Hear

Q. *I have been shopping for speakers to be used in conjunction with a Yamaha M-50 amp, C-50 preamp, and CD-X1 CD player. Can you recommend speakers that will be compatible with my system and take full advantage of the digital age?*—Mark W. Knipstein, FPO, N.Y.

A. Your question is outside my area of expertise, tape recording, and therefore I normally would not try to answer it. But this particular case gives me the opportunity to deal with something on which I have a strong point of view. Though many may disagree, I feel that the single most important component in a high-fidelity system is the speaker and that your choice of speaker should be governed by what sounds good to *your* ears at about the limit of what you can afford. I don't think that spending half the cost of

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.

your entire audio system on speakers is excessive. Of course, you should do extensive listening before choosing a speaker, because what sounds striking on first hearing may not prove very lasting on longer acquaintance. A good technique for selecting a speaker is to pick the one that sounds best, regardless of price. If you can afford it, good. If not, move down to speakers of lower price that sound most nearly the same as this reference speaker.

(Let me add that the policy of *Audio* prohibits me from recommending specific brands and models of audio components, except on rare occasions when there is exceptional justification.)

Pink Magic

Reader Otis Owen Callaway from Carlsbad, Cal., writes of his interesting, perhaps fascinating, experiences in cleaning the head of his cassette deck—initially a failure but ultimately a success:

I first used a record-cleaning solution that consisted of alcohol plus an anti-static substance. Subsequently I noticed excessive oxide on the head, and distortion was noticeable on playback of cassettes. Using plain alcohol to clean the head did not really do the job. I did get some improvement in the sound, but not for long. Using a 10× magnifying glass and a bright bulb, I could see the head gaps and noticed a pink color on them. I scrubbed the head with a cotton swab that had been immersed in alcohol, and allowed the head to dry, but the pink color remained.

"Previously I had experimented with Absorene's Pink Ball of Magic (Absorene Manufacturing Co., 1609 North 14th St., St. Louis, Mo. 63106) to clean old paintings. The bubble-gum color and semi-gum consistency of the Absorene cleaner seems to me to be of grandma's vintage, and, sure enough, it says 1891 on the box. This pink dough absorbs carbon film left by smoke and has helped recondition my old phono records.

I decided to press Absorene onto the tape head. (If one isn't careful, it will mash and spread behind the head and be hard to remove, so gentle contact should be used.) The gaps were cleaned immediately. Now they cannot even be seen, using my 10× magnifier and a bright light. No pink color is evident. As to the sound—how could I have tolerated the previous distortion? It has been ages since my cassettes sounded so good!

I'm not sure that head gaps ever get truly clean. The gap is so narrow, the oxide so fine and the usual cleaning method so crude. I'll bet that oxide remains in the gap despite one's best efforts. And the pink dough that I used may not be for the general public, because it will get into the transport mechanism of the cassette deck if mashed. But for me, it is truly a "Pink Ball of Magic." A

BERT WHYTE

NEW REPRODUCTIVE SYSTEMS

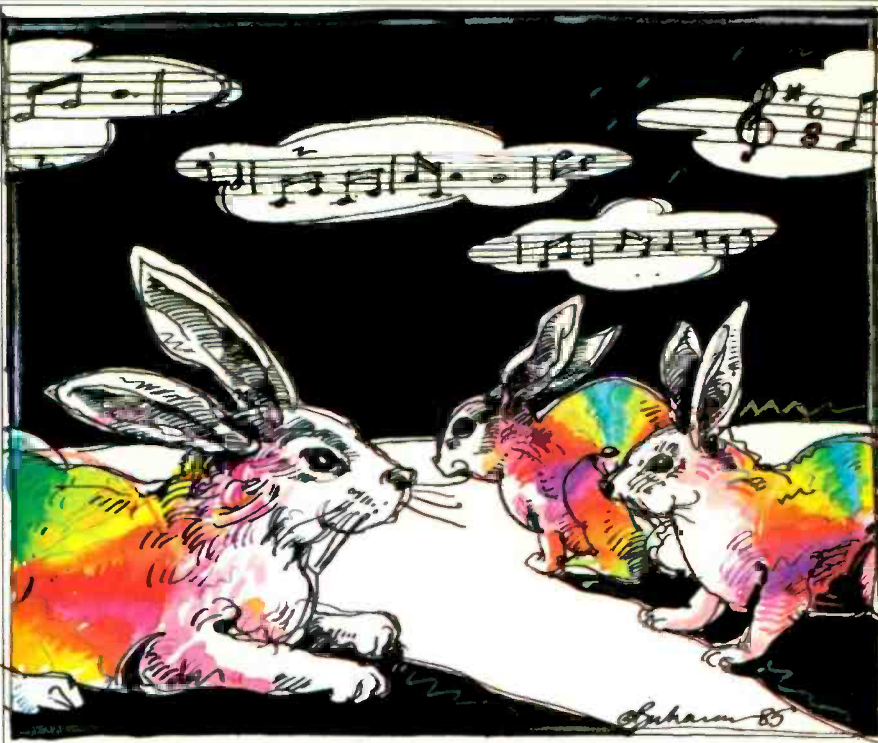

Illustration: Yvonne Buchanan

The audio world seems to be caught up in the glamor and excitement of digital recording and the digital Compact Disc. After a slow start, CD players and software are proliferating at an incredible rate.

In fact, the CD software situation has gotten rather out of hand. The seven CD pressing plants around the world are working around the clock, trying to keep up with demand. Just recently, the new DADC plant in Terre Haute, Indiana issued a bulletin stating they would no longer accept custom pressing orders, but would restrict themselves to CBS productions. They followed this up by announcing an allocation system for supplying CD retailers in the U.S. (As you may know, DADC is a joint venture of Sony and CBS.)

The overtaxed CD production facilities have been a particular hardship for many of the smaller record companies who are trying to jump on the CD bandwagon. Some of the CD plants are now quoting lead times of four to five months. Further, many of the CD pressing plants are giving priority to hot new pop recordings; thus, catalog items suffer, and out-of-print productions are delayed in repressing and restocking.

As you are aware, CD players are now available at an official-low $299 list price, with discounts widely offered. While these certainly are bare-bones units, they nonetheless satisfy the requirements of many people. There are more than 30 models of CD players with more elaborate facilities at higher prices. Even at this early stage of CD development, specialized, audiophile-type CD players are available from Meridian, Mission, and Cambridge Audio; another is coming from McIntosh.

What is happening in record marketing is also interesting. Tom Jung, whose Digital Music Productions issues his superb recordings in just CD and chrome cassette formats, tells me that his sales are 90% CDs to 10% cassettes. Telarc sales are heavily weighted to the CD format, too. Even the major record companies are occasionally issuing recordings only on CD; a case in point is the von Karajan performance of the Mahler Ninth Symphony on Deutsche Grammophon.

Does all this frenetic CD activity signal the imminent demise of the LP vinyl record? Some ultra-enthusiastic CD boosters among the industry pundits are blithely prognosticating that the vinyl LP recording will be in a terminal decline within three to five years! It would be foolish not to recognize the tremendous potential of the CD format (to say nothing of other digital formats that may appear). There is little doubt that CD sales will command a very significant percentage of the overall recorded music market in the next few years (as do prerecorded cassette sales, which in 1984 topped LP sales for the first time!).

Having said all this, it must be noted that the vinyl LP is a tough old bird, with a great deal of resilience. It has survived predictions of its demise in the past. For example, it was "doomed" by the arrival of stereo on prerecorded open-reel tape in 1954. Then came Westrex 45/45 stereo discs in 1958. It was postulated that the vinyl disc couldn't handle quadraphonic sound—tape was the only medium that could. As it turned out, you can say that the whole idea of quadraphonic sound was either ill-conceived or premature, but still, the vinyl LP accommodated itself to this medium too.

But now, in light of all the digital and CD activity, has the old LP reached the end of its technological tether?

Back in 1976, I was visiting Decca Records in London. With my dear old friend Arthur Haddy, Decca's director of engineering, showing me around his studio facilities, we went into a room which was dominated by a huge recording lathe of unusual design. In place of the usual lacquer mastering disc on the turntable was a gleaming, bright copper disc. Arthur explained that this was their experimental recording system for videodiscs! When I said it would be a great thing if some of this new technology could be applied to audio discs, Arthur said that, down the line, this was just what they had in mind.

Thus in 1982, Teldec of West Germany, originally a joint venture between Telefunken and Decca Records, introduced the DMM—Direct Metal Mastering—process. Developed by Teldec technical director Dr. Horst Redlich, the DMM process uses a special Neumann VMS 80 recording lathe, with the Neumann SX 80 CM stereo cutter head. A new type of diamond cutting stylus, without the usual burnishing facets, cuts grooves on a layer

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Some may feel that DMM technology will do little to stem the CD tide, but the LP may be around longer than anticipated.

Neumann system cutting a DMM master

of copper, electrolytically deposited on a stainless-steel substrate. These copper-plated discs must be used for cutting within two to three days after they are plated, while the copper is still in an amorphous state and relatively easy to cut. In less than a week, the copper plating becomes crystalline in structure and cannot be used for cutting.

During the cutting, the diamond stylus is excited at an ultrasonic frequency (about 80 kHz) whose amplitude increases with increasing groove depth. Because of the mechanical resistance of the copper, the cutting stylus must have a vertical tracking angle of virtually 0°. Thus, a compensating network is used to electronically simulate a normal vertical tracking angle.

No stylus heat is necessary, and since there are no burnishing facets on the stylus, there are no "horns" formed on the groove edge. Because copper is used, there is no elastic deformation or springback distortion, as in lacquer cutting, and therefore no pre- or post-groove echo. This makes possible 15% more playing time, without reduction of levels or bass frequencies. The elimination of elastic deformation also results in superior transient response.

The DMM cutting produces a copper mother, and no complex silvering (as with lacquers) is needed, which means greater economy. Since direct stamper production is possible, the pressing of a hot new pop recording can be accomplished within two hours!

The DMM cutting produces an extremely smooth groove wall and retains high frequencies, with low distortion, even at inner groove diameters. Signal-to-noise ratios are typically 70 dB or better. As compared to normal lacquer cutting, there is at least a 6-dB improvement in noise at mid- and high frequencies as well as a dramatic reduction of low-frequency noise (rumble, etc.), up to 15 dB. Pressings made on high-quality Teldec vinyl are virtually free of ticks and pops.

In 1982, I had intended to bring you an extended report on DMM but was deterred by a phenomenon that I and some British critics had noticed. The DMM recordings are superior in terms of noise, transient response and frequency response, but when played on really high-quality, wide-range audio systems, there was, back then, an overly bright, "tizzy" top end. This was exacerbated by many moving-coil cartridges that have high resonant peaks around 17 to 20 kHz.

I conferred with Dr. Redlich of Teldec at the 1983 AES Convention in Anaheim. I suggested that since DMM pressings are not subject to the plating and pressing high-frequency losses found with conventional lacquer cutting, the RIAA cutting curve might be rolled off a little to compensate for the overly bright top end. He seemed to agree with me, but I haven't noticed much difference on recent DMM pressings.

Thousands of people are enjoying the very considerable benefits of DMM on reasonably good hi-fi systems. For hypercritical listeners with very high-quality systems, there may be some relief in sight. Joe Grado has a new tonearm and cartridge of unusual design, said to represent some new ideas and technology in the cartridge/record-groove interface. It is rumored that his combination is very compatible with DMM records (and I plan to audition it in the near future to see if it does indeed improve and enhance the virtues of DMM recordings).

Perhaps as the DMM process becomes more widespread, other manufacturers will develop equipment to cope with the high-frequency anomaly of DMM pressings. Of course, ideally, it is to be hoped that Teldec will manage to correct this problem on their DMM pressings, so everyone can enjoy the advantages of this brilliant technology.

As of now, DMM pressings are available from Teldec and from EMI, and I understand Telarc has cut a few. CBS is said to be planning to import the requisite Neumann lathes and cutter heads, and associated DMM equipment, in the near future.

So once again, the venerable vinyl LP has a new lease on life, through the upgrading of DMM technology. Some may regard it simply as a finger in the hole in the dike, which will do little to stem the digital CD tide, but it may be around longer than anticipated. A

KEN POHLMANN

FILTERS À LA ANALOG

"Good evening, sir! Welcome to the Domain Restaurant. A table for one? This way, please. The chef's specialty today is filter à la analog, traditional fare, but our special brick-wall recipe adds some unexpected spiciness. Medium-rare? I hope you enjoy your meal."

If purchasers of CD players were gourmets and hi-fi salesmen were waiters, that scenario would pretty much summarize the current state of affairs. A lot of analog filters are being consumed, and while they might seem innocuous enough, the particularly steep kinds we cook up for digital audio applications might be causing some unexpected heartburn. In fact, the more we look at analog filters, the more suspicious we become of their potential contamination of digitized audio. Ironically, much of the golden-ears consternation concerning digital audio recorders and players might be due to the fact that most of those systems employ filters which are *analog* in design.

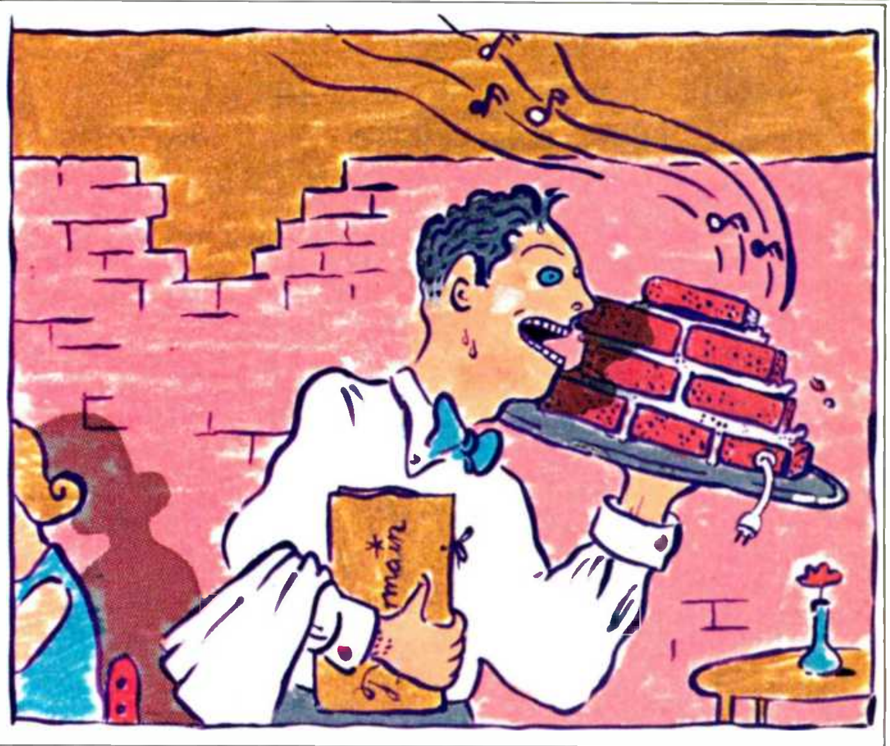

Illustration: Ben Chase

Filtering is an unfortunate fact of life for digital audio systems. An input anti-aliasing filter must precede the digitization system to uphold the Nyquist Theorem's criteria for lossless sampling. Specifically, the highest sampled audio frequency must be no more than half the sampling frequency. The output filter might have an identical design to that at the input, and it similarly filters out all frequencies above half the sampling frequency, but its function differs. The analog signal at the output of the digital-to-analog converter is a pulsed amplitude-modulation waveform, easily spotted by its staircase appearance. Those sudden shifts in amplitude represent high-frequency components not present in the original analog waveform; those artifacts of sampling must be removed to create a smooth waveform. The output filter is, in fact, sometimes referred to as a smoothing filter.

Engineers have been designing filters for a long time; thus, at first glance, there should be little trouble with this particular assignment. Both the input and output filters can share an identical analog design, and the design criteria can be easily summarized. Ideally, we would like to attenuate all audio frequencies above the half-sampling frequency yet not affect the lower frequencies. Moreover, we would like that transition to occur instantaneously so that the usable bandspace is extended as far as possible to yield an extended and flat frequency response. Thus, an ideal filter would have a flat pass-band (the range the filter passes with less than 3 dB of attenuation), an immediate, or brick-wall, filter characteristic, and a stop-band (the frequencies the filter is designed to eliminate, for all practical purposes) attenuated to below the system's quantization resolution. In addition to these frequency-response criteria, an ideal filter would not affect the phase of the signal or any other time-domain characteristic.

Although an ideal filter may be approximated in practice, its implementation presents a number of engineering challenges; a brick-wall design means compromise in other specifications, such as flat pass-band and low phase distortion. To alleviate the problems of a brick-wall response, we could design filters with more gradual cutoff; these, for example, would not exhibit phase nonlinearities. However, the frequency of the half-sampling point would have to be increased to make sure that it was placed in a sufficiently attenuated part of the filter characteristic. Therefore, a higher sampling frequency, perhaps three times higher than that required for a sharp cutoff filter, would be needed to achieve the same frequency response. To limit the sampling rate and make full use of the bandspace below the half-sampling point, a brick-wall filter, at both the input and output of the digitization system, is the only alternative. Our problem is thus stubbornly defined.

Let's consider an output filter design, such as one found in a Compact Disc player. With a sampling frequency of 44.1 kHz, the output filters (one for each channel) are usually designed for flat response from d.c. to 20 kHz (Fig. 1); this provides a guard-band of about 2 kHz to ensure that attenuation is sufficient at the half-sampling point. The pass-band undoubtedly exhibits some frequency irregularity, called ripple, which is typically specified to be less than ±0.1 dB. The stop-band's attenuation is designed to be equal to or better than the system's dynamic range, as determined by word length; a 16-bit system would require a stop-band attenuation of greater than 95 dB. The stop-band also typically exhibits ripple.

[redacted]

Given the filter characteristics, several filter types may be employed, each corresponding to specifications incorporated in mathematical polynomials such as Bessel, Butterworth, Chebyshev, or elliptical polynomials. Each of these functions defines a basic design mechanism which may be cascaded (repeated in series) to sharpen the cutoff. These high-order filters closely approximate the ideal filter's brick-wall response. A passive Chebyshev design is shown in Fig. 2; the steepness of the cutoff increases dramatically as the filter's order increases. Unfortunately, the phase shift increases as well (Fig. 3). Compact Disc players might require a ninth- or thirteenth-order filter; the cutoff looks like the north rim of the Grand Canyon, but the phase shift might exceed 360° at 20 kHz.

We've come face-to-face with the problem: A massive high-frequency phase shift. The big question is, is high-frequency phase shift audible, and if so, how bad is it? John Meyer has examined that question and presented some conclusions, along with speculations about phase shift—that is, the time delay of signals [1]. First, absolute, non-frequency-dependent delay is inaudible. The Solti recording of *Das Rheingold* is 26 years old, which is a lot of delay, but the CD doesn't suffer phase distortion because of it. But Meyer has shown that the frequency-dependent delays called group delays, increasingly present toward the cutoff frequency of the analog filter in the CD player, do indeed cause phase distortion.

Exactly what is group delay, and is it audible? A conceptual worst-case example, suggested by Richard Heyser, proposes a two-way loudspeaker with the tweeter mounted about a mile behind the woofer. If properly equalized, steady-state tones would sound fine. But when the tone ended, we would hear sound emanating from the tweeter a full 5 S after the sound from the woofer had passed by. Likewise at the onset of a tone, the tweeter's attack would arrive 5 S late. Obviously, such massive frequency-dependent delays would be audible. But what about a real brick-wall filter, in which the delay at 20 kHz might be 300 µS relative to 0 Hz? Is that audible? Well, Meyer thinks

Analog filters demand careful planning to avoid contamination of the audio signal. Phase shift, ringing, and dispersion must all be considered by designers.

it is, and he has designed a filter to correct for it. Meyer's circuit uses complementary delays to achieve an absolute delay up to 18 kHz, and a rise to 150 µS at 20 kHz.

Problem solved? Well, not quite. In fact, the closer we look at brick-wall analog filters, the more consternation arises. Most brick-wall filters exhibit resonance near the cutoff frequency, which results in ringing; this, in turn, causes coloration in frequency response. The sharper the cutoff, the greater the propensity for ringing.

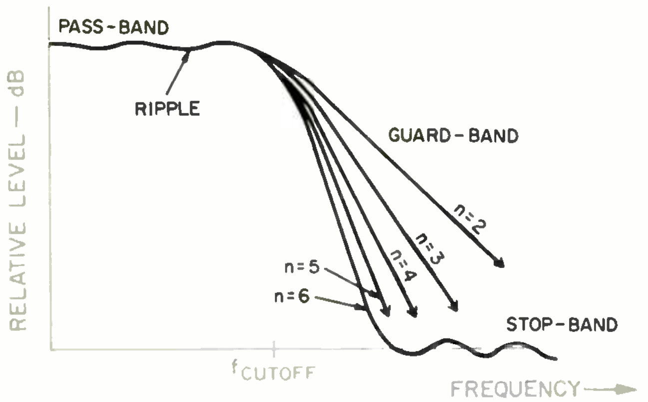

Fig. 1—How filter slope increases with filter order.

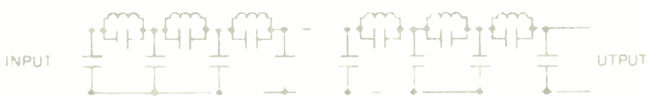

Fig. 2—A passive, low-pass Chebyshev filter, showing cascaded design. The filter's "order" is the number of cascaded stages.

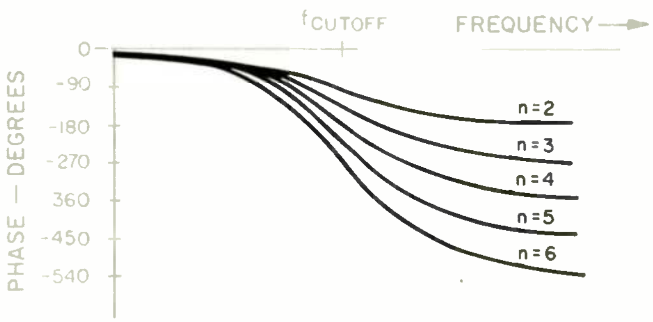

Fig. 3—How phase shift increases with filter order.

And that's not all: Thomas Stockham and Roger Lagadec have identified a new and somewhat mysterious phenomenon called time-domain dispersion [2]. In their experiments, so-called "perfect" filters, with no phase distortion or ringing, affected test signals with pre- and post-echoes (−32 dB, 40-mS delay) placed symmetrically about a waveform's attack. Subsequent tests linked the echo pairs to the filter's ripple; both the ripple amplitude and ripple frequency seemed to contribute to the observed dispersion. The frequency variation caused by ripple in itself is inaudible, but the artifact the ripple produces might provide a new and unexpected clue toward an understanding of our perception of digital audio. Fortunately, in practice, dispersion can easily be licked with a stricter ripple tolerance. Lagadec has suggested ripple amplitude of ±0.001 dB.

Thus, we are learning that the filters necessary in an audio digitization system are by no means trivial design exercises. It is becoming increasingly clear that these analog circuits demand careful design specification to avoid contamination of the audio signal. High-frequency phase shift, ringing, and dispersion must all be considered. Maybe our initial design criteria for a severe brick-wall filter were inappropriate. As Lagadec has asked, are such "macho" filters really necessary? Some experimenters are using digital audio systems without *any* filters.

As noted, it is supremely ironic that analog circuits should cause digital audio so much trouble. If only there were a way to avoid analog filters and perform the same function more efficiently, perhaps even elegantly. Well, there is a way. Next month we'll taste-test filters à la digital. **A**

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RESEARCH FOR THE ROAD

Once again, David L. Clark lets us in on what Detroit's auto engineers are learning and telling each other about car stereo:

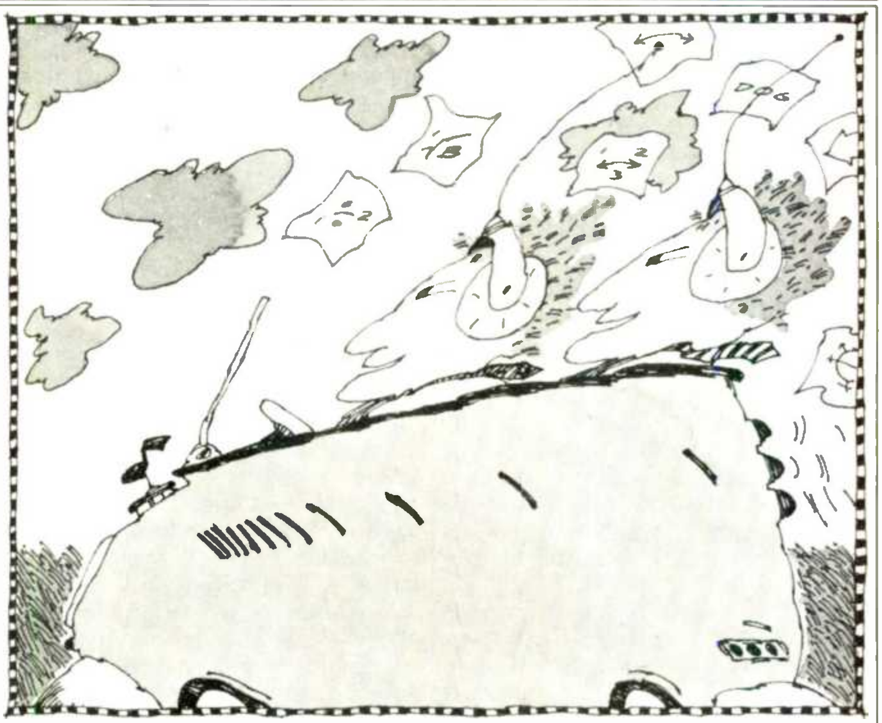


Illustration Thomas H Waters

Thirty thousand engineers from all over the world gathered in Detroit for the Society of Automotive Engineers' annual convention last February 25th through March 1st. Many of them drove, not for their love of cars but because they work in such nearby, less-than-exotic places as Dearborn, Warren, or Highland Park. Every year, however, the meeting takes on an increasingly international flavor. One year soon, I'm sure the kindly Editor of *Audio* will send me to Tokyo to cover this event. (Only if you drive there.—*E.P.*)

Now in their second year, the Audio Systems technical sessions were among the largest in the convention, with 20 papers. The number and quality of the presentations were a direct result of the efforts of organizers Lawrence A. Lopez and John M. Steel, both of Ford. The major topic was automobile acoustics, a much-neglected subject until now. Curiously missing were talks on car CDs or digital audio tape (DAT); it's my guess that manufacturers are holding back on CD-player introductions until they get solid information on DAT format standardization or recordable CDs.

Conference chairman Dick Stroud of Delco and assistant chairman Frank Andrews of Chrysler ran the sessions smoothly, starting off with a bit of humorous car-radio history. Ford engineers Clem Rowan and Carlos Altgelt showed slides of the step-by-step installation procedure developed by Earl Muntz in the '20s—two skilled technicians required up to seven days to complete the job. Back then, all radios were aftermarket installations and cost several hundred 1920s dollars.

Present-day radio developments were not neglected. Papers on antennas, circuitry and large-scale integrated-circuit chips were presented by Philips, Shinwa, National Semiconductor, Clarion, and NEC. Clarion told how they shrank the size of their latest cassette mechanism to make room for more circuit gimmicks in their newest car receivers. (After the Sony Walkman, I guess it's just hard to impress me with cassette miniaturization.)

Robert Orban and Greg Ogonowski, both presidents of companies which manufacture AM-radio broadcast processors, gave a plea for the standardization of AM-receiver amplitude response (Audiophiles with weak stomachs should skip to the next paragraph.) It seems that the conventional AM-radio i.f. section yields a response that is 3 dB down at about 2 kHz and 20 dB down at 5 kHz. Broadcasters have been able to partially compensate for this dead top end with pre-emphasis from processors like those of Orban and Ogonowski. With sharply tuned ceramic i.f. filters, new "wide-band" AM and AM stereo receivers are making a mess of things with their sizzling flat-to-5-kHz response. The resulting 20-dB peak means that lots of new radios are used with the treble turned all the way down. The processor-makers' proposal is to pick an optimal receiver curve and let broadcasters adapt to it. They suggest one that is still 3 dB down at 2 kHz, for compatibility, but only 12 dB down at 5 kHz. A sharp notch at 10 kHz would reduce adjacent-station carrier beat interference, but allow some high end out to 12 kHz, assuming a strong boost at the station. After the wearisome marketplace competition for an AM stereo system, agreement on an important and rational standard such as this one should be easy.

In my report of last fall's IEEE convergence conference, I accused Dick Stroud of presenting a "Delco chauvinist" paper exaggerating GM's contributions to automotive audio. I must apologize. He had been present, as one of the authors, but did not actually deliver the paper. He told me that there is a bunch of hard-working people down in Kokomo, Indiana, Delco's headquarters, but many of their efforts never see production. He said he had an engineering prototype sound system in a car parked in the basement garage, and asked if I would be interested in having a listen. You bet! I had to swear on my CD collection that I would never tell a soul about the car—at least not certain details about its sound system.

The white, 1985 Olds Calais would not seem to be the best listening room GM has available, but the sound was among the most satisfying I have heard in a car. Many custom aftermarket installations will out-decibel this system but I've yet to hear one with as natural a frequency balance. What impressed me the most was the natural, front-oriented imaging, with the rear

It is an exciting time for car audio engineering. Significant problems are being identified, and engineering solutions are being found.

speakers providing ambience without distracting directional cues. Mr. Stroud pointed out that even with the treble turned down, cymbals retained much of their definition and shimmer. The system did not rely on response "hype" to make a strong first impression. Even in the sporty rear seat, the sound was listenable—which is also most unusual.

Stroud had made his point: GM has a pool of talented engineers and the resources it takes to tackle a little problem like natural sound reproduction in a car. What ends up in production, it seems to me, must not be purely an engineering decision. Perhaps things are changing at General Motors; Stroud informed me that this sound system is quite likely to be offered on production models in the not-too-distant future.

Back at the meeting room, the acoustics portion of the sessions was begun by John Bareham of the Danish instrumentation manufacturer Brüel & Kjaer. John, who is a native of Ann Arbor, Michigan, has an intense personal interest in music performance and sound reproduction. Using Time Delay Spectrometry equipment, he has evaluated the sound field in a number of listening rooms to develop a correlation between reflection patterns and good sound. When he measured car interiors, however, he found the direct, early reflections and diffuse portions of the sound arrivals to be all bunched together in time. This condition results in many more early arrivals (around 1 mS) than in a large room, and in a quickly decaying diffuse field of reflections. Delayed arrivals of about 1 mS were found to produce comb-filter coloration effects and a "closed-off" sensation. Thus, the confines of the car environment can be viewed as moving the inevitable reflections into an undesirably early time zone. Mr. Bareham found that, in practice, many early reflections are due to protective grilles and carpetlike coverings over the speakers themselves. Cleaning up these details and using optimum placement, directivity and absorption can reduce early reflections and result in a better, less carlike sound.

Masahiro Hibino of Mitsubishi presented details of an elaborate objective/subjective scheme for the evaluation of car systems. A unique, discrete-spectrum test signal was first used to determine frequency response, noise and distortion levels at once. Intermodulation distortion, reverb time, and three-dimensional plots of the decay spectra of the car interiors were also recorded. The subjective tests consisted of binaurally recording music selections played in each vehicle. Pair-comparison tapes were then assembled from the masters. Subjects were asked to judge the better of the pair in each of eight performance categories. Although it was not so stated, I assume the comparisons were made without listener knowledge of which vehicle the sound came from (blind or double-blind tests). Subjective preferences were then compared to the objective test results. Not surprisingly, wide range, low distortion and low noise were preferred, but long reverb time and flat reverberant frequency response seemed to dominate the preference judgments. Mitsubishi can now be confident in using these repeatable, objective tests in development work, followed by listening tests as a final check.

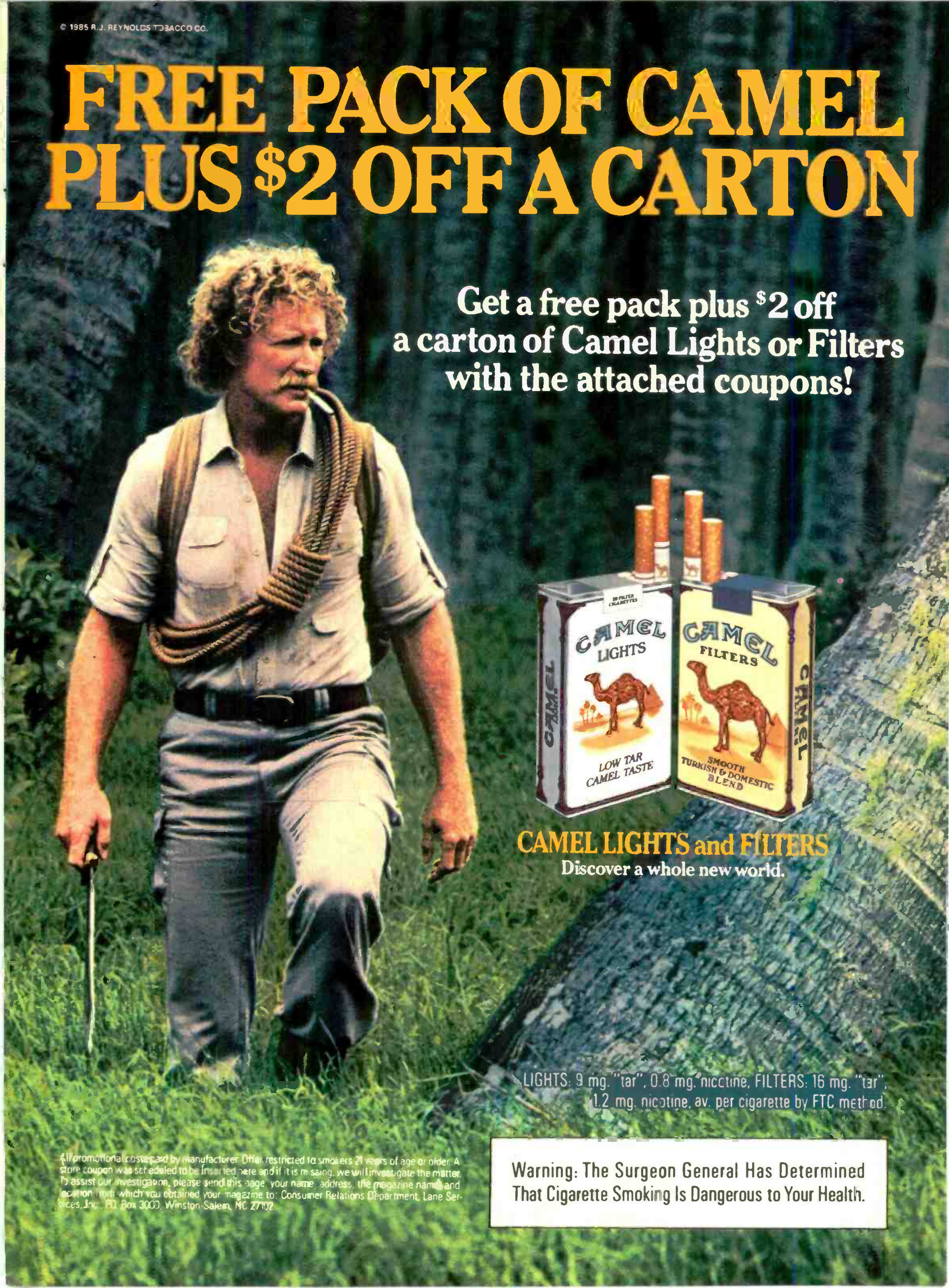
Although some procedural questions remain unanswered (such as one about binaural dummy-head details, brought up by an engineer from Daimler-Benz who is conducting similar studies), the method deserves to be applauded. This is an example of scientific research being used to define engineering goals in engineering terms. It is easy to forget that sound reproduction in rooms went through similar stages in the '20s and '30s when Bell Labs and the film and recording industries were seriously engaged in such research, refining new concepts such as stereo. We haven't asked too many basic questions since then; we just seek to make response wider and distortion lower. Now, the unique acoustical difficulties of car interiors are prompting new studies, and I'm all for it.

Vendors, who supply many of the sound components to auto makers, presented papers showing that they are doing their share of the research. Panasonic and Jensen presented engineering reports on new systems. Yasushi Tamura and Masaharu Hiraga of Sanden Corp. studied the perception of low frequencies in the presence of vibration and suggested in-seat, audio-responding vibrators. This might sell in California, but the idea didn't go over big at the convention. An excellent overview of performance criteria for digital car systems was given by Len Kulkarni of Jensen. The presidents of sister companies JBL and Harman-Motive gave quasi-humorous talks about the past, present, and future of aftermarket and vendor-supplied sound systems. Everyone at the seminar was on the edge of his chair waiting for some earthshaking announcement from these industry leaders, but it never came.

An excellent pair of papers by Ford engineers Earl Geddes and Henry Blind gave another insight into problem-solving at a big auto company. Dr. Geddes' paper proposed a method for obtaining repeatable frequency-response measurements averaged over the range of likely head positions. (For fine-tuning a system, consistency of measurement is vital.) Dr. Geddes' two-mike technique was instrumental in the development of the prototype sound system presented by Mr. Blind. I was invited to listen to this system and was particularly impressed by its smooth response and clarity. Unfortunately, it is not slated for U.S. production at this time.

A down-to-earth paper from American Motors wound up the audio conference. The AMC engineers were sure their sound could be improved, but they couldn't justify retooling for an all-new approach. The aiming of drivers, baffle integrity, grille material, and speaker specification were all reviewed and optimized. Electrical equalization was found to be unnecessary to achieve a very flat response from 40 Hz to 15 kHz.

The Audio Systems session for '85 may have ended on this practical engineering note, but its main thrust was the basic research being undertaken on car acoustics, sound-system measurement and perception. It is an exciting time for audio engineering. Significant problems are being identified, and engineering solutions are being found. Expect the establishment automobile makers to be introducing some tough acts for the aftermarket installers to follow. *David L. Clark*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SPLICE OF LIFE

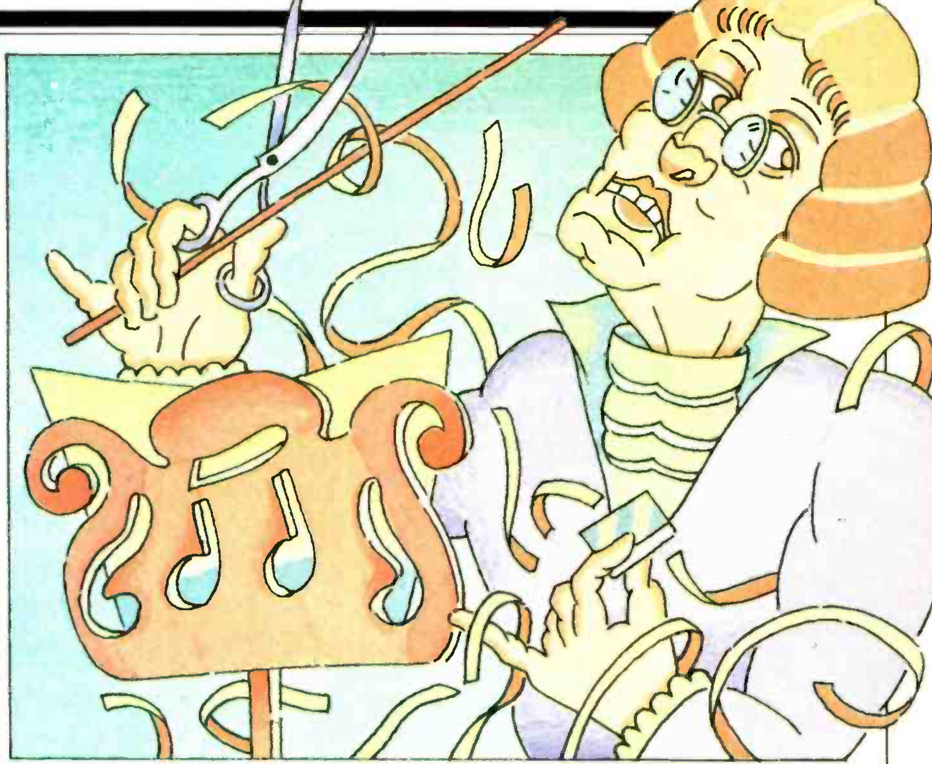

Illustration: Michael A. Donato

Digital audio moves so fast that the mere lag between writing and publication can put us out of date—does *everybody* now know about low-cost digital editing? Maybe. Anyhow, herewith more on my own recent discoveries in that area.

I think we can assume that in a very short time the preparing of digital audio material will be as routine, in every price range, as it has long been in analog recording. Not quite as cheap as the razor blade, but priced within reason. It should be possible to work usefully in digital recording at every level, from the simplest one-man operation to L.A.'s fanciest mega-syncs. Might eventually get down to consumer equipment, what with the remarkable possibilities in time coding.

I can be specific about the particular equipment that my friend Al Swanson in Seattle used to polish up my unedited digital Brahms, as described in this column last month. The units in his layout are not the only ones around, nor is his the only possible approach, but at least I can give you some idea of the reasoning—and cost effectiveness!—of his choice. He has four basic units in his studio, plus assorted computer elements including keyboard and the all-knowing CRT monitor that told us where we were and what we were doing at every moment. The most important item is the dbx 700 digital audio processor, a unit that created a noticeable sensation with its CPDM encoding when it first appeared, a while back. Using the dbx 700 implies, you understand, a basic choice of system, including VHS applied to audio recording. The next two of Swanson's units conform: Both are JVC recorders using VHS videocassettes.

It is possible to edit similarly in Sony Beta (PCM) format at low cost, but with restrictions. You can edit 14-bit PCM using home video equipment, but with less flexibility, and less accuracy, and with glitches, Swanson says. One could also avoid these drawbacks in PCM, but at far greater expense. So for budget editing, Swanson's system depends on dbx and VHS.

The first step involved analog, but not analog recording. My unedited PCM tape of choral music was decoded into analog, and was then fed directly into the dbx 700, whose output (now digital, again) was taped onto a JVC BR6400 video recorder. This is not a special VCR, simply a standard "industrial" model, perhaps a bit more rugged and direct in application than the corresponding consumer models but otherwise quite similar. Here is one advantage of the dbx-VHS combination: The source player does not have to be an expensive editing type. (I gather that for similar work in the Sony Beta area, you must acquire two of the editing-type machines, thus adding considerably to equipment cost.)

A second JVC video recorder in Swanson's studio, a BR8600 editing VCR, is indeed special. It costs more, but only one is required. The edited and assembled recording is taken down, piece by piece, on this "receiving" machine.

Finally, and vitally, these units are tied together with the all-essential editing controller, an updated equivalent of the familiar audio control unit, "boss" machine for a million hi-fi systems over the years. From a number of availabilities, Al chose the Convergence Systems VE-93 (that's a brand name). He gave me two good reasons for this choice, which I pass on. First, it was the least expensive unit available with time-code facilities. More important—and we can all understand *this*—the VE-93 comes ready-made with the drivers and interfaces for the JVC line of industrial video recorders, including the two units mentioned above. Half-inch format, of course. Al sees no real need for the more rugged ¾-inch formats (which may have fewer dropouts) unless you are (I add) one of those who Must Have the Best, at Any Price, in which case you wouldn't go for this economical approach to digital editing in the first place. There is plenty of audio bandwidth available via half-inch tape, the cost is less, and the playing time gratifyingly long—two hours per cassette. (Ah, but you *must* be sure you have a flying erase head, and you *should* also have frame servo in your half-inch receiving recorder—that's a Swanson quote. No need for these in the source machine, however.)

So—you simply plug all this together, along with your own special peripherals, like speakers, amps, typewriters, computer parts, ashtrays and other studio appurtenances. Frankly, the result in Al's studio didn't look any too simple for my unaccustomed eyes. It was a cross between a very elaborate basement hi-fi installation and a typical

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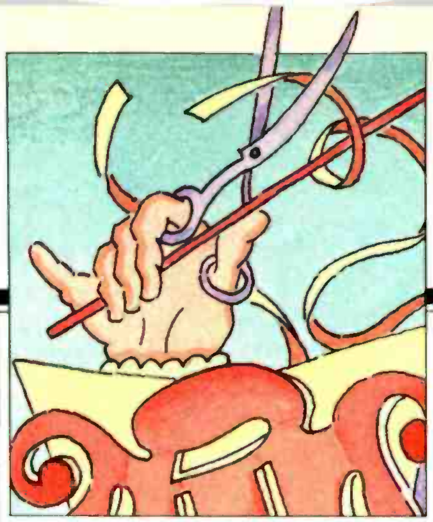

working studio of the most casual sort, with everything surrounding Al's comfortable seating place. But from a pro viewpoint the configuration was aggressively practical, I admit—compared, that is, to what *some* audio people get themselves into, be it messy or neat as a pin. The hookup, you see, was easy and the working conditions are comfortable. Al is his own man.

Now, for those intelligent readers who are innocent and/or unknowing (I am certain there are many—and why not?), a brief description is now in order as to what Swanson was doing with my music as I looked over his shoulder. There are three basic, interdependent facets in digital tape editing (including this bottom-cost sort). They are remarkably different from all the analog snipping and cutting of these last 30+ years. The *editing itself*, the matching of sounds, the removal of unwanted material, is really not much changed. Only the *method* is revolutionized.

First, in digital one *never cuts the tape* (or we shouldn't, if we do!). We do not even touch it. We edit by *copying* onto a new tape, with automatically controlled joints and excisions that have been neatly programmed ahead of time in each case.

In analog, it is unwise to copy because of the quality loss involved. There are too many copying jobs already being performed, notably from those gigantesque, multi-track master tapes and mix-downs—less in classical areas, but still too much. Now we have returned to a more pure, audiophile approach, with a minimum of analog copying. Nevertheless, to copy is to lose, no matter how perfected are the electronics, and so analog editing by the copy system is not a particularly good idea. As a billion used razor blades will attest.

But in digital, due to the very nature of the message, we *can* copy, and even base our whole editing technique on copying from one tape to another—hopefully, with no loss whatsoever in quality. *If* all goes well. It often does.

So the rock-bottom editing system copies from one VHS videocassette to another, assembling the material in the process. This we do—and here's the second new facet—via time code, an audio-track signal applied directly to the tapes, video frame by frame. (There are other variants in other types of editing.) The time code is read by the machines and used as the basis for an astonishing range of precise controls and movements that are automated, visible on the CRT, never mistaken, and—even with this relatively modest equipment—dependably accurate. By this method, using the VHS videocassette base, the resolution is to about one-sixtieth of a second (one video field, or half a frame) or better, but edit points can be shifted only in increments of about one-thirtieth of a second, or one video frame. At 15 ips in analog, that is one-half inch of tape. (For specific sonic examples of this, see last month's column.) That's less exactitude than you can get with razor blades (even on audio cassette at 1⅞ ips, one-thirtieth of a second is one-sixteenth inch of tape), but good enough when dealing with the comparatively continuous sound of singing voices. With fast piano music, it might not do as well.

Now, anyone who has bumbled around an old-fashioned recorder with an "odometer" counter like an automobile's knows how frustratingly inaccurate any mechanical timing can be. I never used the things—you rarely got back to the same place twice in a row. Anything that depends on a mechanical connection (even the fancier readouts) is no more than roughly accurate. But the time code, an actual signal applied to the tape, is as good as a very fine set of gears, and always returns to the exact same place, within its level of tolerance. Just as important, the basic time coding in this marvelous era of digital operation allows for a most extraordinarily easy and exact automation of every imaginable and practical sort, smoothly and effortlessly, with the proverbial push of a button. Believe me, if you haven't worked with such updated automation (or at least stood over the shoulder of someone who is), you have missed plenty.

Most people have an idea of it, of course. If you have mastered your own VCR, you have some idea of the feel of it (assuming you are getting what you want), and those who manipulate audio-cassette recordings have an idea, an inkling (my best word) as to what can be done. Same for disc jockeys who devise ingenious semi-automated ways to switch from one recording to another at precisely the right moment. But, I say, none of this can match the smooth, effortless precision, the unfailing accuracy of location, the automatic procedures that go on while you sit and watch them happen, which can derive from an applied digital time code. That's what the magic letters SMPTE are all about when those video and movie people get into their own special coding.

I do not intend to go beyond my own outsider knowledge here, only to relate my own experience. I gather that time codes have not been much used in analog home audio; that the Nagra recorder (reported on in its first stereo form, many years ago, in this department) is a notable exception. (It's widely used for professional video and film soundtracks.—*I.B.*) Perhaps there will be more—that is, a sort of "printed on" audio signal that can be used like the cogs on a fine gearing to control tape access minus slippage. Might be nice in some very amateur recording gear, yes? But somehow this kind of procedure is inherently better off in a digital environment, with the numerous technical advantages (in particular, copying integrity) which are a part of the digital process.

So we have, for budget digital editing, the copy system, the time code and, finally, what I am calling *rehearsal*. It is tied to the others and just as important. Until my experience this year I had not run into it—why should I have? But wow! What a difference. I simply marveled; I could scarcely believe. Even in this low-cost, bottom-simplicity type of digital editing, you have full-fledged rehearsal. You could also call it tryout. In ways that are still somewhat mysterious to me (after only a few hours' experience), you may do a dry run on any sort of sonic joint or edit, ahead of time, and listen to it exactly as it will sound, when and if you make it final. No cutting and patching, GM

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To copy is to lose, so analog editing by the copy method is not a good idea. But in digital, we *can* copy, without any loss in quality.

which perhaps will destroy bits of priceless music when things don't work. Via the audio processor and the controller et al., you set up your splice and the machines play it for you, using the time code. Not quite right? You edge up a bit closer, a tiny fraction of a second, and try it again. And again, until you are satisfied. Then, and only then, do you do the actual copying splice onto the receiving final tape, automatically as per prior instructions.

If you aren't pleased, if you think another place in your music might be better (this is where experience counts, in analog or digital) you have lost nothing; your signal is intact no matter how many hairsbreadth joints you have rehearsed. Thus, you see, this kind of preparation opens up a whole range of hitherto risky experiment—as I know so well—in those "impossible" editing joints that sometimes miraculously work out. No priceless slivers lost on the cutting-room floor, or too small to reattach; no more unremovable thumps and bumps! Agony is the only word for old-style disasters of that sort, whether on a one-man project or at the expense of a major recording session. Agony no more, opportunity galore.

There is still one more highly positive aspect of budget digital recording, to further offset the marginal accuracy (from some points of view) that is achieved—those discrete one-thirtieth of a second "cogs" of location. *It keeps track.* What a bonanza! You can't get lost. You always know exactly where you are, and you can always go direct to some other place, unfailingly. The machine takes you there.

Never again a roomful of half-played reels, semi-identified or anonymous; no more hanging screens of short lengths of tape stuck to nearby surfaces like so much chewing gum awaiting possible re-use. No more snarls of tape accidentally reeled onto the floor and then stepped on—I've often enough reduced myself to tears in that sort of editing.

Yes, there are disadvantages. You can't cross-fade; it's butt to butt. You can't go slow and rock the tape (but this is not a problem when you can actually rehearse your proposed splice to find what it will sound like). You can't alter the final tape with second thoughts—the time code will be unjointed and all that follows will have to be done over again. (But your second thoughts are okay in rehearsal.) Most of all, there is that matter of accuracy, easily solved if you move up to much more costly equipment. But don't! So much depends on the ear, on experience, on the rapport between producer and engineer, on familiarization with new procedures. For some people it won't work. I myself had no trouble getting what I needed for low-cost digital editing. Couldn't you? Worth a try—whether you buy outright or use a Rent-a-Pro like Al Swanson.

Clive Davis: Finding Songs

To broaden our base beyond album-oriented rock, Arista uniquely married songs with popular entertainers, and came up with the hits that propelled their careers.

Everybody in the music business has an opinion of Clive Davis, the former head of CBS Records and current president of Arista: He's marvelous. He's awful. He's a genius at finding and developing talent. He's a genius at self-promotion. He's a visionary. He's an egomaniac.

Opinions can be readily argued; facts cannot. Part of the reason for Davis' sometimes inauspicious reception in the music community stems from his role in the shift of power in record companies from "music people" to lawyers and professional managers. Clive Davis was president of CBS Records for almost eight years, yet the Harvard Law School graduate admits to having no musical background whatsoever. Nevertheless, under his guidance it became the most important record company in the business. In his fascinating book, *Clive—Inside the Record Business*, he tells of his eye-opening experience at the 1967 Monterey Pop Festival. After that epiphany, Davis turned CBS from a musically conservative company into the corporate leader in rock 'n' roll by the end of the '60s, by signing top acts like Janis Joplin; Blood, Sweat & Tears; the Winter brothers; Santana; Chicago; Laura Nyro, and Sly and The Family Stone. He successfully negotiated to keep Dylan on Columbia, and not long before he was to leave, he signed Bruce Springsteen at John Hammond's urging. As his confidence grew at CBS, he began to take a more active role in the careers of many of his artists—tailoring their images, picking hit singles, occasionally even going into the studio with them. His success was dramatic, almost unprecedented.

His ouster from CBS in 1973 was even more dramatic. He was accused of misusing company funds. No criminal charges were ever filed and nothing proven, but he lay low for a year and a half and worked on his book. He fielded and turned down lucrative offers including ones from Island Records' Chris Blackwell and from Robert Stigwood.

Instead, in 1975 he began a totally new enterprise, Arista Records, in partnership with Columbia Pictures, which had had little success with its Bell Records. One of the only three artists he kept from the Bell roster was Barry Manilow. Under Davis at Arista, Manilow became a superstar; Arista also hit with other easy-listening acts such as Melissa Manchester and Air Supply. But Davis also won praise for supporting a line of avant-garde jazz discs, and for signing innovative rock artists such as Patti Smith and Graham Parker. From scratch, Arista became a major force in the record industry.

Far from making him more circumspect, Davis' troubles seem to have made him even more outspoken, and he has assumed the role of corporate spokesman on issues varying from record pricing and marketing to the death of rock 'n' roll. No matter what Clive Davis says or does, he'll never be unimportant—or uninteresting. *T.F.*

You have been personally involved in signing and bringing out records by such a wide range of people, from Neil Diamond and Barry Manilow to Johnny Winter and Patti Smith. I couldn't possibly relate to such a broad range of music. How do you do it?

Of course, a lot is dictated by necessity. Commercial considerations. My roots are really in AOR [Album Oriented Rock] in the sense that I began with early signings of Janis Joplin, Santana, the Winter brothers, even Blood, Sweat & Tears—who became a little middle-of-the-road later in their career, but when they began were very avant-garde in the fusion of jazz and rock. And Chicago of course, Ten Years After, Pink Floyd, and Billy Joel. But I found after I started Arista that over this past 10-year span, up until relatively recently, there were very few American artists, American rock groups, other than one or two heavy-metal ones, that were breaking, and broke big. So out of economic necessity I had to turn to see if I had any other kind of talent to explore. In Arista's era I worked much more in the song area to supplement AOR because I could not live off only American groups. No company could.

What do you mean by song area?

Finding songs for entertainers such as a Manilow, such as an Air Supply, such as a Melissa Manchester. We're talking now from '75 to, say, '83. Except for The Cars, whom we almost signed. It's a dramatic story . . . . We had a memorandum of agreement all initialed, and thought we had them locked up. At the last minute, Elektra offered more money and got them. But I was there, and had them and loved them, and they had, in effect, agreed to come to Arista, interestingly enough. Of course, we had Patti Smith and The Outlaws at that time. But a lot of the industry's success was with foreign groups. And we as a young company did not have subsidiaries in Australia, let's say, to

For Singers

CLIVE DAVIS

give us Men at Work, or in Canada to provide Loverboy or Rush, or foreign groups such as AC/DC, those foreign bands that were breaking here. There were very few major, original American groups. And here my career had begun with the original groups that I mentioned. So you had to survive by taking established artists, as I did; by attracting to a new operation groups like The Grateful Dead and The Kinks or The Alan Parsons Project, along with the discovery of The Outlaws and Patti Smith. We had to exist by doing something other companies were not doing.

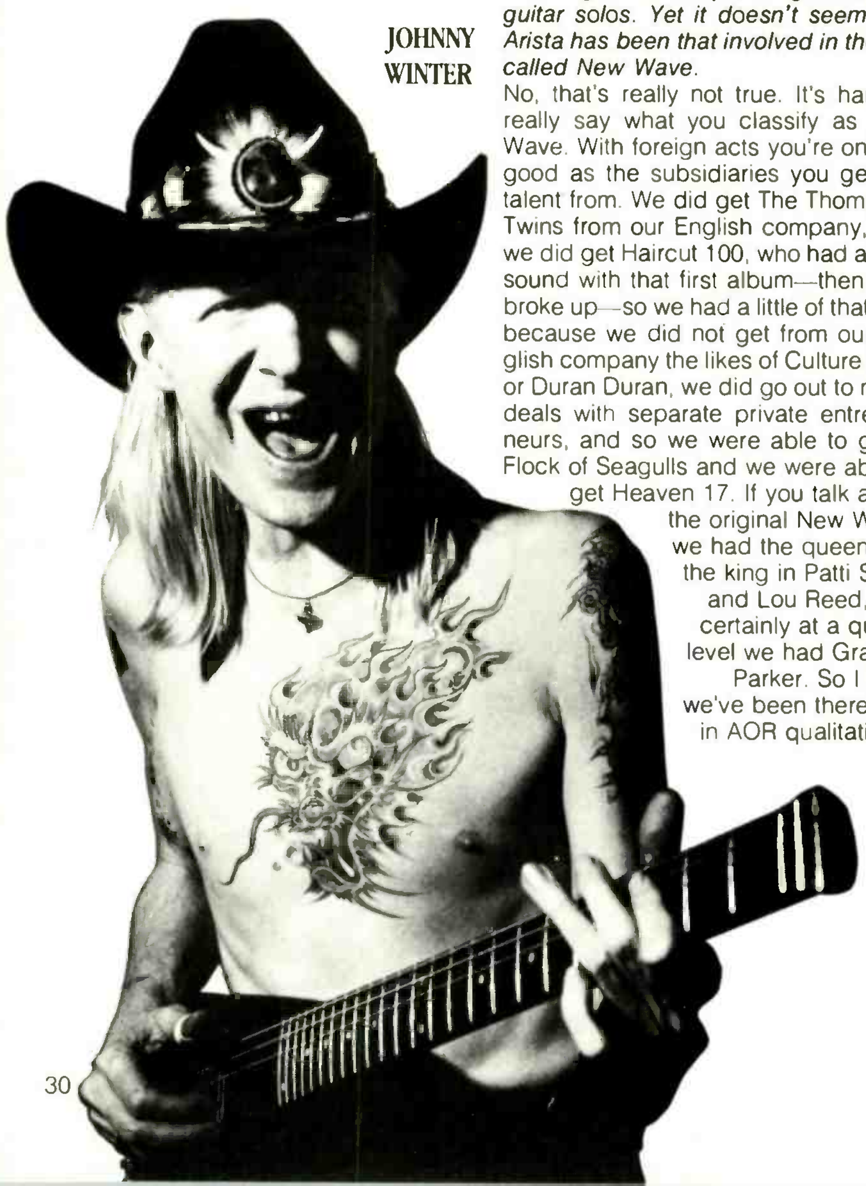
I was never really disco-oriented, so I didn't do what Neil Bogart did with Casablanca. I did it in the pop area. We uniquely married songs with popular entertainers and had terrific success with Manilow and Air Supply and Melissa, to supplement building an AOR base of artists that had varying degrees of success. I was even in the avant-garde with Stiff Records and Ze Records, and Lou Reed, and Graham Parker to supplement Patti Smith. But AOR radio was so conservative they were really only into the oldies with Led Zeppelin and The Stones. I had to turn to that, apart from black artists and jazz artists. We had to be catholic in what we did because if I continued primarily with a base of AOR artists, we would not have survived the holocaust that occurred after The Bee Gees. We had to broaden our base from the beginning, and we were uniquely successful. We were one of the very few companies that were very song-oriented, and for entertainers like Dionne Warwick and Aretha Franklin and

Photograph: Elena Seibert

Barry Manilow and Air Supply—whether they wrote or not—we came up with the hits that propelled their careers.

Are you saying that the move into the pop-song area was something you would not have done if you did not have to do it?

I like pop music, personally. Right now the market dictates a lot of what you do, and right now the market is *not* receptive to pop acts. So therefore, apart from the pros like a Neil Diamond and a Barbra Streisand and a Barry Manilow, you're not finding singer-songwriters. So I might like, and I do like, James Taylor or Jackson Browne, but you don't find companies signing artists like those today because the market is not going to play it on the radio. I tested the market substantially in the mid-'70s with avant-garde artists that I felt comfortable with, because I love originality. I worked with Dylan; I didn't sign him, but I was there. I was at the signing of Bruce Springsteen. And I signed Joplin. I was there for the *original* talents. That's what gives me the greatest pleasure. I love a great song. I do not demean being able to write pop hits, but I do like to be with the hallmark of originality. Unfortunately, America has really not come up with a great original talent since Springsteen—except for Prince. It's formulated. There's a lot of corporate rock.



JOHNNY WINTER

A lot of the New Wave acts are British. It's interesting hearing you talk of the importance of the song, because that seems to me to be at the heart of the New Wave movement. That return to the song instead of just long, indulgent guitar solos. Yet it doesn't seem that Arista has been that involved in the so-called New Wave.

No, that's really not true. It's hard to really say what you classify as New Wave. With foreign acts you're only as good as the subsidiaries you get the talent from. We did get The Thompson Twins from our English company, and we did get Haircut 100, who had a nice sound with that first album—then they broke up—so we had a little of that. But because we did not get from our English company the likes of Culture Club or Duran Duran, we did go out to make deals with separate private entrepreneurs, and so we were able to get A Flock of Seagulls and we were able to get Heaven 17. If you talk about the original New Wave, we had the queen and the king in Patti Smith and Lou Reed, and certainly at a quality level we had Graham Parker. So I think we've been there and in AOR qualitatively, even if it wasn't in mass numbers. Mass numbers we have with The Thompson Twins, who are a platinum act. A Flock of Seagulls, over two albums, sold about 1.2 million in the aggregate. And I'm looking for rock 'n' roll acts because I think America is ready for its own now.

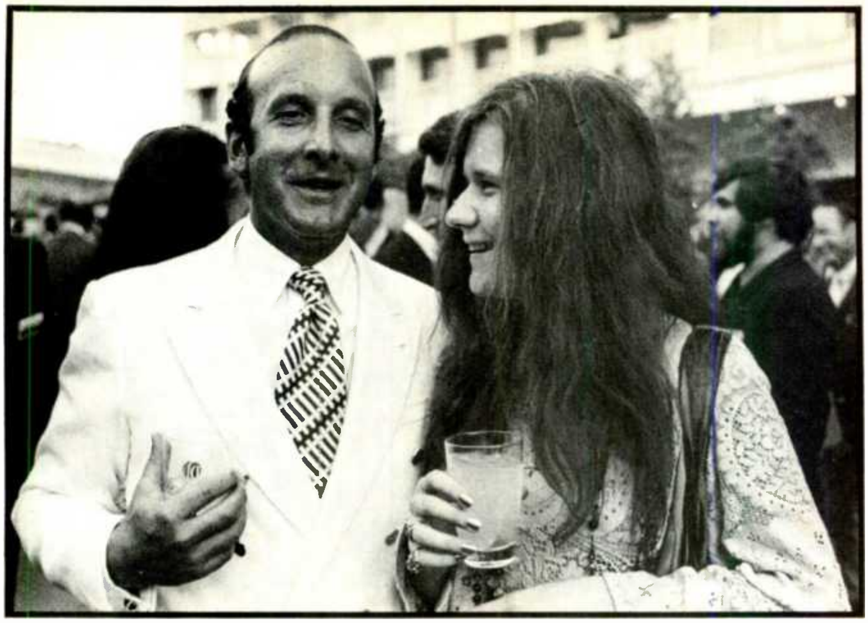
What I'm saying to you, in answer to your question about the universality of the acts I've been involved with in one capacity or another, is that a lot is dictated by commercial considerations. And because American AOR dried up for the most part, and was not prolific as it was in '67 to '72 or '73, to become a sizable label we had to go into pop and black music, which relies more heavily on the song, and not AOR play which has a harder rock edge. We built up . . . . we certainly had the biggest growth of any company in the business, and I would say in the pop or black areas we were either number one, two or three every year. That's what accounted for our ability to survive and to diversify and grow.

You must have been right at the forefront of breaking black acts on pop radio and butting heads with MTV to get black acts on there. Was that a frustration?

Candidly, no. I never came to that with MTV. I don't think MTV avoided black acts, any more than an AOR station. How many black acts does WNEW [in New York City] play?

Good question.

They don't play them, not because they're against blacks, but because it doesn't fit their format. Their format is hard rock, or rock 'n' roll, and there aren't that many black rock 'n' roll acts. You can't ask them to play Dionne Warwick or Ray Parker. Yes, one or two Ray Parker records, maybe. But you've got to understand the other person's problem. It's certainly not racial prejudice. It's based on segmented formats. Once you understand the problems of MTV or radio you recognize that it would be silly. It doesn't fit their format. I never bumped heads at all with them. I did bump heads with AOR radio because of their conservatism, and their not playing Lou Reed's *Street Hassle* or not playing some groups in Middle America or the South. It's shocking, not playing some of the avant-garde stuff. I think that's terrible. Until KROQ



DAVIS AND JANIS JOPLIN

Photograph: Courtesy of Clive Davis

[in Pasadena] and WBCN [in Boston] showed that new music can play, you were there in a bastion of oldies but goodies. It was terrible, except for harder rock stuff. Even now—where's the new Dylan? Where's the new Springsteen? Where's the new Dan Fogelberg or Jackson Browne? It's horrendous to me that there's no new artists coming along with music that is lyric-oriented!

Are you blaming this on the stodginess of AOR radio?

Yeah! Absolutely.

They don't encourage these sounds?

Absolutely not. It has to be shoved down their throats pretty much. Yeah.

It seems that it still hasn't caught on. If you want to hear New Wave in New York, you've got to tune in to WLIR on Long Island.

Well, for your definition of New Wave. Big New Wave, in the broader sense, has become mainstream music today.

True.

I mean, Duran Duran and Culture Club and The Thompson Twins are Top 40, primarily. They still don't give the exposure to Elvis Costello or X. No, they don't. Graham Parker is great! He doesn't get the kind of play in the South or Midwest that he should get. Nowhere near.

Will they ever break nationwide, except for the New Wave acts that have crossed over to pop success?

Today, first of all, AOR doesn't have the strength it did five years ago. Contemporary Hit Radio, the equivalent of Top 40, now dominates. It's a shame that the new artists who are literate and lyrical and articulate and intelligent, lyric-oriented as distinguished from harder rock-oriented, don't have the avenues for exposure of their music; ergo, record companies shy away from it. How long can you keep banging your head up against the wall if you're not going to get exposure?

In that line, let's talk about Patti Smith. You seem to have a very special relationship with her.

I do because she was one of very few originals. You know, when you start a new record company and you're able to come up with an original who breaks all over the world as she did . . . . She did it in her own style and her own way, with her own charisma, with very few compromises and condescension, with true poetry and excitement. She was very warm and personal and would always drop in, so we established a personal friendship and relationship. Then when she got hurt and her neck was in a brace for a year she lived right here at One Fifth Avenue, and I would go down there to visit her. Because she's bright. She's a Renaissance woman. She's an artist in her own right, not only as a poet, but she's an artist from an artistic point of view. She was literate; you know, she lived for years with Sam Shepard. She was a delightful, stimulating person to both talk to and be around.

What's happened to her now? I understand she got married.

Enigmatically—not enigmatically because she got married; she's certainly entitled—the enigmatic part is that in her marriage and in her pursuit of domestic and personal happiness, she really dropped out of the jungle of musical warfare, so to speak. She's had a child. She did reappear. . . I had no contact with Patti, not even a phone call for over three years. No one did, except her mother. It wasn't that I was phoning her; I didn't ask for product. We were so close, I figured, if she's happy, who am I to even remotely bring up the subject of music? Then, several months ago we had a tenth anniversary party for Arista. We took over the Museum of the City of New York. I didn't even invite her; I didn't have her address or her phone number. The photographers were there. It was a major event, if you will. All of a sudden there's this incredible stir, and who walks in unannounced, no advance notice, but Patti with her husband Fred. She had heard about it through her manager. She came in and threw her arms around me and said, "I just had to do this for you." I didn't ask her anything about recording. She showed me pictures of her child. She seemed happy. She was overwhelmed by the attention because there were a lot of TV cameras and press there, clicking away. She was a little shaky because of that. Because it was really a return from absolute isolation, it appeared to me. But she was extremely warm. She said she'll come back.

Where's she living?

Detroit.

You used the term musical warfare. Re-reading your book, it does seem like warfare. Is it, really?

Well, it can be. I mean, on a day-to-day basis it's not.

It sounded like it in the book.

Well, I'll tell you. That book coincided with an explosion of original talent in every area. I wish there was such an explosion today. You get the warfare when a hot new artist comes along, and we all go after that artist at once. But since there are so few of those today in America, the opportunity for

What a shame the literate, articulate new artists who are more lyric-oriented than hard rock-oriented don't have avenues for exposure of their music.

Photograph: Courtesy of Clive Davis

DAVIS AND SLY STONE

that kind of competition at the artist-signing level is not nearly what it was from 1967 through 1973. The biggest new, original talent, in my opinion, is Prince. To my knowledge he was first offered to Columbia, and I don't know what happened there, but they did not get him for whatever the reason, and then he went to Warner Bros. So it wasn't that anybody knew of Prince. He was part of a local group that was creating noise. It wasn't that everybody was going after this hot new group; I mean, it doesn't happen. Now it happens in the banking deals to some extent.

How do you mean?

Well, if you hear that a Bowie is free, or a McCartney or an Elton John or The Rolling Stones, then there's competition, obviously. I'm sure that Atlantic wanted to retain The Rolling Stones.

You call them banking deals because of the vast amounts of money involved?

Yes. Very few of those deals have ever made money for the label. They usually are deals where the artist uses the competitive interest of the companies, and walks away with an enormous sum of money . . . . I would think that the history of the last seven years should be a clear message to all record companies to stay away from these banking deals, because they just don't make money.

Why do record companies pursue them? Is it a prestige thing?

Part of it is that. Part of it is miscalculation—not recognizing when an artist has peaked, and thinking it is going to go on. Of course, certain artists do go on for a long time. But I would say the history of most of these deals is that the company has lost considerable sums of money.

One thing I have never understood is how different record companies can come up with such widely divergent offers for the same artist. I just read somewhere that one record company tripled the offer made by another company for a certain artist.

There is a different mentality at almost every record company. I'm amazed at some of the deals that I hear of. I can't even believe that a rational businessman would offer those amounts of money.

Let's talk about The Cars.

Well, that was a brand-new group, that wasn't a banking deal. I was signing them for the standard terms of a new artist, which at the time probably was $25,000 and a recording budget of $100,000 to $125,000.

This was around when, '76?

Probably, yeah. It's not that different today. I'm just now signing an artist that I've gotten excited about. The first American rock artist in a long time. I'm closing the deal at $25,000 to sign, and a $130,000 recording budget.

Who's the artist?

He's not signed so I'll only tell you that I think he's original and exciting, and I was really turned on, which was the first time in a long while. Not that I haven't been turned on to an artist, because there is a black artist I'm launching, Whitney Houston, that I'm very excited about. But we're talking here now about rock, as opposed to black and pop. I am very excited about the black roster that we've built here. It's spectacular, I think. I mean, working with Aretha, and having the success we've had in re-launching Dionne Warwick . . . .

I want to get into that in a minute, but before we do, tell me—when you're going to make an offer for an artist, what do you look for?

A new artist?

Either new or old.

It's vastly different. In the established category, sometimes the talent is just there. The question is how much money they're asking, and whether you think they're going to go out of style. You have to make a judgment, creatively, as to where that artist is at. Because sometimes artists and their managers ask astronomical monies. You've got to believe they can retain their superstardom. Or are they going to diminish in popularity?

With a new artist it depends on the category of music. If it's rock, I look for originality. Also, today you've got to look for hit songs. Very few artists break from AOR today. Years ago, and for many, many, many years, you *could* break from AOR play; the category was sufficient to sell millions of albums for Pink Floyd without a Top 40 single, or Bruce Springsteen, or other artists. Today, you gotta have a single, so you're also looking at their song sense, and looking at their musical-composition sense—apart from charisma. So, in the rock area, it's either commercial appraisal of material or looking from an originality point of view. In the pop area you're listening for hit songs. In the black area you're listening for where the material is coming from, whether there will be hit songs, plus the artists' ability to entertain, and the kind of vocal ability they have.

How about stage presence?

Stage presence is more in the rock area, and the black area, too. It really varies so much. I didn't look for stage presence when I signed Springsteen.

Eighty percent of my time is in the creative arena—discovering new talent, finding good material for established artists, and watching an album evolve.

Photograph: Courtesy of Arista Records

PATTI SMITH AND DAVIS

It was just pure originality of lyric content. He was very uncharismatic as a rock personality when he was signed in '72. He really was not a major performer onstage. He didn't move around. He was totally different than he is today. He developed into the best rock 'n' roll performer alive over the years, on his own. But nobody knew he would, neither John Hammond, who brought him into my office, nor I, who then appraised him. I said no to 10 or 12 or 15 or 30 John Hammond acts—and then said yes to Springsteen. That's why I feel, candidly, very close to the signing process involving Springsteen. Because I said no to a few acts, the previous week, that John might have been interested in, and this one was different. His lyrics were piercing. I can remember going on closed-circuit TV just reading his lyrics, saying you're not going to break him because of his musicality, but his lyrics are spectacular, and listen to this imagery, and I recited his poetry to the Columbia sales force. Yes, and I had the videotape sent out to be shown to every retailer. Because that was the approach we were taking. And he didn't break right away. He came, really, out of the folk/rock poet tradition, but he has developed into the most incredible live performer. Joplin, on the other hand, was a vibrating, charismatic, exciting, exhilarating live performer from the day I first saw her. I knew I had to have her.

Talking about getting on closed-circuit TV to your Columbia sales force, is that a big part of your job? Keeping your promotional people and salespeople and marketing people motivated and excited about acts?

I leave that to others within the company, but it's part of it, yes. But I find that today the sales and promotion forces are so sophisticated, much more sophisticated musically. Originally, it was a great part of what I had to do, because when I inherited Columbia they were all so middle-of-the-road oriented, into the music of Mitch Miller and Andy Williams, who was a great seller, and Tony Bennett and what have you, that a lot of orientation was required. Today, not that much orientation is required, and they pretty much pick up on their own, whether someone is a really great talent or not. Most of my time, 80% of my time, is spent in the creative arena, at the artistic level of finding new talent, finding material for established talents who don't write for themselves, and watching an album evolve. All these cassettes on my desk are either songs for artists or albums in preparation. I'm monitoring, listening to them, helping pick the singles, editing the record, and in a few specialized cases, going into the studio to produce it, if it's a song I found for a pop act or a black act. That's 80% of my time.

Do you think you are different in that way from most other major record-company presidents?

I think that it's probably different from most. It's not singular, but I think that a lot of executives who have been very successful in their own right operate in their own style, which is not quite as creatively oriented.

PAUL SIMON, ART GARFUNKEL, AND DAVIS

Photograph: Courtesy of Clive Davis

This is the first section of a two-part interview.

the Magic Speaker from Acoustic Research

Kenneth L. Kantor

With science marching on and all that, the sonic differences between brands of a given hi-fi component are often reduced to subtleties. Loudspeakers, however, are the notable exception; they remain an enigma. Maybe that's what makes them so much fun. There are roughly 1,500 home loudspeaker models on the U.S. market. Each model has, by and large, its own distinct sonic character. Why so many different sounds? Some certain response must be correct; why can't loudspeaker designers consistently approach it?

Consider, for a moment, the typical audiophile venturing to the local high-end shop to audition amplifiers. For this purpose, he requests a pair of the most "revealing" speakers available. These are graciously provided. As our friend struggles to hear the audible implications of the sub-subsonic filter versus the damping factor of 10,000, he moves his head—not much, just a few inches here and there. Each time he moves his head, the response he hears from the speakers, as measured by conventional methods, is changing by more than a few dB. He never even notices—and he is a *very* fussy listener. Actually, he so likes the loudspeakers that he pronounces them to be beyond "revealing"; he pronounces them positively "merciless."

Clearly, conventional frequency-response measurements are not sufficient to quantify loudspeaker performance in a meaningful way. In fact, the measurement techniques most often used to test speakers are engineering conveniences only. They do not take into account the characteristics of the human hearing system and so do not always relate very well to listening tests.

The other thing they don't take into account is music. Where and how music is recorded profoundly affects the requirements for accurate reproduction. It is too simplistic to say that accuracy is absolute. Stereo recordings contain precious little information about how spatial characteristics should be reproduced. Both practically and mathematically, two electrical voltage signals cannot fully define the sound field in a listening room. It is unfortunate but true: Every loudspeaker is more than a reproducer, it is an interpreter.

Photograph: Robert Lewis

These are not just engineering problems. They cannot be solved by designing better drivers or using different speaker cable. The answers lie in understanding human hearing in relation to sound reproduction. How do we perceive the location of a sound source? What actually causes tonal coloration? What makes a room sound large or small? And the bottom line: How do all of these considerations relate to loudspeaker design?

Kenneth L. Kantor is Director of the Advanced Development and Research Division of Teledyne Acoustic Research in Canton, Mass.

The new MGC-1 speaker from Acoustic Research is based on a body of psychoacoustic data which is well documented but little known, rather than on rabbit-from-the-hat trickery. The design uses side-firing drivers, which are fed a delayed and contoured signal, to establish a firmly fixed soundstage that is both wider and deeper than the space in your listening room.

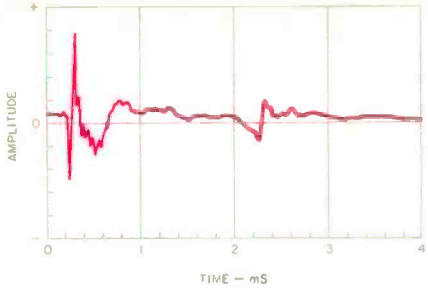


Fig. 1—Time response to a 10-μS pulse of a conventional speaker system in a typical listening room, with microphone at listening position. (All vertical amplitude scales are linear except where otherwise noted.)

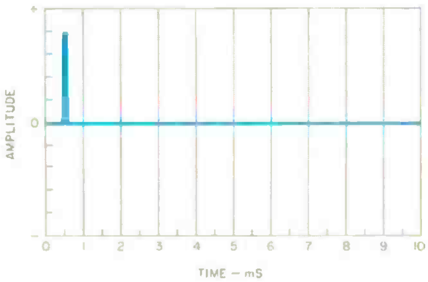


Fig. 2—Time response of an ideal speaker to a 10- μS pulse in a nonreflective room.

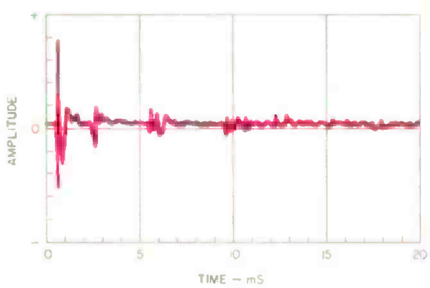


Fig. 3—Same as Fig. 1, with time scale lengthened to 20 mS to show room-boundary reflections.

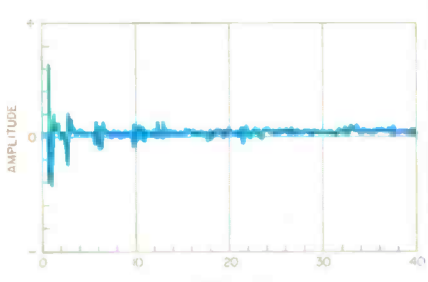


Fig. 4—Same as Fig. 3, with time scale lengthened to 40 mS.

Psychoacoustics Background

In essence, psychoacoustics is the science that relates the properties of sound sources and listening environments to our perceptions of them. Modern psychoacoustics was born in the middle of the 19th century with the publication of the classic book *On the Sensations of Tone*, by the German physicist Hermann von Helmholtz [1]. That von Helmholtz could learn as much as he did, using the primitive mechanical means available to him, is remarkable. It wasn't until electronic signal generation and measurement became possible that the science of psychoacoustics really took off, fueled by the advent of telephony. While our understanding of human hearing is far from complete, there is psychoacoustics work covering most aspects of sound perception. Buried in 100 years of research are a number of studies very relevant to loudspeaker design and measurement.

Psychoacousticians have determined that the ear is sensitive to more than just the frequency content of sound signals; temporal and spatial properties also affect perception. For amplifiers and the like, this presents no problem; the time distortions caused by electronic devices are minute compared to the ear's sensitivity, and these devices are irrelevant to the spatial characteristics of the reproduction system. Loudspeakers, however, have very complex temporal and spatial responses. Whenever a loudspeaker is used to reproduce sound, the audio signal undergoes spectral, temporal and spatial distortions which profoundly affect our perceptions. By understanding the nature of these distortions, we can reduce their influences and even exploit them to improve perceived reproduction accuracy.

It is well-known that when a speaker is used in a listening room, only a portion of the sound reaches the listener's ears directly from the drivers. Some of the energy is reflected by the speaker cabinet itself—off of grille frames, trim rings, and cabinet edges. Some of the sound bounces once or twice off the room boundaries before reaching the ear; some bounces around the room for quite a while before being absorbed. The longer the reflected path, the later the sound arrives.

The characteristics of the first-arrival signal dominate our perception of the location and timbre of sound sources. To determine the influence that a given echo will have on this perception, it is necessary to know its amplitude, its spectrum, its delay time and the direction from which it arrives. With this in mind, let's examine the behavior of real loudspeakers in home listening rooms.

Figure 1 shows the time response of a conventional loudspeaker to a single, 10-μS pulse; the horizontal scale totals 4 mS, with each division being 200 μS. The measurement was made in a typical listening room, with the microphone at the listening position. If the reproduction from the speaker were perfect, and the room added no reflections, this response would look like the ideal shown in Fig. 2.

There are three predominant reasons why the response is distorted. First is the dispersive nature of the system. In other words, signals of different frequencies reach the listener at different times. Since the pulse contains many frequency components, these time delays change its shape.

Dispersion is due to the physical separation of drivers covering different frequency ranges, to electrical phase shifts in the crossover networks, and to mechanical phase shifts in the drivers. The subject of loudspeaker dispersion was first examined in detail by Richard C. Heyser [2], who went on to develop useful mathematical and measurement tools to study it. Prior to Heyser, most speaker designers used frequency response alone as a quality index. Heyser's work was not in psychoacoustics per se, as it dealt little with human perception. However, it did establish an important link between loudspeaker engineering and the large body of psychoacoustics dealing with temporal aspects of sound perception.

The second type of pulse distortion seen is the occurrence of delayed and attenuated repetitions of the initial pulse, caused by reflection and diffraction from cabinet elements. In this example, these occur for about 400 μS after the initial pulse, corresponding to delay paths of about 14 cm. The third type of distortion present is floor reflection, seen at about 2 mS after the initial pulse.

Some of the ways in which the signal

Conventional frequency response measurements are engineering conveniences; they are not sufficient to quantify speaker performance.

in Fig. 1 deviates from the ideal can lead to both tonal and localization errors in the perceived sound. The audible effects of signal dispersion have been the subject of much investigation and heated debate. Blauert and Laws [3], and others, have concluded that phase shifts can affect the timbre of special test signals, but only when the delay times are much longer than typically found in home loudspeakers. Most researchers agree that phase delays of less than about 1 mS will not cause tonal coloration in a loudspeaker. However, their effect on localization is less well-understood. It is known that if the phase shifts between two stereo loudspeakers differ even slightly, imaging can suffer. The effects of consistent phase shifts on imaging are unknown; every speaker designer has an opinion on the matter. Improving loudspeaker performance in other ways tends to reduce phase shifts, anyway.

The effects that very early reflections have on localization have been studied by many researchers. Blauert [4] found that reflections up to about 600 μS can distort transient localization. Kates [5] examined the problem of very early reflections caused by loudspeaker cabinets and found that, in addition to tonal coloration, they cause image blurring and ambiguity. It is clear that for best imaging, and for minimum tonal coloration, early cabinet reflections should be minimized.

As we begin to examine reflections with longer delay intervals, we find that their effect on localization diminishes. Tonal coloration becomes the major problem until times beyond roughly 20 mS are reached, when reflections begin to affect perceived ambience. The degree to which reflections of different time delays distort the perceived spectrum has been measured by Atal, Schroeder, and Kuttruff [6]. Their results agree well with studies of loudspeaker reflections done by both Kates [7] and Salmi and Weckström [8]. All indicate that reflections occurring at about 2 mS are the worst offenders. From this we can infer that the floor reflection seen in Fig. 1 will cause tonal coloration to an extent underestimated by conventional measurement techniques, a conclusion reached also by Kates. The floor reflection can also stretch the sonic image in the vertical plane when the speakers are reproducing sustained tones.

Figure 3 shows the same signal as Fig. 1, displayed over a longer time scale. The horizontal axis is now 20 mS; each division is 1 mS. Reflections from the various room boundaries are clearly visible. These reflections cause significant spectral coloration and some imaging errors. By noting at what point in time a reflection occurred, it is possible to calculate how far the reflected sound travelled, compared to the direct sound, before reaching the listener. To do this, multiply the echo delay time (in milliseconds) by 1.1 to get feet. For example, a reflection off a wall located 2 feet behind a speaker would have to travel about 4 feet farther than the direct sound before being heard. This reflection would therefore reach the listener about 3.6 mS after the direct sound (4 divided by 1.1 equals 3.64).

Figure 4 shows the response of the speaker over 40 mS; each division is 2 mS. Only a few distinct reflections emerge from the background reverberation after 20 mS. While the reproduction of certain types of music might benefit from the presence of some reflections later than 20 mS, the early reflections we see from the loudspeaker cabinet and listening room distort both localization and perceived spectrum. To assure the greatest reproduction accuracy, it is desirable to have as little reflected energy as possible reach the listener for the first 20 mS after the first arrival. Beyond this time, the effect of reflections on localization is minimal, and their effect on timbre is largely diminished.

In a given room, the density of early reflections is a function of loudspeaker directivity [9]. The more directional the radiation, the less the excitation of the room. This suggests that a more directional loudspeaker will be less subject to room-induced colorations. If the radiation could be accurately aimed toward the listener, an additional benefit would be realized: The listener would be assured of receiving the greatest proportion of the radiated energy directly, thus increasing the ratio of direct to reflected sound and further reducing colorations. Additionally, if it were possible to position directional speakers such that each ear was relatively well-isolated from the opposite speaker, it would lead to better stereo separation and a broader soundstage.

It is not possible to determine a single, ideal response for a loudspeaker's long-term reflection pattern. For some program material, reproduction would be most accurate if the speaker/room combination added no reflections at all. This "headphone" type of reproduction might be appropriate for binaural recordings and for synthetic studio material. On the other hand, accurate reproduction of "live" recordings is known to be improved by the presence of significant room reflections well beyond 20 mS. This seems to be the case even if there are such reflections contained in the recording, due to the fact that recorded reflections arrive at the listener coincident with the direct sound and so provide no spatial cues.

Barron [10] studied the influence of later reflections in concert halls and concluded that for the best spatial impression these should be mostly lateral—that is, coming from the sides of the listener. Ando [11] studied the effects of later reflections both in concert halls and with loudspeakers, and found that reflections well beyond 20 mS added subjective realism to reproduced sound. Ando was able to determine both specific delay times and specific angles from which reflections should arrive for the most subjective benefit. Although these times and angles change slightly, depending on certain properties of the music, they are consistent enough to be applied usefully to both concert-hall and loudspeaker design. Ando found that reflections arriving from angles that produced the lowest interaural cross-correlation—that is, the largest mathematical difference between the signals at the two ears—yielded the best subjective results.

Differing listening rooms and differing program material suggest the need for a loudspeaker that allows independent control of the reflected energy beyond 20 mS. This would enable the system to provide optimum long-term response with different kinds of recordings and music. It would also solve a major dilemma which has plagued loudspeaker designers for years: Whether to optimize the anechoic spectrum or the room spectrum. Inde-

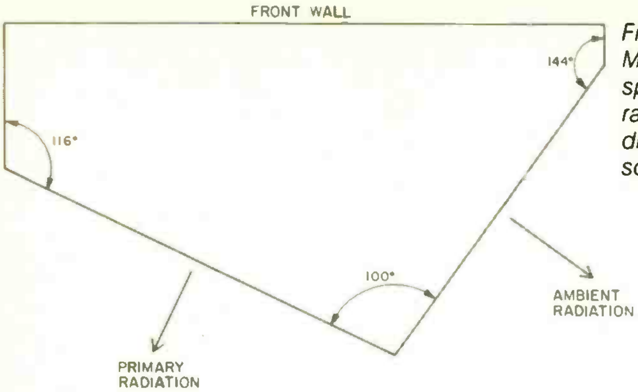
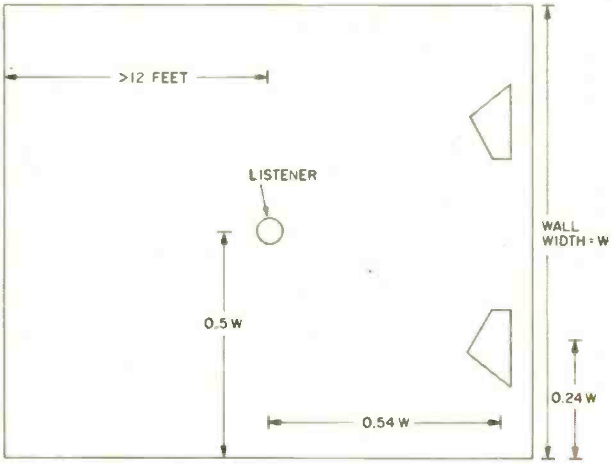


Fig. 5—Top view of MGC-1 (right-channel speaker), showing radiation directions for direct and ambient sound.

Fig. 6—Recommended room placements for MGC-1 (dimensions shown as submultiples of front-wall width). Recommended listening positions are 3.5 meters (11½ feet) or more from rear wall.



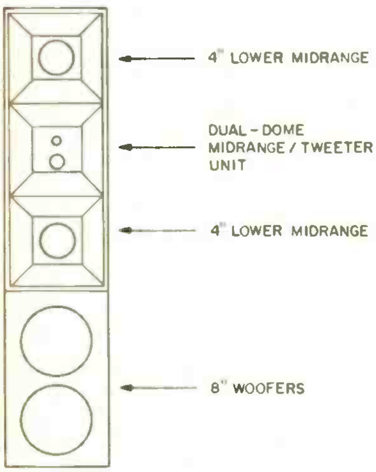
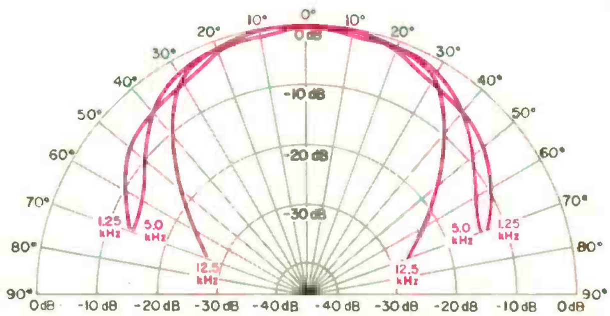


Fig. 7—Arrangement of primary drivers in MGC-1.

Fig. 8— Horizontal polar radiation patterns of MGC-1 primary drivers at 1.25, 5.0, and 12.5 kHz.



pendent control of the later energy would allow the frequency equalization of the room reverberation alone, without sacrificing early-arrival accuracy. Clearly, for optimum reproduction both must be correct.

Considering the psychoacoustic issues covered so far, we can summarize our goals for a loudspeaker as follows:

- Provide flat first-arrival frequency response.
- Reduce all reflections at times less than 20 mS, to improve imaging and reduce tonal coloration.
- Allow frequency equalization of the room reverberation without affecting first arrival.
- Provide the option of variable lateral reflections later than 20 mS, with optimum arrival angles.
- Aim the main radiation directly at the listener from directions that will produce the most stereo separation, i.e., the lowest interaural cross-correlation.
- Keep phase delays under 1 mS, worst-case.

A New Approach

What we want is a loudspeaker that provides the clarity and detail of a directional electrostatic unit together with the full, rich ambience of an omni, and then some. We want to be able to adapt this speaker to the requirements of different rooms and recordings. We want excellent imaging and excellent frequency response. It's your basic, run-of-the-mill audiophile erotic dream, but perhaps not impossible.

A good solution to the early-reflection problem seems obvious enough, in theory if not in practice. The ideal design should limit the radiation angles in both the horizontal and vertical planes, aim this radiation at the listener from the correct direction, and take care to avoid cabinet reflection and diffraction effects. The radiation pattern should be even [12], and restricted only enough to avoid significant wall, floor and ceiling reflections. We would also like the radiation angle of the loudspeaker to be as constant as possible versus frequency, at least above a few hundred hertz, where the ear becomes more sensitive to reflection problems.

That leaves the problem of controlling the long-term impulse response. If

Psychoacoustically, the ideal speaker would let the user control the ambient field to enhance, rather than distort, sound accuracy.

we built a speaker whose directivity could be varied, we could control the total amount of reverberant energy, but not the reverberant frequency spectrum. Also, in a small room we would still have a dominance of early reflections. Berkovitz [13] identified this problem and suggested an approach using digital signal processing (the AR ADSP, Adaptive Digital Signal Processor). While this method has been shown to work effectively, it remains very expensive and dependent on listening position.

Assuming that the proper choice of radiation pattern adequately reduces room reflections from our speaker, it is possible to consider adding a supplementary radiation system to provide the desired late reflections after a sufficient delay. This second system could be oriented to optimize the directions of later reflections and could be equalized and adjusted independently of the main system. If the time delay were made adequately long, and the radiation pattern of the second system were controlled so as not to produce strong wave interference with the direct sound, the perceived tonal and localization properties of the main system would be, in theory, unaffected.

System Details

The Acoustic Research MGC-1 loudspeakers are based on the concept of a controlled-directivity main system, with supplemental radiation of the ambient field. They include an electronic control unit which allows the user to adapt the ambient radiation parameters to a variety of installation situations and program requirements.

In order to obtain the correct signal-arrival angles, the MGC-1 loudspeakers are constructed as a mirror-image pair. Figure 5 is a top view of the right speaker, showing the radiation directions for both the direct and ambient sound. It was determined that these signals should arrive at the head of an optimally located listener from angles of 26° and 54°, respectively; 0° is defined as directly forward of the listener. The angles were chosen to provide minimum interaural cross-correlation for both the direct and reflected energy, in accordance with Ando's data. The angles define the speaker cabinet shape as well as the optimum speaker and listener positions in a given room. The user wishing to fully exploit the radiation geometry would arrange the system as in Fig. 6. All the relevant dimensions are computed as fractions of the width of the front wall, labelled W; the calculations are very simple and result in a floor plan very similar to that typically encountered. The distance between the listener and the rear wall does not affect the radiation angles as such, but it is recommended that this distance be greater than 3.5 meters (11½ feet), if possible, to avoid an early reflection from behind the listener.

Figure 7 shows the arrangement of transducers used to radiate the direct-arrival sound. It was decided that all drivers covering frequencies of importance to localization be placed on approximately the same acoustic center. This assures that signals of differing frequencies are heard at the same height, and it reduces vertical interference problems. Since woofers are best located near the floor, their crossover frequency (250 Hz) was made low enough to avoid interference effects and vertical image shifts.

The low end is radiated by two 8-inch acoustic-suspension drivers, with a low-frequency −3 dB point of 39 Hz. The range from 250 Hz to 1 kHz is covered by two 4-inch drivers, one mounted above the upper-frequency radiators and one mounted below. This results in an acoustic center coincident with these radiators and very little vertical interference at the 1-kHz crossover point. The vertical spacing of the 4-inch units was calculated to produce nulls in their vertical radiation pattern at the angles where detrimental floor and ceiling reflections would otherwise be likely. The frequencies from 1 kHz up are radiated from a 1½-inch dome and a ¾-inch dome. These domes operate on a single magnet structure so that they may be placed close enough to avoid vertical interference at their 5-kHz crossover point.

The midrange and high-frequency drivers are surrounded by carefully designed pieces of acoustically absorbent foam. This foam is used to control the radiation pattern of the direct sound and to eliminate cabinet reflection and diffraction effects. The foam does an excellent job at frequencies above about 1 kHz. The system maintains very uniform front radiation in all planes until about 30° off the primary axis. Beyond this angle, the radiation rolls off smoothly, with no lobing. Polar measurements at three frequencies are shown in Fig. 8.

Below 1 kHz, the system becomes increasingly less directional. Since the radiation is angled toward the listener, this causes no problems with side-wall reflections. The floor and ceiling, however, would create trouble were it not for the vertical radiation nulls produced by the separation between the 4-inch drivers. These nulls begin to form at frequencies where the foam loses effectiveness; the result is a relatively constant vertical directivity from below 500 Hz to almost 20 kHz.

Other methods of controlling the radiation pattern were tried. If single drivers, electrostatic or dynamic, are used to cover broad frequency ranges, it is virtually impossible to achieve constant directivity; either the radiation angle is too wide at low frequencies or it is too narrow at the top end. Computer-designed arrays of up to 31 drivers were also tried. One such attempt is shown in Fig. 9. These invariably suffered from severe lobing and unacceptable on-axis time and frequency responses.

Both theory and experimentation suggested that the ambient radiation be restricted to midrange information. Frequencies above 5 kHz were found to greatly increase the tendency of listeners to hear a discrete echo—an undesirable effect—while adding little to the sense of ambience. Delaying frequencies below 300 Hz also added little to the subjective performance. Due to the longer wavelengths of these lower frequencies, it is difficult to restrict their radiation pattern and avoid interference with the direct sound.

To provide the electronic delay required to place the first echo beyond the 20-mS time window, and to control the spectrum and level of the ambient field, a dedicated electronics unit is used to power the ambient drivers. This unit taps off a signal from the input terminals of each speaker and returns a processed and amplified signal to the ambience drivers. Connections are provided to allow the user to insert an equalizer in the ambient amplification chain, or to use the AR Stereo Remote

The MGC-1 allows the user to adapt the ambient radiation parameters to a variety of installation situations and program requirements.


Fig. 9—An early prototype of the MGC-1, which had a directional array.

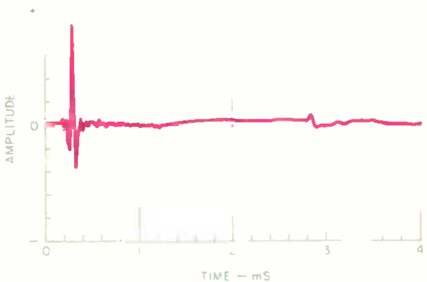


Fig. 10—Response of MGC-1 to 10-μS pulse, measured on-axis.

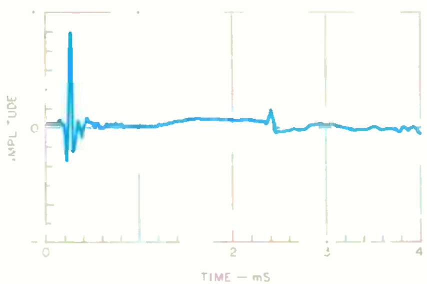


Fig. 11—Same as Fig. 10, measured off-axis.


The final version of the MGC-1; ambience drivers are in niche on the left.

Control (see *Audio*, January 1985) to vary the room ambience from the listening position.

Controls on the electronics unit include an overall ambience level adjustment, individual left- and right-channel level adjustments, and individual-channel delay adjustments. These controls allow the user to adapt the system to a wide variety of listening rooms and placements. Each speaker may be placed anywhere from 1 to 10 feet from the side wall, while maintaining correct response.

The control unit also gives the user the ability to determine how the ambient signals are derived. Normally, stereo left and right ambient signals are sent to the left and right speakers. However, the ambient signal can be made monaural to reduce the sound stage on overly ambient recordings. Conversely, the ambient signals can be L − R and R − L to extract and reradiate recorded ambience. This setting can give very realistic results with good concert-hall recordings, and can create striking spatial effects with studio recordings, both largely independent of listening position.

The ambient sound is radiated by a 6-inch cone driver and a 1-inch dome tweeter. It is intended that this radiation reflect off the side wall before reaching the listener. This diffuses the ambient sound somewhat and creates the desired arrival angle of 54°. It also adds an acoustic delay to the onset of the ambient field, to supplement the external delay provided by the electronic control unit. To ensure that very little of the ambient radiation reaches the listener directly from the side drivers, they are surrounded by absorbent foam in a manner similar to that of the main system.

Measured Performance

Let's look at how the performance of the MGC-1, as measured by AR's engineers, compares to that of the conventional system we examined earlier. In the process, we can formulate some new loudspeaker measurement techniques to better quantify perceived sound quality.

Figure 10 displays the response of the MGC-1 to a 10-μS pulse; the horizontal scale is 4 mS, with each division being 200 μS. The measurement conditions are identical to those used earlier with the conventional system. The relative coherence of the pulse, the reduction of early cabinet effects, and the attenuation of the floor reflection can be seen. Figure 11 shows the same measurement taken 25° off the primary axis, demonstrating a consistent response over the desired coverage area. Figure 12 expands the horizontal scale to 20 mS. It is easy to see that the room reflections are significantly decreased as compared to the conventional system. The long-term response of the system is shown in Fig. 13. The electronic controls were set to provide moderate late reflections. The energy after 20 mS is similar to that of a conventional speaker used in a much larger room.

By interpreting the data we discussed previously concerning the influence of reflections of different delays, we can derive a "weighting" curve applicable to the measurement of speakers in rooms. This will help us assess the extent to which room reflections will cause spectral coloration for a given speaker, room, and position combination. Such a curve is shown in Fig. 14. Reflections prior to 600 µS are discounted, since they must be studied separately to determine their origin and effect on localization. Also, decreasing importance is placed on reflections after 20 mS, as their desirability is program-dependent.

Figure 15 shows this weighting process applied to two different loudspeakers in the same room and location. The top graph is for the MGC-1 with its ambience radiation switched off; the bottom is for the conventional system analyzed earlier. From the weighted echo amplitude, we can compute the echo energy versus time, as shown in Fig. 16. Now the differences between the two loudspeakers become very clear.

We can go one step further in this process by computing the spectrum of the weighted echo-amplitude data. This is shown in Fig. 17. One curve is for the MGC-1; the other is for the conventional system. These curves are a comparative indication of how good a job a certain loudspeaker will do at delivering an "anechoic" first arrival to the listener. The lower the curve, the less the reflection-induced coloration of the speaker. It is worth noting that the curve does not directly depict either the anechoic or the room spectrum of the loudspeaker. The idea is not to make the echo spectrum flat, but to reduce it. Listening tests have shown that there is a good relationship between this approach and subjective impressions.

As mentioned earlier, psychoacoustic experiments have indicated that reducing the interaural cross-correlation, or IACC, of a reproduced signal is subjectively preferable. Since a lower IACC implies a greater difference between the signals at the two ears, it could be inferred that this leads to greater stereo separation and a broader soundstage. This inference is only valid if just one speaker from the stereo pair is used for the measurement of IACC. The precise relevance of measurements made with both speakers at once is still unclear [14]. In other words, psychoacoustics researchers know that IACC affects stereo localization, but they are not sure exactly how; it is clear, however, how IACC affects ambience and soundstage width. Figure 18 shows the IACC of the MGC-1 reproducing white noise. For comparison, the conventional system is shown under identical conditions in Fig. 19.

Subjective Performance

Sooner or later you have to plug the theory into the ear. The proof is in the pinna, as the old saying goes. With this in mind, objective and subjective listening tests were conducted to compare the performance of the MGC-1 to that of high-quality conventional loudspeakers. In the course of this testing, several interesting points emerged.

With the MGC-1s, virtually all listeners indicated that they heard a soundstage wider than the actual speaker separation. With the ambient radiation switched off, this effect was modest, typically about 15° beyond each speaker. When the ambient radiation was added, the soundstage extended to the 54° angle of the first reflection, equal to about 28° beyond each speaker. As expected, the soundstage reproduced by conventional loudspeakers rarely extended beyond their actual separation.

On music signals, localization remained very stable as changes in the

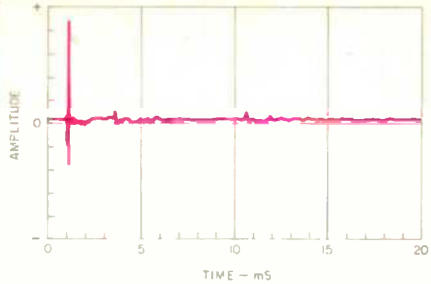


Fig. 12—Same as Fig. 10, with time scale lengthened to 20 mS. Note reduced room-boundary reflections as compared to Fig. 3.

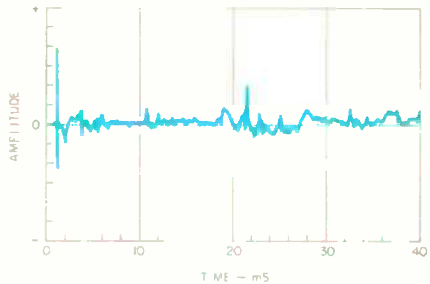


Fig. 13—Long-term (40-mS) response of MGC-1 to 10-µS pulse, with electronic controls set to provide moderate late reflections similar to those of conventional speakers in a larger room.

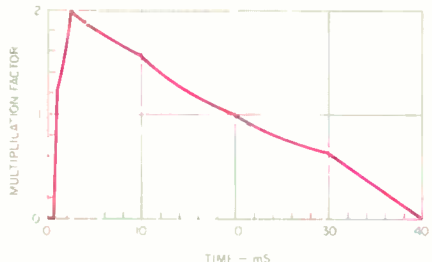


Fig. 14—Time-weighting curve for assessing spectral coloration due to room reflections.

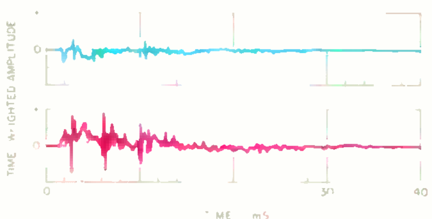


Fig. 15—Time-weighted echo amplitudes of MGC-1 with ambience radiation switched off (top), and of conventional speaker (bottom).

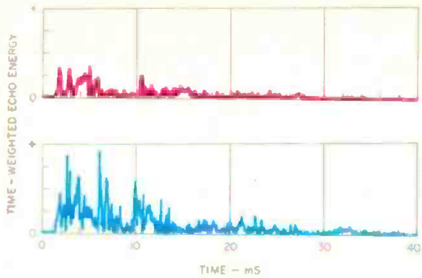


Fig. 16—Echo energy vs. time for MGC-1 (top) and conventional speaker, calculated from Fig. 15.

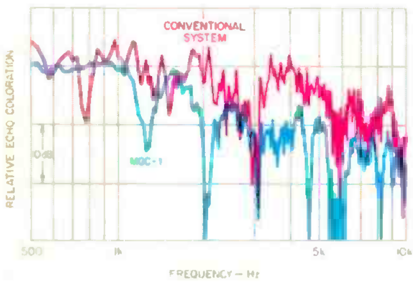


Fig. 17—Computed echo-amplitude spectra of MGC-1 and conventional speaker. (Vertical scale: 10 dB/div.)

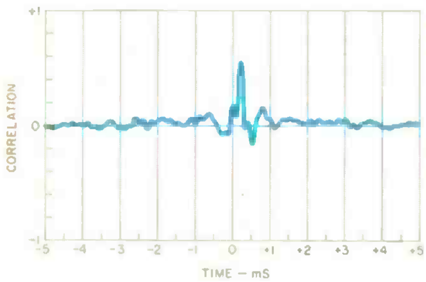


Fig. 18—Interaural cross-correlation (IACC) of single MGC-1 reproducing white noise.

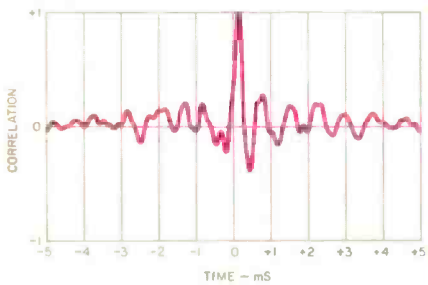


Fig. 19—IACC of single conventional speaker reproducing white noise.

Listeners found the MGC-1's soundstage to be wider than the actual speaker separation, especially with the ambience radiation added.

ambient level were made, up to the point where an excessive amount of ambient energy was being radiated. Listening position was found to be far less critical than we had originally predicted. It was surprising to find that the stereo image never collapsed into one speaker, even when the listener was located directly in front of it. Presumably, the increased proportion of delayed energy reaching the off-axis listener partially compensates for the "precedence effect," allowing localization toward the opposite loudspeaker to be maintained.

Subjective reaction to the system was always positive. Listeners preferred some amount of ambience radiation with all types of music. The delayed signal was described as making the image more stable, the ambience more natural, and the sizes of sound sources more lifelike. Many listeners commented on the sensation that the small listening room had been replaced by a larger one, more like the recording environment. This effect was very pronounced when using the loudspeakers' difference-signal mode of ambience derivation.

Conclusions

The traditional view of loudspeaker design concentrates on purely physical measurements and ignores many important characteristics of the human hearing system. This approach inherently limits the degree to which subjective loudspeaker performance can be improved. The psychoacoustically ideal speaker has a more complex set of functional requirements. It must deliver to the listener a first-arrival signal that is correct in frequency, time, and direction. It must also provide some means for the user to control the ambient field of the listening room so that this field enhances, rather than distorts, reproduction accuracy.

Our approach to the design of the MGC-1 has been to create a system with optimized, independent radiators for the direct and ambient sound. We believe that the positive reactions of listeners provide the ultimate validation of any loudspeaker design.

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1

REVOX B215 CASSETTE DECK

Manufacturer's Specifications

Frequency Response: 30 Hz to 18 kHz; to 20 kHz with CrO_2 and metal tapes.

Harmonic Distortion: 0.8%.

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

Separation: 40 dB.

Erasure: 70 dB.

Input Sensitivity: 50 mV.

Output Level: Line, 775 mV; headphone, 2.8 V.

Flutter: ±0.1% wtd. peak.

Fast-Wind Time: 75 S for C-90 cassette.

Dimensions: 17.7 in. W × 6 in. H × 13.1 in. D (45 cm × 15 cm × 33 cm).

Weight: 20.4 lbs. (9.2 kg).

Price: \$1,400; B205 remote-control transmitter, \$125.

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

For literature, circle No 90

Photograph: ©Bill Kouirinis

The Revox B215 cassette deck uses sophisticated microprocessing for many internal functions. There are actually three microprocessors: One for the time counter, another for the automatic tape-matching system, and the third for housekeeping and for control interfacing with other components in Revox's B200 series.

All units in this series can be operated from the same optional remote-control unit. But they can also connect, via rear-panel serial ports, to a separate interface box which can then be connected to a home computer (for programmed control) or to infrared remote-control receivers in other rooms. With the Revox units interconnected in this way, one could simultaneously start the B215 tape deck and switch the receiver to "Tape" mode by pressing "Play" on the remote transmitter—whether the transmitter is pointed at the receiver, the B215, the interface unit, or an infrared receiver in another room.

The most important use for the on-board microprocessing is the automatic alignment to match the characteristics of any tape used. In just 20 S, adjustments are made automatically to bias, record sensitivity and equalization to ensure flat response, good Dolby NR tracking and low distortion. Information on the internal settings can be stored for two Type I tapes, three Type IIs, and one Type IV. The B215 also incorporates the Dolby HX Professional system, which varies bias during recording in accordance with the spectral makeup of the signal for lowest distortion overall.

The microprocessor-controlled time counter yields elapsed-time indications after only a few seconds of play, no matter where the cassette is started. A selected elapsed time can be entered, and a fast-wind made to that point. Two time addresses can be stored for one-button fast-wind returns, or for looping (continuous play) between them.

Another helpful feature of the B215 is a system which automatically sets recording levels. Automatic fade-in and fade-out during recording is an additional nicety.

The tape drive uses four motors, two for the direct-drive capstans and two for spooling the tape. An optical end-of-tape sensor stops the transport at the start of the clear leader, instead of at its end. This positions the tape exactly where recording can be restarted as soon as the cassette is flipped; time is not lost while the leader passes the heads once in each direction.

Control Layout

The B215 deck is large, but it has a friendly look, with brushed aluminum as the top of the front panel and dark gray for the lower part. The black designations on top and the white ones below are very easy to read over a wide range of lighting levels, making the B215 one of the best units in this regard. The very large, aluminum pushbuttons and the large, medium-gray and red ones all stand out clearly from the panel and require just a light touch for actuation.

After the deck is plugged in but before it is turned on, a red standby indicator illuminates in the "IR-Sensor" window at the upper left end of the gray panel. The deck can be turned on in either of two ways, with the B205 remote control or with the "Power" pushbutton at the upper right of the front panel. With turn-on, the red indicator goes off, and the "Real Time Counter" and "Peak Program Indicator" LCDs appear. The counter display shows "--:--" over "Min" and "Sec" to remind the user that calibration has not been done for an elapsed-time indication. The "Peak Program Indicator" has "L" and "R" horizontal meter scales and calibrations from "−30" to "+8" in between. Just to the right of the meters is "Bal" with an arrow above it, pointing up (next to the "L" scale), and an arrow below it, pointing down (next to the "R" scale). At the lower left of the same display area, "Source" announces that the incoming signal is being monitored. Additional details of these displays will be given while discussing the use of the pushbuttons.

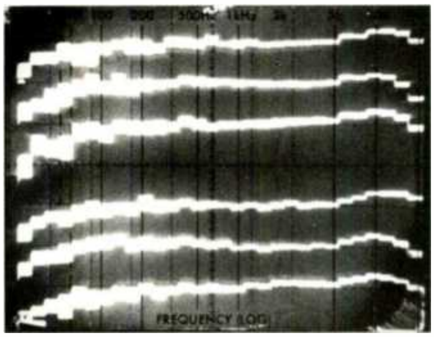

Fig. 1—Record/playback responses using Dolby C NR. Top three traces made with Maxell UD-XL I (Type I), TDK HX-S (Type II) and TDK MA-R (Type IV), all at Dolby level. Bottom three traces with the same tapes but at −20 dB. (Scale: 5 dB/div.)

To the right of the displays are the "Set Level" and "Fade In/Out" pushbuttons. "Set Level" automatically sets the digitally controlled input-level attenuator while you play the loudest portion of a disc, so that the highest recording levels will be just below the point where unacceptable distortion would occur. Automatic setting continues as long as the button is held in, so the actual time taken is determined by the user.

With the "Fade In/Out" button, the signal can be faded between full off and the preset attenuator level, whenever desired. You cannot, however, vary the fade speed or interrupt the fade halfway. Fades can be made any time during recording without stopping the transport.

Fading is also invoked by the "Pause" control, which is grouped, with the other transport-control buttons, to the fade button's right. There is an automatic fade-in if recording is started from record-pause mode (rather than "Stop"), and an automatic fade-out if you interrupt recording with the "Pause" instead of the "Stop" button. Pressing "Pause" also automatically switches the monitoring back to "Source," in anticipation of continued recording—a convenient feature.

It is possible to switch among modes as desired, and punch-in recording is possible by holding "Rec" and "Play"

A helpful feature automatically sets the recording level so the highest peaks are just below the distortion point.

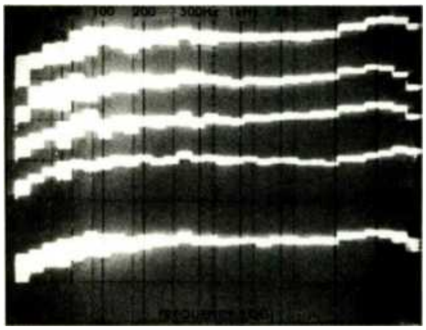

Fig. 2—Record/playback responses. Upper four traces, all made with Dolby C NR, are: +6 dB on Maxell UD-XL I, +4 dB on TDK HX-S, +6 dB on TDK MA-R, and +10 dB on Maxell UD-XL I. Bottom trace shows overlaid responses with Dolby B and C NR and without NR, all made on UD-XL I tape at −14 dB. (Scale: 5 dB/div.)

at the same time. The above constitute a nice collection of features for the serious recordist.

In "Rec/Pause," the meter display shows "Source" and, above, a flashing "Record." Pushing "Pause" again initiates recording, with the display indicating the change in monitor status from "Source" to "Tape."

Below the transport buttons are nine gray pushbuttons plus the "Store" button, which is red. The top row consists of "Loop," "Recall," and two "Address" buttons, "Loc 1" and "Loc 2." The next row is for "Cancel" and the aforementioned "Store." The bottom row has "Save Status," "Play Time," "Min," and "Sec."

When a cassette is first inserted, "Real Time Counter" is blank, as mentioned earlier. With a push of "Play Time," a standard tape length (whichever you used last) will be displayed; successive pushes will step the indicated length from "C 46" to "C 60" to "C 90" to "C 120," and back to the start again. After the selection of the correct length, a few seconds of playing or recording will get a calibrated, elapsed-time reading in the counter display. After calibration has been completed, a start of recording will automatically store the "Min/Sec" address (tape location) in "Loc 1." By use of the "Min," "Sec" and "Store" buttons, and then "Loc 1" or "Loc 2," any location on the tape can be put in memory. Except when in record mode, a push of "Loc 1" or "Loc 2" will initiate a fast-wind to that exact point on the tape. The counter display shows "Loc" and "1" and/or "2" above it when there is an entry or two to indicate. When both locations are used, a push of "Loop" will initiate continuous play and rewind cycling between the two points, even fast-winding to the start point from any location on the tape. Arrows appear between the tops and bottoms of the "1" and "2" in the display, reminding the user that the deck is in "Loop" mode. "Recall" and a location button will get a display of the corresponding tape-time location. "Cancel" will, of course, clear the memory of whichever button is pushed.

"Save Status" is used to store all recorder settings including level, NR system, balance, etc., in a nonvolatile memory for use with a timer (which, of course, shuts off all power to the recorder for a period of time).

Under the counter and meter displays are 11 pushbuttons, 10 gray and one red. The top row, just to the right of the infrared sensor mentioned earlier, has two buttons for input level ("−" and "+") and two for balance ("L" and "R"). When an input-level button is held in, a relative level from "−∞" to "+10" appears in place of the "Min/Sec" readout. A brief push will get single steps up or down, and a hold will obtain continuous stepping which increases in speed as the button is held in. The arrows above and below "Bal" show when there is electrical balance, but the level indication must be used to find the best setting.

The second row of buttons under the displays consists of "Tape Type," "NR System," "MPX," and the red "Align." When a cassette is first inserted into the holder, tape type is automatically sensed and displayed, provided that the cassette has the sensing holes which indicate this information. "Tape Type" allows manual setting for "Type I," "Type II," "Type II—120 µS," and "Type IV." All are self-explanatory with the exception of "Type II—120 µS." This is an unusual and useful feature for the serious recordist: If there is a more-than-average amount of energy in the higher frequencies, the results with a Type II tape may be better with 120-µS EQ instead of the usual 70 µS. The selected tape type is announced along the bottom of the meter display, Type I to Type IV, left to right.

The selection of "MPX," "Dolby B," or "Dolby C" is similarly indicated along the top of the meter display. "MPX" is an on/off selection, and "NR System" steps the choice from off to "Dolby B" to "Dolby C" NR.

Alignment, in the case of the Revox B215, means electronic adjustment of the recording function and not the mechanical adjustment of a record or playback head. A push of "Align" with the deck in record/pause mode starts the process that adjusts bias, record sensitivity and equalization for the best responses with low distortion, both with and without Dolby NR. It's a 20-S procedure, and while it's functioning, "Align" appears at the lower right in the meter display. There are a total of six memory locations for alignment information: Two for Type I tapes (A1 and A2), three for Type II (A1, A2, A3), and one for Type IV (A1). With the use of "Align," the settings are automatically put into memory, normally A1 location. To save the settings for another tape formulation without disturbing the information in memory A1, push "Align" and then the "Pause" button to step to the next memory location. Overall, this is a very good way to handle tape matching, with the convenience of storing the matching-condition information for the tapes most used. These

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The drive, which had a look of long-term durability, ran very quietly—perhaps the best of any I've yet tested.

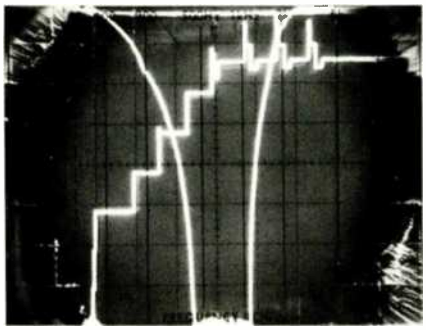

Fig. 3—Tests of two gain-adjustment functions. Curved trace shows fade-out from 0 dB to maximum attenuation, and fade-in from maximum attenuation to 0 dB. Stepped trace shows action of "Set Level" function as input is increased in 10-dB steps from −70 to 0 dB (see text). (Vertical scale: 10 dB/div.; horizontal scales, 1 S/div. for fader, 5 S/div. for "Set Level" test.)

memories are also nonvolatile, holding their contents even if the recorder's power is disconnected.

Along the bottom row of buttons below the display are the headphone jack, all the way to the left, two "Phones Volume" buttons ("−/+") and the "Monitor" selector (causing "Source" or "Tape" to appear in the meter display). The headphone level can be set to one of eight steps. My immediate reaction to this design was a bit of skepticism, but I reserved judgment until I actually tried listening.

The shallow, vertical well for the cassette has a very open design, which gives outstanding access for any sort of cleaning or demagnetizing. Inserting a cassette was a simple process of putting the top in first, then pushing in the bottom. I liked the finish and the ruggedness of the drive elements, particularly the large diameter of the capstan shafts.

On the B215's back panel are the expected stereo pairs of in/out phono jacks. There is also a DIN-type socket for the serial interconnection link with other Revox equipment. The power cord is detachable.

Removing the steel top and back covers allowed examination of the interior. The chassis has a rigid, box-girder construction, providing excellent support for the transport system and the circuit cards. The large flywheels were very evident, and the rest of the drive was judged to be very well-constructed, with a definite look of long-term reliability. The drive was very quiet, even in play mode—perhaps the quietest of any deck I've tested to date. The soldering on the cards was excellent, with slight flux at a few hand-soldered points. There were a total of four fuses, all in clips.

Measurements

The playback responses of the Revox B215 were the best I have measured to date, with many points within ±0.3 dB of the reference level. Playback of a standard flux level was indicated correctly, and tape play speed was 0.2% fast, at the most.

For record/playback measurements, I used "Align" to match the deck to a large number of tapes having a wide range of bias and sensitivity characteristics. For the test signal, I used what I call "PN/Music"—pink noise rolled off at 2 kHz—to ensure accurate assessment of the performance with Dolby C NR. (Testing with sine-wave signals can give a misleading impression of response irregularities with Dolby C NR.) The record/playback responses were at least very good with *every* tape tried, and excellent with most. Maxell UD-XL I, and TDK HX-S and MA-R, were judged to be the best overall and were therefore used for the detailed tests that followed. Excellent results were also obtained with these Type I tapes: BASF Pro I Super, Fuji FR-I, Maxell XL I-S, PDMagnetics Tri-Oxide Ferro HG, Sony AHF, TDK AD and AD-X, and Yamaha NR-X. Type II tapes with excellent results included BASF Pro II Chrome, Fuji FR-II, Maxell UD-XL II and XL II-S, PDMagnetics 500 Crolyn HG, Sony UCX and UCX-S, TDK SA-X, and Yamaha CR. Among Type IV tapes, Maxell MX, Memorex Metal IV, Sony Metallic, TDK MA, and Yamaha MR were excellent. I was further impressed by the fact that the B215 got very good responses with BASF Metal IV in the C-120 length, much better than other decks I have tried.

Revox did not provide detailed information on the alignment process, but a little detective work with the aid of my Hewlett-Packard computing counter got these clues: There is a sequence of four tones—17.4 kHz, 477 Hz, 17.4 kHz, and 3.7 kHz—with many stepped-level changes in the first three tones and a relatively small and smooth change in the level of the final tone. The deck's output was muted during "Align," but it was possible to observe the sequence with playback later. There were many changes during the 20-S process, and I could see that there were many comparisons made between 477-Hz and 17.4-kHz outputs at a number of absolute levels. It appeared more than likely that settings for bias and record sensitivity were very accurately set for good responses and low distortion. The 3.7-kHz level adjustment was judged to be the final touch-up for the flattest responses across the band.

Figure 1 shows record/playback responses, with Dolby C NR, for the three selected tapes, both at Dolby level and 20 dB below that. All of the responses are very flat, including those at 0 dB. (I should point out that with the PN/Music test signal, there will be less high-end roll-off in the playback because the rolled-off test signal causes much less tape saturation.) Having made that parenthetical note, I call attention to Table I, which lists the −3 dB limits for all three tapes, with and without Dolby C NR. These tests were made with sine-wave test tones which were *not* rolled off at the higher frequencies. The results were outstanding at Dolby level: The low-end responses dipped down 3 dB at 22 to 24

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AU

The B215 had the best playback responses I've yet measured. Record/play response was at least good with *every* tape, excellent with most.

Because it also controls other Revox components, the B205 remote unit has more buttons than the B215 tape deck.

Hz, came back up somewhat, and finally rolled off at 9.4 to 10.4 Hz. Figure 2 shows record/playback responses with PN/Music at higher levels. The outstanding Dolby NR tracking is illustrated in the bottom trace, where the results at −14 dB for no NR, Dolby B and Dolby C NR are all overlaid, making just one trace.

Table II lists a number of measured record/playback characteristics, all excellent. The measurement for 10-kHz phase error and jitter between channels was one of the best I have ever seen, and the multiplex filter was positioned exactly. The level of bias in the output during recording was very low.

The level of the third-harmonic distortion (HDL_3) was measured, with Dolby C NR, as a function of level for the three tapes, and as a function of frequency at −10 dB with TDK HX-S tape. Table III lists the distortion in the output from −10 dB to the points where HDL_3 equals 3%. The distortion-limit levels are somewhat low, but the distortion figures for 0 dB correspond very closely to specifications. The mid-band distortion was not as low as some other decks' (Table IV), but 0.24% at the frequency extremes is very good.

Signal/noise ratios were measured with and without Dolby C NR, with both IEC A and CCIR/ARM weightings. The results in Table V are a close match to other high-performance decks at Dolby level, but are somewhat low with reference to the 3% limit point. This does, of course, correlate to the somewhat low 3% points measured earlier. Perhaps we should recall the deck's outstanding frequency responses to remind us of the trade-offs involved in recorder design.

Table VI shows measurements obtained for a number of input/output properties. Everything seemed quite in order, but the overload level of 2.65 V calls for caution on the part of users who might feed the deck from equipment whose output capability is greater than this.

Figure 3 shows time and level plots of "Fade In/Out" and "Set Level." The sweep rate for the fades is 1 S/div. The fade-out takes about 2.4 S and the fade-in a little over 1 S, both acceptable times.

To test the "Set Level" function, I first attenuated the output from my test generator by 70 dB and set the B215's input level control to "−∞" to challenge the automatic function with an extremely low-level test signal. The B215 automatically and rapidly readjusted its input attenuator to its maximum setting, "+10," but, as Fig. 3 shows, the resulting record level was still only −35 dB.

I then increased the test generator's output in 10-dB steps. For the changes from −70 to −40 dB of generator output, the B215's attenuator remained at "+10," and recording level rose in accordance with the input-level changes. When the generator's output reached −30 dB, recorded level shot past its final limit, dropped briefly, then settled at the desired recording level, and the B215's attenuator reset itself to "+8." The action on subsequent 10-dB jumps in generator output was the same—a sharp rise, two sharp drops, and a final adjustment. The attenuator readout reflected these changes: "−2," "−12," and "−22." The B215 set its recording level below the distortion limit on these final four input-level steps. Because of its obvious stepping, "Set Level" should *not* be used during actual final recording, but it is a great convenience for setting up.

The input-level pushbuttons were used to make the deck's input attenuator step from maximum (+10) down to −∞. There were 1-dB steps from +10 to −44, followed by −46, −48, −51, −54, −60, and finally −∞. Each of the steps was substantially without error, and the tracking between sections was within 0.1 dB from +10 down to −54. These results are much superior to anything else that I have checked in the past.

There are eight positions for balance on either side of zero. The first "L" step, for example, increases "L" level by 1 dB; the second "L" step decreases the "R" level by 1 dB; the third step increases the "L" level by another dB, etc.,

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 UD-XL I	22	21.1	8.2	23.1	23	14.1	8.5	24.6
TDK HX-S	22	22.7	8.3	24.5	23	16.0	8.6	25.5
TDK MA-R	24	23.4	8.4	23.1	24	17.0	8.8	23.9

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
66 dB	59 dB	−93 dB	25°	7°	−32.7 dB

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

		Output Level					
Tape Type	NR	−10	−8	−4	0	+4	HDL_3 = 3%
Maxell UD-XL I	Dolby C	0.10	0.14	0.27	1.0		+3.1 dB
TDK HX-S	Dolby C	0.14	0.22	0.46	1.1	2.7	+4.2 dB
TDK MA-R	Dolby C	0.17	0.22	0.50	1.2	3.0	+4.0 dB

If you haven't discovered the ultimate truth about audio cassettes, you're about to. No one makes finer normal or high-bias audio cassettes than TDK.

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Flutter was marvelously low, a consistent 0.10% weighted throughout a C-90 tape—the best I have measured to date.

until, with the eighth step, "L" has been increased by 4 dB and "R" has been decreased 4 dB. It is an interesting way of balancing, and it could be the best way, at that.

The headphone volume adjustments were measured as: Maximum (0 dB), −4.1, −9.2, −14.2, −20.2, −28.1, −38.6 dB, and off. My first reaction was that the steps were too coarse, but trials revealed that the changes seemed quite right for whatever the user might desire—"a little softer," for example. I tried a number of headphones and found there was enough gain to drive any of them to very high levels.

Tracking between channels was outstanding, so there was no need for balance trimming. The deck's output polarity was inverted in "Tape" but not in "Source" output mode.

Each of the horizontal bar-graph meter sections has 24 separate segments, although the bottom one in each meter is always on. Scaling extends from "−30" to "+8," with the lowest figures somewhat out of calibration. Accuracy was good from "−18" to "−6," however, and the single-dB steps from "−5" to "+8" were all within 0.1 dB—superb over this important recording-level range. The dynamic responses of the meters met the requirements of the standard for peak program meters, with response to −1 dB with a 10-mS tone burst and a 1.4-S decay time. There were slightly higher meter indications with the tone-burst offset, but there should have been more of a change. The frequency response of the meters was down 3 dB at 7.0 Hz and 169 kHz; the latter appears to be unnecessarily high.

Substantially no changes in tape play speed were detected with changes in line power from 110 to 130 V. Short-term variations in play speed were less than ±0.01%, excellent indeed. The flutter was marvelously low and very consistent throughout the length of a C-90, 0.010% wtd. rms and ±0.023% wtd. peak. After checking the effect of changing modes and loading and unloading the tape, I concluded that the B215 showed the best overall flutter performance I have measured to date.

The fast-wind speed was high, just 73 S for a C-90, but the stops were smooth and gentle. Times required for changing modes were very short, really too short to measure with a stopwatch. Cueing with fast-forward or rewind and "Stop" worked well, and seemed quite natural after a few trials. Calibration of the elapsed-time counter took about 7 S. With calibration made at the start of a cassette, errors built up during the playing, totalling a minute or so halfway through a C-90. Recalibration at that point reduced the error to several seconds, which is very acceptable. This is a good feature, but I would expect better accuracy. In case of any question, it would appear best to recalibrate the counter halfway through.

Table IV—HDL$_3$ (%) vs. frequency at 10 dB below Dolby level.

Tape Type	NR	Frequency (Hz) 50	100	400	1k	2k	4k	6k
TDK HX-S	Dolby C	0.24	0.17	0.14	0.16	0.08	0.10	0.24

Table V—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 UD-XL I	67.5	70.6	52.0	55.1	68.6	71.9	49.4	52.5
TDK HX-S	69.0	73.2	53.1	57.3	69.8	74.0	50.6	54.8
TDK MA-R	69.1	73.1	53.3	57.3	69.9	73.9	50.7	54.7

Table VI—Input and output characteristics at 1 kHz.

Input	Level Sens.	Level Overload	Imp., Kilohms	Output	Level Open Ckt.	Level Loaded	Imp., Ohms	Clip (Re: Meter 0)
Line	47 mV	2.65 V	96	Line	779 mV	690 mV	1.5k	+16.0 dB
				Hdphn.	2.8 V	0.52 V	219	

Use and Listening Tests

The owner's manual has a very good (albeit undetailed) text, well organized, with helpful illustrations. Technical freaks would probably like more information on "Align" and the use of the microprocessors. The manual does not mention that punch-in recording is possible. Brief use pointed out to me that a cassette had to be advanced at least a short distance for "Align" to work; that was easy to do, and the benefits were great.

No record clicks could be detected by ear or meter, even when using Dolby C NR. There were very soft pause and stop "clunks" down in the tape noise (no indication on the monitoring meter). I found that with "Stop," and more so with "Pause," very short sections of the tape being used were not erased completely—leaving little beeps from my earlier tests. A very short rewind would be in order to prevent such distractions if a tape is being reused and has not been bulk erased.

For record/playback listening tests, I used pink noise for tracking tests and dbx-encoded disc versions of digitally recorded originals: *Wolftracks* with John Kay and Steppenwolf (Nautilus NR-53/dbx PS-1084), music of Rodrigo (Varese Sarabande VCDM 1000.150/dbx PS-1032), and others. The results were excellent, aided, I am sure, by the peak-responding meters, which were easy to read over a fairly wide range of illumination levels. With recording levels set quite high, I did prefer the Type II results over Type I, and the Type IV results over Type II; in each of these successive comparisons, the bass became less muddy and the music better detailed. Once again, I concluded that, with listening at high levels, the maximum recording level was best kept to that for a distortion of about 1%—about 0 dB on the B215.

The Revox B215 utilizes its microprocessors for many important and helpful things. "Align" performed very well, and the responses were among the best seen to date. Flutter performance was superlative, and the construction of the transport was judged to offer long-term reliability. The B215 is large, so it won't fit just anyplace, but it should have considerable attraction for those who seek performance and advanced features. *Howard A. Roberson*

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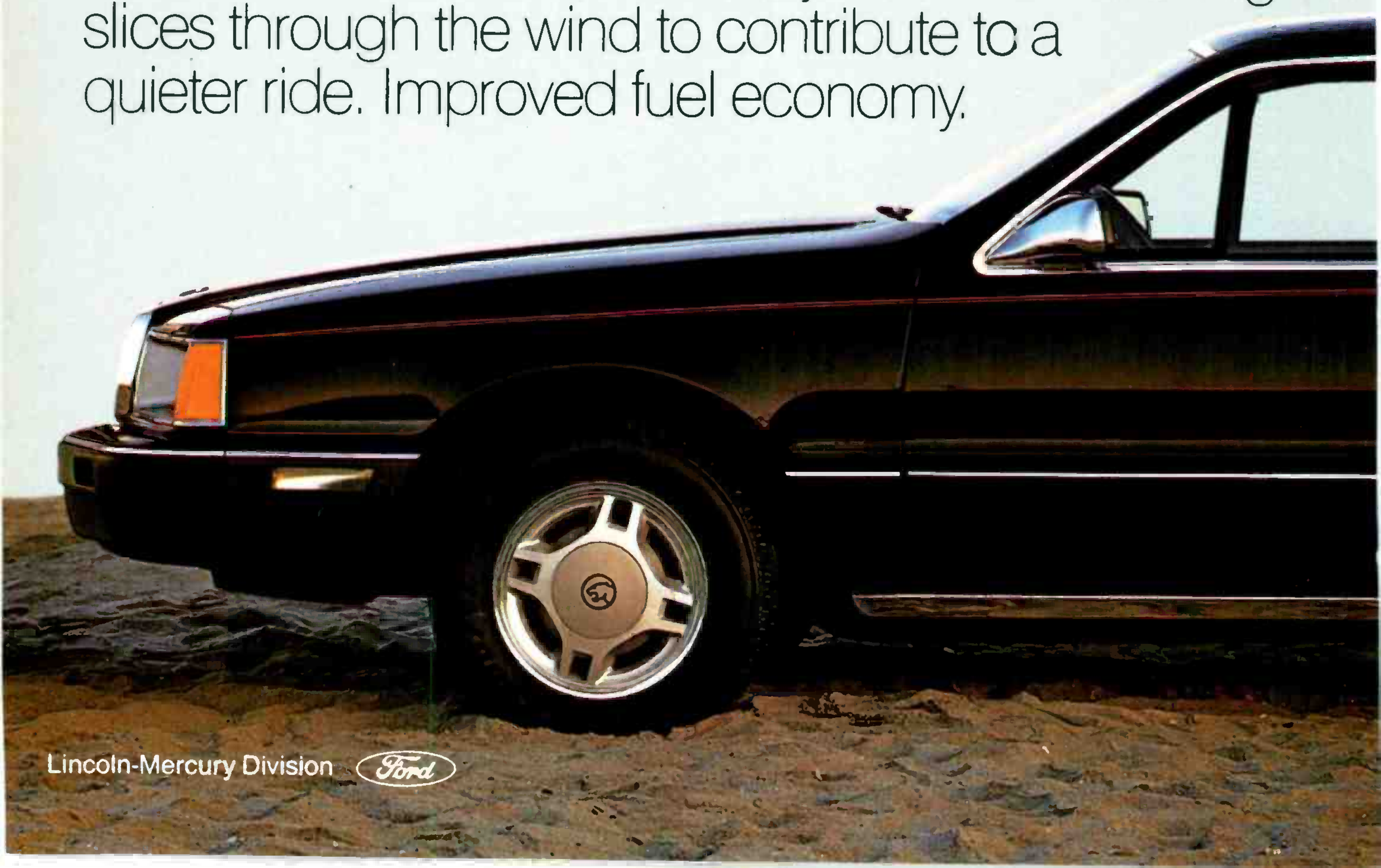

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2

SONY CDP-650ESD COMPACT DISC PLAYER

Manufacturer's Specifications

Frequency Response: 2 Hz to 20 kHz, ±0.3 dB.

Harmonic Distortion: 0.0025% at 1 kHz.

Dynamic Range: Greater than 96 dB.

Channel Separation: Greater than 95 dB.

Number of Programmable Selections: 20.

Output Level: 2.0 V, fixed and variable.

Phone Output Level: 28 mW into 32 ohms.

Power Consumption: 16 watts.

Dimensions: 16-15/16 in. W × 3⅛ in. H × 13-3/16 in. D (43 cm × 8 cm × 33.5 cm).

Weight: 19 lbs., 6 oz. (8.8 kg).

Price: $1,300.

Company Address: Sony Dr., Park Ridge, N.J. 07656.

For literature, circle No. 91

Digital Compact Disc technology is moving along at a rapid clip. Sony, one of the "founding fathers" of CD, measures its progress by, among other things, the generation number of its players. The CDP-650ESD is Sony's third-generation, top-of-the-line player; as such, it incorporates a host of technical advances, both internally and externally, which are worth mentioning at the outset.

Most important, perhaps, is the fact that Sony has, at long last, swung over to digital filtering and oversampling—a technique first espoused by Philips, their partner in the development of the CD system. Moreover, Sony's use of oversampling and digital filtering goes a step further than anyone else's in that it employs a single master clock to synchronize all decoding and digital-to-analog conversion operations. The very significant benefits of this technology became apparent to me when I tested the unit and listened to it, but more about that later.

Much of the advanced circuit integration developed by Sony for their miniaturized car CD players and their acclaimed Model D-5 portable CD player is also found in the CDP-650ESD, including the incredibly dense VLSI chip that replaces the function of three ICs used in earlier-generation players. The tracking, servo and laser pickup mechanism is the same lightweight, lower-mass assembly used in the aforementioned D-5 and car players; the motor which guides the laser pickup and keeps it on track is a brand-new, linear unit which replaces the bulky, worm-gear motor used on earlier models. This new motor enables the player to access any point on a CD in 1 S or less—even track 99 of a 99-track disc, if any such were ever produced (besides test discs)!

Random-access programmability has been increased to 20 selections, including programmed access to index points on those discs which are index-configured. (More and more such discs are appearing lately.) In addition to specific, programmed play, Sony has incorporated a new playing mode which they call "Shuffle Play." In this mode, the selected tracks or index segments are played back in random order. I wondered what possible use this might be to consumers; when I inquired, I was told that it might be handy to have when playing a multi-track disc for background music or for dancing. The disc could be repeated over and over, but the order of selections would be different each time so that listeners wouldn't become bored. I rather think that this function won't be used by too many people, but if nothing else, it does display the power of the microprocessor used in this machine. Another novel convenience is the "Auto Delay" function, which allows you to delay the playback of each chosen selection by 2 S. Repeat play and AMS (Automatic Music Sensor, for rapid selection of a given track) are pretty much the same as they were on earlier Sony players.

Control Layout

The front panel of the CDP-650ESD has a completely new look, especially in the display area. The disc-compartment drawer remains basically as it was on earlier machines. The compartment drawer is opened by touching an "Open/Close" key just to its right, and is closed by touching the front of the drawer itself, by touching the "Open/Close" key or by initiating "Play" of a disc. Numbered keys from 0 through 20, plus a key labelled "+10," are located near the panel's center and are used to call up desired tracks either for immediate play or for programming. With the aid of the "+10" key, it becomes easy to call up or program track numbers higher than 20; for example, to call up track 44 (assuming there were that many tracks on a disc) you would punch the "+10" button four times and then touch the "4" button. The "Play," "Pause," "AMS" (automatic track advance and track retard), and play-mode keys ("Continue," "Single," and "Program") are to the right of the numeric keyboard, while "Check" and "Clear" keys (for verifying programmed instructions or clearing them from memory) are just below the numeric keys. The "Stop" key and a pair of manual-search keys are near the lower right corner of the panel; the latter allow fast search in either direction while listening to a disc.

At the lower left corner are the switches to turn the player on and off, either manually or by an optional external timer. Five more buttons are beneath the display: "Repeat" (which

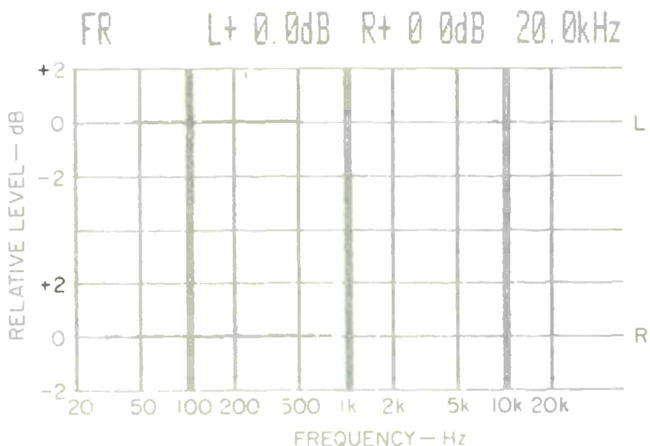

Fig. 1—Frequency response, left (top) and right channels.

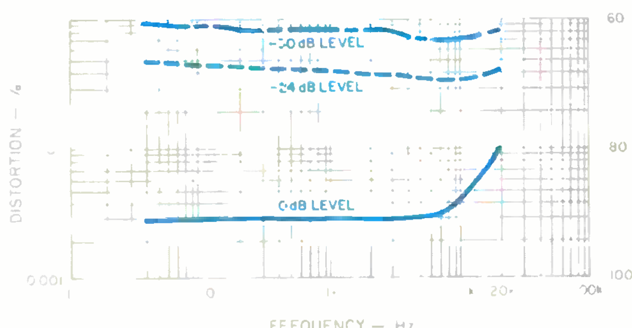

Fig. 2—THD vs. frequency at three signal levels.

Sony has, at last, gone to digital filtering and oversampling, using a single master clock to synchronize all D/A conversion operations.

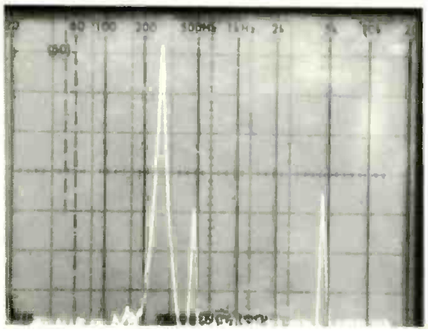

Fig. 3— Spectrum analysis done on early CD player, showing desired tone (tall spike) and spurious beat tones.

repeats a selection program or the passage between two user-selected points), "A↔B" (which sets those points in memory), "Time" (to select elapsed- or remaining-time display), "Auto Delay," and "Shuffle Play." At the lower right corner are an output-level control (which varies both headphone output level and the level at the rear-panel variable output jacks) and a stereo phone jack.

The display area on the front panel provides a variety of useful data concerning the status of the player and the disc being played. A "Disc" indicator lights up when a disc has been inserted properly. When a disc is first inserted, a "Track" indicator shows the total number of tracks contained on the disc for a few seconds, then displays the

SONY'S DAS-702ES: GILDING THE DIGITAL LILY?

Along with the remarkable Sony CDP-650ESD Compact Disc player tested for the accompanying report, I also evaluated another new product from Sony, the DAS-702ES external D/A converter. In essence, this unit duplicates functions which must be incorporated into any CD player, the translation of the digital code extracted from a digital program source (such as a Compact Disc) into the closest possible replica of the original analog audio signal. In fact, it's only usable with signal sources having digital outputs, like the CDP-650ESD, but no other CD players that I know of so far. Thus, my first reaction to this additional component was to ask why anyone would want or need it, since full decoding is performed by the D/A circuitry already contained in every CD player (including the Sony CDP-650ESD, which is intended to serve as a companion piece for the DAS-702ES).

The people at Sony suggested that this separate D/A decoder (or converter) is a state-of-the-art device which, if connected to the CDP-650ESD, would yield sound superior even to that of the top-of-the-line CD player itself. Furthermore, I learned that the DAS-702ES offers greater digital-to-analog decoding flexibility and might well be needed in the future for certain other D/A decoding chores. For example, the digital input applied to this decoder need not be confined to a sampling rate of 44.1 kHz (the standard CD sampling frequency). The unit can also handle a sampling rate of 32 kHz (the standard sampling rate for digital-audio broadcasting in Europe and elsewhere) and the 48 kHz used in professional digital recording with equal ease.

I was curious to learn whether I would be able to measure or hear any difference between the sounds produced by the superb CDP-650ESD operating on its own, and the sounds produced by hooking up that player (via its digital-output jack) to the DAS-702ES. To satisfy my curiosity, I repeated virtually every measurement that I had made on the CDP-650ESD alone, on the combination of the CD player plus the separate D/A unit. I resolved to do a blind listening test between the two setups as well, using my associate to set up the test in a random switching sequence and instructing him not to tell me when he was switching setups from one to the other. But I'm getting a bit ahead of myself.

On the DAS-702ES, the digital input jacks are paralleled by a pair of jacks identified as "Digital Outputs." These provide a convenient feedthrough to pass the undecoded digital program material to other devices which might require data in digital format (such as, for example, some future type of dedicated, digital tape-recording mechanism, or even the

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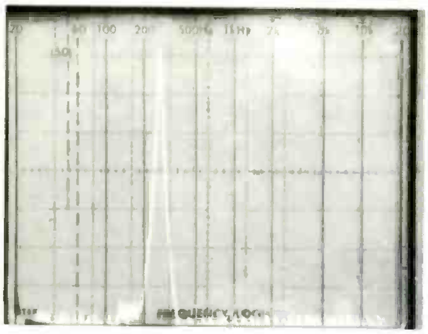

Fig. 4— Same test as in Fig. 3, done on the Sony CDP-650ESD. Note absence of unwanted beat frequencies above the residual noise floor.

number of the track actually being played. A time counter displays the total amount of playing time on a disc when the disc is first inserted, after which it reverts to displaying the elapsed time of the track being played or the total time remaining on the disc. A "PGM" (ProGraM) indicator illuminates when the player is in the standby mode for programming. An "Index" indicator shows the index number of the selection being played (or, during the "check" sequence, of index numbers programmed for future play). Lights on a 1 to 20 numeric grid show how many selections you've programmed. If you program more than 20, the word "Over" lights up, along with the grid.

The rear panel of the CDP-650ESD is equipped with fixed-

black box that will someday be used to generate the video graphics signals encoded in certain CDs).

The only front-panel controls on the DAS-702ES are a power "On/Off" switch, a "Digital Input" switch (for selecting between the two sets of digital input signals which may be connected to the unit), a headphone jack for monitoring decoded output using stereo phones, and an output-level control which regulates both headphone and variable line-output levels. The rear panel is equipped with the aforementioned pairs of digital input and output jacks, as well as pairs of fixed- and variable-level analog (decoded) output jacks.

Measurements

Many of the published specifications supplied for the DAS-702ES, though excellent in their own right, are actually somewhat poorer than the specs supplied by Sony for the CDP-650ESD operating by itself! For example, frequency response claimed for the separate decoder/converter, though extending from 5 Hz to 20 kHz, carries a tolerance of ±0.5 dB, as opposed to ±0.3 dB and a range of 2 Hz to 20 kHz for the player. Rated distortion for a 1-kHz signal at maximum recorded level (using a 44.1-kHz sampling rate) is listed as 0.004%, as opposed to 0.0025% for the CDP-650ESD. Dynamic range is marginally lower than that of the player alone, as well. And so on.

Sony maintains that when you get down to the published specs that are involved in the digital domain, such minute differences are not what determine which unit will sound better. I certainly couldn't take issue with that, but I did want to make some measurement comparisons for my own satisfaction.

In Fig. B1 you will find a graph of frequency response plotted in the same way as Fig. 1 of the CDP-650ESD report. Note that at 18.5 kHz there is already some attenuation of response. Figure B2, plotting distortion versus frequency, confirms what Sony admits: The separate D/A converter actually has slightly higher distortion at the three output levels I use to measure THD. Signal-to-noise ratio

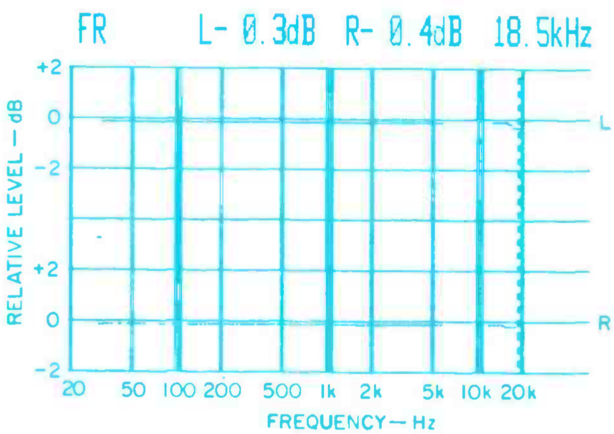

Fig. B1— Frequency response, left (top) and right channels, DAS-702ES D/A converter.

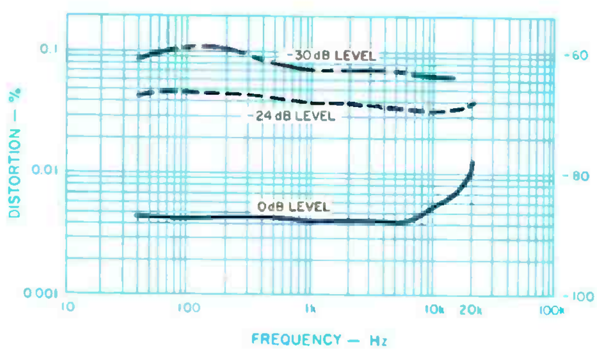

Fig. B2— THD vs. frequency at three signal levels, DAS-702ES.

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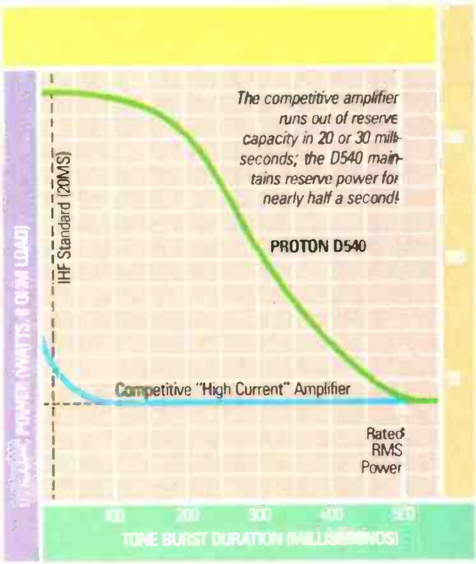

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P R O T O N

The CDP-650ESD exhibited the flattest frequency response of any player I've ever tested. Deviation from absolutely flat never exceeded 0.1 dB.

and variable-level output jacks. There is also a multiple-pin accessory connector which, the owner's manual cryptically tells us, is to be used "to connect optional equipment which will be available in the future." By this time, I suspect, many of us know that the "optional equipment" will be a black-box accessory which will allow access to the video graphics that will soon be available on Compact Discs. The addition of this accessory will allow such digitally generated graphics to be displayed on your TV screen while you listen to the audio content of the same CD.

The rear panel also has a "Play Mode" initializing switch. This switch sets the turn-on play mode, determining whether the CDP-650ESD will set itself for continuous, single-selection, or programmed play when first turned on. The rear-panel switch would therefore be set to the mode you want most often, while the front-panel mode keys are used to

(unweighted, at least) was also a bit poorer on the DAS-702ES, 94.9 dB as against 97 dB for the CDP-650ESD (see Fig. B3). About the only parameter that measured better with this decoder than with the CDP-650ESD alone was separation, which, at mid-frequencies, reached levels as high as 86 dB and remained higher than 82 dB at 20 kHz.

Using the same test disc, I photographed the usual square-wave, unit-pulse and phase-shift signals as they appear on an oscilloscope in order to compare them with the photos obtained for the CDP-650ESD unit. Try as I might, I couldn't see the slightest bit of difference between Figs. B5, B6, and B7 and the corresponding photos taken for the CD player alone. Can you?

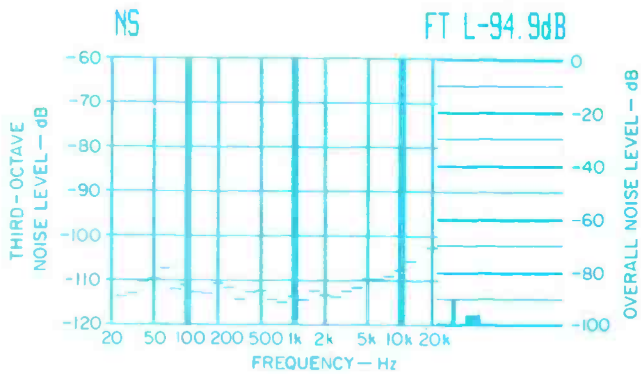

Fig. B3— S/N analysis, unweighted, DAS-702ES.

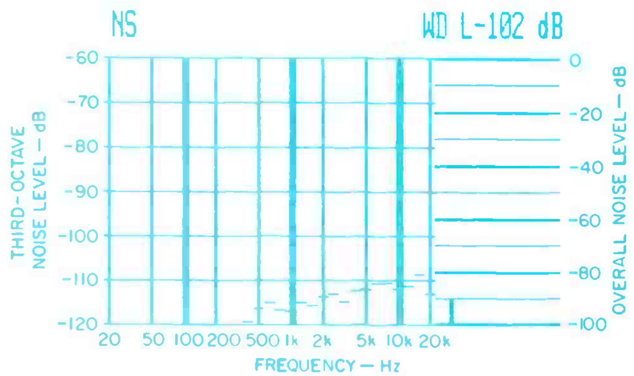

Fig. B4— S/N analysis, A-weighted, DAS-702ES.

Listening Tests

Next, I was ready for the "moment of truth." Dutifully blindfolded, I asked my assistant to play some of my favorite CD tracks through both setups: The CDP-650ESD outputs feeding my reference system directly, and the player's digital output hooked up to the DAS-702ES, whose analog outputs were, in turn, hooked up to another pair of inputs on the reference amplification system. Happily, there was no problem adjusting for precisely equal outputs; when you deal with Compact Disc players, output levels are easily controlled and referenced to maximum recorded level. In this case, maximum recorded level provided an output of exactly 2.0 V rms for both setups.

After extensive listening, I have to tell you that I could not, at any time, distinguish between the sound of the two systems. They were both marvelous, of course, but until I have a need for a decoder that will handle digital information using a sampling rate of either 32 or 48 kHz, I myself see no reason to invest in this separate decoder, however more sophisticated its circuitry may be.

Dealing in this rather controversial area of esoterica (which is not my usual habitat, I might add), I don't want to let the matter stand there. I have a feeling that I am going to be deluged by a sack of mail from readers who will tell me that *of course* they can hear an obvious improvement when the separate (and costly) D/A converter box is used to do the digital-to-analog decoding. In order to forestall such a deluge of mail, I'm going to strongly urge Editor Eugene Pitts to allow other ears to conduct similar testing. If those ears disagree with my conclusion, I will not be upset or the least bit insulted. I will, in fact, conclude that perhaps Sony had very good reasons after all for introducing, as a consumer product, a component part of a Compact Disc player which

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This feature-laden player has just about every convenience I would want. They're easy to use and are augmented by the wireless remote control.

change from that play mode. Finally, the rear panel houses a special digital-output jack—a first for any CD player, as far as I have been able to determine. At this jack, you can access the full digital code picked up from a CD by the laser pickup, before it is converted to an analog signal by the player's own D/A conversion circuitry. Aside from the obvious ability to dub CDs onto a digital recorder while the musical information is in the digital domain, this special output lets you connect an external digital converter component, such as Sony's DAS-702ES (see sidebar).

The 41-button remote control duplicates virtually every control on the front panel, right down to the volume control.

Measurements

To begin with, let me state that the CDP-650ESD exhibited the flattest frequency response of any CD player I have yet

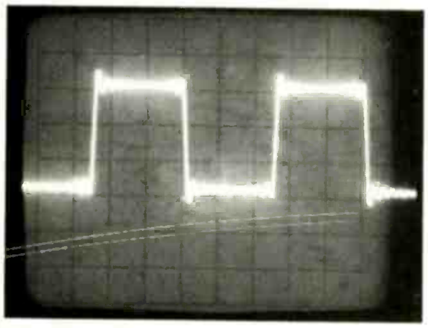

Fig. B5—Square-wave reproduction, 1 kHz, DAS-702ES.

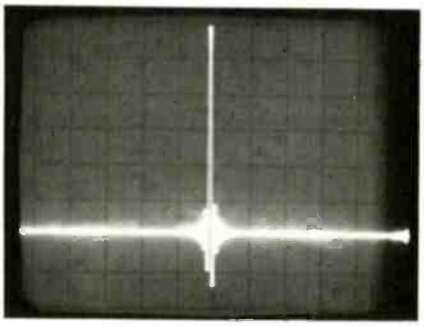

Fig. B6—Single-pulse test, DAS-702ES.

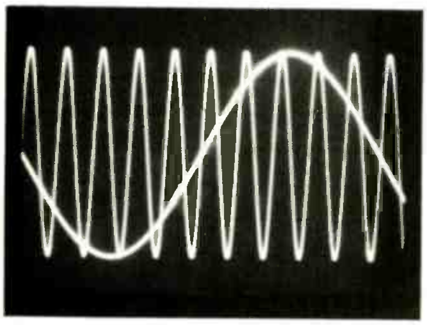

Fig. B7—Two-tone phase-test signal (200 Hz and 2 kHz), DAS-702ES.

sells (at $1,500) for more than the best complete player they now have available. I look forward eagerly to further tests by others, since without them I will remain rather puzzled by this D/A converter—feeling all the while that perhaps I'm missing the point somewhere. . . . *L.F.*

I have done some fairly extensive A/B tests, with very close mid-band level adjustment, as well as many, many hours of open subjective listening to the CDP-650ESD in comparison with the first-generation player that had perhaps the most highly respected sonics. In the open listening, there was a smoother, less-shrill character to the Sony that sounded as if all frequencies from about 4 kHz and up had been shelved down about a quarter or a half dB. There was an edge to the sound of the other machine, as if a bit of interstation FM noise had been added, noise which was whistley, whiny, and scrapey in character. These differences tended to go away for me when I was doing the A/B tests. However, three other casual, nonaudiophile listeners made the same sort of comments when I was independently demonstrating the unit's disc handling to them. They were not prompted to give any sort of comment on the sound; they volunteered the remarks. My conclusion is that I like to listen to the new Sony in preference to the old player, whether or not there is any hard data from a blind A/B test backing up statements on its sonic superiority.

The sound of the CDP-650ESD when combined with the DAS-702ES was, however, a different story—probably because I had troubles with the converter right from the start. I sent the unit home, via UPS, since I do my most serious listening there. The switch controlling the digital output arrived broken, because of its being located as the most vulnerable component during boxed carrying and because Sony uses the very worst sort of packaging—crushable, coffee-cup foam. I fixed the switch once, and Sony fixed it (very quickly, thank you) after two more trips. Neither fix would have been needed had that switch not been placed at the furthest possible point from the handle for the carry home and if not for that awful foam. Neither is worthy of a top-of-the-line product.

Anyway, I thought that the sound of the combined Sonys was less good than the sound of the 650 alone, but still better than the first-generation player. I do not have sufficient switching facilities to be able to check this sort of a three-way comparison, and I think that my difficulties in getting the 702 working probably influenced my judgment about its character. I'd buy a 650, but in the absence of another use, I'd pass up the 702. *E.P.*

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Sound quality of the CDP-650ESD is absolutely magnificent, far better than Sony's first generation of players.

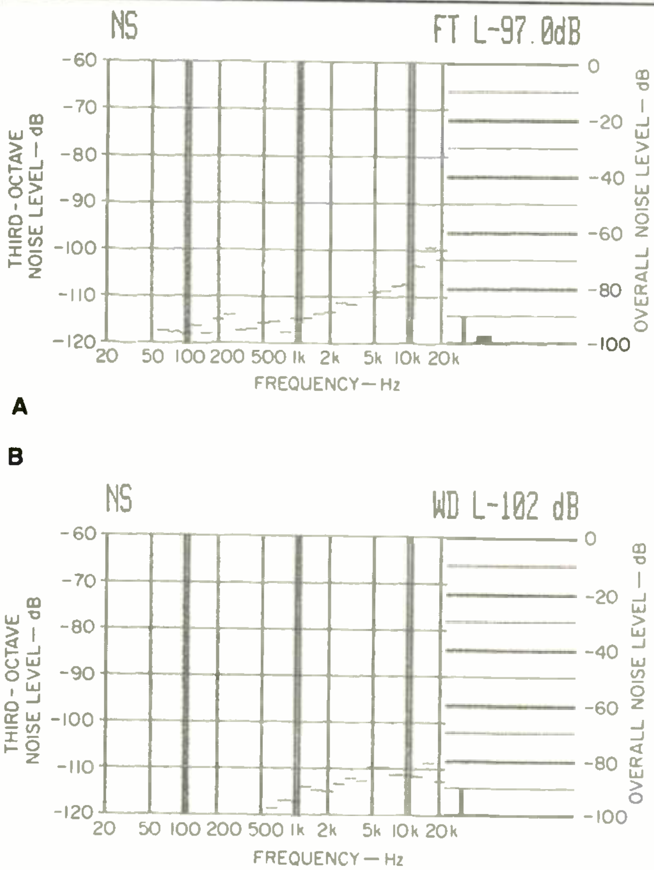

Fig. 5—S/N analysis, unweighted (A) and A-weighted (B).

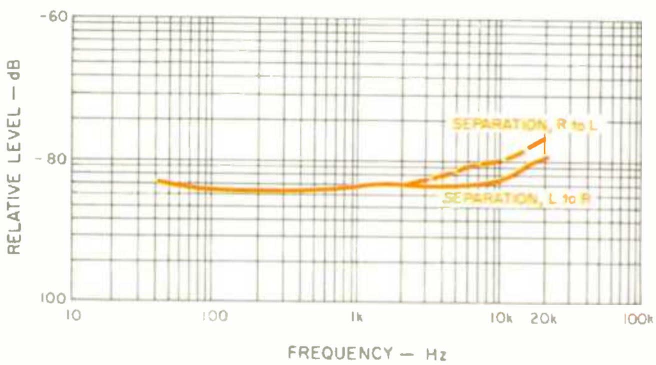

Fig. 6—Separation vs. frequency.

tested. As you examine Fig. 1, a plot of frequency response for the left- and right-channel outputs, you are not going to see very much because the plot of output, for the most part, fell smack on the 0-dB line of the graph. Maximum deviation from absolutely flat response was never more than 0.1 dB, and, as you can see from the notations on the graph, at the highest test frequency (20 kHz), deviation from flat response was 0 dB.

Harmonic distortion at mid-frequencies for a maximum recorded level signal measured under 0.003%. I have tested other players with such low distortion, but I have never run across a player that exhibited such a low distortion figure at high frequencies (0.01% at 20 kHz). Part of the explanation lies in the fact that Sony has swung over to a combination of oversampling and digital filtering—but that's not the whole answer, since many other manufacturers have employed these circuit techniques before. Another factor is the use of a single master clock (as opposed to several nonsynchronized clocks) to synchronize the decoding operations to the 44.1-kHz sampling rate of Compact Discs. Figure 2 shows how harmonic distortion varied with frequency for recorded levels of 0, −24, and −30 dB.

Figures 3 and 4 are perhaps of even greater interest. Figure 3 shows what happens when a test signal is recovered by an earlier generation CD player. The tall spike represents the desired output signal, while shorter, spurious components to the right represent undesired output resulting from nonlinearities in the system and from the use of multiple digital clocks in the decoding system. The same signal, reproduced by the Sony CDP-650ESD, was scanned by a spectrum analyzer in the same way, and the output over a wide spectrum of frequencies is shown in Fig. 4. All that you can see now is the desired output at the left and the random, residual noise floor. There are no unwanted "beat" frequencies at any other point in the display!

Unweighted signal-to-noise ratio measured a very high 97.0 dB, increasing to 102 dB when an A-weighting network was used (see Figs. 5A and 5B). SMPTE IM measured only 0.002% at maximum recorded level and 0.015% at −20 dB recorded level. IHF IM (twin-tone) measured only 0.0021% at 0-dB level and 0.0021% at −10 dB level. Stereo separation, plotted as a function of frequency in Fig. 6, ranged from 82 dB at mid-frequencies to around 76 dB at high frequencies.

This player's reproduction of a 1-kHz square wave is shown in Fig. 7. Notice how much closer this waveform is to a true square wave than were the waveforms other players reproduced from this signal in earlier tests. It's not just that the "ringing" on the leading edge of the square wave, associated with the use of steep, multi-pole analog filters, is absent. There's also much less of the low-level ripple normally seen on the horizontal portions of the square wave with players using digital filtering and oversampling. This suggests very minimal phase shift for the square wave's higher order (high-frequency) components. The virtual absence of any phase shift indicated by the comparison of 200-Hz and 2-kHz signals on opposite channels in Fig. 9 confirms this. In Fig. 9, both the low-frequency (200-Hz) and higher frequency (2-kHz) sine waves cross the zero axis in the same direction, at precisely the same time.


BRIDGESTONE

This player is likely to convert those few diehards who are not yet convinced that the CD is the best thing to happen to home audio in many a decade.

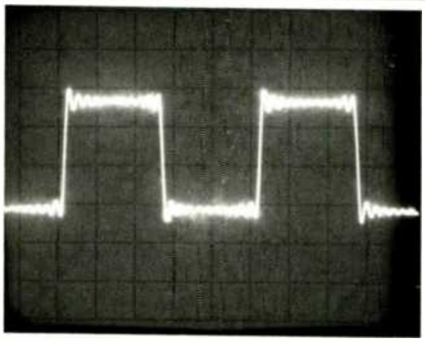

Fig. 7—Square-wave reproduction, 1 kHz.

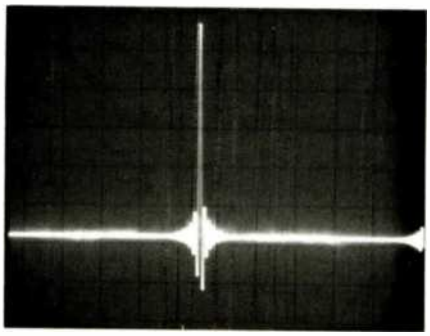

Fig. 8—Single-pulse test.

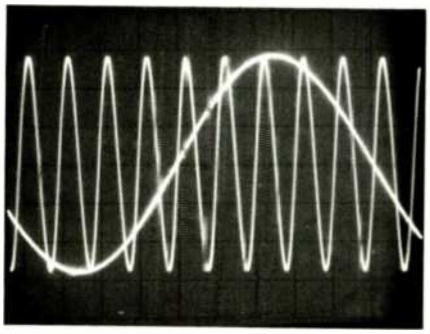

Fig. 9—Two-tone phase-test signal (200 Hz and 2 kHz).

Use and Listening Tests

This feature-laden player has just about every convenience I would want in a CD player. Furthermore, the features are easy to use and are all augmented by the multifunction, wireless remote-control unit which is supplied with the CDP-650ESD. About the only possible feature that Sony has left out is access to a given point on a disc according to time (minutes and seconds into a given track). Sony says that their own opinion surveys of CD-player owners indicated that this feature is rarely used (and seldom requested), while accessing by index (which this player does offer) is increasingly desired.

When I first read that the CDP-650ESD could access any point on a disc within 1 S or less, I presumed that this was a bit of promotional exaggeration, but I felt that no one would really quibble if, in fact, the laser pickup took 2 or even 3 S to reach its destination. Much to my amazement, the claim is no idle exaggeration. I have a special test disc with 99 tracks on it designed to check accuracy of access and other qualities relating to a player's tracking ability. This unit found track 98 in no more than 1 S! I realize that this feat, in and of itself, doesn't really mean that much. But to my mind, it tells me a great deal about the lightweight laser pickup and about the accuracy, speed, and reliability of the new linear motor used in this player. These assemblies and this kind of pickup travel suggest that there will not be much mistracking with this machine: All of its built-in, error-correction circuitry will be available for correcting or concealing errors in discs, with none of it "spent" to compensate for disc-reading errors caused by the player's poor tracking.

Sound quality of the CDP-650ESD is absolutely magnificent. It is far better than the sound quality of Sony's first-generation players, and, with really good software in place, it is also distinctly better sounding than their excellent second-generation players—about which I had nothing but praise last year. I realize that I have used superlatives to describe earlier CD players from Sony, as well as from other manufacturers. It's important to point out that I am talking about relatively minor sonic differences here. Of course, the first players offered great sound—given decent CDs to use with them—and I still maintain that the sound produced by those first- and second-generation players, when playing properly produced CDs, was better, by far, than anything I had heard from LPs or analog tapes. What I am saying now is that the slight problems that I (and others) attributed to some of those early players seem to have been eliminated in this third-generation unit from Sony. I can't tell you if it's their new VLSI chip that's doing the trick or if it's the single master clock, the lighter laser pickup, or the new linear motor. Possibly it's all these things added together, plus the experience gained by Sony's design engineers after nearly three years of intense activity in Compact Disc design. All I know is that the CDP-650ESD is a magnificent-sounding machine that, when heard playing well-made CDs, is likely to convert those few remaining diehards (yes, there are still a few) who aren't yet convinced that the Compact Disc is the best thing that's happened to audio and home sound reproduction in many a decade. Until I can be shown that a better sounding CD player exists, I'm going to consider this model my new standard of reference. *Leonard Feldman*

3

PROTON 440 TUNER

Manufacturer's Specifications

FM Tuner Section

Usable Sensitivity: Mono, 10.3 dBf.
50-dB Quieting Sensitivity: Mono, 15.3 dBf; stereo, 33.2 dBf.
S/N + Hum: Mono, 75 dB; stereo, 70 dB.
THD: 0.2%.
Capture Ratio: 1.5 dB.
AM Rejection: 60 dB.
I.f. Rejection: 90 dB.
Image Rejection: 55 dB.
Stereo Separation: 45 dB at 1 kHz.

AM Tuner Section

Usable Sensitivity: 20 µV.
Selectivity: 35 dB.
S/N: 43 dB.
Image Rejection: 35 dB.
I.f. Rejection: 50 dB.
THD: 0.5%.

General Specifications

Dimensions: 16 in. (40.6 cm) W × 3 in. (7.6 cm) H × 10 in. (25.4 cm) D.
Weight: 15 lbs. (6.8 kg).
Price: $270.
Company Address: 737 West Artesia Blvd., Compton, Cal. 90220.
For literature, circle No. 92

When Larry Schotz designed his noise-reduction circuitry for NAD, they called it Dynamic Separation, but Schotz no longer gives manufacturers exclusive use of his innovative and original circuitry. So now, Proton is using a slightly different version of the same noise-reducing idea, and calling it SNR. As you may have guessed, SNR gives at least abbreviated credit to its inventor; the initials stand for Schotz Noise Reduction. Since the circuitry used in the Proton 440 and the NAD 4155 (reviewed in the December 1984 issue) is *basically* the same (though active devices used in the circuits are different), I won't go into a long description of how SNR works. Instead, here's a brief summary:

The circuitry reduces noise normally heard during weak-signal stereo FM reception by blending the high-frequency content of both channels during quiet moments or pauses in the music. Wider separation at high frequencies is restored when there is more significant high-frequency stereo information in the signal (louder treble content) or when the signal itself is stronger and therefore less noisy to begin with. Unlike ordinary "blend" circuits (which reduce treble separation during weak-signal reception regardless of program content), the SNR circuit works dynamically. It is most effective when signal strength ranges from around 20 dBf (the stereo switching threshold of this tuner) up to about 45


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The best the SNR circuit did was to reduce noise by 7 or 8 dB, but that can be enough to turn an unusable signal into a tolerable one.

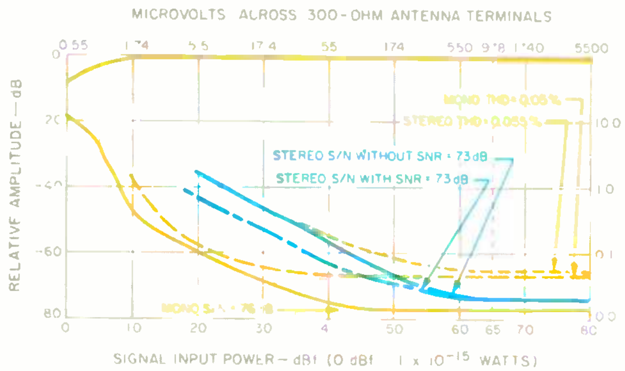

Fig. 1—Mono and stereo quieting and distortion characteristics, FM section.

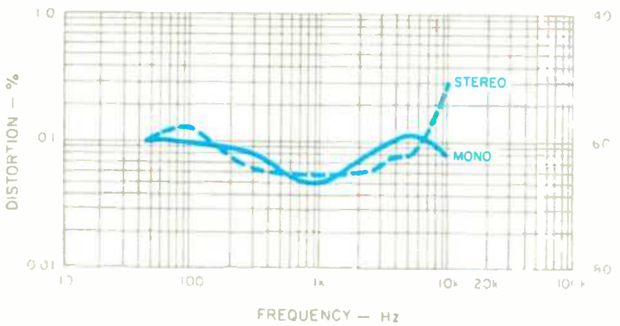

Fig. 2—Harmonic distortion vs. frequency.

or 50 dBf. Beyond that signal strength, the signal-to-noise ratio (about 65 dB at 50 dBf) is high enough so that no further action of the SNR circuitry is necessary.

Control Layout

The simple, all-black front panel of the Proton 440 has its "Power" on/off pushbutton at the extreme left. Nearby are a pushbutton for mono/stereo selection and an "SNR Off" button which deactivates the Schotz Noise Reduction circuit whenever the user deems it necessary. An illuminated numeric display shows the AM or FM frequency to which the tuner has been set; above this display is a five-element LED signal-strength indicator, a "Stereo" indicator light, and a "Locked" indicator which flashes as you approach a correct tuning point and stays continuously lit when correct tuning has been achieved. Two more indicators, to the right of the main display, are identified as "Search" and "Enter." The "Search" LED is illuminated whenever you put the tuner into the search mode, a tuning method which seeks the next usable incoming signal on the FM dial. The "Enter" LED lights when the "Enter" pushbutton is pressed to memorize one of 12 possible station frequencies (six AM and six FM).

The three remaining buttons on the front panel are for the tuning functions. Up and down arrows advance the tuner to the next higher or lower usable signal frequency, either in 200-kHz increments or in the search mode, depending upon whether the "Search" button has been depressed.

On the rear of the Model 440 are spring-loaded, 300-ohm FM, AM and ground terminals which, when depressed, expose tiny holes that grab and retain stripped wire ends. These terminals, similar to speaker terminals found on amplifiers, allow easy connection of stripped wires, but cables terminated in spade lugs are not so easy. Fortunately, the cable for the separate AM loop antenna has stripped and tinned ends for easy insertion. If you use an FM dipole other than the one supplied with the tuner—one that's equipped with spade lugs—you'd be better off removing those spade lugs and stripping and tinning the lead ends before connecting it to the terminals on the back of the 440. There is also a coaxial connector, conventional in design and use, for 75-ohm transmission lines. An output-level control and two output jacks complete the rear-panel layout.

Measurements

Usable sensitivity in mono was extremely good, measuring 9.0 dBf, close to the theoretical limit of sensitivity. Stereo-switching threshold was set at around 23 dBf, at which point noise plus distortion was already −36 dB compared to a reference 100%-modulated audio signal. Figure 1 shows how quieting and distortion vary with input-signal strength. Although THD in the stereo mode remains fairly constant whether or not the SNR circuit is activated, the signal-to-noise ratio does change considerably when SNR is used in the signal-strength region from just above stereo threshold to 50 dBf. For that reason, I plotted two curves for stereo THD (for a 1-kHz modulating signal) in Fig. 1. As you might expect, the lower curve (the one depicting better S/N ratios) is the one obtained with the SNR circuit on. At 30 dBf, for example, stereo S/N measures 45 dB without the SNR circuit, but it improves to 52 dB with the SNR circuitry on.

The best mono signal-to-noise ratio at strong signal levels measured 76 dB, while maximum S/N in stereo was 73 dB. At strong signal levels, the SNR circuit does not cause any further improvement in S/N, as you can see by examining Fig. 1. In mono, 50-dB quieting occurred with only 12.0 dBf of signal input. In stereo, without SNR, 50-dB quieting occurred with a signal input of 35 dBf; with SNR, only 28 dBf of input was required to achieve the same 50 dB of quieting.

Figure 2 shows how harmonic distortion varies with modulating frequency in mono and stereo, using 100%-modulated signals in each case. Mono THD, at 1 kHz, measured only 0.05%, barely increasing (to 0.55%) in stereo.

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I have not come across a tuner that is more sensitive than the Proton, and when you consider its low price, that's rather remarkable.

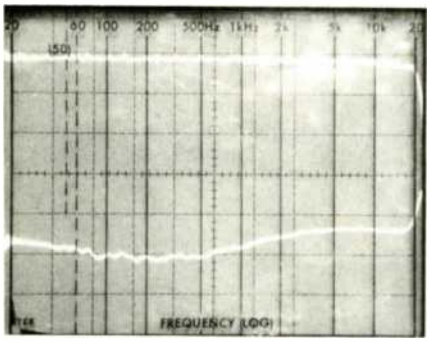

Fig. 3— Frequency response (upper trace) and separation vs. frequency, FM section.

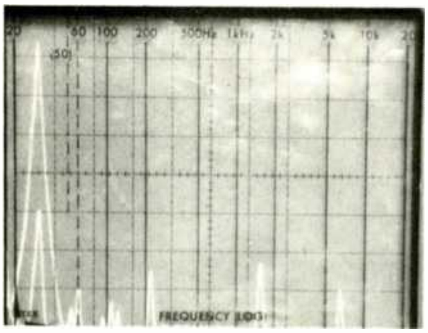

Fig. 4— Analysis of 5-kHz distortion and crosstalk, FM section.

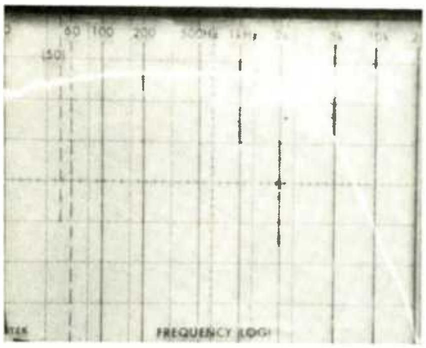

Fig. 5— Frequency response, AM section.

Figure 3 is my familiar 'scope photo showing a logarithmic sweep from 20 Hz to 20 kHz. The upper curve represents frequency response in the stereo mode, and the lower trace shows relative separation (the vertical scale is 10 dB per division). In checking spot frequencies, I measured separation of just under 50 dB at 1 kHz, 43 dB at 100 Hz, and 39 dB at 10 kHz. Essentially the same results were obtained with and without the SNR circuit on, because these measurements were made at a high (65 dBf) signal level.

I attempted a similar sweep at lower signal levels with the SNR circuit turned on, to show how the dynamic blend works, but soon realized that these results would not truly illustrate how the SNR circuit operates. This is because SNR is dynamic; as soon as the sweep would reach high frequencies, what blending there had been a moment earlier would vanish and full separation would be restored. In this case, therefore, you will have to take my word for it; the SNR circuit does work, and it works well. When I listened to musical program material received from fairly distant transmitters, noise was significantly reduced when I activated the SNR circuit; I sensed no apparent loss of stereo separation or stereo imaging.

Figure 4 shows the crosstalk and distortion products appearing at the output of the unmodulated channel when a 5-kHz, 100%-modulated signal was applied to the opposite channel. In this 'scope photo, the sweep is linear (5 kHz per division) and extends from 0 Hz to 50 kHz. Subcarrier product rejection was good—around 65 dB below maximum modulation signals—and SCA rejection was better than 70 dB. Capture ratio measured a bit higher than the 1.5 dB claimed, but AM rejection, i.f. rejection and image rejection were all close to published specifications. Alternate-channel selectivity (not specified by Proton) measured better than 65 dB.

Figure 5 shows frequency response of the AM tuner section. Roll-off began just above 2.5 kHz, and the −6 dB point occurred at around 4.0 kHz. This is slightly better than the average of most AM sets I have measured but is hardly anything to get excited about. Sensitivity and harmonic distortion figures for the AM section conformed closely to published specifications, as did the signal-to-noise ratio.

Use and Listening Tests

If the Proton 440 proves one thing, it is that devotees of FM radio need no longer spend a great deal of money to get very satisfactory FM performance. True, I have measured a few tuners (generally much higher priced) that offer better quieting than the Proton 440, and a few that have somewhat better stereo separation. I have *not* come across a tuner that is more sensitive than the Proton 440, and when you consider its low suggested price, that's rather remarkable in itself.

Larry Schotz's SNR circuit is useful over an important range of signal strengths, as I mentioned earlier. It won't provide any benefits at all if you are lucky enough to live where strong signals are the rule rather than the exception. Nor will it do anything for you if stereo signals are too weak (under 25 dBf or so) to cause the 440 tuner's stereo-decoding circuitry to switch in. Even when it does work, don't expect it to take a noisy signal and render it noise-free. The best the SNR did at any signal level was to reduce noise by about 7 or 8 dB without audibly degrading stereo effects. Under many circumstances, this improvement can turn an unusable signal into a tolerable one. As for standard features that most people want, such as preselection of favorite stations, ease of tuning, search tuning and the like, the Proton 440 has them; they all work well and are easy to use. If you have FM stations worth listening to in your area but find that some of them don't offer quite enough "quieting," even with an outdoor antenna in your listening location, the low-cost Proton 440 may well be worth a look—and a listen.

Leonard Feldman

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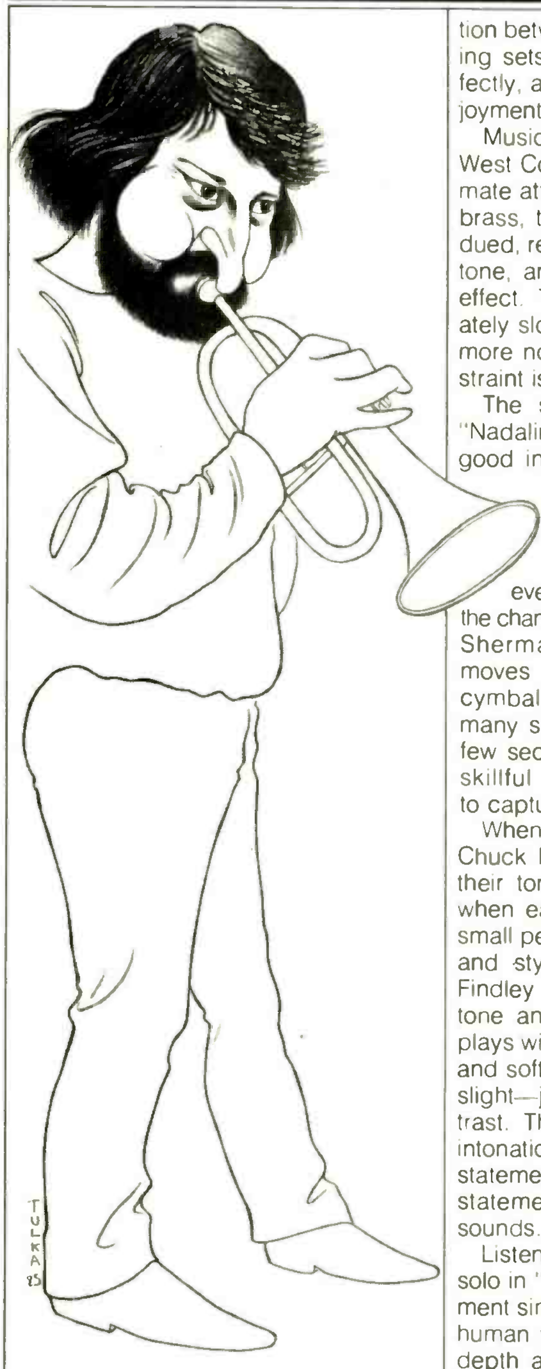
SHEW TIME! SHEW TIME!



Trumpets No End: Bobby Shew, Chuck Findley.
Delos D/CD 4003.

Put this disc in your CD player, and the room instantly fills with smoke, the lights dim, and the waiter brings another round of drinks. The superb interaction between the music and the recording sets the psychological stage perfectly, adding an extra measure of enjoyment to a beautiful recording.

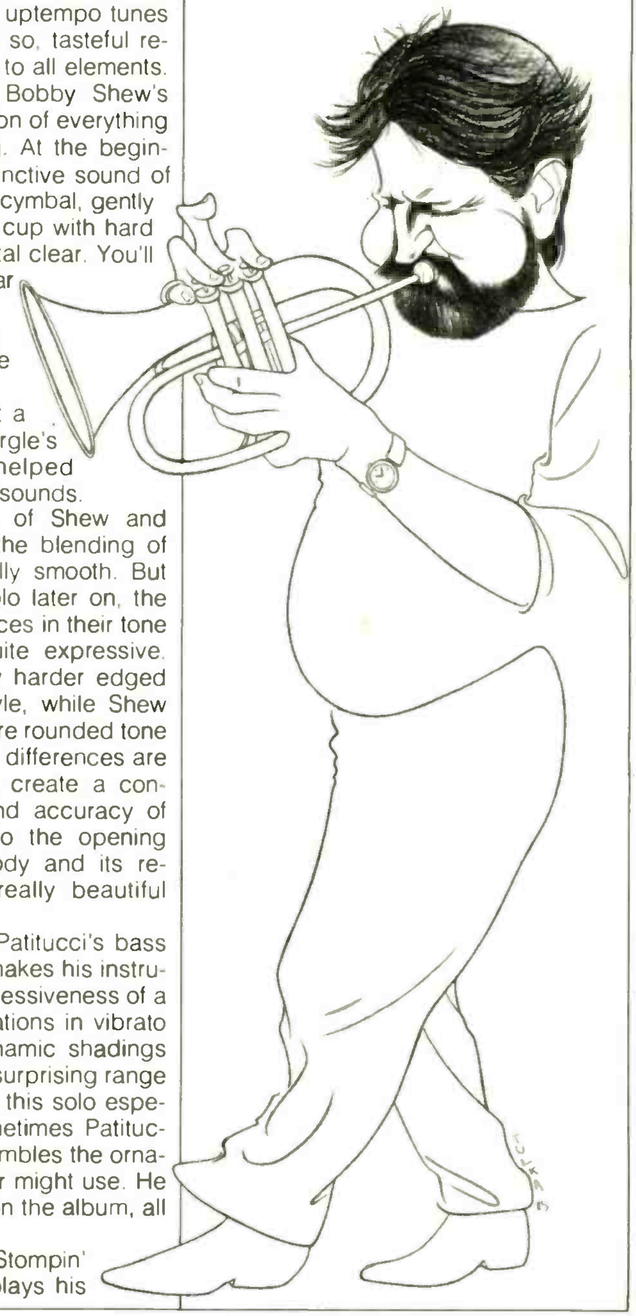
Musically, this is mellow, laid-back, West Coast jazz, played with consummate attention to detail. Despite all the brass, the style nearly always is subdued, relying on subtleties of phrasing, tone, and harmonic color to make its effect. Tempos generally are moderately slow, making the uptempo tunes more noticeable. Even so, tasteful restraint is the approach to all elements.

The second track, Bobby Shew's "Nadalin," is a distillation of everything good in this recording. At the beginning, the distinctive sound of a suspended cymbal, gently struck on the cup with hard sticks, is crystal clear. You'll even be able to hear the changes in color as Sherman Ferguson moves around on the cymbal, drawing out many subtleties in just a few seconds. John Eargle's skillful engineering helped to capture all of these sounds.

When the trumpets of Shew and Chuck Findley enter, the blending of their tones is beautifully smooth. But when each takes a solo later on, the small personal differences in their tone and style become quite expressive. Findley uses a slightly harder edged tone and tonguing style, while Shew plays with a slightly more rounded tone and softer attacks. The differences are slight—just enough to create a contrast. The blending and accuracy of intonation they give to the opening statement of the melody and its restatement make for really beautiful sounds.

Listen also to John Patitucci's bass solo in "Nadalin." He makes his instrument sing with the expressiveness of a human voice. His variations in vibrato depth and speed, dynamic shadings within a phrase, and a surprising range of tonal qualities make this solo especially memorable. Sometimes Patitucci's pitch-bending resembles the ornamentation a sitar player might use. He has many other solos on the album, all of them excellent.

In the third track, "Stompin' at the Savoy," Shew plays his double-belled trumpet (called, of course, a "Shew-horn"). One bell is muted, the other is open, enabling him to trade phrases with himself by opening and closing an extra valve. Rarely have I heard such an authentic muted trumpet sound on disc. The complexity of that sound, with its suppressed fundamental and new resonant peaks in the upper partials, is a delight.

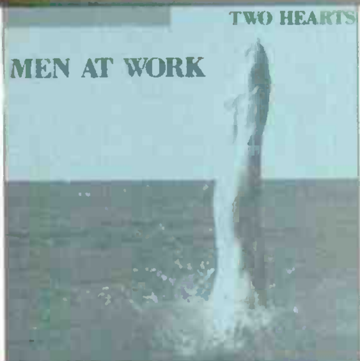


Illustrations: Rick Tulka

THIS MONTH'S BIG EVENTS ON CBS COMPACT DISCS.

JULY

5



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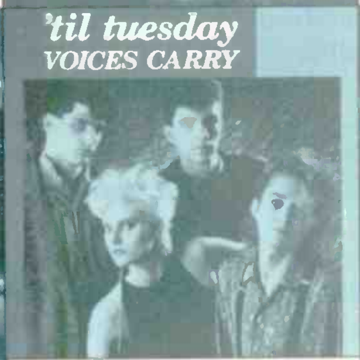

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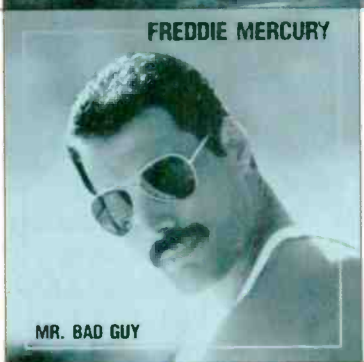

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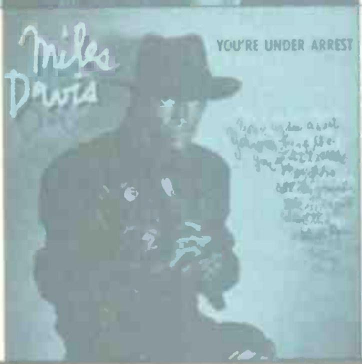
JUST RELEASED!

PAUL YOUNG "The Secret Of Association"
JOHNNY MATHIS "Right From The Heart"
WEATHER REPORT "Sportin' Life"
ELVIS COSTELLO "Armed Forces"
TCHAIKOVSKY: Violin Concerto
Zukerman; Israel Phil. / Mehta
Canadian Brass Live!
An Isaac Stern Vivaldi Gala
STERN, PERLMAN, ZUKERMAN, Etc.



22

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COMPACT disc DIGITAL AUDIO

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Under Charles Dutoit, the many intricacies of Honegger's orchestration are beautifully clear.

The recording, made at Annex Studios in Hollywood, has an excellent sense of intimacy combined with exactly the right amount of room ambience. How much of this is because of the acoustics of the room and how much comes from artificial reverb added later is difficult to say. Whatever Eargle and Ralph Jungheim did to achieve this quality, it sounds convincingly real. To me, that's the highest kind of praise for both the engineer and the producer.

The accuracy of the tone colors is further testament to the skill of Eargle and Jungheim in using the digital medium. They avoided the glossy, surrealistic quality that pervades pop recording. Instead, they made a recording that sounds natural and live. This approach complements the efforts of the musicians beautifully. All the carefully scaled variations in timbre are just as easy to hear as if this were a live performance.

Two other recordings by Eargle and Jungheim were released by Delos at the same time as *Trumpets No End*. Mavis Rivers' *It's a Good Day* and Joe Williams' *Nothin' but the Blues* are equally well-recorded and enjoyable CDs. *Steve Birchall*

Honegger: Symphonies Nos. 3 and 5. The Bavarian Radio Orchestra, Charles Dutoit.
Erato ECD 88045.

In general, the works of Arthur Honegger have not fared well since his death in 1955. There is associated with much of his writing a hard-edged, mordant quality which stands in contrast with most of his *Les Six* contemporaries. These two works underscore that nature, and the music does not win friends easily.

We have come to speak of Charles Dutoit and the Montreal Symphony Orchestra in the same breath, because of their very successful recordings of French music on London Records.

And here Dutoit is doing much the same on the Erato label with a German orchestra!

Recording quality is excellent. One senses a basic pickup, with a minimal number of accent mikes. Fore/aft orchestral balances are appropriate, and the reverb is moderate. The many intricacies of Honegger's orchestration are beautifully clear, and the bottom end is solid and never overdone.

The Third Symphony carries the subtitle "Liturgique." Its first movement,

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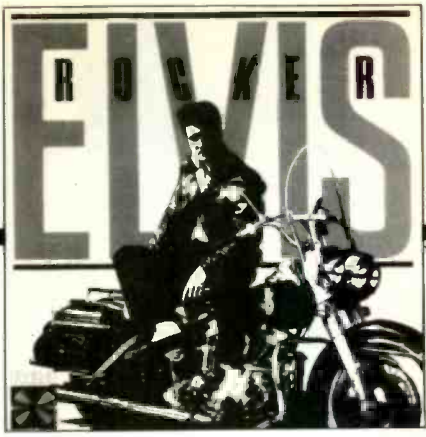
Though the recordings on *Rocker* are primitive, their new clarity in the CD format will be a joyous discovery for Elvis fans.



"Dies Irae," fairly bristles with anger. It soon gives way to a gorgeous adagio, "De Profundis," which is the essence of Honegger's unique harmonic palette. The work closes with a "Dona Nobis Pacem" whose strange, dragging, march-like opening seems to have little to do with the movement's title. By the end, though, it is transformed into the vision of peace which we expect.

The Fifth Symphony is subtitled "Di tre re," referring to the ending of each of the three movements on the note D (re, in solfége), played by the timpani.

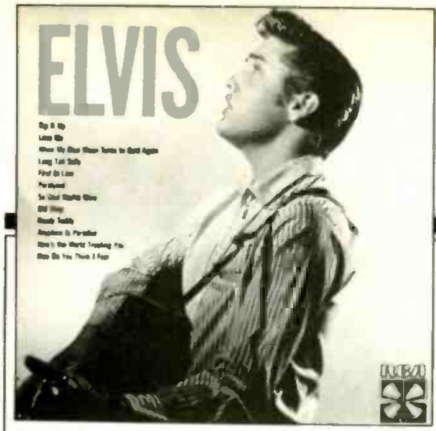
Until now, the finest performances of Honegger have appeared on the Supraphon label, with Serge Baudo conducting various Czech orchestras. Dutoit's traversal of these works shows him to have as much feeling for the music as has Baudo, and he has the advantage over Supraphon in technical matters. More Honegger from Dutoit and Erato is eagerly awaited, at least in this household. *John M. Eargle*

Rocker: Elvis Presley
RCA PCD1-5182.

Elvis
RCA PCD1-5199.

Elvis Presley would have been 50 years old on January 8, 1985. To celebrate the occasion and to get further mileage out of their catalog's deceased shining star, RCA reissued numerous past albums and juggled old, previously released material into new configurations to create the illusion of new packages. Two of these newly created albums are *Rocker* and *Elvis*. Both have received very impressive cleanup jobs.

Rocker features eight classic selections recorded in 1956, and two from 1957. The original mono master tapes were digitally remastered, and the results are surprisingly clean: There is no audible tape hiss and no discernible extraneous noise whatsoever. Although the recordings themselves are primitive—dead center, single-planed, limited in presence and dynamic range—their new clarity will be a joyous discovery for Elvis fans old and new. Early gems—including "Jailhouse Rock," "Hound Dog," and "Blue Suede Shoes"—emerge out of total silence. Although Elvis' voice is consistently doctored with reverb and sometimes recorded so far back in the mix you'd think he was in Tupelo and the studio was in Memphis ("I Got a Woman," for instance), it's still great to hear his brash, youthful, sexy exuberance undistorted by the ravages of time on vinyl. Scotty Moore's masterful but too-short solo spins on guitar sound fresh and vibrant in arrangements that seem pretty dated to these '80s ears.



On *Elvis*, the technical wizards have done more than digitalize; they've removed the artificial stereo processing used in the 1960s.

It's also great to see the unfamiliar photograph of Elvis, in a black leather jacket, looking young and tough, perched on a road-devouring Harley-Davidson on the cover of this CD.

Kudos to all involved in the technical revamping of this nearly two-decade-old material: Project engineer Rick Rowe, mastering engineer Jack Adelman, and technical supervisor Charles Kaplan. Whether you need this particular configuration of readily available Elvis classics is up to you, but they sure sound fine on this mean, clean CD.

Yet another of RCA's releases in celebration of what would have been The King's 50th year of life, *Elvis* features a mixed bag of early Presley performances, also from 1956. It contains a few of the well-known, uptempo songs of *Rocker*—"Rip It Up," "Ready Teddy," and "Long Tall Sally"—plus a selection of ballads and lesser-known rockers.

This CD has received the same tender, loving technical care as *Rocker*, although here the dedicated recording pros responsible remain uncredited on the disc's liner notes. However, these anonymous technical wizards have accomplished more than a mere swab-the-decks-and-digitalize job. They have removed the artificial-sounding, electronic reprocessing for stereo to which this material was subjected when stereo first became important in the '60s. The original, natural, mono channelling has been restored. The arrangements and original recorded sound are still '50s-primitive, but the new-found clarity in the digital format is revelatory. Only one cut, "First in Line," reveals tape hiss from the original source, and even this is minimal.

Unlike *Rocker*, which paints a one-dimensional picture of Elvis, perpetuating one of our stereotypical images of The King, *Elvis* presents a handful of mini-portraits, some of them alien to our distorted memories. "Old Shep," for instance, is an incredibly sappy, sentimental ballad of a man and his old canine buddy, in which Elvis tried his hand at the piano for the first time on record. "How Do You Think I Feel" has an uncharacteristic Tex-Mex texture, while "So Glad You're Mine" has a honky-tonk piano intro and a bluesy vocal. Mixed in with these, and featuring the smooth vocal backup of The Jordanaires, are the soulful ballads that had female teens of the '50s weeping and screaming in the aisles.

Much of this is one-time interesting, but ultimately not Presley masterpiece material. Once again, it's your choice of configuration for Elvis' recorded history; you can be assured that this stuff will turn up again in one package or another before RCA runs out of permutations. *Paulette Weiss*

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Big Bam Boom: Daryl Hall and John Oates
RCA PCD1-5336.

Hold onto your seat when you put this high-powered CD of Daryl Hall and John Oates' *Big Bam Boom* on the box. The first distant, electronic chord that opens this disc swells up and explodes like a grenade under your butt. No buts about it, this album is accurately titled. Its brief initial cut, "Dance on Your Knees," will immediately catapult you into a state of charged excitement with its 1½ minutes of slam-bang, percussive rock 'n' roll.

Hall and Oates are a phenomenon in modern rock, the only duo of consistent, long-term popularity who just as consistently pump out high-quality, high-energy, highly listenable rock tunes. This nonstop dance-athon is one of their most solid albums in years, and as modern as a microchip. The boys from Philly have managed to save their soul while updating for the modern age with captivating electronic tricks and whooshing tape segments. Besides the '80s electronics, the duo has come up with an arsenal of popping percussive techniques from the streets, techniques that slam *Big Bam Boom* into pulsing life for its full 40½ minutes of playing time.

The original analog version of this 1984 album translates well to Compact Disc. The impact of the disc's aforementioned opening chord, for instance, is unquestionably intensified by its emergence from absolute silence. The wonderfully jerky, clean percussion on "Method of Modern Love" comes across crisp and solid. Equally clear is the sound of percussion being swallowed into silence on "Bank on Your Love," an effect that may have been achieved by running this taped segment backwards. The blessed transparency of this CD allows the multiple layers of these fast-moving arrangements to be heard without collisions of sound. "Some Things Are Better Left Unsaid," for example, is filled with shifting, layered electronics and almost subliminal vocal echoes. Without the clarity of digital recording, this cut's thrilling sense of movement across aural space as well as its nearly buried details might well have been totally lost.

Spatial presencing is exquisite; individual voices and instruments can be pinpointed in space through multi-layered aural planes and accurate left-right channel manipulation. For instance, subtle as it is, Hall's one-time utterance of "All American Girl," in the introduction to the song of the same name, is clearly discernible in the far-distant background of both left and right channels.

The dynamic range of this disc is remarkable. Hall and Oates, under the guidance of producer/mix consultant Arthur Baker, play with juxtaposing the very faintest of musical accents against some of the biggest bam booms of rock you've ever heard on record. There is no distortion apparent anywhere.

"Out of Touch" and "Method of Modern Love" rocketed the analog album to the top of the charts as 1984 flipped over into 1985. Confirmed rock fans with a penchant for clean CD sound will want this little disc exploding out of their speakers *immediately*.

Paulette Weiss

The Best of Me: David Foster
Mobile Fidelity Sound Lab MFCD 810.

Grammy award-winning producer/composer/arranger David Foster was little known to the general public until this year's televised award ceremonies. He's one of those faceless artists whose songs have become famous from the lips of highly visible performers, including Al Jarreau, Chicago and the once-ubiquitous Boz Scaggs.

This little compendium of Foster's own arrangements of his best work is a dreamy, romantic 41+ minutes of sophisticated, easy-listening music. Foster plays nearly all of the instruments on this mostly instrumental album, with the support of splendid synthesizer work which creates the illusion of massed violins, horns, and further lush orchestration. Synth programmers Steve Porcaro and Amin Bhatia, and Fairlight computer wiz Nick Camas, deserve to stand up and take a bow.

The sound is first-rate. This is another Mobile Fidelity digitalized Original Master Recording, which means the original analog master tape was cleaned up and then digitally encoded for the CD format. Texture, presence, and dynamic range are all excellent, although this recording does lack that exquisite, crystalline quality present on many lushly orchestrated productions which have been digitally encoded at the outset.

As for the music, these are simple but beautiful melodies which manage to create an aura of romantic intimacy despite their potentially overwhelming synth-orchestral presentation. This is dinner-by-candlelight music, swooning-into-each-other's-arms music. And if you can't afford to hire your own string quartet to accompany a romantic interlude the way Gary Cooper did for Audrey Hepburn in the movie *Love in the Afternoon*, this vibrant, sweet CD will do very nicely.

Paulette Weiss

EDWARD TATNALL CANBY

PRESERVATION HAUL

The Chopin Collection, Mazurkas. Artur Rubinstein, piano.
RCA ARL3 5171, three-record set, digitally remastered, $29.98.

What a splendid reconstituting of past recordings that must be brought up to date whenever possible, just as we reissue new editions of Shakespeare to modernize the basic message! It seems to me, in spite of the familiar, tricolor digital logo, that the importance of the digital element here is more for the future than for present sales markets. The updating is, as always, ingenious and to the point; the product is merely copied onto a digital recorder instead of an analog machine, thereby pinning down the state-of-the-RCA-art sonics in a form that can exist and be copied without further additions or losses. Excellent idea. And useful, one hopes, far into the future, until the digital message itself collapses—but then there will (hopefully) be more copies, intact and as good as the original. Thus we can achieve permanent masters, as nearly as human ingenuity and sense for history can dictate.

In earlier years, I disliked Rubinstein as a powerhouse player whose recordings banged and whammed. Too loud! Too flamboyant! Now I have come around the whole way—it was my fault as well as that of my equipment. I did not perceive the subtleties of Rubinstein's extraordinary playing, and I did not like the blastings and buzzings of his piano on my early phono gear. In his last years, to the age of 90, the pianist was gentler and more thoughtful in his playing, but a better performer than he had ever been.

This volume of reissued Rubinstein was made in early stereo at the end of 1965, on 30-ips tape with three channels, the prevailing method at the time. It therefore documents the final years of the powerhouse Rubinstein, still youthful regardless of actual age. But what I can now musically hear is the extraordinary legacy of 19th-century piano style that is still alive in these performances—as few of today's pianists can understand, let alone achieve again. This is the way Chopin sounded at the end of the last century, not far removed and by direct tradition from the composer, even if by then the music was louder and more public. Those marvelous irregularities, the elaborate hesitations (rubato), the minutely detailed phrasings and shapings of every note, are out of history—and into the digital domain.

The updating procedure here is simple. The original three-track, 30-ips tapes are played on a new, solid-state analog machine with brand-new heads. A part of the ultimate quality is in the tapes; as much more is in the reproduction. So the result is a very positive improvement; this time there is no compression, minimum tonal adjustments (if any), and the middle channel is reduced for a more modern stereo. Then, for LPs, the most carefully done cuttings are rushed to plating within an hour, to avoid that bête noire of piano recording, groove echo. (Print-through could be minimal due to precautions in the 30-ips tape-recording process.) Yes, I heard a few very faint too-early beginnings, but only a minimum. Good job.

The outcome of all this is a newly splendid set of recordings, the sharp, vital piano transients undoubtedly improved by the better reading of the original signal. And these better sounds are caught and trapped by the receiving digital recorder for a new permanence—further readings of the originals probably would involve diminishing returns and perhaps even deterioration, but the digital signal is virtually immortal, if we copy it accurately when needed.

Six sides of mazurkas, all moderately slow and moody in triple time, is a lot, but Rubinstein makes those six sides unfailingly interesting. There's more and will be more—for instance, the Nocturnes and Waltzes in ARC1 5018, also three LPs using the same digital technique.

Les Echos de Bellefonds. French traditional hunting horns.
Erato ERA 9273 (RCA import), $10.98.

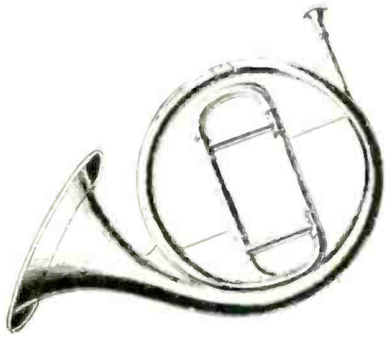
If you like startling sonics, you had better jump for this one. A sound of brass instruments such as you cannot imagine.

Every so often we hear some cute little "hunting horn" bit in the middle of a classic piece, more often than not German or Austrian, supposedly used by the ancient folk and/or aristocracy, nicely adapted to symphonic use by such as Haydn, Mozart, Brahms and even Richard Strauss. Always, they are played on modern French horns, complete with the elaborate valve system that allows any old tone to be played in precise, tempered pitch. All the more astonishing to hear what a *real* hunting horn sounds like, and the strange, obviously traditional ways in which it is played.

The French take ritual hunting even more seriously than the British with their hounds and red coats. In France, of course, they use a different color coat—I've seen them in blue on their horses, with helmets that look WW II vintage, dashing through the French woods in frantic groups and alone, trailed by quantities of hounds—just as in England, only more so. My hunters had a master of the hounds and one little trumpet, used to call everyone together. But there are grander and more ancient traditions in this royal sport, with real horns that spiral around the body above the horse; they have huge, double metal circles and a bell as big as any in the symphony orchestra—and no valves. It's done with the lips, and the breath, if you have any.

As you might guess, there are now contests for hunting-horn blowing in the ancient manner. Every one of the 11 Herculean players on this disc has been Champion of France one or more times.

So you put on the record. Out comes a blast like a dozen diesel locomotive horns all at once. Wow! Raucous, out of tune, strangled and blatty, a raw, wonderfully harsh sound that reminds me of the bellow of an agonized bull, a high, shattering squeal, or—I search for some equivalent sound—the wild screech and yelp of auto tires just before a crash. You see what I mean. Sonic power in all its nonelectronic



The Viennese atmosphere is the best thing about the "Bourgeois Gentilhomme"; the sugary sound is the worst thing about it.

majesty. When a group of these incredible sound-makers begin together, their impact is overpowering.

As you play on, you begin to realize that these uncouth sounds are ritual, carefully and exactly produced. The first notes are forced out, raucously toneless until they settle down. The tones stop with a curious yelp or hiccup—I thought these were dogs, but no. And in between, there is a vibrato so extreme that for a moment I thought the French tape recorder must have had an oval drive wheel. This sounds like a preposterous saxophone, not any horn you have ever heard!

The "music" here is all fanfare, dozens of little pieces all sounding very much alike. There are two levels of sound, moderate and *loud*; each phrase ends with a fade down to nothing, followed by a ritualistic silence—as though awaiting an answer from some other group miles away. (That's undoubtedly the practical origin.) It is indeed very formal, rigidly traditional in the best French manner.

The last word is in the tuning. It is "natural," the raw overtone series, and no attempt is made to adjust to sensitive modern tastes. Almost everything is grossly, blatantly out of tune—actually very much *in* tune according to nature. Particularly the 11th overtone, just halfway between two notes of the normal modern scale, but also the thirds and sixths. All in all, the weirdest sound you'll ever hear.

Eduardo Mata

Richard Strauss: Bourgeois Gentilhomme Suite, Op. 60; Dag Wirén: Serenade for Strings, Op. 111. The National Arts Centre Orchestra of Canada, Eduardo Mata.
RCA HRC1 5362, digital, $12.98.

Richard Strauss lived on endlessly, beyond his time. His vast, often bombastic early works (some were used in the film *2001: A Space Odyssey*) and his contemplative, very late pieces (roughly after 1930) are beyond controversy—you either hate the one or the other. The in-between music, a quarter-century of it, is exasperating, an outrageous mixture of good and bad, sublimity and banality, and few listeners ever agree as to which is which.

The music of C. P. E. Bach and J. G. Meuthel may be introspective and highly ornamented, but it is not unintelligible.

That's where this mostly genial and often sugary music fits in, from 1912 to 1916. It comes from the opera after *Der Rosenkavalier*. "Bourgeois gentilhomme" combines, in an unlikely way, the Molière comedy of manners (the nouveau-riche anti-hero trying to be a gentleman) with the ancient Greek legend of Ariadne (who was ditched by her lover, Theseus, on the island of Naxos). The mixture didn't jell and this suite was detached, with new music added, economically, to fill it out as a concert piece.

The somewhat Viennese atmosphere (not French in the slightest!) is the best part of it. The sugary sound is the worst, unless you know the French music which Strauss benignly thinks he is imitating, in the fashion of old Fritz Kreisler, who palmed off "ancient" music by various composers that he composed himself. In the middle of this grossly un-French mix you will hear unlikely quotes from—guess who? Somehow, when Strauss quotes himself (bits of "Don Juan," "Till Eulenspiegel," and "Don Quixote") he is infuriating—unless, of course, you are charmed.

The very sympathetic playing by this Canadian orchestra is recorded in digital by the same RCA team that has done such a good job on the recent RCA Prokofiev releases.

And the Dag Wirén? An amiable "Serenade for Strings" as a filler.

Keyboard Music in the *Empfindsamer* Style. Music of C. P. E. Bach and J. G. Meuthel. Preethi de Silva, harpsichord and fortepiano.
Titanic Ti-123, $10.

As long as Titanic and other small labels can turn out LPs with a quality in some ways superior to those of the biggest outfits, I think we should take notice on purely audio terms, even though the musical contents may be exotic, as here (though by no means unlistenable).

Played directly after several big-label, digital LPs, for instance, this record was noticeably quieter and better behaved in the vinyl. No thumps, no low rumble, no revolving noise. Not a single tick on a whole LP side. Nothing more than a very low and absolutely rhythmless continuum of pinkish noise (less harsh and hissy than white), scarcely noticeable at all until it stops. That's an A+ for the LP surface. The harpsichord on side one, and the fortepiano on side two, are very cleanly recorded, if rather closely.


Preethi de Silva

This present small-label quality (it didn't used to be that way) is an artifact of present economics and production. Many hands, many responsibilities, make quality-control difficult, whereas few hands and direct involvement make for optimum product. The clincher, of course, is the wide availability of absolutely first-rate audio equipment and, indeed, the entire record-producing array, at a cost which a small label can afford. There are always people who will take advantage of the best—when it is there.

The music is in a special, very personal manner that was briefly important in the period just between big Baroque—Bach, Vivaldi, et al.—and the times of Mozart. It is introspective, elaborately ornamented, but not unintelligible. The Meuthel "Variations," two sets for fortepiano, are not unlike the earlier J. S. Bach "Goldberg Variations," on a much smaller scale. By the way, C. P. E. (Carl Philipp Emanuel) Bach is the middle Bach son. He lived through all but three years of Mozart's own short life.

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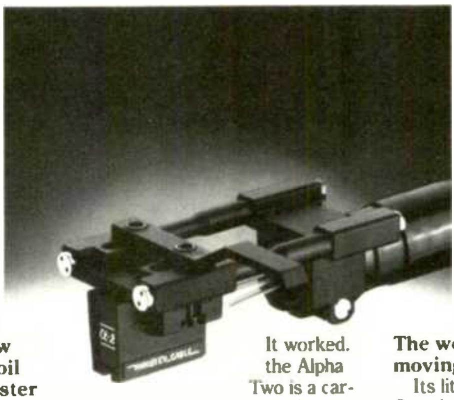

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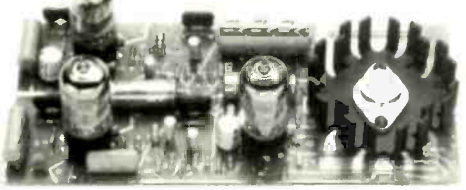

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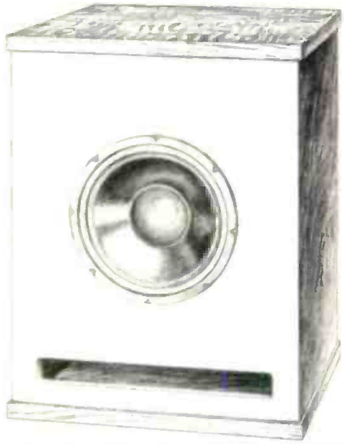

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