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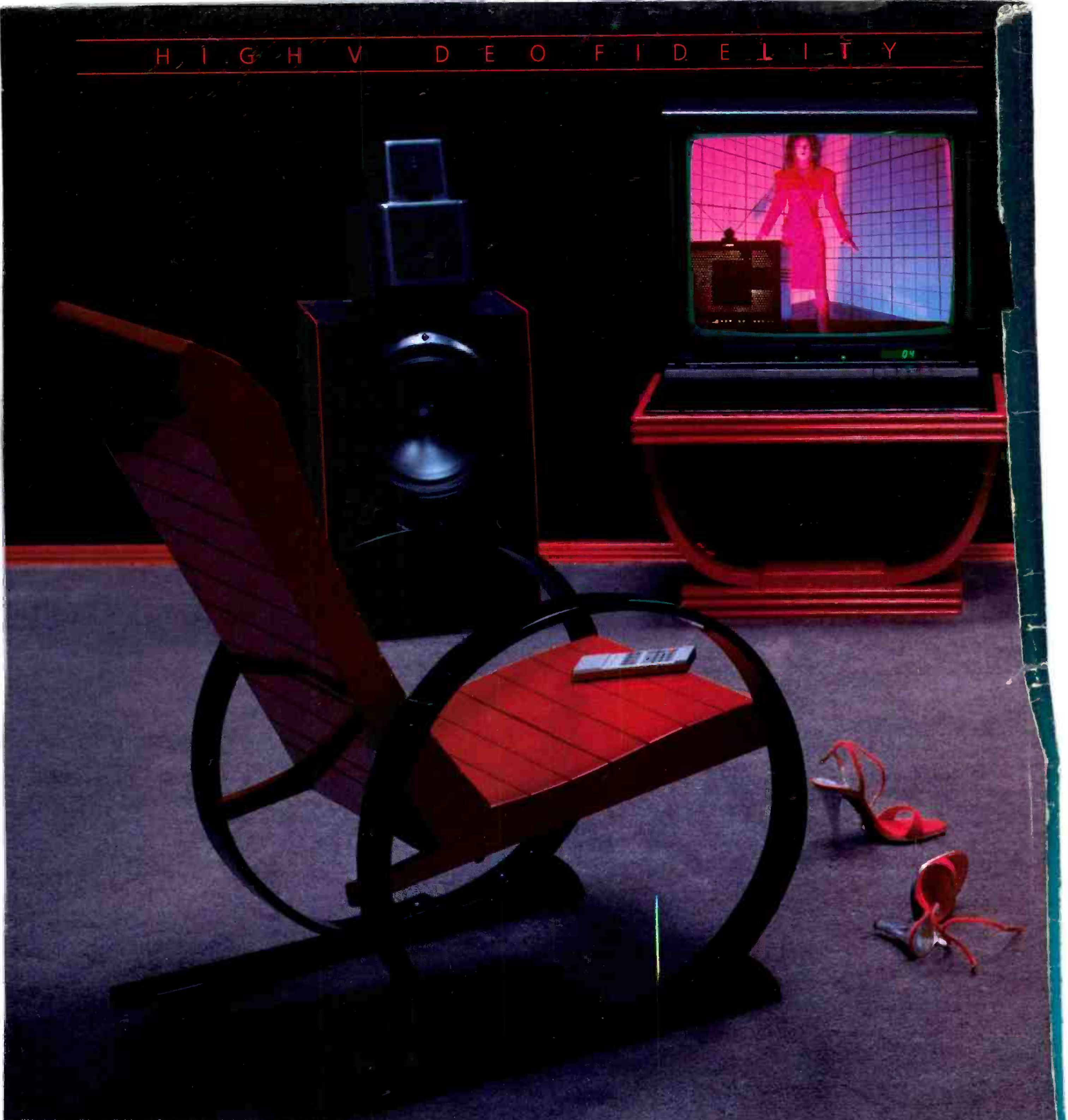


"Flashdance" is available on Stereo Beta Hi-Fi Videocassettes from Paramount Home Video for $39.95. © Paramount Pictures Corporation.

The NEC VC-739E with Beta Hi-Fi sound. A technological breakthrough in video recording and playback whereby the video heads record both the audio and video information. Compared to conventional VCR's which use stationary audio heads, the VC-739E offers 30 times greater dynamic range. In fact, the audio specifications of the VC-739E exceed even those of a studio open-reel tape recorder!

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# THE NEC VC-739E BETA HI-FI VCR. THE VCR WITH THE PICTURE THAT SOUNDS AS GOOD AS IT LOOKS.

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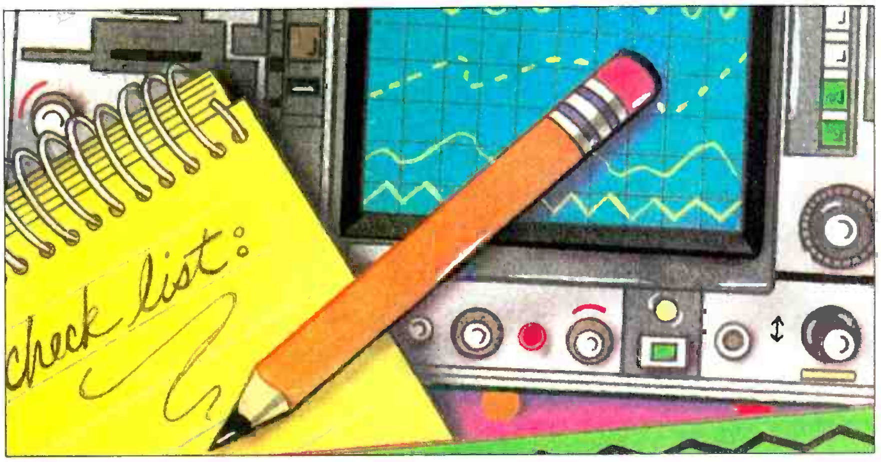
# Audio

MARCH 1984 VOL. 68, NO. 3

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## FEATURES



## EQUIPMENT PROFILES



## MUSIC REVIEWS



## DEPARTMENTS



The Cover Equipment: Harman/Kardon CD491 cassette deck.
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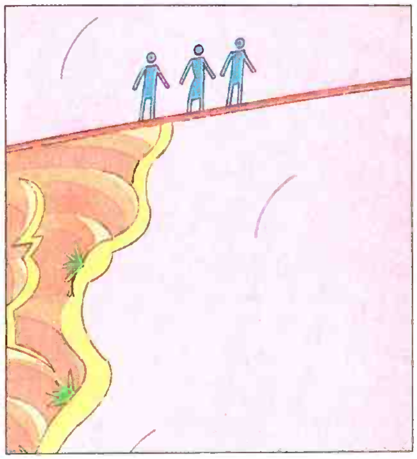

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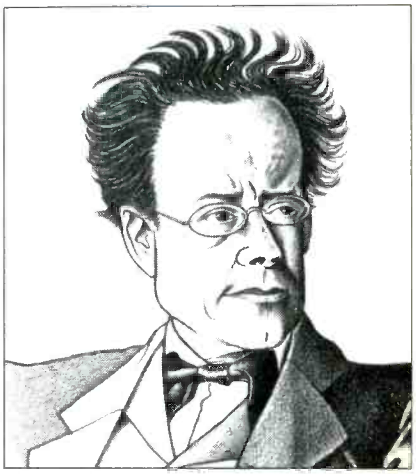

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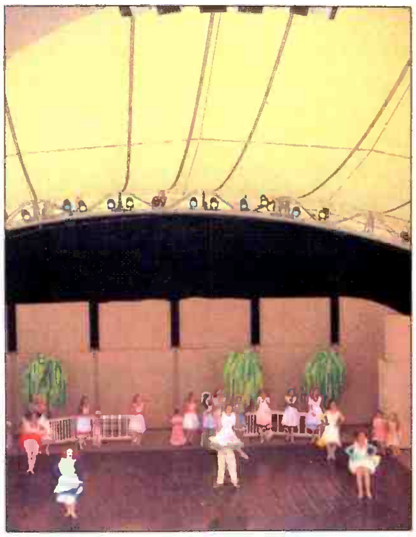

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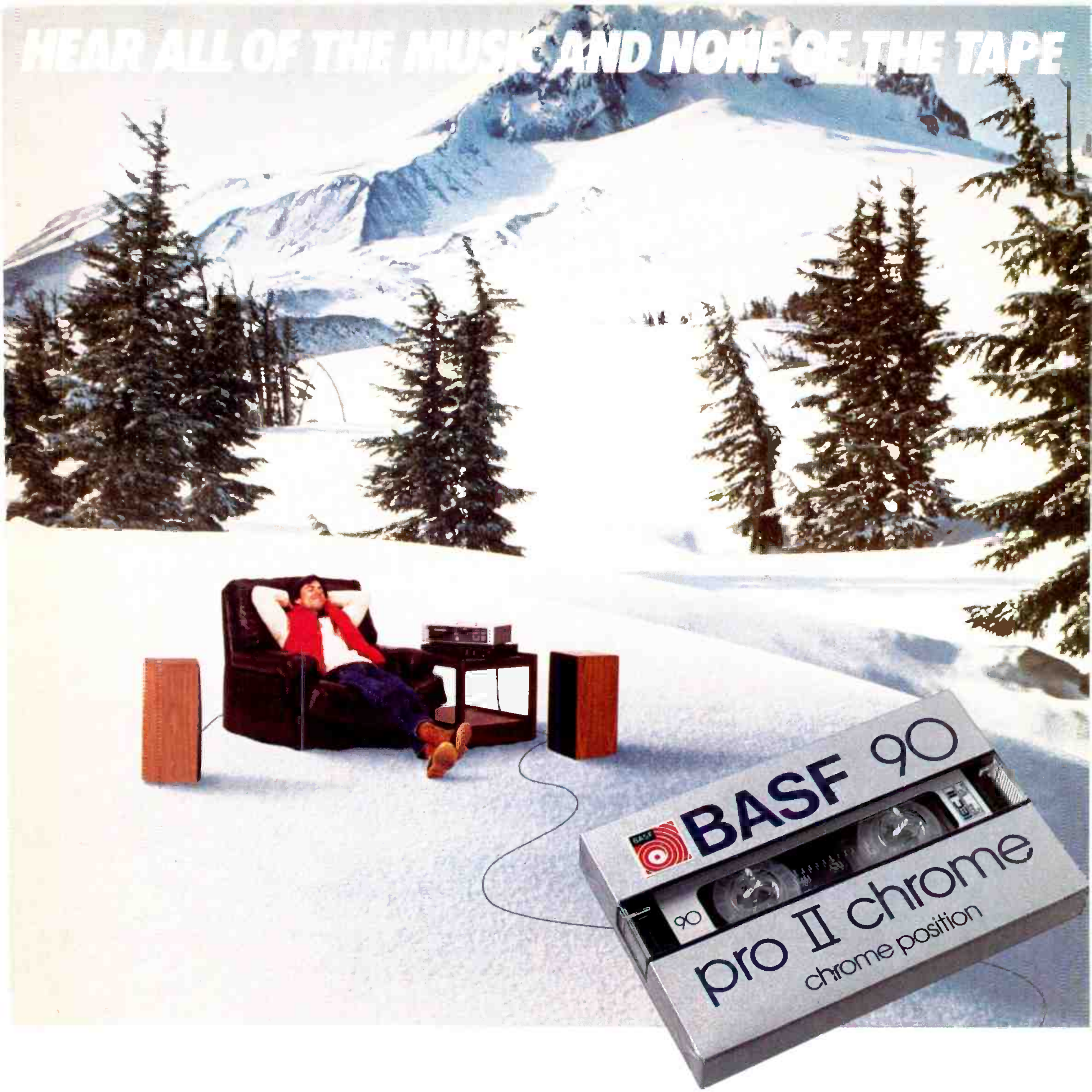


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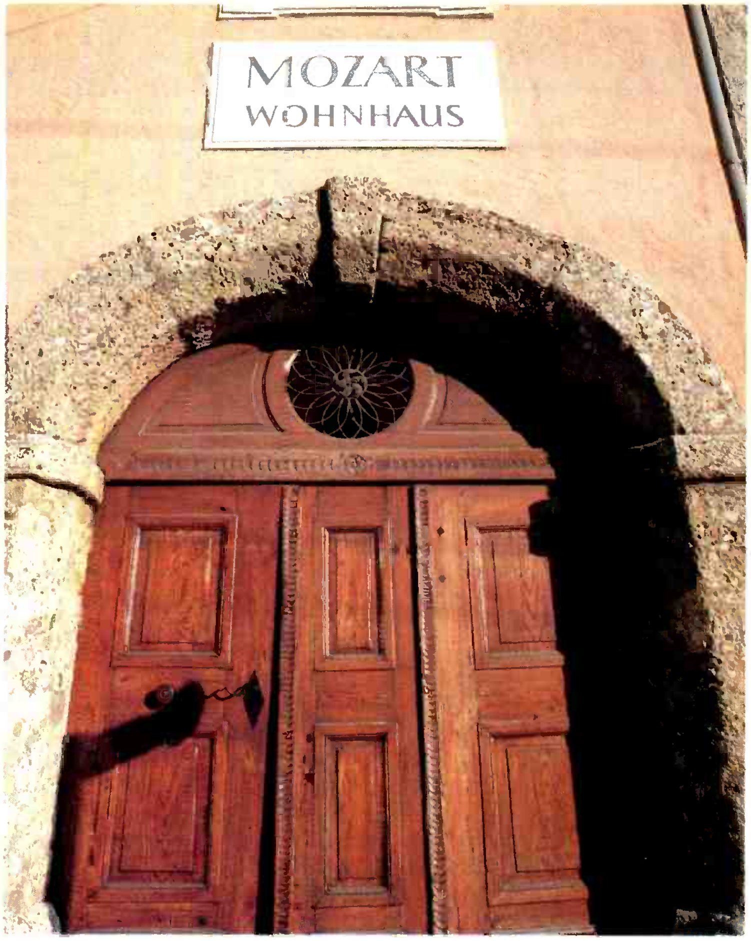
# It took a touch of genius to fill this house with music.




As you might expect, the curators of Mozart's residence in Salzburg, Austria, attach considerable importance to the quality of music reproduction in the museum. Their overriding concern is the faithful re-creation of Mozart's works.

They chose JBL loudspeakers.

JBL engineers share the concerns of the curators. JBL loudspeakers deliver not only the notes but the spirit of great musical performances. From wax cylinders to the latest digital and advanced analog recordings, JBL loudspeakers will help you appreciate musical genius.

For a demonstration, visit the audio specialists at your nearest JBL dealer. Or the Mozart museum in Salzburg.

JBL

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JBL/harman international

**CD Hooray**

Dear Editor:

It is hardly surprising that Messrs. Sax and Mayorga ("The Audio Interview," Jan. 1984) find a 30-ips, half-inch studio master analog tape slightly better than a Compact Disc! But when, after 30 years of trying, will analog technology be able to provide a pressing containing anything close to the exact content of those tapes, much less a cartridge which could track such a pressing?

The Compact Disc may not be quite as good as a studio analog tape, but it gives the consumer an affordable medium for reproduction capable of consistent superiority to anything ever before put into a groove, cassette, or reel.

So please ask the purists to stop telling us what's wrong with the CD and to let us enjoy what's right. When they develop a 30-ips tape player for under $1,000 and exact copies of their tapes for $19.95, I'll buy them. And when they make the perfect pressing, I may still have a turntable to play it.

Leon Vick
West Hollywood, Cal.

**What's Up, *Audio*?**

Dear Editor:

I am concerned with the direction *Audio* seems to be taking; too many nontechnical articles are appearing. I specifically question the need for mini reviews of one-brand systems. Are they appropriate for *Audio*? Does the answer depend on the nature of the readers you are trying to attract and/or hold? I prefer to see *Audio* lean more toward the serious audiophile and not the beginner.

Memorable technical articles seem to be a thing of the past, and I would like to see more loudspeaker reviews by Dick Heyser.

Finally, why has *Audio* gotten thinner over the past few years?

Karl Hartman
Kingston, R. I.

*Editor's Note*: The technical heritage of *Audio* is not being abandoned to pander to the beginner, and we are not jettisoning articles of technical merit. The one-brand reviews are of interest to many of our readers, and if you will note, we do include technical data on each system.

More reviews by Dick Heyser would be nice, but there is a limit to how many such in-depth tests he can do. We have a partial solution in the works to provide more speaker reviews. As for being thinner, editorial pages have remained fairly constant; only the total number of ad pages has decreased.—*E.P.*

**SOTA Revisited**

Dear Editor:

How refreshing to see our efforts so nicely justified with such a detailed and comprehensive technical report of the SOTA Sapphire turntable ("Equipment Profile," June 1983). We are gratified by a couple of measurements, some of which hitherto modesty had not permitted us to claim: The figures on speed stability, flutter (0.03%, DIN weighted), rumble (−84.5 dB, weighted), and −34 dB "breakthrough" attenuation in a 100-dB SPL field.

We wish to make these brief points. One, we do believe that specifications are meaningful, because many do correlate with sound quality directly. Isolation and damping, plus stability and integrity of setup and placement, are *always* factors in sound reproduction, even if perhaps we cannot now measure all the variables. Similarly, "high definition" and "clarity" are not magical effects, but directly reflect engineering decisions open to logical, scientific and public validation.

Second, a small correction: Our "base, from which the subchassis is suspended" has not "twice" the mass of the subchassis and platter. The non-moving subchassis, at 22 lbs., has about twice the mass of the moving platter, at 11 lbs. The weight of the "base" or cabinet, somewhat less than the platter, is not the critical factor in defining the SOTA's "excellent stability" since it mass-couples to the environment, thus providing the necessary inertia.

Finally, a larger issue of general interest. Ed Long's discussion about the very slight resonances in the record disc, from 880 to 1,350 Hz, supports our findings regarding spurious energy when using a "passive" disc clamp (simple pressure at the spindle clamp). There are limits to how well this approach will minimize vinyl resonances. An "active" system, such as a vacuum hold-down, with continuous yet adjustable low-level suction on the entire surface of the record, provides the most effective way now available to damp resonances, no matter the nature or condition of the record. A good "active" system will always be superior to even the best "passive" disc clamps, where unequal pressure and bowing are impossible to avoid. We're pleased to have our judgment confirmed by Ed Long's finding that the SOTA Sapphire was superior to his reference turntable, which uses a "semi-active" clamp system.

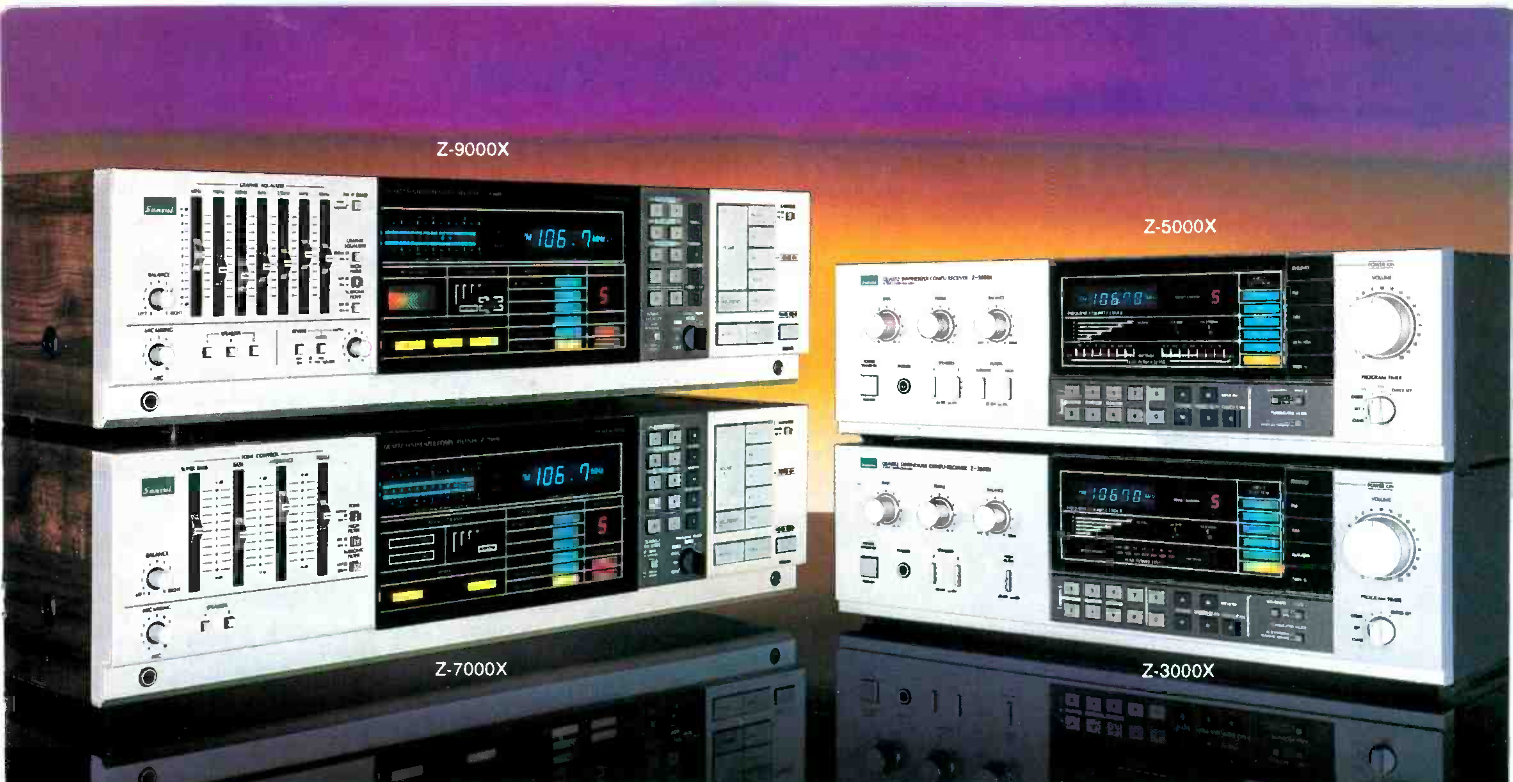
We appreciate Ed's support and salute his thoroughness. We also thank *Audio* for its coverage of emerging American companies. In the face of an awesome media blitz for the "new technology on the block," here is a report which captures the undeniable merits of a known system that, we feel, is as yet unsurpassed in the reproduction of recorded music.

Robert S. Becker
President, SOTA Industries
Berkeley, Cal.

*Editor's Note:* Thank you for the nice words concerning Ed Long's review, and please accept our apologies for our confused description of the relative weights of the base and platter. From my point of view, it is somewhat disconcerting, now that we are finally beginning to find some ways to measure "definition" and "clarity," to find that there is, indeed, a "new technology on the block," which requires development of new analysis techniques and new critical listening habits. "Unsurpassed"? Well, at least in numbers of releases, CD lags behind the LP, which will continue to give me much pleasure for many years.—*E.P.*

**Addendum: Boston MC-1vdH Cartridge**

A few of the very early Boston Acoustics MC-1vdH phono cartridges (see "Equipment Profile," Feb. 1984) had their rubber dust shield loosen up and hang down from the cartridge, thus rubbing the record surface. You should not attempt to stuff the rubber sheath back into the body of the phono cartridge. Simply return the defective cartridge to the manufacturer for a replacement.—*B. V. Pisha*

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Unlike most high fidelity companies, Sansui doesn't reserve its most advanced technology exclusively for the top-of-the-line model.

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Similarly, all models incorporate a high degree of automation, thanks to microprocessor control. One-touch Simul Switching simultaneously turns on the power and one input—turntable, tape deck or AM, FM broadcast. The microprocessor also controls the Quartz-PLL digital synthesized tuning that presets 8 FM and 8 AM stations. The drift-free tuning, whether auto scan or manual, is so precise that in congested areas even the weakest station sounds as if it's just around the corner. There's also a programmable digital quartz timer/clock with three daily independent memory functions. You can awaken to FM; fall asleep to cassette music; and arrive home to hear your favorite record.

The top-of-the-line Z-9000X makes listening even more pleasurable with a 7-band graphic equalizer, a built-in reverb amp, preset volume control, plus preamps for MC and MM cartridges.

**More music control across the board**

Combine all this with power handling capability ranging from 130 to 55 watts, and you can appreciate why no other collection of receivers gives you so much control over your music.

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**Watts per channel**

Minimum RMS, 20-20KHz, both channels driven into 8 ohms, at rated Total Harmonic Distortion.

| | | |
|---|---|---|
| Z-9000X | 130 w. | .005% |
| Z-7000X | 100 w. | .005% |
| Z-5000X | 70 w. | .007% |
| Z-3000X | 55 w. | .008% |

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The new 500 CROLYN® High Grade cassette will exceed even *your* high standards. We engineered it for you, the audiophile. We want to hear from you. We challenge you to compare it with the likes of XL-IIS and SA-X. Hear the difference genuine chromium dioxide tape makes versus cobalt-iron oxide imitations or other "chrome equivalent" tapes. Also, ask about 1100 Metal HG and Tri-Oxide Ferro HG.

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Only the people who invented the compact cassette (Philips, the "P" in our name), and chromium dioxide (Du Pont, the "D" in our name), could bring you a tape this great.

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| | 500 CROLYN® HG |
|---|---|
| Tape Background Noise | SUPERIOR |
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| Dynamic Range | SUPERIOR |
| Frequency Response | EQUAL |
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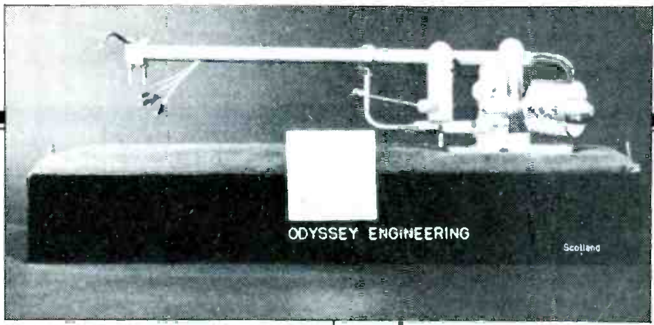
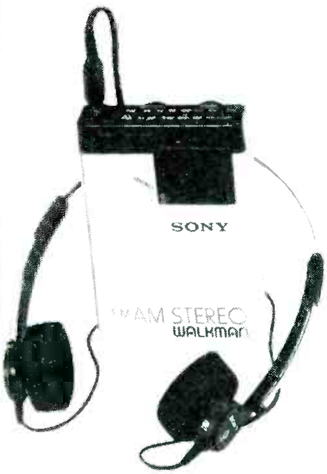


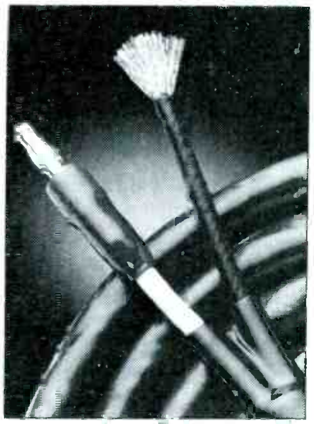

**Odyssey Tonearm**

Asymmetry is the hallmark of the Odyssey RP1-XG tonearm. The three-section counterweight and the bearings are at the level of the stylus, not the arm tube, for greater stability. In the lateral plane, the counterweight is parallel to the cartridge rather than to the arm tube, and the pivot is offset from the arm mounting post for easy overhang adjustment. The "headshell" is a minimum-mass triangle, and the arm tubes are interchangeable. The RP1-XG will fit SME mounting centers or in a 30-mm hole. A choice of three arm tubes and three counterweights accommodates cartridges with a wide range of weights and compliances. Price: $798.00.
For literature, circle No. 100




**Sony AM Stereo Walkman**

The SRF-A1 Walkman, from Sony, is the first such portable to receive AM stereo as well as FM. Decoding is semi-automatic, using a switch with one position for the Kahn/Hazeltine system and another for all three others (Harris, Magnavox and Motorola). The radio includes an LED center-tune indicator, a distant/local switch and, of course, headphones. Power shuts off when the headphones are unplugged, to conserve batteries. Price: $79.95.
For literature, circle No. 101

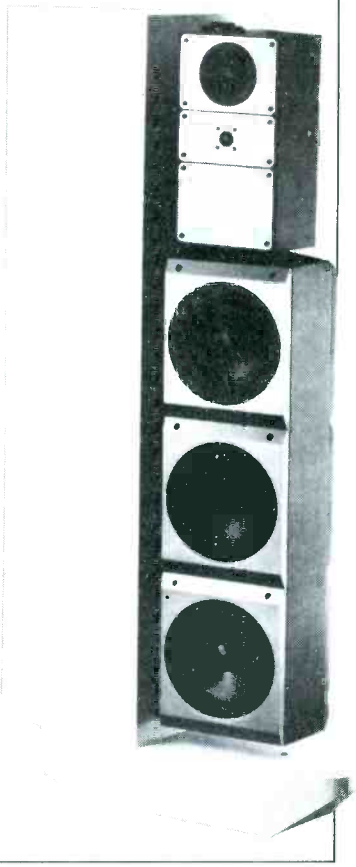


**Monster Cable Speaker Cable**

Monster Cable's Powerline speaker cable has been replaced by Powerline 2. The new cable uses a "Time Coherent" winding configuration, which Monster Cable says eliminates phase inaccuracies and equalizes the speed of low and high frequencies through the cable. Price: $2.25 per foot.
For literature, circle No. 103

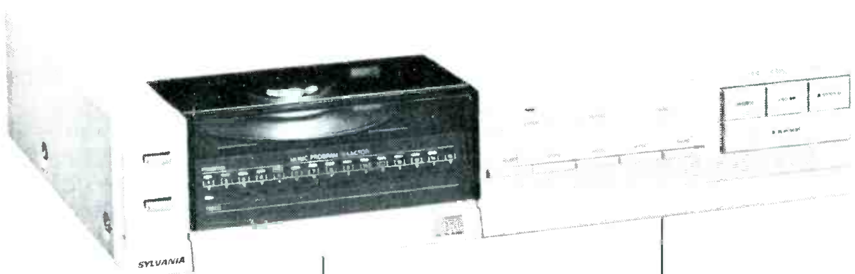
**Wharfedale Loudspeaker**

The Option 1 is a self-powered, floor-standing speaker system with dipole radiation over much of its frequency range. The system includes a subwoofer (rated 3 dB down at 25 Hz), a bass dipole system including one rear-facing and three forward-facing 8-inch woofers, a rotatable enclosure with front and rear midrange drivers plus a forward-facing tweeter, and four 150-watt power amplifiers (600 watts total) plus an electronic crossover. Price: $6,000.00 each.
For literature, circle No. 104



**Sylvania CD Player**

The first audio product from Sylvania in several years is the new FDC303SL Compact Disc player. The player features front-drawer loading and 15-selection programming, with single-button commands for repeat and next-track. Price: $949.95.
For literature, circle No. 102



# TAPE GUIDE

HERMAN BURSTEIN

## Tape Shedding and Dropouts

*Q. I am very happy with my cassette deck, but have developed a problem of my prerecorded cassettes shedding terribly. If I play one of these cassettes, lasting about 20 to 30 minutes, the head is loaded with oxide. In some cases this affects the sound quality. I religiously clean the head, pinch roller, and capstan. Could there be something wrong with the head? Also, the prerecorded cassettes exhibit dropouts and quivers. It is as though there is a dirty spot which the signal didn't magnetize. This always happens at the same places on the tape.*—Thomas Raines, Oshkosh, Wisc.

A. If your prerecorded tapes shed excessively but virgin tapes you have bought and recorded yourself don't do so, the fault must lie in the quality of the prerecorded tapes. They are often of less than top quality and therefore more susceptible to shedding. If the dropouts and quivers you describe always occur at the same places on the tape, again the tape must be at fault; these defects could be due to pronounced oxide shedding.

## Recording at Home for Car Playback

*Q. My home cassette deck has both Dolby B and C NR, while my car deck has neither. Also, the car deck has no bias selector switch. What would be the best way to go about recording tapes for playback in my car? I plan to use premium-grade normal and high-bias tapes, depending on the type of music being recorded.*—Bradley J. Anesi, Oswego, N.Y.

A. For car playback without Dolby NR, theoretically you should record your tapes without Dolby in order to obtain flattest frequency response. However, as a practical matter, you may find it more to your liking if you record with Dolby B. This will add some treble boost, which in the noisy environment of a moving car may be desirable. Dolby C will add even more treble emphasis, but probably too much. The absence of noise reduction in a car deck tends to be slightly less important than in the case of a home unit, because car noise (when the motor is on) tends to mask audio system noise.

The fact that the car deck has no provision for bias adjustment is completely unimportant so far as playback is concerned. Bias is employed only in recording.

You do not state whether your car deck provides for a choice between 120- and 70-µS playback equalization. If you record with 70-µS EQ, but your car's deck provides only 120-µS equalization (as decks without an EQ switch invariably do), the result will be a moderate treble boost in playback, over and above whatever boost results from non-Dolby playback of Dolby-encoded tapes.

## Half-Speed for Cassettes

*Q. My cassette deck operates at half-speed (15/16 ips) as well as at normal speed. Using metal tape, I have been impressed with the results. I wonder why more companies haven't come up with half-speed decks.*—James E. Shields, Chicago, Ill.

A. To achieve *high fidelity* at 15/16 ips is far from easy, and cassette decks today (except for the very cheapest, selling below $100 or so) do aim at a high level of performance. The problems include maintaining high-frequency response, which requires an extremely narrow gap in the playback head and virtually perfect azimuth alignment; risk of saturation at high frequencies because of the large amount of treble boost needed in recording at 15/16 ips, and keeping wow and flutter suitably low. While these problems can be surmounted, it is costly to do so. Hence, cassette-deck manufacturers, as things now stand, have virtually given up on half-speed. On the other hand, a revival of interest in half-speed is possible, along with an improved ability to satisfy this interest owing to constantly advancing tape technology.

## Record Level Technique

*Q. There have been many suggestions made to me regarding the best cassette recording technique. These range from adjusting the record level to read 0 VU during peaks in the musical program to the technique described hereafter, which is the one I use. [In essence, this consists of taping a phono disc at successively higher levels, noting the record level reading for each, and noting in playback the highest level that comes short of audible distortion.*—H.B.] *I have run into one problem using this technique: My tapes of certain programs are not compatible with some other decks, so that distortion is heard in playback.*—John Vitucci, Melville, N.Y.

A. The technique you have adopted is one that I have recommended, namely that, for a given type of tape, you should experimentally determine how high you can record before noticeable distortion sets in. If a tape so recorded sounds okay in playback on your deck but not on some other decks, the latter apparently are at fault. Their playback heads or playback electronics (or both) are being overloaded by the high signal levels on your tapes.

## VU Meters and "VU Meters"

*Q. Why do open-reel tape decks still incorporate pseudo-VU meters rather than the new peak-reading fluorescent or LED displays?*—Patrick J. Hoepfner, Portland, Ore.

A. Some open-reel decks have *true* VU meters, which have standard specified characteristics with respect to response and decay times, frequency response, and overload. But, as you say, others have pseudo-VU characteristics that depart from standard. Some manufacturers, or at least their marketing personnel, apparently feel that a meter is more "professional-looking" than other types of indicators, and thus lends more cachet to the deck. Inasmuch as a true VU meter tends to be relatively expensive, similar but cheaper meters have sometimes been substituted.

## Dolby vs. dbx NR

*Q. What are the relative advantages and disadvantages of Dolby and dbx noise-reduction systems?*—William J. Flickinger, Barberton, Ohio

A. Dolby B tends to reduce noise about 8 to 10 dB, Dolby C about 18 to 20 dB, and dbx about 30 dB. Dolby C has a special treble boost curve in recording that serves to reduce the chance of tape saturation and treble loss; this is achieved by a drop-off in treble boost at the very high end. Dolby tends to produce less distortion than dbx at low levels, while dbx has the advantage with respect to distortion when recording high-level signals. Dolby requires adjustment of the tape deck with respect to the particular tape being used, to match the tape's sensitivity (amount of signal output for a given signal input); input and output levels must match in order to achieve good tracking, namely preservation of treble response.

**Wow!**

*Q. My cassette deck was purchased three years ago, and its performance has been satisfactory until recently, when I began to detect wow in playback. This is true for all cassettes, whether commercial prerecorded ones or my own recordings. It is very slight, and some acquaintances state that the deck sounds perfectly normal to them. However, it definitely does not sound normal to me. I have thoroughly cleaned the capstan, pinch roller, and heads, but with no improvement. I would appreciate your suggestions.*—J.R. Joslin, Key Largo, Fla.

A. Sensitivity to wow varies among individuals, which could explain why you hear something that your friends do not. I doubt that the problem lies in your cassettes, although this could easily be checked by playing them on other decks, say those of your acquaintances or at an audio store. The fault probably lies in your deck. It could be such a thing as a slipping belt or an out-of-round idler wheel. If you are mechanically adept, perhaps you can get inside your deck and have a look-see, and clean or replace the offending component. But in most cases one is best off with the services of an authorized shop or the factory.

**Crystal Ball**

*Q. Reviews of VCR machines with high-fidelity audio, such as the Sony Beta Hi-Fi, indicate audio specs which approach that of digital tape decks. Do you think that an entirely audio tape recorder which employs video techniques will ever become available? I realize that in the case of decks such as the Sony, one can use the audio portion alone without the video, but consider the number of extra tracks that would be available without the video portion.*—Carl V. Ashworth, Richmond, Va.

A. Your guess is as good as mine. I imagine that both the VCR and digital approaches to tape recording will be assiduously explored in the continuing search for high-quality recording at consumer-affordable cost. In view of the better specs obtainable with digital techniques, even though those for VCR are very good, it seems that digital will win out. With digital, frequency response is ruler flat, and distortion and noise are almost nonexistent. Further, digital enables one to dub repeatedly with no loss, or virtually so. On the other hand, there are some "golden ears" who claim to hear things in digital recordings that they don't like. This might influence the way things go.

**Muffled Sound**

*Q. I have just purchased a cassette deck and am really happy with it except for one problem. When I put in a tape to play, I get a muffled sound; it seems there is no treble. So I stop the deck, start it again, and then the music sounds normal. This happens with more than one tape, but not all the time. I would appreciate help with my problem.*—Todd Gebhardt, Exton, Pa.

A. I do not have a definite answer. Perhaps, when you first insert the tape, the azimuth alignment is incorrect; that is, the gap of the play head is not at a right angle to the long dimension of the tape, and the process of stopping and restarting the transport somehow reseats the tape and achieves correct alignment. When you insert the tape into the well, do you do so carefully and fully?

There is also the possibility that the problem lies in the electronic circuitry. There may be a poor connection in the playback circuit, which is restored when the deck is stopped and started. I'm sorry to be so indefinite, but the solution to your kind of problem usually requires a checkup of the deck in question—ordinarily by a qualified technician.

(*Editor's Note:* There is also the remote possibility that there's dirt on the heads which is being shaken loose by these manipulations. If the deck is new, as appears to be the case, that's rather unlikely, though.—*I.B.*)

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

## Reader Response: Power Amps and Speaker Impedance

*I feel that you did not do justice, and may have added confusion to, the question asked by Bob Robinson in the "Audioclinic" column in the March 1983 issue.*

*Although it is true that maximum power transfer occurs when impedances match (amplifiers and speakers rarely do), the answer would have been much easier to understand if it had been explained in terms of Ohm's Law, and its related power lines:*

$E = IR; P = I^2R = E^2R.$

*The amplifier's output impedance can be neglected because it is much lower than that of the speaker.*

*My explanation would have been along the following lines:*

*The amplifier will, at any given volume setting and program source, produce a voltage (E) across the speaker load (R), with resultant power being $P = I \times E$, where I is the current determined by $I = E/R$.*

*Reducing the speaker impedance by half, and given the same program and volume setting, the current (I) will double, and, as a result, the power delivered to the load will double.*—Albert Reichel, Kent, Wash.

*I was a bit surprised by an answer to a question about load impedance and amplifier power output which appeared in the March 1983 issue.*

*It is true that, when loads are matched to the inherent output impedance of a source, maximum power transfer occurs. But in order to achieve the high damping factors desirable for driving a loudspeaker, an amplifier's dynamic source impedance must be considerably lower than the loudspeaker's impedance, especially at bass frequencies. In this respect, a modern solid-state amplifier looks like a voltage source to the speaker. This explains why amplifier power ratings are higher for lower load impedances (which by the way, was not the case in the days of vacuum-tube amps and impedance-matching transformers).*

*It is generally true that, for solid-state amplifiers, lowering the load impedance will allow the amplifier to deliver more power. If one could do this and maintain loudspeaker efficiency, the acoustic output would therefore rise, so that a listener would turn down the volume. This would lower the power output from the amplifier to an acceptable level, and, of course, prevent burnout. Even if one does not turn down the volume, the maximum power an amplifier will deliver will be limited to the maximum signal level that it can produce under steady-state conditions. As long as one can tolerate the acoustic intensity, any well-designed amplifier will be sufficiently ventilated to deliver its rated output under steady-state conditions without burning up. That statement must hold regardless of the load impedance, because the maximum power delivered will be subject to the limitations described above.*—Edwin A. Karlow, Riverside, Cal.

## Receiving Weak AM Signals

*Q. My problem is that my receiver is weak in "pulling in" AM stations. Is there anything I can do to improve this condition so that I can hear distant stations?*—Name withheld

A. The AM sections of most receivers are little more than portable radios. If you live in a structure which has a lot of metal, this will attenuate the signals to a point where they cannot be received well, and the situation is not helped at all by the poor front-end performance of many receivers. Their performance is adequate for local signals. Weak signals can often be received by using an external antenna, consisting of little more than a piece of wire perhaps 20 feet long, insulated from the structure in which you live. Some receivers have no provisions for connecting such an antenna. Even where such provisions exist, the addition of the antenna broadens the selectivity of the front-end, which introduces images and whistles which add further problems to weak-signal reception. As a first thought, give this a try and see what happens.

The alternative is to get a communications receiver designed for weak-signal reception and which covers the broadcast band. It has good i.f. selectivity, a very important element in rejecting adjacent-channel signals.

Your only problem with receiving any given station is whether or not it is on a clear channel. You may want to experiment with some kind of directional antenna for this receiver. Try winding a loop of many turns and connecting this between the antenna terminals. Make the loop about 3 feet in diameter, and mount it well clear of surrounding objects. Provide some way of rotating the loop. This loop will be a bidirectional device and, hence, not completely satisfactory. For unidirectional applications, it will be necessary to erect a vertical antenna and phase it with the loop so the system can be calibrated in terms of compass points.

This arrangement is the basis of the direction-finding apparatus used for certain types of marine navigation. Firms which manufacture such equipment can perhaps supply the loop and vertical antenna assemblies suitable for your applications.

A communications receiver includes items which can be useful, such as a notch filter. (This filter rejects some of the odd whistles which often ruin distant-signal reception.) Further, such receivers are equipped for short-wave listening. If you have not experienced this, you may well find it interesting.

## Playing Vertically Cut Discs

*I noticed your recommendation to readers in the March 1983 issue about playing laterally and vertically cut records. I'd like to tell you about something that I stumbled into some time ago about "vertical" grooves.*

*The idea of reverse-phasing stereo cartridges presumes that the grooves are truly cut on the perpendicular, because the two outputs are converged at unity. It seems, however, that many, if not most cylinders and discs were cut on some diagonal plane. Therefore, optimal signal-to-noise ratio is not achieved on many such recordings by wiring the cartridge as you have described.*

*What I have been doing is wiring the cartridge reversed, but mixing in a different manner. I preamplify the two outputs independently but identically. I then mix them, via a two-in/one-out mixer. Either input is set to nominally correct line level. The other is then ad-*

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

FM stations must often use a limiter to compensate for the fact that more and more high-frequency content has been introduced into program material.

*justed until there is a maximum noise null. The settings are rarely at unity gain and vary from record to record.*

*This scheme also works for the short-lived "compatible" discs, such as Emersons, which ostensibly could be played on lateral or vertical reproducers. The process resulted in better S/N ratios with much less filtering required. This method was also applied to the Edison "Kinetophone" synchronous soundtrack cylinders which I have been transferring, along with their matching films, to videotape.*—Art Shifrin, Douglaston, N.Y.

### FM Pre-Emphasis

*Q. Can you tell me why FM transmission requires pre-emphasis and why reception calls for de-emphasis (75 µS in both instances)?*—Michael D. McCormick, Tampa, Fla.

A. FM could have been left strictly alone, with neither pre-emphasis during transmission nor de-emphasis during reception. The received frequency response would be flat.

The problem is that the noise present is audible mainly at high frequencies. If these frequencies are boosted during transmission and correspondingly lowered when the signal is received, the noise is reduced, at high frequencies, by the amount of de-emphasis.

The pre-emphasis used in the U.S. for non-Dolby broadcasts is 75 µS, which corresponds to a boost of about 13 dB at 10 kHz. For broadcasts using Dolby NR, a milder pre-emphasis of 25 µS is used. When played back with normal de-emphasis and without NR, this compensates for the high-frequency boost otherwise heard from undecoded Dolby signals.

The reason pre-emphasis was considered possible by those who set standards for FM broadcasting was that highs found in typical program material are low in spectral distribution. Boosting them, therefore, will not create overdeviation at high frequencies or excessively wide sidebands which could be a source of interference to adjacent-channel services. As time has passed, more and more high-frequency content has been introduced into program material. To compensate for this, it is often necessary for the station to use a high-frequency limiter to reduce the level of such frequencies, at least on peaks.

### FM Signal Dropout

*Q. About a year ago, a friend and I each purchased stereo receivers of the same make and model. Since then, we have both noticed, with the receiver set to the FM mode, that the volume of sound will suddenly decrease dramatically. This has happened on all the stations I listen to. We both live in a rural area. Would that make a difference?*—Josh Jaeger, Iowa City, Iowa

A. I wonder if the mysterious drop in volume has to do with your being located so far from the stations to which you listen that their strength is influenced by atmospheric conditions. If I am correct about this, you will experience most of these difficulties during the spring and fall, while winter is the least affected time of the year.

You did state that you experience drops in volume, but I hope this more correctly translates into loss of signal strength. Normally, of course, changes in signal strength, although creating added noise, do really cause a drop in volume level. I have no other ideas at this time, except for possible defective components in the receivers. It just seems too much of a coincidence that you both should be plagued by the same problems.

### Improved Record Playback

*Q. I read that sonic quality increases during the first few "plays" of a disc and then declines. Is this true?*—Rudi Schmid, Kensington, Cal.

A. I do not believe sonic quality improves during the first few plays of a disc except in one respect: The noise background will sometimes be reduced as a result of the polishing of the groove walls by the playback stylus. ▲


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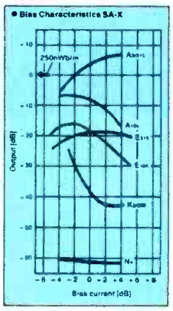


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IVAN BERGER

# SAAB STORY: CLOSING PHASE I

Phase I of our *Audio* test car setup is pretty well complete. The system has grown a bit in cost and complexity (see Table) and improved in sound enough to make me happy—but not satisfied. Sonically, the end result is excellent; philosophically, though, I wonder if it's good enough to justify the elaborate means by which it was achieved.

Five major changes have been made since the last installment (September 1983): New midrange drivers, new woofers, new center speakers, a new rear deck, and the installation (at last) of rear-deck speakers.

The new midrange drivers are ADS 206-0314s, which mellowed the formerly edgy sound and lowered the permissible crossover point between the front satellites and the rear subwoofers. (The subwoofers are now fed via an 85-Hz low-pass filter, the front satellites via a 180-Hz high-pass one; the "gap" between—actually just a dip—compensates for typical car resonances.) Both the mellowness and the lowered crossover are definite benefits. The sound is smoother, and the transition to the rear-deck woofers much harder to detect (not that it was all that obvious before).

The dual-KEF subwoofer box that took up half my Saab's trunk has been retired upstairs, to join my home system. In its place, we've mounted 10-inch woofers in the deck itself, neatly concealed behind an overall cloth cover. This solution is a lot more practical, but not as fantastic sounding as the boxed KEFs. Mainly, the problem is the vast enclosure presented by the Saab trunk (21 cubic feet), which few car woofers are designed for. At the moment, I have Alpine 6110 woofers, which Alpine freely states sound better in a smaller box. When I get some test gear (coming soon), I'll use it to compare the Alpines' response to that of a pair of 10-inch Protons which have arrived since. The Protons, too, should sound better in a smaller box, but the mismatch is less great in their case. Meanwhile, I'm still searching for 10-inch woofers made for large infinite baffles.

A second problem (since fixed) was poor sealing of the trunk. Even small air leaks can reduce a woofer's low-frequency output (unless they turn out, by lucky coincidence, to act as properly sized and sited to be reflex ports), and the closer they are to the woofer the more effect they have. The first time round, my rear deck left two gaps about 1½ × 4 inches each, plus many cracks around the deck's edges, where it meets the trunk lid, and around the edges of the fold-down rear seat. After yet another trip back to the installer, New England Radio, I got this taken care of: The deck was remade to plug the gap, and all the major cracks were filled with weather-stripping—as I had originally suggested.

There's now a beautiful console in


The new center console was chiefly built to hold the center speakers (see text). Note also the "bucket" beneath the dash at right, to hold equipment under test.

A new rear deck holds a pair of Genesis AM-165 speakers where they belong, at the front of the deck; dual 10-inch subwoofers are concealed beneath the cloth.

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Miswiring the door-speaker channels widened the stereo space pleasantly; miswiring the back helped perspective, too.

the middle of my car, housing not only the head-end and equalizer but three speakers and six switches. The speakers are, from left to right, a right-channel tweeter, a left-plus-right midrange, and a left-channel tweeter (all Audax drivers). A fader near the base of the steering wheel proportions the sound between this central system and the satellites under the ends of the dash. (I found it interesting that the midrange in this center system, which sounds fine, is the same Audax model as the ones which were replaced in the main satellites because they sounded harsh—the difference is probably in the crossover point, though it might be the enclosure.)

With the center dialed out, the sound is as it was before: Each front-seat occupant hears the speaker immediately in front of him, but hears almost nothing from the channel opposite. As you dial in some center, you begin to get a sense of stereo imaging, at last—but a very narrow image, dead ahead. I find this system is more useful when used with the ADS speakers in the doors; without the center, their image is too wide, so the narrowing effect helps here.

Putting in the center system involved an extra electronic crossover and another Philips amp, which strikes me as overkill. It also meant moving the radio down a bit, which makes its controls harder to reach (except for the volume control, which I now keep brushing accidentally, giving me a blast of sound each time). Not only that, but the new console, like the original one, faces the radio straight back down the car's center line. Even after a few months, I miss the way the previous console had been angled—slightly towards the driver for easier tape loading.

At the base of the new console are a tape compartment and six switches. The tape compartment is fairly handy, but eliminates the space where I used to keep a tiny Rubbermaid wastebasket for on-the-road trash. It also eliminates the under-console bucket we originally put in to hold radios and equalizers under test; a new bucket, angled slightly toward the driver, has therefore been built beneath the passenger-side dash.

The switches (mostly Carlingswitch Curvettes) control the inputs to the main amp system (for testing other head-ends), the supplementary amp (on/off and front-rear speaker selection), and an under-dash map light. (The sixth switch, if you're counting, is a spare for possible future use.)

The map-light switch originally operated the burglar alarm. New England Radio thought that making the switch inconspicuous would keep burglars from figuring what it was; I thought that burglars would hit every unmarked switch in sight, in hopes that one would turn the alarm off. So the alarm switch has been moved out of sight. Unfortunately, though, the alarm system stopped working almost at once—I don't know whether it's the alarm or the installation. Every time I get it fixed, it works fine at first, but then its exit delay time shortens to zero during the next 24 hours.

The rear-deck speakers now in place are Genesis AM-165s. They were originally placed at the extreme back edge of the rear deck, a position I'd not seen used before. I kept asking the installer if that would have any effect on the sound, and they kept ignoring the question. When I got into the car, however, I could tell it did: The Genesis speakers, normally quite musical, sounded honky and nasal, as if they were buried in a horn, as, in fact, they were. My suspicions about this were confirmed by talks with Mike Burk of AFS Kriket (who gave me invaluable advice throughout this project) and Roy Allison of Allison Acoustics (a leading authority on room-interaction effects). As further confirmation, I found the speakers sounded musical again as soon as I opened the rear hatch. So, in the new deck panel,

## System Contents

| | |
|---|---|
| **Source** | |
| Alpine 7347 FM/AM/cassette receiver | $ 599.95 |
| **Main System** | |
| AudioMobile SP-300 three-band equalizer-preamp | 309.95 |
| AudioMobile CX-E2 active stereo crossover networks (two, at $244.95) | 489.90 |
| Rockford Power VI four-channel power amp with crossover (two channels bridged to mono) | 680.00 |
| Rockford Power II stereo power amp | 425.00 |
| Philips EN-220 stereo power amp (two, at $199.95) | 399.90 |
| Audax HD-100-D25 tweeters (two, in satellites, at $17.00) | 34.00 |
| ADS 206-0314 replacement midrange drivers (two, in satellites, at $42.00) | 84.00 |
| Audax HD-9.8-D25 tweeters (two, in center console, at $17.00) | 34.00 |
| Audax MHD-10P-25-FSC midrange (in center console) | 26.00 |
| Alpine 6110, 10-in. subwoofers (two, at $60.00) | 120.00 |
| **Equipment Cost** | 3,202.70 |
| ***Labor (Design and Construction)** | 750.00 |
| **Subtotal** | $3,952.70 |
| **Subsidiary System** | |
| ADS 320i, two-way separates, stereo pair | 379.00 |
| Genesis AM-165, two-way plates, stereo pair | 240.00 |
| Alpine 3502 stereo power amp | 349.50 |
| **Equipment Cost** | 968.50 |
| ***Labor (Design and Construction)** | 250.00 |
| **Subtotal** | $1,218.50 |
| **Total** | $5,171.20 |

*Labor estimates do not cover time spent in changing and experimenting, but represent what such a system would cost to install from scratch.

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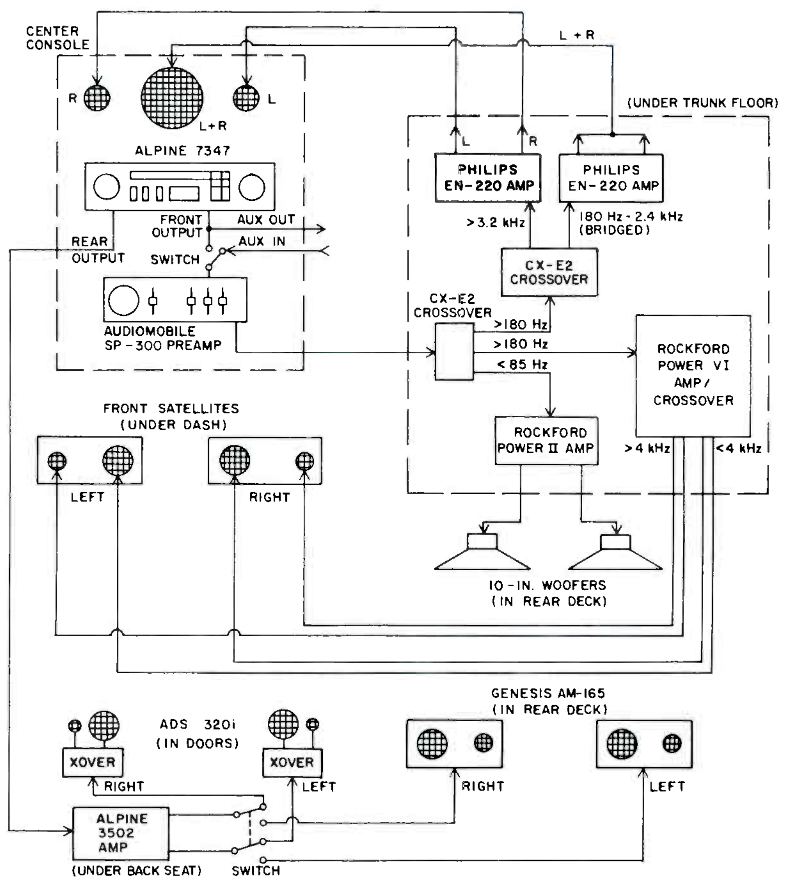
**The system has a lot of flexibility, and I use it all. Passengers are a bit bewildered, at first, by the way the sound can shift.**




*More elaborate than most home systems, the one in our project car incorporates extra speakers, inputs, outputs and switching for test purposes, plus a center speaker system to help deal with acoustic problems common in cars.*

they're mounted near the front, and sound much better that way—though still not as good as they sound in other situations. (I'd recommend them very highly for situations where they'd radiate directly at the listener, but less warmly for the tricky acoustics of a rear deck.) At this go-round, New England also put a quick-disconnect plug on the wires to the rear-deck woofers and full-range speakers, so I can easily remove the deck when carrying big trunk loads.

The Alpine amp had originally been miswired, feeding left-channel sound to the right-door speaker, and vice versa. Fortunately, using the door speakers with the under-dash satellites, this "error" pleasantly widens the stereo space. The sound from the rear-deck speakers is also improved by this mistake, adding a touch of stereo fullness to the sound from the back. This is because each passenger is sitting within a front-back stereo pair—in my case, front-left and rear-right. Against their judgment, I was able to get New England Radio to leave that "mistake" alone.

While the idea of mischanneling the door speakers was the result of a happy accident, the idea of crossfiring the rear ones came from several sources—chiefly, an article by Dan Shanefield ("Four-Channel—What Do You Really Hear?" *Audio*, November 1975) and a letter from him pointing out that some GM factory systems do this, too. I have not had the chance to try his other suggestion in the same article, of aiming the rear speakers at the opposite walls, since my rear speakers fire straight up.

This system gives me a lot of flexibility, and I use it all. Passengers are a bit bewildered, at first, by the way the sound source shifts as I readjust the pots and switches, but they do like the results. The best frequency response comes with the main system, which I use most of the time. For large-hall concert music, I usually turn the back speakers on, faintly, to add distant ambience; for jazz, folk and such, I use the door speakers instead of the rears, to add ambience of a more intimate kind. For rock, where all bets at realism are off, anyway, I sometimes listen only to the door speakers; for country, I tend to listen mainly to the doors, but dial in some center fill (which also brings the subwoofers into play). For chamber, I tend to listen to the main front satellites alone. And I make exceptions in all these cases, based on the particular recording.

There has to be a better way. I'm sure the system can sound good when bi- instead of triamplified. I strongly suspect that front-satellite speakers can be made to give me good stereo perspective without the complexity or narrowing effect of the center speakers. (That would also give me a better place to stick the head-end and its controls.) I wonder whether monophonic subwoofer amplification, or even a single subwoofer, would sound as good as my current stereo setup and, if not, how much difference would be audible. These modifications would cut me down from nine channels of main-system amplification to four, which would let me cut out three amplifiers and one crossover ($1,070 to be saved there) and some drivers (savings of $135), plus the labor cost of installing them.

Even with these modifications, the system would hardly be a cheap one. But the means used would be far more in line with the results—which, I acknowledge, are darn good. So Phase II will be one of devolution. But that's a few months off, as yet. Meanwhile, we begin using our project car for its original purpose—as a test bed for in-car audio equipment. ◢

# AUDIOPHILE FILE™ XL-S

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

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

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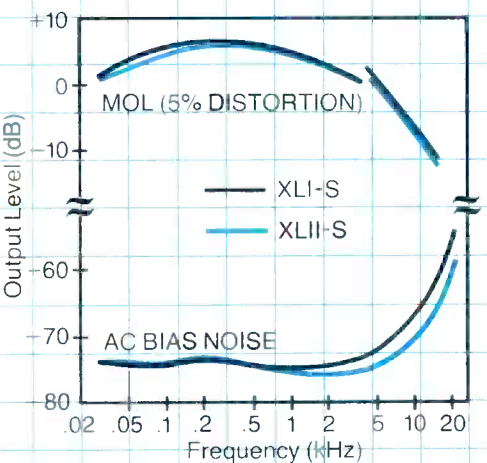
Through a new formulation of our magnetic particles, we were able to reduce the perceived residual AC bias noise level by 1 dB in the critical 2 kHz to 10 kHz mid-frequency range. And simultaneously increase sensitivity and maximum output levels by as much as 2 dB.

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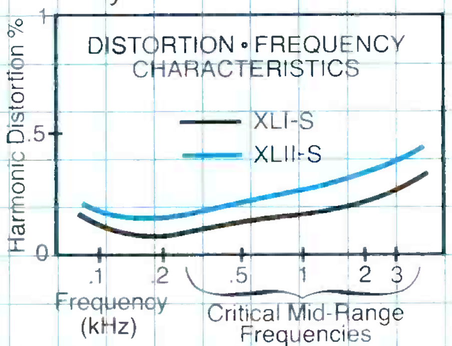


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Our refined particle crystallization process is the basis for all of these accomplishments. Maxell engineers are now able to produce a more compact needle-shaped Epitaxial magnetic particle of extremely high uniformity.

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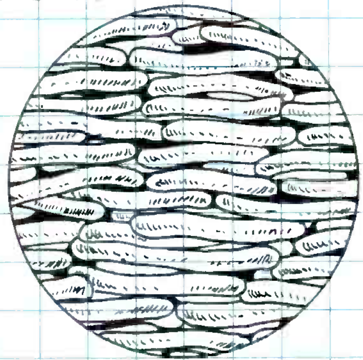

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**IT'S WORTH IT.**



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EDWARD TATNALL CANBY

# CHAIN OF COMMAND

Lately I've been hipped on the neat symmetry of audio's far ends, out beyond the loudspeakers one way, beyond the mikes in the other. Out there, it is all air, space and direction. In between, it's circuitry. Transducers! At each end we have them, the same but opposite, and they are the biggest thing in audio.

Until I joined *Audio*, I had never heard of a transducer, nor a host of similar terms, like parameter. These words do not exist in the musical and literary worlds. Yet they are a part of our language, literary or no, and if used nicely they are rich in meaning—they have a good sound and look well on the page. That is, if you avoid burying them via the engineer's worst literary fault, polysyllablicity. Maximum attenuation, my foot! (See Dec. 1983.) Just say "off." And then use on, up, down, go, stop, thick, long, square, round, those ancient words—and *transducer* will look lovely.

Thanks to the residue of four years of school Latin, I had no trouble with transducer. It means simply "leader across," out of its Latin roots. A duke is a leader with a "k." Il Duce, that erstwhile leader, made the mistake of joining up with another one, Der Fuhrer. Same meaning but different root. DuPont's famous trademark name, Duco, means, in Latin, "I lead." What else! A Latin pun on the corporate name. Our transducers, however, don't lead from the top, they lead across. "Trans," in Latin, still takes us over countless bridges, gaps, ideas, changes of state, territories—mass transit ("it goes across"), for instance, or translation ("across from one language to another"). Latin is indeed useful.

We only have two families of primary transducers in audio, in spite of many others, mikes and speakers. The rest are secondary, en route in the audio chain, transfer stations between the processings. The phono cartridge and its opposite, the cutting head. The tape heads, record and play. They take up a lot of our attention but they aren't primary, like those major gateways, pearly or no, which lead into our territory at one end and out again at the other.

Oh yes—the erase head. It is a marvelous transducer to nowhere, and a very good thing, if you ask me. If we

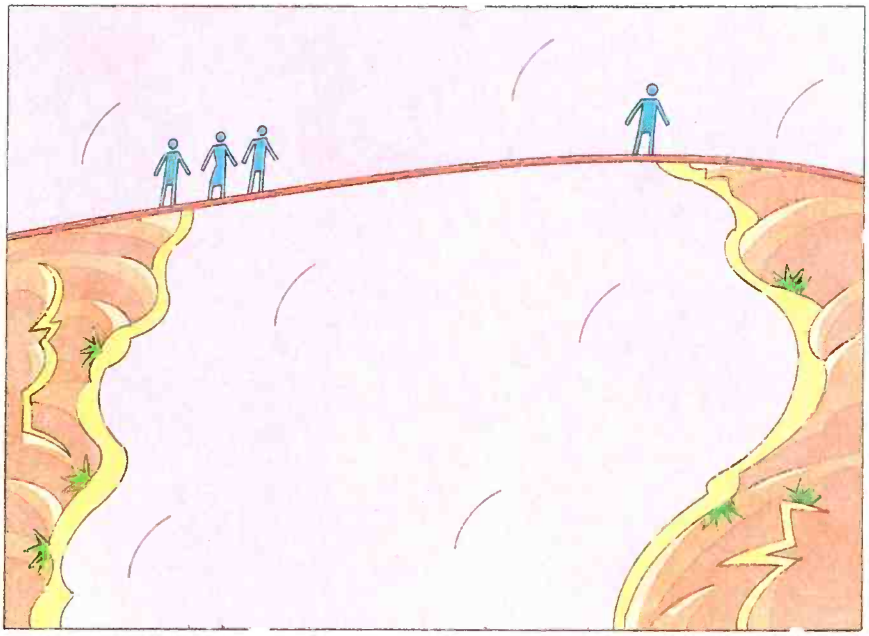


Illustration: Philip Anderson

would erase as much as we record, we'd be better off. As for the bulk eraser, in audio it is on the order of the nuclear bomb. Nowhere in seconds.

Curious that microphones and speakers have always come to us in such bewildering variety. They shouldn't, one would think, because variety is not a part of the transducer definition. We always assume it to be what it says, an impartial, accurate leader-across, with a minimum of side distractions. We measure all our transducers for accuracy and faithfulness to the signal being led across, and rate the fi accordingly. Every speaker, every microphone, except for a few highly specialized items, is valued first of all as a true signal carrier. Like the "straight-wire" amplifier—that's the way we think of them and even advertise them. A speaker is *not* a signal processor, nor is a microphone. Any deliberate signal alterations or adjustments in the electronic circuit at these points are minimal: A bit of attenuation, a modest cutoff, above or below. If you do fancier things, you do them elsewhere.

One is, indeed, very much like the other, excepting mainly that they are in mirror image. With one, we put in force and get out electricity; with the other, we put in electricity and get force out. And whatever is done in between is either amplification, to take care of those inevitable losses to inefficiency, or some sort of storage medium, such as LP or tape. There are, to be sure, other jobs, but these are the primary ones.

But the variety is there, all right, and it is significant. It involves not the electronic signal, but the other side—which is space, air, ambient sound waves. Directional modifications, for instance. Phasing. Here, in both species of primary transducer, we are already beyond the circuitry and involved in an utterly different medium. These terminal transducers, then, are 50-50 propositions by their very nature, one half dealing with electronics, the other half with mechanics, signals in outer space. At both ends of the chain.

The slots and holes we find in the bodies of directional mikes could be nowhere else because they are entirely acoustic. The careful avoiding of inset cavities in front of the speaker cone (a relatively recent development), the staggered mounting of woofs and tweets for phase coherence, the aiming of the speaker beam, all this and plenty more are out beyond any circuitry. If electronics sometimes ingeniously appear in these areas, they are acoustic surrogates, doing what is basically an acoustic job.

Well, of course, of course! Kinder-

# Chrysler creates LASER XE. The sports car that had to outperform the competition.

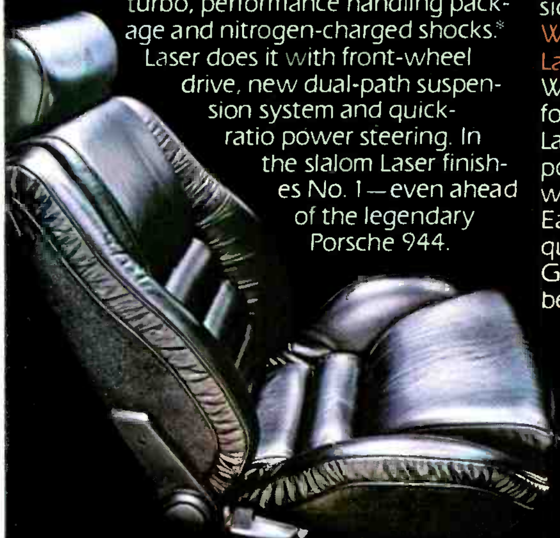
We gave Laser XE world-class performance. In the slalom, Laser beats all entries—from Trans Am to Mustang GT. We built Laser XE to outperform the competition: Camaro Z28, Trans Am, Mustang GT, Supra, Mazda RX-7.

Laser beats Porsche in the slalom.

Laser outperforms Trans Am in braking.

Laser is faster than Camaro Z28 from 0-50 mph.

Laser does it when you equip it with turbo, performance handling package and nitrogen-charged shocks.* Laser does it with front-wheel drive, new dual-path suspension system and quick-ratio power steering. In the slalom Laser finishes No. 1—even ahead of the legendary Porsche 944.




We turbocharged it. From 0-50, Laser XE leaves Camaro Z28 with its shadow. Z28 is a powerhouse—but Laser XE is the sophisticated new wave. Its multi-point injection system "spritzes" fuel in at four points. Its water-cooled bearing reduces a critical turbo temperature by 500° F. Its turbo engine boosts h.p. 45% and moves Laser like light. With 5-speed your time to 50 mph is 5.8 seconds. Z28, Trans Am, Supra and RX-7 are in your remote-controlled side-view mirrors.

We gave it high-performance braking. Laser XE stops where Trans Am doesn't. We think total performance calls for performance braking. So we gave Laser XE semi-metallic brake pads, power brakes all around and optional wide 15" alloy wheels with Goodyear Eagle GT radials. Result: Laser stops quicker than Z28, Trans Am, Mustang GT, Supra, RX-7. Even Porsche 944 can't beat our world class braking.

We gave it a brain—and a performance seat that performs. Laser XE thinks with you. Its 21-feature electronic monitor even talks your language. Its navigator computes for you while its color graphic displays make you a calculating driver. Laser XE's AM/FM stereo remembers what you like to hear and its self-diagnostic system is the nearest thing to an on-board mechanic. Your seat responds with cushions you pump up for thigh and lumbar support, and you can choose a 6-way power seat and Mark Cross world-class leather.

We gave it our best: a 5 year/50,000 mile Protection Plan. We believe a performer has to be a survivor. We build for that. And back your engine and powertrain with a 5 year/50,000 mile Protection Plan, with outer body rust-through protection for the same period.** See dealer for details. Buckle up for safety.

35 Est. Hwy.
22 EPA Est. MPG.†

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Laser. A Product of The New Chrysler Technology.

*Based on overall results of USAC sports car certification tests versus 1983 models. Laser XE equipped with optional handling suspension. Turbo package and 15" road wheels and tires.

**5 years or 50,000 miles, whichever comes first. Limited warranty. Deductible required. Excludes leases. †Use EPA est. mpg. for comparison. Actual mileage may vary depending on speed, trip length and weather. Hwy. mileage probably less.


CHRYSLER
LASER

"THE COMPETITION IS GOOD. WE HAD TO BE BETTER."*

Lee A. Iacocca

We only have two families of primary transducers in audio, in spite of many others—mikes and speakers.

garten audio. Nevertheless, here is the reason why these in-between transducers hold such fascination for our most brilliant designing engineers, both at the microphone end and at the speaker. All the rest of audio is as nothing, I suggest, compared to the subtlety, the challenge, even the mystery of these two critical transducer areas dealing with interlocked media, crossing from one to the other. Not surprisingly, it is here that the computer, too, is at its best—those remarkable three-dimensional simulations of mechanical speaker motion, for instance, formula by formula, before a part is fabricated or a sound heard. Astonishing, even for the computer man.

You can sense my drift. I am moving outwards from the audio center in both directions, to both the end transducers which are so similar, if exactly opposite, in function. Like electric motors and generators. Remember the Gramme dynamo, the first, which would work the other way as a motor? More transducers, in another field.

And now one further argument. Transducers are not dead ends. Ours certainly aren't. What exists out there beyond the speaker, and beyond the mike, is the reason for our transducing—and obviously we must think of it as a part of, shall I say, the greater audio chain. Not only sound waves impinging on, emanating from the transducer but, necessarily, the whole complex of enclosed space with its reflections, reverb, presence, and so on. This, at both ends—before the mike, after the speaker—is the actual medium for human perception and creation. This is where audio starts, and where it ends, and because there must be some sense to audio, we go even further—we are inextricably tied into the whole gamut of human expression in sound, be it educational, artistic, entertainment or whatever! All vitally a part of the greater audio chain.

No, this is not some high-flying Canby philosophy. It is just a matter of fact, insofar as we can pin things down, measure them usefully and put them predictably to work. Why else is audio so interesting in so many ways?

Well, returning to everyday practicality, I'll have to admit that our two types of primary transducers tend to go their very different ways. And so do those opposite acoustic spaces beyond them that complete the transduction.

Beyond the mike, out in space at the beginning of the chain? Wow—a whole further world of professional audio, full of a million exciting activities. And beyond the speaker? Ah, there's the rub. Also plenty of sonic spaces. But whose space? Alas, it isn't ours. We have precious little control of it, nor very much influence on the owners. They go their own way, and this can be distressing.

Except with the professional soundman, the speaker designer loses his grip on the audio chain when his product goes into its shipping box. Out of his hands. Those speakers move into thousands of private domains, and he can only guess, and hope. In my opinion, even after a half-century of hi-fi, it's a forlorn hope—that this final segment of the greater audio chain will be completed in a way to bring out the best of the entire chain. If we are satisfied with maybe one in a hundred or a thousand cases, maybe we're doin' okay. The few perfect, ideal home realizations of all that immense amount of design and art and sheer work that leads (leads across) to the listening human ears.

Well, it's tough. But this is an audio democracy, isn't it? Our cash flow, at least, is okay in good times; the people buy our equipment and keep us in business. But do they take full advantage of its abilities, to complete that final stage of transducing? Not so you'd notice it. Readers of this magazine are, of course, exceptions.

And so I'm pessimistic, when it comes to the consumer. Money—yes. But does he ever learn anything? When he wants to, he does. That's life. Today, the required know-how is everywhere. We all have microphones to play with, speakers or phones to reproduce with. Plenty of us have the better sort of equipment, ready at hand, or at ear. For 50 years there have been books on home hi-fi (mine included), carloads and trucks full of pamphlets, leaflets, press releases, instructive ads (plus demos, lectures and TV spectaculars), all profusely detailing our subject. There's a hi-fi salon in nearly every village and town. It's all there for the asking and has been for so long. But . . . .

I'll give you a little example of current transduction, out of the loudspeaker and into the final listening space, the end of the chain. Extreme, maybe, but all too common.

I recently visited friends in a fancy penthouse apartment outside of Manhattan, brand-new building in park-like surroundings. Ah, such peace and quiet, after noisy downtown New York. We had a long, pleasant, and relaxed conversation in what I found was a very comfortable silence. Then during a pause, I heard a series of odd, tiny squeaks, very faint. What could they be? A bird, outside on the penthouse terrace or in a cage next door? Mice in the walls? Suddenly, in a flash (I'm good at such things), my mind resolved those squeaks—into one of the loudest climaxes for strings in Tchaikovsky's "Romeo and Juliet." That was what it was. The inconspicuous (but excellent) hi-fi system had not been turned off. This was its normal background playing level, hour after hour, probably month after month. So what can you do?

I made a remarkable boo-boo in my series on Silva Hall (Oct., Nov., Dec. 1983). I forgot to mention the building's architects—the non-sonic ones. Hardy, Holzman and Pfeiffer & Associates. Guess I'm too audio minded. They designed the visible macrostructure. Christopher Jaffe's firm, Jaffe Acoustics, Inc., integrated the audio. Was Silva Number One? The Concord Pavilion in southern California was indeed earlier than Silva, but it is an altogether different kind of building, in a warm climate, and was originally equipped only with AR, Jaffe's ERES™ being added later for a wider usefulness. Several earlier installations might qualify in part for First—but why quibble? I still opt for Silva Hall as the all-out, decisive example, the real First of its Kind. My own choice. Silva does have the first digitally controlled AR system in this country, shortly after an English hall. Virtually all of this pioneering is by Jaffe, Inc., to whom I again bow.

No doubt I made some engineering errors and would be glad for comment. I took the risk. All in all, I see no need for corrections to my big point, which is the importance of this new kind of electronic architecture, so dramatically presented in Silva. 

BERT WHYTE

# DO THAT VOODOO

One has but to look in the loudspeaker section of *Audio*'s Annual Equipment Directory issue (Oct.) to realize how many loudspeakers are on the market. If none of them seem to suit your tastes, in the opinion of some industry wags, "just wait 10 minutes and we will have another new loudspeaker for your evaluation." Apparently, there is a common belief that big bucks can be made in loudspeakers—just manufacture a model that tickles the public's fancy and you can start visiting Rolls-Royce showrooms.

Truth is, of course, most of the ubiquitous walnut boxes are of a numbing sameness in design and performance. Until quite recently, what changes and improvements were made in these speakers were a result of empirical art, rather than of scientific rationale.

In the last few years, black magic has given way to arcane disciplines in scientific analysis and design in the development of new loudspeakers. Such things come to mind as laser interferometry and laser holography, computer modeling, along with the use of Fast Fourier and Hilbert Transforms. And, of course, one of the most important of the new technologies is *Audio*'s own Richard Heyser's Time Delay Spectrometry and Time Energy Frequency studies. There is now a dedicated instrument for TDS and TEF, the Tecron System 10, manufactured by Crown International of Elkhart, Ind. Gerald Stanley, head of reseach for Crown, explained the System 10 in the November 1983 issue of *Audio*.

All the foregoing is preface to the story of the development of a remarkable new loudspeaker. When Crown introduced their new Tecron System 10 at the 72nd AES Convention in Anaheim, they made an offer that anyone who placed an order for the unit would be able to buy it at a special introductory price of around $10,000. (Current production price is $14,500, which is still a long way from the $35,000 to $40,000 assemblage of test equipment heretofore necessary to do TDS and TEF studies.) One of the people who took advantage of the offer was John Bau, director and designer of Spica, a small loudspeaker manufacturer in Sante Fe, N.M. After numerous delays, the Tecron System 10 arrived at Spica and therein hangs a tale.

*The Spica TC-50 loudspeaker*

John Bau wanted to develop a small, relatively inexpensive two-way loudspeaker that would exhibit good phase behavior, especially in the region from 350 Hz to 5 kHz. Working with their Hewlett-Packard 9845 computer and an extremely sophisticated engineering software program, plus the Tecron System 10, Spica's early investigations showed that the crossover network (really the heart of the loudspeaker project) would not meet their criteria using the usual Butterworth configurations.

This led to an exhaustive examination of Bessel filters as an alternative transfer function. Spica discovered many attractive things about them, but after much work, they did not find a high-pass function that summed perfectly with a Bessel filter. However, they did find one function that summed perfectly up to 5 kHz and used this as a target function when assembling some prototype crossovers. Using Time Delay Spectrometry, the delays between the 6½-inch cone-type dynamic woofer and the 1-inch dome tweeter (with crossover optimized to both amplitude and phase) were adjusted to match those of the computer model. They found on measurement that the phase response of the complete system was linear phase—±15° from 350 Hz to 4.2 kHz.

This is a very simplistic idea of the very complex research John Bau did at Spica, which resulted in the design and fabrication of the acoustic suspension, wedge-shaped Spica TC-50 loudspeaker.

The TC-50 measures 13 in. W × 15½ in. H × 11½ in. D. Frequency response is rated at ±3 dB from 55 Hz to 15 kHz. One watt at one meter gives an 83 dB SPL. Spica considers the phase response of the TC-50 in the midrange part of the audio spectrum, where the ear has maximum sensitivity, "near perfect." This speaker can handle 50 continuous watts of program power and 100 watts peak. Impedance of the TC-50 is 4 ohms. The wedge shape is, of course, to ensure that the woofer (really also a midrange unit at a crossover of 2.7 kHz) and the tweeter lie in the same acoustic plane for phase coherency. The Spica TC-50 sells for $420 per pair.

I can hear you commenting, "Okay, so what is the big deal? Those specs are not very impressive." On the face of it, you're right. But conventional specifications don't tell the story here. Just hook up the Spica TC-50 to a good-quality amplifier of somewhere around 25 to 100 watts and listen. If you react like most people, including yours truly, you will be positively amazed by the sound of these diminutive loudspeakers. The smooth naturalness of the overall response is notable, but it is the incredible imaging, front-to-back depth, accuracy of instrument localization, and stability that is so unexpected—and astonishing. Here are images *within* the sound field that are so realistic they are almost palpable. Try as you may, you simply cannot isolate sounds as specifically emanating from the right or left loudspeaker. Instead, we have a broad soundstage, a veritable panorama of sound. Bass response is clean and solid down to the −3 dB point at 55 Hz and then falls off rapidly. Depending on the amplifier used, the speakers can achieve surprisingly loud listening levels. But caution is necessary, since there is no


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Like a Stradivarius
Antonio Stradivari (1644-1737) invested his violins with all the historic and contemporary technical knowledge of his day, applied his own research, intelligence and master craftsmanship to produce an instrument that still leads the musical world in performance capability, technology and value. Almost 250 years later, his violins are still . . . the *best.*
Since its beginning in 1949, McIntosh has been the technological performance and value leader for this industry. Continuous research and development at McIntosh explores the virgin terrain of new performance and value that lies beyond the boundaries of the technological map described by others. This pioneering effort constantly pushes the boundaries of existing knowledge. Over the years, the United States Patent Office has granted thirty patents that certify the results of this innovative and exploratory research. Each patent has exposed new areas of technology which leads to the superior performance of a McIntosh and exposed new areas of effort and thought that is unmatched by any other research group in this industry, in the world. McIntosh is truly the technological leader and McIntosh is dedicated to continuing that leadership. McIntosh still . . . the BEST.
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Transient response of the Spica TC-50 is remarkably good, and, as long as the speaker is not overdriven, distortion is quite low.

protection circuitry. However, if you should blow a speaker, John Bau says not to worry, as replacement speakers matched within 0.5 dB are readily available. In fact, John tells me all TC-50 speakers are kept to that 0.5-dB tolerance. Transient response of the TC-50 is remarkably good, and, as long as the speaker is not overdriven, distortion is quite low. The major impression one immediately perceives with these loudspeakers is their effortless naturalness and their sheer musicality. They are among the least fatiguing speakers extant.

What is the secret behind all this exemplary performance? Why, friends, it is largely in the design of the crossover, which, as noted, was achieved with the comprehensive use of the Tecron System 10 Time Delay Spectrometry and TEF facilities, as well as the HP 9845 computer. One certainly must not forget to give credit to John Bau, who broke with traditional concepts of filter design and whose new crossover has provided such a significant advance in sonic quality.

John tells me that current developmental work will soon bring forth a new three-way Spica and, not too far down the line, a servo subwoofer system.

Some Spica enthusiasts have bought two pairs of the TC-50 and placed them on their sides, one pair stacked on top of the other, with the tweeters facing in, in an effort to obtain more level and more bass. The floor position will help in and of itself, but there will be acoustic coupling of the two woofers, and indeed will be an increase in bass. John Bau states that this positioning will upset the acoustic geometry of the TC-50 and degrade its imaging qualities. Nonetheless, many people say it doesn't affect them much and they're happy with this setup.

As for myself, I have used the TC-50s with amplifiers ranging from an 80 watt/channel Audionics, to a 200 watt/channel Levinson ML-3, and a 200 watt/channel conrad johnson tube amplifier. (The latter two used with extreme care!) I've combined the TC-50s with a pair of Janis W-1 subwoofers, which have 100-watt interface amplifiers/crossover at 100 Hz. The result was sensational—all the solid, clean bass you could desire, down below 30 Hz, with wonderful musicality and superb imaging. Using the conrad johnson Premier One amplifier to drive the TC-50s from 100 Hz up, there was plenty of level, and I dared a few CDs without disaster. With the subwoofers and interface units nearly six times the cost of the TC-50s, this might seem silly, but John Bau tells me quite a few people are doing just that with a variety of subwoofers. Of course, it is a darn good reason why John is designing his own subwoofer.

How nice to have a success story like the Spica TC-50, especially since it was science, not hocus-pocus, that won the day.


# Why this is the tape that sets the standard.

JVC sets the standard for all VHS videotapes, no matter who makes them.

That's the way it has been ever since JVC engineers originated the format for VHS videocassette recorders.

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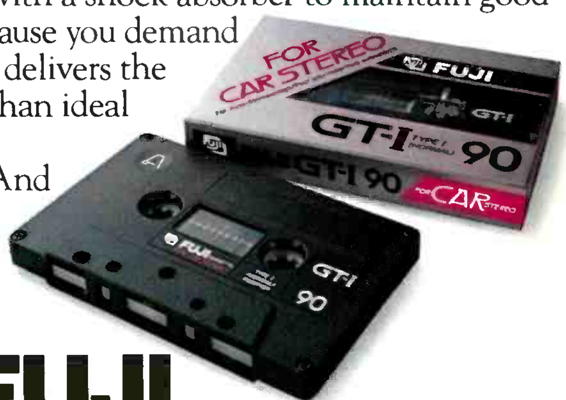
# Announcing the first audio tape to go from 0 to 230 degrees without missing a beat.


The Fuji GT-I is the only audio tape specifically engineered to handle the hazards of the road.

We built the GT-I to survive the icy depths of winter and the searing heat of summer. In fact, the GT-I can even withstand the harsh environmental extremes of your dashboard. We designed the GT-I with a shock absorber to maintain good vibrations on the toughest roads. And because you demand peak performance, we made sure the GT-I delivers the highest fidelity, even under your car's less than ideal accoustical conditions.

So take the Fuji GT-I for a spin. And see how much smoother the road can be when you drive with a tape that's built to give you more treble and less trouble.




**FUJI.**

Nobody gives you better performance.



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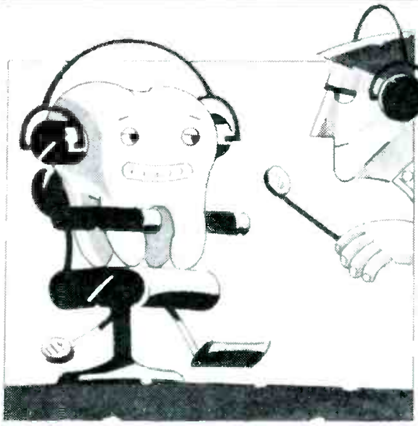
IVAN BERGER

# MUSIC IS A GAS

### Music in the (Operating) Theater

There's a trend nowadays to give local instead of general anesthesia for some operations. With a local, reports *New Scientist*, patients suffer fewer postoperative complications and are not bedridden as long.

London's Charing Cross Hospital has added a new wrinkle—providing locally anesthetized patients with their favorite music, via headphones, during the operation. Patients are less bored and, with the sounds of drill and saw masked by music, less anxious. (I find the same holds true for me when I'm in the dentist's chair.)



There's an effect on the surgeons, too. According to *New Scientist*, "Surgeons don't swear in front of their patients and tend not to say 'Ooh, look at that' when they discover something of great interest in the patient." That, too, could help ease patients' anxieties.

Illustrations: Philip Anderson

### Cough-Cutting

I've done a bit of live recording over the years, but I'd never heard of the trick referred to in ETC's January review of a live-performance album, "editing a cough down to a gentle swish," so I called and asked Mr. Canby about it.

How's it done? "You just cut the cough's initial attack out of the tape," he told me. "With that gone, no one recognizes it as a cough, and they don't hear it."

So far, such tricks are hard to do in digital. But from judging the one digital editing system I've actually seen in use (3M's), it should by no means be impossible. The 3M system lets you observe the waveforms of both signal segments you were splicing. It shouldn't be impossible to display the waveform of a signal to be modified, manipulate it digitally (perhaps using a light pen to redraw it), then play back the new wave to see how it sounds.

Do *not* expect to see this feature in your first all-digital cassette deck (whenever that will come). But I wouldn't be surprised to have some studio-equipment company call up next week and tell me they can do it.

### For Tube Freaks Only

Tucked among the other press releases at the Winter Consumer Electronics Show, I found one on a telephone answering machine which might be of interest. Aimed at "the serious music lover concerned for the image he or she projects" and "the audiophile distressed by the harshness and opacity of . . . solid-state," it featured all-vacuum-tube electronics, minimal feedback, and premium capacitors and resistors. It also used Philips cassettes at twice normal speed, a ribbon microphone for user announcements, and an acoustic-suspension speaker for message playback.

There were, however, a few catches: For one thing, the price was a rich $3,000. And the company name (Fornix) and phone number (a 555- exchange) proclaimed it all as a gag. A pity . . . I guess.

### I Miss My Maggie

Bert Whyte's November reminiscences about his early connections with Magnecord and binaural recording gave me some nostalgia, too. My first tape deck was a Magnecord PT-6, back in my college days. It was verging on the antique by then, of course, and was a literal basket case when I got it: The previous owner had taken it apart and couldn't get it back together. (You could build about three modern tape decks from the number of shafts and idler wheels in that transport.) I swapped an Eico HFT-90 tuner for it, one that I had built from a $40 kit and added a Lafayette tuning meter to. I sent off for the Sams PhotoFact service manual, and my mechanically minded roommate reassembled it from the exploded views.

Lying around the basement of my college radio station, I found a pair of extensions for use with 10½-inch reels. They bolted to the ends of the transport's front plate, and were powered by rubber belts to the normal reel hubs. I also found one of the staggered-gap binaural head assemblies, and mounted that in place of my separate record/play and erase heads—not to get stereo, but to get half-track heads, to cut my tape costs. I got some good tapes, too—noisy, but otherwise not bad—including some of Bob Dylan before his first record came out, and Buffy Sainte-Marie before she got her vibrato.

Most of the noise came from the 5879 tube in the preamp. I cut that down some by hand-selecting my way through all the 5879s in a friend's repair shop, but there was still too much. When my Maggie died, I bought a maverick machine, the Premier Tapesonic, which I still have. But I still miss that Maggie.

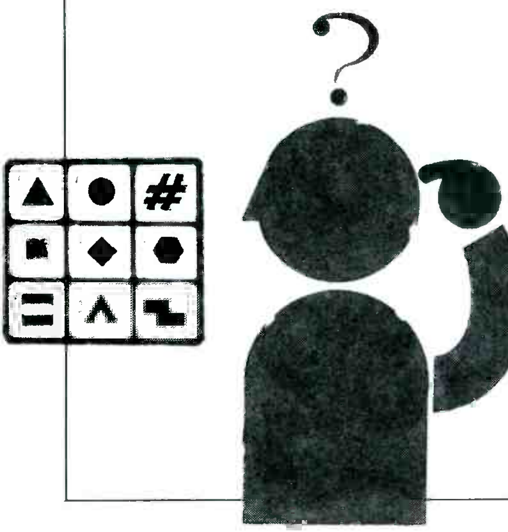
### Chuff . . . Chuff . . . Chuff

I guess it's now official that videocassette recorders have entered the mainstream of hi-fi. At Aiwa's press conference last December for its new Beta Hi-Fi VCR, one of the demo tapes gave me a shot of nostalgia: It included that traditional hi-fi hallmark, steam locomotives.

As a spokesman for the Kahn system pointed out, AM stereo is progressing at a faster rate than FM stereo (or color TV) did.

## Button, Button

In multilingual Europe, they tend to label controls with symbols rather than words. Sometimes, the symbols can be puzzling to the uninitiated, though. Years ago, I noticed a button with a scissors symbol on a Studer studio tape deck. Curious, I pressed it—and a V-shaped blade shot up and cut the tape at a 45° angle! I was alone in the room at the time, so there was no witness to my shame—and no one to pass the buck to.



Last year, on a visit to the factory which Thorens shares with studio-turntable maker EMT, I noticed a button with a counterclockwise arrow. This time, I asked before pressing. Turns out it's for back-cueing: Press it, and the turntable rotates backward for a bit. The back-rotation distance is calibrated so that when you start up forward again, the platter will have just come up to speed when that point passes the stylus again.

Having done my time in broadcast studios, I can appreciate that. We used to slip the record back by hand on a felt turntable mat, hold the record's edge still while the table came to speed, then let go of the record when we'd finished announcing it. EMT's way is more elegant and impressive, if maybe not so much fun.

## Reduction Recognition

Aiwa's new AD-F990 cassette deck has every auto feature we'd ever heard of, plus one we hadn't—Auto Noise Reduction Detection. It detects whether a cassette was recorded with Dolby B, Dolby C or no noise reduction at all, even if you switched in the middle. It sounded like magic, so we checked. What the system actually senses is not the noise reduction per se but a coded signal laid down on the tape by the F990. So, magic it's not—but a handy idea, nonetheless. It would be great if this became a universal system, used (with identical encoding) by all manufacturers, but considering how competitive they are, that *would* be magic.

## AM Flashes

The road to AM stereo does not run smooth. Broadcasters aren't eager to invest in AM stereo broadcasting systems when they don't know what system the receiver makers will adopt; receiver makers aren't eager till they find out what system the broadcasters will use. There are some straws in the wind, all blowing in different directions:

Sansui will soon have its FM/AM-stereo tuner, the TU-S77AMX, which receives all the systems automatically. It will cost $390—$40 more than the equivalent model (TU-S77X) with only monophonic AM. Their car-stereo unit with stereo AM is the CX-990, for $519.

Sony's SRF-A1000 portable ($90), which receives most systems automatically (for the Kahn system, you must flick a switch), has been on sale since last July; some AM-stereo stations are giving it away for promotional purposes. A Walkman-type Sony portable has just appeared.

According to John Strom of Sony, "Almost every AM station I speak to has either gone stereo, is going in the next three months, or is on the fence. The only exceptions are non-AM stations, or those with all-talk or nostalgia formats." Since John told me this in early October, readers should, by now, be able to evaluate that "next three months" prediction for themselves.

Harris, whose system was reputedly most favored by broadcasters (71 stations had already purchased it), ran into problems with the FCC due to an unauthorized change in its equipment, so stations using the Harris system had to shut it off for a few months. In January, though, the revised system was approved.

WQXR has become the first classical AM station to go stereo, and the second station in the New York area to do so (pop station WNBC was first). Both New York stations use the Kahn system.

Though the Motorola system was picked earlier by GM's Delco radio division, this did not ensure that any GM car would offer it; the individual car divisions are free to take what they like from Delco. Buick, however, will make the Delco AM-stereo radios available in selected 1984 models. If this catches on, other divisions are likely to join in later.

Chrysler, meanwhile, has announced that it, too, will offer Motorola-system AM stereo in '84 models. These Mopar radios will be built in Chrysler's own Huntsville, Ala., plant.

These developments make it likely that the Motorola system will win out—the more so should Ford join them, making it universal among the Big Three.

On the other hand, there is the broadcast side still to consider. As of January, the numbers of stations using the systems were, in alphabetical order: Harris, 75 on the air out of 94 shipped; Kahn, 84 shipped to 82 stations ("But we're getting the big stations," Kahn says, "10.7% of the AM audience"); Magnavox, six U.S. stations, and Motorola, about 75 stations.

Kahn also points out that, despite the confusion, AM stereo is progressing at a faster rate than FM stereo (or color TV) did.

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# SOUND REINFORCEME

GLEN BALLOU

**Scarcely anything is more embarrassing to a hi-fi buff than setting up a sound system for a large meeting and having people complain that the sound is too soft, too loud or can't be understood. This primer of basic concepts tells how systems for big halls operate.**

There is an expression, "Among the blind, the one-eyed is King." When it comes to installing a temporary P.A. system or background-music system for a club or church meeting, audio buffs often fall into the category of the one-eyed. Since we audiophiles are considered connoisseurs of music and sound quality, any system we are asked to install is expected to be perfect—that is, loud, clear, with good dispersion, of hi-fi quality, and all those things we have in our home stereo.

Achieving high fidelity in a home stereo and in a sound reinforcement system are very different tasks, however, so we must think in different parameters for each. Table I shows various parameters and how they differ between the home stereo system and the sound reinforcement system.

What do these numbers and symbols mean? Let's go through them, defining them and how they affect sound:

*Room dimensions* determine room volume, surface areas, and shape. The shape of a room can enhance sound or can be detrimental. Square rooms, or rooms that have dimensions which are multiples of their other dimensions, can have large standing waves. These waves can either cancel or boost certain frequencies.

*Room volume* has many effects on sound. Large volume means:

- Long distances from the loudspeaker to the farthest listener;
- Normally higher reverberation times ($RT_{60}$);
- More power required for adequate Sound Pressure Level (SPL) at the farthest listener;
- Both wide-dispersion and high-Q loudspeakers may be required;
- Absorption of high frequencies by the air, and
- Multiple echoes and far reflections.

*Surface area and absorption coefficient ("a")* of walls, floors and ceilings make the difference between indoor and outdoor sound systems. Outdoors, the sound from a source attenuates about 6 dB per doubling of distance. Since there are no reflective surfaces outside (except the ground), the sound appears to come from the sound source and has the same tonal quality everywhere within the source's coverage pattern. The main differences heard are varying SPL and attenuation of high frequencies with distance and dispersion.

In an enclosed area, sound emanates from the source, hits surface areas, and reflects back into the audience area. The amount of reflection is dependent on the reflective characteristics of the surfaces. Surfaces are normally considered as absorbers, with the amount of absorption, in percent, equaling the absorption coefficient of the surface. For instance, the assembly-hall wall in Table I has an "a" of 0.07. Therefore, when a sound hits that wall, 7% is absorbed, while 93% is reflected. The hall's acoustical tile ceiling, with its "a" of 0.75, absorbs 75% of the signal hitting it, and only 25% of the sound is reflected back into the room. If the reflecting surface is close to the source, the reflection usually aids the system. However, if the reflecting surface is more than 45 mS (about 43 feet) from the source, it adds

# NT FOR THE AMATEUR

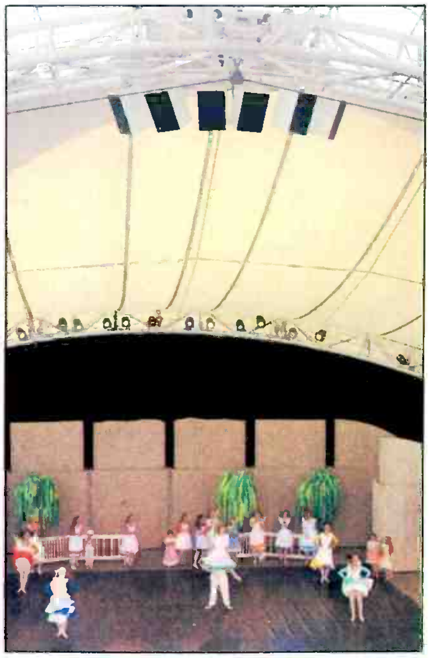
noise rather than information. If there are enough reflecting surfaces more than 45 mS from the source, the indirect or reverberant sound increases, while the direct sound from the source continues to decrease at a rate of 6 dB per doubling of distance.

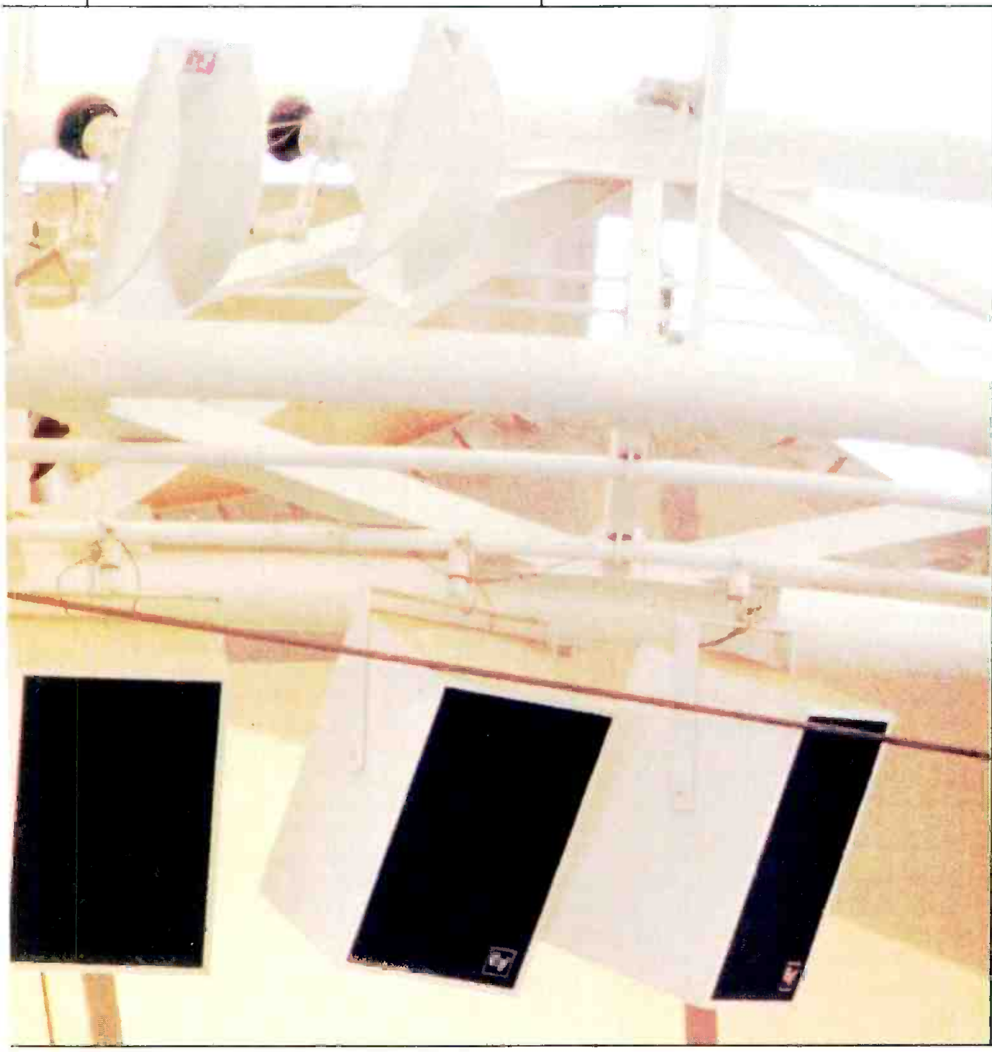
In the living room, the reflecting surfaces, the listener and the loudspeakers are close together, and the direct sound is almost always louder than the reverberant sound. In the seating area of the hall, however, reflected or reverberant sound is usually greater than direct sound, reducing intelligibility. This is because the audience is usually seated beyond the "critical distance" ($D_c$), where direct and reverberant sound levels are equal.

*Reverberation time ($RT_{60}$)* is the time required for a sound to diminish 60 dB, or to one-millionth of its initial level (see Appendix).

$RT_{60}$ can be shortened three ways: Decreasing volume, increasing surface area, or increasing "a." In the assembly hall of Table I, for instance, the high "a" of the acoustical tile ceiling reduced the $RT_{60}$ from 4.98 to 1.09 S. Reducing $RT_{60}$ usually improves intelligibility in large rooms.

Living rooms, because of their size and absorbing materials (carpets, curtains, furniture and walls), usually have a short $RT_{60}$—so short, in fact, that a reverberant field is not set up. The measurement is somewhat meaningless in this context. Assembly halls are often very hard, as they have hard floors, ceilings, walls and furniture. These increase the $RT_{60}$, often way above ideal.





*"Sā" (surface area × absorption coefficient)* reduces the amount of reflecting or reverberant sound as it is increased. An "a" of 1 is equivalent to an open window, while a hard surface (smooth steel) is equivalent to an "a" of 0.01 or less. A completely hard room (all surfaces "a" = 0.01) would be very reverberant and, with the proper volume and non-parallel walls, could be considered a reverberation chamber. If the room had an "a" of 0.99, it could be considered an anechoic chamber, where all sound would be absorbed. Increasing Sā (by increasing surface area and/or absorption coefficient) will decrease the $RT_{60}$ (reverberation time) of the room. The "a" of materials is always frequency-dependent, often being the greatest in the range of 1.5 to 4 kHz.

*Critical distance ($D_c$)* is the distance from the sound source (loudspeaker) where the direct and reverberant sound levels are equal. Direct sound from the loudspeaker attenuates at a rate of 6 dB per doubling of distance. If we use 4 feet as the 0-dB reference, then attenuation with distance is as follows: 8 feet, 6 dB; 16 feet, 12 dB; 32 feet, 18 dB; 64 feet, 24 dB; and 128 feet, 30 dB.

Beyond critical distance, direct sound continues to attenuate at 6 dB per doubling of distance. Reverberant

*Photos courtesy of Electro-Voice*

**The rules which apply to sound systems in a living room have relatively little application to speaker systems in assembly halls.**

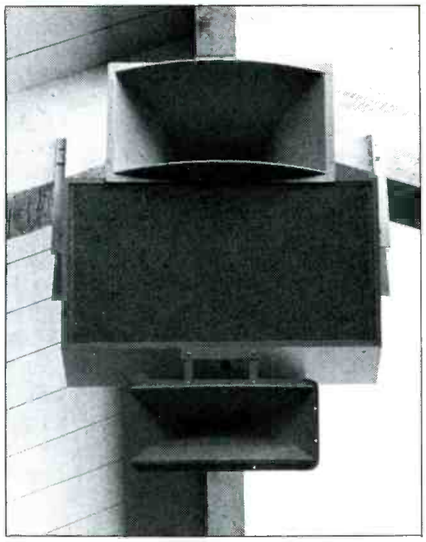


*Fig. 1—Speaker Q is increased by stacking, as in this system in St. John Neumann Church, Irvine, Cal. More horns, stacked along the same axis and firing in the same direction, would further increase Q.*

*Photographs: Contractor-designer, GMF Sound, Orange, Cal. Photos supplied by Electro-Voice.*

sound, however, has now built up to the level of the direct sound. Reverberant sound, by definition, is diffuse, random, and therefore approximately the same level everywhere past $D_c$. So, as the direct sound gets weaker, the reverberant sound takes over until the direct sound is so small that it is masked by the reverberant sound, and intelligibility ceases.

Most living rooms never have a true critical distance, because their $RT_{60}$ is short (less than 1.6 S). This type of room is considered quasi-diffuse, and beyond $D_c$ attenuates at 2 to 3 dB per doubling of distance.

A short $D_c$ in a living room is advantageous, because more listeners are seated in the reverberant field and, therefore, hear the sound more nearly alike. Since living-room absorption is usually controlled by rugs, curtains and furniture, a short $D_c$ must be controlled by the audiophile's purchasing a relatively low-Q (non-directional) loudspeaker.

When the loudspeaker is going to be used for reinforcement in an assembly hall, a longer $D_c$ is required. First, a long $D_c$ allows maximum attenuation between loudspeaker and microphone, reducing feedback. Second, it increases the distance over which sound can be projected with clarity.

Again, the room volume and $RT_{60}$ have been fixed by the architect's design. Therefore, increased $D_c$ must be obtained by increasing loudspeaker Q.

*Loudspeaker Q* is a measure of the loudspeaker's directivity. As the room becomes larger and more reverberant, the loudspeaker Q must increase so the articulation will remain adequate. One can categorize Q into three groups: Low Q (less than 3), medium Q (3 to 10), and high Q (above 10). A loudspeaker with an omnidirectional coverage pattern (sound is dispersed evenly throughout an entire sphere) has a Q of 1.

If the loudspeaker had a perfectly hemispherical coverage pattern, its Q would be 2. In other words, with the same power into each of two loudspeakers of equal sensitivity, the one with a Q of 2 would produce 3 dB more sound on its axis than the loudspeaker with a Q of 1. (Efficiency is frequently thought of as interchangeable with sensitivity, but in sound reinforcement terms, efficiency is actually calculated from both sensitivity and Q, and thus is not a direct measurement.) If the loudspeaker covered an area of exactly 40° × 90°, its Q would be 12.86 (see Appendix) and would produce 11 dB more power on axis than the loudspeaker with the Q of 1. Unfortunately, loudspeaker Qs are always less than ideal, due to lobing and diffraction, so a loudspeaker with a specified pattern of 40° × 90° would probably have a Q nearer to 7. This loudspeaker would have an SPL 8.5 dB greater than the loudspeaker with a Q of 1. While this may not sound like much, it means a 7-to-1 reduction in required amplifier power.

Loudspeaker Q also varies with frequency. Low-frequency radiation is normally quite omnidirectional, because the wavelength is long compared to the surface area of the loudspeaker enclosure. As the frequency increases, the wavelength decreases, until it is short compared to the surface area of the loudspeaker. Therefore, as frequency increases, Q increases. An increase in Q means a narrowing of coverage pattern or an increase in loudspeaker beaming. A disadvantage of beaming is a hot spot on-axis and poor high-frequency coverage off axis.

Loudspeaker Q has several effects on the sound system:

- High Q increases critical distance ($D_c$) which, in a home system, would make the listener sit in the direct sound field. A high-Q speaker often sounds dry, with variations in response and loudness throughout the room. In the reinforcement system, a speaker with high Q means higher articulation at the most remote listener.
- High Q narrows the coverage pattern. On the plus side, this can reduce reflections off walls and ceilings. On the minus side, it can mean poor coverage in the audience area. In both the home system and the reinforcement system, high-Q loudspeakers will cause some areas to be very hot, while other areas will be very dull from a lack of high frequencies.
- High Q usually requires large loudspeaker arrays in a sound reinforcement system (Fig. 1). In a home

**The concept of "critical distance," at which the level of reverberant sound equals the level of direct sound, doesn't apply in the living room.**

*Table I—Typical values for various parameters affecting sound systems in a home listening room and an assembly hall.*

| | **Home** | | **Assembly Hall** | |
|---|---|---|---|---|
| 1. Typical Room Dimensions | 18′ × 15′ × 9′ | | 60′ × 40′ × 20′ | |
| 2. Room Volume | 2430 cubic ft. | | 48,000 cubic ft. | |
| 3. Surface Area & "a" | Sq. Ft. | "a" | Sq. Ft. | "a" |
| Walls | 594 | 0.06 | 4000 | 0.07 |
| Ceiling | 270 | 0.05 | 2400 | 0.75† |
| | | | 2400 | 0.05†† |
| Floor | 270 | 0.55 | 2400 | 0.03 |
| Total | 1134 | | 8800 | |
| 4. $RT_{60}$ | Empty, 0.6 S<br>4 People, 0.56 S | | Empty: 1.09 S†, 4.98 S††<br>80 People: 0.95 S†, 2.97 S†† | |
| 5. Sā | Empty, 197.64<br>4 People, 213.64 | | Empty: 2151†, 472††<br>80 People: 2472†, 792†† | |
| 6. $D_c$ | Empty, 4.44 ft.<br>4 People, 4.6 ft. | | Empty: 14.64 ft.†, 6.85 ft.††<br>80 People: 15.69 ft.†, 8.87 ft.†† | |
| 7. Loudspeaker Q | 5 | | 5 | |
| 8. $D_{LIM}$ | Empty, not applicable | | Empty: 46.26 ft.†, 21.65 ft.††<br>80 People: 49.58 ft.†, 28.03 ft.†† | |
| 9. $D_{2max}$ | Empty, not applicable<br>4 People, not applicable | | Empty: Any distance†, 13 ft.††<br>80 People: Any distance†, 22.42 ft.†† | |
| 10. $D_2$ | 13 ft. | | 55 ft. | |
| 11. $\%AL_{cons}$ | Empty, 3.2% | | Empty: 9.8%†, 44.8%††<br>80 People: 8.55%†, 26.7%†† | |
| 12. S/N Ratio | 10 dB | | 15 to 25 dB | |
| 13. Power Required | 131 watts | | 955 watts | |
| 14. NOM | 0 | | See text | |

† = Acoustical tile ceiling
†† = Hard ceiling

system, it can be produced by mistake (for example, by poorly designed cone or dome loudspeakers).

- Low Q can usually be tolerated in the home stereo system, because people usually do not sit in front of their loudspeakers to critically listen to true stereophonic reproduction. If they did, they probably would demand loudspeakers with a Q of at least 8 and proper (corner) placement. For just easy listening and background music, low-Q loudspeakers would produce more even coverage throughout the living area.

In the reinforcement system, low Q usually will reduce articulation because it shortens $D_c$. If the entire audience area were walked with a real-time analyzer, the coverage would probably appear even in level and response. Unfortunately, what is even is not necessarily the direct articulate sound but reverberant sound which, after $D_{2max}$ (the maximum distance for reasonable articulation), is often only mud and noise.

One of the simplest ways to increase the Q of the loudspeaker array is to use two loudspeakers in a stacked configuration (Fig. 2). Also, installing the loudspeakers against a wall or in a corner increases Q, particularly at the low frequencies.

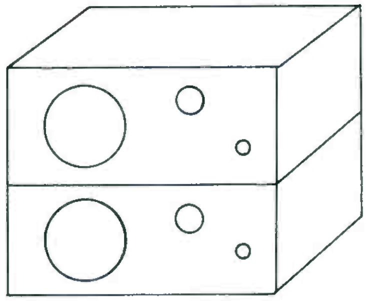


*Fig. 2—Loudspeaker stacking.*

Installing a loudspeaker on each side of the stage area actually *reduces* the effective Q for seats on the sides of the room (Fig. 3). In the formula for $D_c$ (see Appendix), I use the term "N," which is the number of loudspeaker groups. In practice, this is a ratio between the number of speakers which can be heard as actually producing direct sound to a given listener and the total number of speakers. For instance, in a distributed, ceiling loudspeaker system, anywhere from one to five speakers might be producing direct sound to a listener. If five speakers produced direct sound, and there is a total of 35 speakers in the ceiling, "N" would be 7 and would have the effect

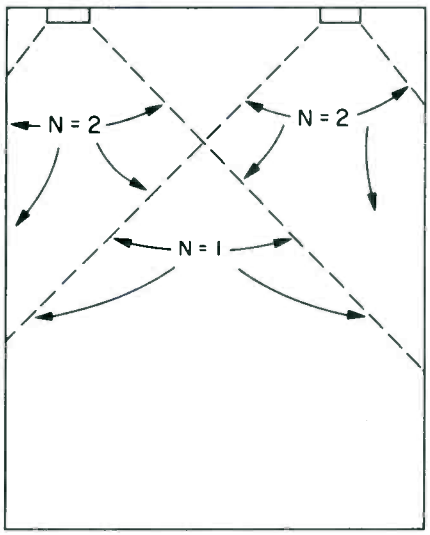



*Fig. 3—Effects of "N."*

**Loudspeaker Q varies with frequency, affecting coverage angles and the articulation at distances far from the speaker.**

of reducing $D_c$ by 62%. When installing a loudspeaker on each side of the stage, "N" becomes 2; therefore, effective Q is reduced 50%, which reduces $D_c$ and $D_{LIM}$ 30%.

*Limiting distance ($D_{LIM}$)* is defined as 3.16 × $D_c$ and is the maximum distance where articulation remains adequate in a room with an $RT_{60}$ of 1.6 S. Below 1.6 S, $D_{LIM}$ does not apply, as articulation will remain adequate at any distance, as long as the signal-to-noise ratio remains adequate.

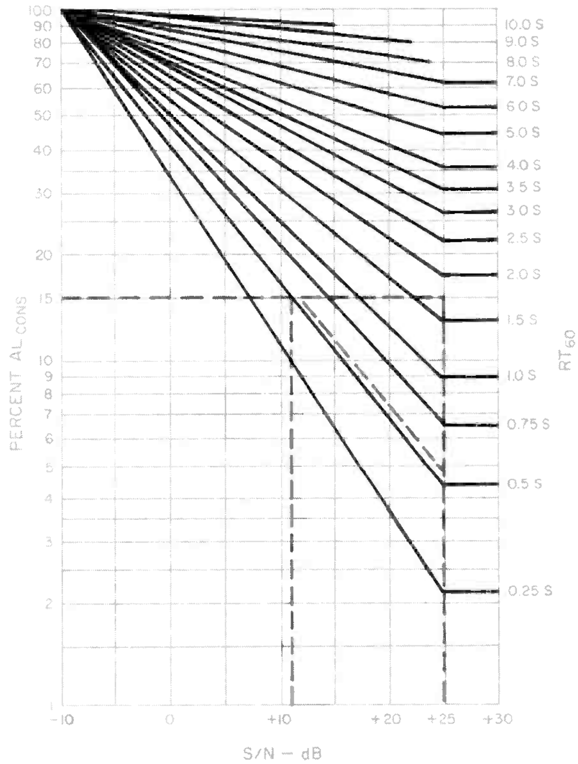
*Maximum projected distance ($D_{2max}$)* is the distance over which sound can be projected with reasonable articulation. When $RT_{60}$ is about 1.6 S, $D_{2max}$ should not exceed $D_{LIM}$, or 3.16 × $D_c$. When $RT_{60}$ is short, as in the average home, articulation will remain good as long as the signal-to-noise ratio remains adequate. This is obvious, as communication is possible between rooms or even between floors in the average home.

As the $RT_{60}$ time increases beyond 1.6 S, which is often the case in assembly halls, $D_{2max}$ shortens to a condition where, at $RT_{60}$ = 4.5 S, $D_{2max}$ becomes 0.62 × $D_{LIM}$. In our example, the empty room with the acoustical tile ceiling will have good articulation throughout, while without the tile, articulation would only be good to 13 feet from the loudspeaker.

*Distance between the loudspeaker and the farthest listener ($D_2$)* should always be less than $D_{2max}$. If this cannot be achieved by placing the loudspeakers on the stage, they should be moved closer to the audience or actually placed in the audience area. This requires consideration of time delay; however, in the assembly hall of our example, time delay will not be a problem. It starts to become a problem when the distance between sound sources begins to exceed 45 feet.

*The percentage articulation loss of consonants (%$AL_{cons}$)* determines whether or not the sound system will be clear enough to understand easily. A maximum %$AL_{cons}$ of 15 is used for most sound system designs since it was determined by Peutz and Klein that 15% articulation loss is tolerable unless the talker is very poor or the listener has a bad hearing defect. To keep the %$AL_{cons}$ low, we can either vary $D_2$ by proper placement of the

*Fig. 4—The effect of signal-to-noise ratio on system articulation, %$AL_{cons}$, at the limiting distance, $D_{LIM}$.*




loudspeaker or vary Q by stacking, etc. Also, we should be sure the loudspeakers are aimed at the audience, not at the back wall or ceiling. If a majority of the sound hits the audience, which absorbs sound, "m" (the ratio of the absorption coefficient where the speakers are aimed to the room's average absorption) is increased, and articulation is therefore improved. Finally, we should keep "N" as small as possible, preferably 1.

As can be seen, our assembly hall, with all hard surfaces and an $RT_{60}$ of 2.97 S with 80 people present, would never reach an $AL_{cons}$ of 15% unless a loudspeaker system with a Q of 24 were available, which would usually require a large array. Under these conditions, the audiophile will be much better off just looking at the room, turning around and going home, rather than trying to overcome the laws of nature.

*Signal-to-noise ratio* is an important consideration, not only for good articulation, but also for low listener fatigue. Since the living room is usually quiet and its $RT_{60}$ is low, the S/N can be as low as 10 dB. Volume, therefore, is usually adjusted for listener preference, not for a proper S/N.

In the assembly hall, S/N is important, because the $RT_{60}$ and the noise level are usually higher. Figure 4 gives the required S/N ratios for various $RT_{60}$ environments. It is important that the noise be kept as low as possible so the signal will not have to be excessive. High noise means high signal requirement, which translates to more chance of feedback, loudspeaker failure, insufficient power, and higher reverberant noise.

*Power requirement* is an important consideration when using home stereo loudspeakers for sound reinforcement in an assembly hall. Most home loudspeakers have low efficiency and therefore require high power to drive them to acceptable levels.

In the living room, where projection distances are small, low-efficiency loudspeakers and high-power amplifiers are adequate. For instance, with a $D_c$ of 4.6 feet and a quasi-diffuse or reverberant room, we can assume the signal will be down about 4.5 dB from the 4-foot reference point at the 13-foot seating position. If the loudspeaker

**Another useful concept is limiting distance, which is the maximum distance where loudspeaker articulation remains adequate.**

has a sensitivity of 82 dB SPL at 4 feet with a 1-watt input, then the same 1-watt input would produce an SPL of 77.5 dB SPL at 13 feet. Doubling the power increases the SPL by 3 dB, so, to produce a peak SPL of 100 dB at 13 feet, a 131-watt amplifier would be required. Because of the crest factor, or the fact that music signals are not sine waves, the average SPL would only be 90 dB when the peaks reach 100 dB. If the same signal were coming out of both stereo channels, which might or might not be the case, the total peak SPL would be 103 dB, and the peak amplifier power would be 131 watts per channel.

If we used the same loudspeaker in the assembly hall with the acoustical tile ceiling and 80 people, we would require over 7 dB more power than in the living room, or 955 watts to produce 103 dB peak SPL. While it is possible but not practical to find an amplifier with 900 watts of output power, the loudspeakers will not withstand the power and would self-destruct.

In the same hall, an efficient loudspeaker with a sensitivity of 97 dB SPL at 4 feet for 1 watt, as is used in theaters and in professional installations, would only require 30 watts of power to produce a peak SPL of 100 dB. While low-efficiency loudspeakers are adequate for home use with today's high-power amplifiers, they can be completely unsatisfactory for sound reinforcement.

*Number of open microphones (NOM)* affects the gain before feedback. Each time the number of open microphones is doubled, the gain is reduced 6 dB; therefore, all unused microphones should be turned off. To avoid feedback while keeping system gain the same with two microphones as with one, the talker would have to be 30% closer to the microphones—with four mikes, 50%. (NOM is not shown in our comparison table, as it is not a factor in the home, where there usually are no open microphones.)

### Conclusions

What does all this mean? When putting in a temporary sound reinforcement system be aware of the problems you can come up against and, just as important, know which problems you can correct and when you should walk away from the whole thing. Some simple rules to follow are:

- Aim the loudspeakers at the audience.
- Try to aim the speakers so that only the audience area, not the walls, ceiling and space above the audience's head, is covered.
- Keep the distance between the loudspeaker and the microphone greater than $D_c$.
- Hang the loudspeaker above the stage so it will not blast the front rows; this will also improve naturalness.
- Use efficient loudspeakers whenever possible.
- Never try to obtain frequency response from d.c. to infinity. Roll off the high and low frequencies which cause amplifier and loudspeaker failure and reduce articulation.
- Keep the distance between the talker and the microphone about 6 inches.
- Use as few microphones as possible.
- Do not split the loudspeakers on each side of the stage.
- Keep the furthest listener in the audience as close to the loudspeaker as possible.

There is no such thing as luck when installing a sound system: All system parameters can be calculated and results guaranteed before the system is installed. Any audiophile planning to install a sound reinforcement system should enroll in an audio seminar such as those run by Syn-Aud-Con and should read *Sound System Engineering* by Don and Carolyn Davis, who operate Syn-Aud-Con. Their address is P.O. Box 1115, San Juan Capistrano, Cal. 92693.

## APPENDIX

1. $RT_{60} = 0.049\ V/S\bar{a}$ (Sabine equation).

2. Q is the Directivity Factor of a loudspeaker system.

$$Q_{rectangular} = 180/\text{arc sin}\ [(\sin\{\theta/2\})(\sin\{\phi/2\})]$$

$$Q_{conical} = 2/(1 - \cos\{\theta/2\})$$

where $\theta$ is the horizontal coverage pattern and $\phi$ is the vertical coverage pattern. Theoretical Q is calculated with no variation in SPL within the coverage pattern. It is impossible to achieve, and all manufacturers use actual Q, which has no variation in SPL on-axis but is −6 dB at the edge of the coverage pattern. A good approximation for actual Q is the theoretical Q/2.25. The new constant-directivity horns have an actual Q close to Theoretical Q.

3. $D_c$ is Critical Distance and is equal to

$$0.03121\sqrt{QV/RT_{60}} \text{ or } 0.141\sqrt{QS\bar{a}}$$

4. $D_{LIM}$ is the Limiting Distance and is equal to 3.16 $D_c$. Actual distance for 15% articulation loss is dependent on $RT_{60}$ and S/N. Assuming an S/N of 25 dB, $D_{max}$ equals $D_{LIM}$ where $RT_{60}$ is 1.6 seconds.

5. $D_2$ is the maximum distance between loudspeaker and listener.

6. $\%AL_{cons} = (656\ D_2^2\ RT_{60}^2\ N)/(VQM)$

where N equals the number of groups of loudspeakers, M is the ratio of "a" in the coverage pattern of the speaker to the "a" of the room (normally, you should assume that both N and M are 1), and $D_2$ equals $D_{max}$. When $D_2$ is greater than $D_{LIM}$, $\%AL_{cons}$ will equal 9 $RT_{60}$.

7. $\Delta D_x$ or relative attenuation in dB equals

$$10 \log\left(\frac{Q}{4\pi(D_x)^2} + \frac{4}{R}\right)$$

where $\Delta D_x$ is the relative attenuation in dB, $D_x$ is the attenuation distance, R is the room constant, and Q is the directivity factor.

8. Electrical power required, in watts, equals

$$10^{0.1[\text{SPL desired} + 10\text{ dB crest} + (\Delta D2 - \Delta 4') - L_{sens}]}$$

where $\Delta D_2$ equals the distance from loudspeaker to furthest listener converted to relative loss in dB, $\Delta 4'$ equals 12 dB, and $L_{sens}$ equals loudspeaker sensitivity in dB at 4 feet with 1-watt input power.

# Performance-Check Your Amp and Preamp

M. J. SALVATI

## PART II
## Maximum Output Power, Power Bandwidth, Damping Factor, Preamp Maximum Input and Output Voltage, Crosstalk and Separation

Last month we showed how to check some amplifier specs using just an audio generator, a.c. voltmeter, and a few homemade accessories. Most of the performance checks discussed this month require another item of test equipment, an oscilloscope. Before you start screaming, let me say that brand-new, dual-trace triggered-sweep 'scopes are available for below $600 (Soltec 515-2, Kikusui 5020, and Iwatsu 5702), and an old Heathkit or Eico recurrent-sweep 'scope can probably be obtained for around $100. If even that is too steep for your aching wallet, a device can be built for under $10 that will serve as an oscilloscope substitute in the following measurement procedures.

That device, shown in Fig. 1, is essentially a peak rectifier which serves as a clipping indicator in conjunction with an ordinary d.c. voltmeter. Its operating premise is that when clipping occurs, the peak voltage (as indicated on the d.c. voltmeter) will not increase further as the input signal to the amplifier is increased. The only drawback is that a few amplifiers don't clip cleanly, so their peak output voltages will increase a little even when they are clipping. Obviously, $10 won't buy you the world.

To use the clipping indicator, connect a d.c. voltmeter having a range of 0 to 5 V to the output of the clipping device. (If your voltmeter doesn't have this particular range, a range of 0 to 3 or 0 to 2.5 V will do.) Your next step is to connect the input terminals of the clipping device as directed whenever an oscilloscope is called for in the measurement procedures. Use the indicator's "Range" switch to keep the meter indication on scale; use the "Polarity" switch to check if clipping is non-symmetrical (i.e., clips in one direction before the other).

### Maximum Output Power

This measurement procedure is *not* the one normally used for determining power output. Most power output measurements, including those mandated by the FTC and IHF, use the amplifier's rated distortion as the standard against which maximum power or voltage output is determined. Since good distortion analyzers are costly and specialized pieces of equipment, it is unlikely that many readers will have access to one. So, in keeping with the "simple equipment" premise of this series of articles, our maximum output measurements are limited to what the IHF calls "clipping power." In this measurement, the determinant for maximum output is the point at which clipping occurs. This is a fairly good method on modern transistorized amplifiers, since, according to Ed Foster, "today's amplifiers enter the clipping region very abruptly, and the difference in power capability as measured at some arbitrary percentage of distortion and that at clipping is negligible" ("New IHF Amp Standard," *Audio*, June 1978).

*Equipment Needed.* A signal generator, a.c. voltmeter, load resistors, and oscilloscope (or equivalent) are needed for maximum power output measurements. The signal generator and a.c. voltmeter must cover at least 20 Hz to 20 kHz. The voltmeter's accuracy should be no worse than 3% over this frequency range.

The load resistors must be capable of dissipating the full rated power output of the amplifier under test. This means large wire-wound resistors of better than 5% tolerance. You will need at least two 8-ohm resistors. If any of your power amplifiers are specified at 4 ohms, obtain four 8-ohm resistors. These can be parallel-connected as 4-ohm pairs, or all four can be used singly for 4-channel amplifiers. Ideally, the load resistors should be non-induc-

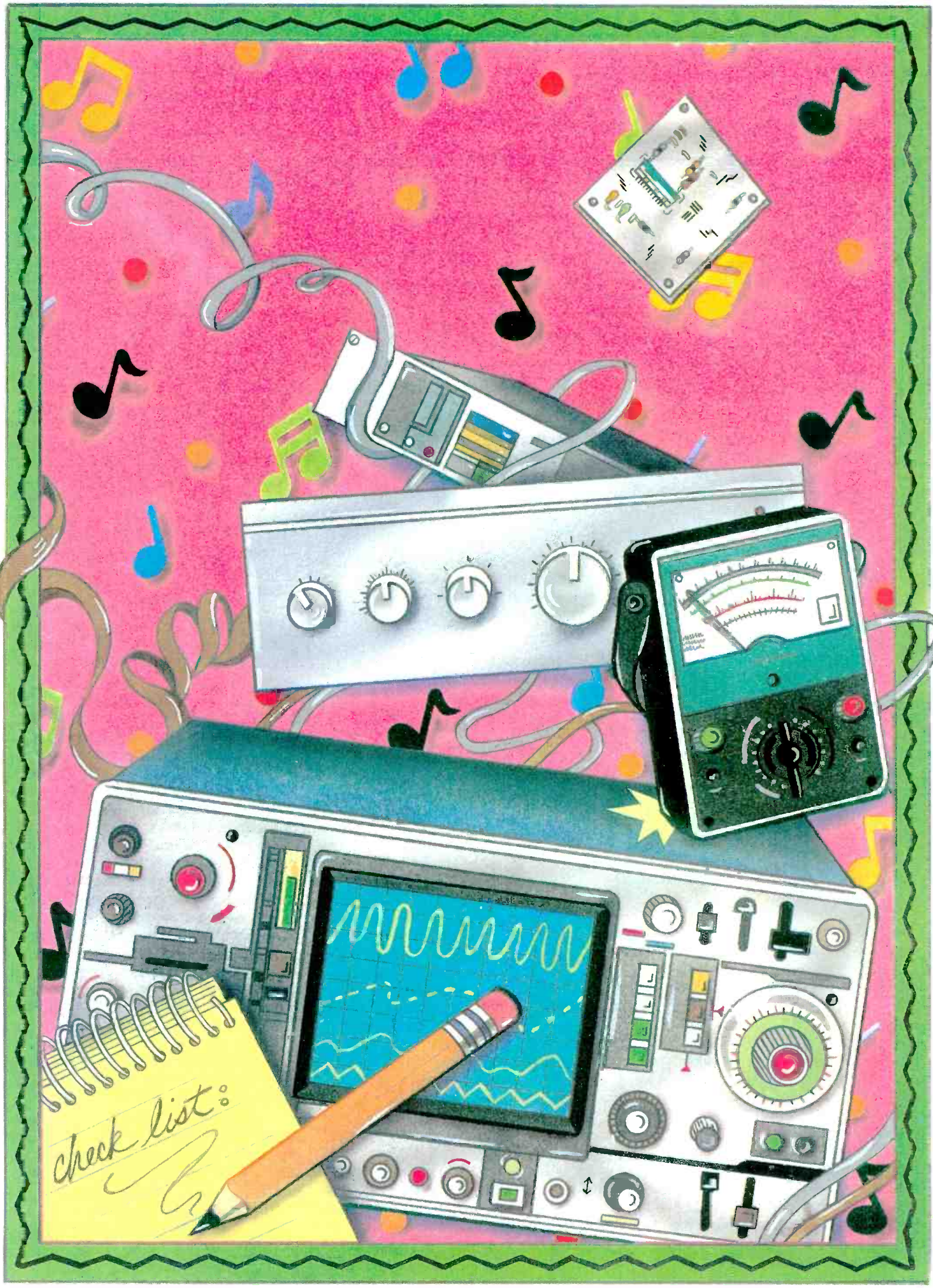


Illustration: Donna A. Corvi

**Nearly any oscilloscope ever made will do for power measurements, as it's used here only to indicate when clipping occurs.**

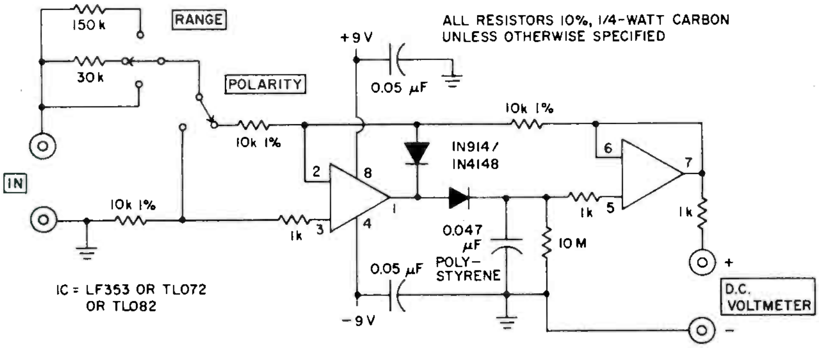



*Fig. 1—This clipping indicator can be used, in conjunction with a d.c. voltmeter, as an oscilloscope substitute in the measurements for maximum power output, power bandwidth, damping factor, and preamp maximum output voltage.*

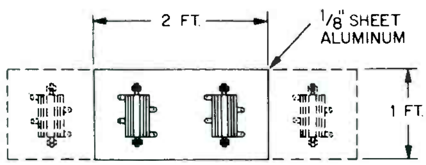



*Fig. 2—High-power load bank for 2-channel amplifier. Dashed lines show extra parts required for 4-channel or 4-ohm amplifiers.*

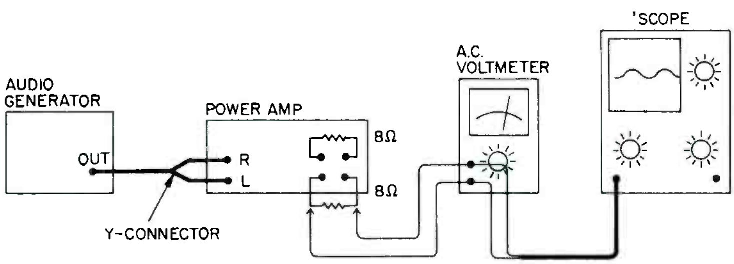



*Fig. 3—Equipment setup for measuring maximum power output and power bandwidth.*

tive at all measurement frequencies. Such resistors are available from Dale (NH250) and RCL (ALN-250) in the 250-watt size; these must be mounted on a large sheet of ⅛-inch-thick aluminum for heat-sinking (see Fig. 2). However, since these resistors are expensive and not stocked in retail stores, you will probably have to use whatever surplus bargains you can find. In all probability they will work satisfactorily, since low-resistance, high-power resistors are nowhere near as inductive as loudspeakers. Furthermore, the IHF now specifies a reactive load for some power measurements.

Nearly any oscilloscope ever made will suffice for this procedure, as its only purpose is to indicate when clipping occurs. If you don't have access to a 'scope, build the clipping indicator described above, and use it whenever a 'scope is called for.

*Basic Measurement Procedure.* To measure maximum power output, proceed as follows:

1. Turn on all equipment (Fig. 3) and allow a few minutes warmup.
2. Set any filters, equalizers, and tone, boost or loudness controls on the amplifier to their flat-response positions. Set the amplifier's volume or gain control at minimum, and its balance control for equal outputs.
3. Set the generator frequency to 1 kHz. If measuring anything other than a separate power amplifier, set the generator output level to 0.5 V. If measuring a separate power amplifier, set its level control (if any) to maximum, and the generator output level to minimum.
4. Connect the generator output to a high-level input (AUX, tuner, or tape) of each channel. Both right and left channels of a stereo amplifier must be driven; all four channels of a 4-channel amplifier must be driven. Set the amplifier's mode or function switch to match the input selected.
5. Connect appropriate high-power load resistors to the speaker terminals of each channel. Connect the a.c. voltmeter and oscilloscope to the load resistors of the channel you wish to measure.
6. Set the a.c. voltmeter range switch to a range appropriate for the amplifier's rated power. (Use the data in Table I for power-to-voltage conversions.)
7. For power amplifiers, turn up the generator output-level control until the a.c. voltmeter indicates the voltage corresponding to about one-third of the rated power output (see Table I). For amplifiers other than separate power amplifiers, turn up the amplifier's gain or volume control for one-third rated power output. Let the amplifier operate at this level for 30 minutes.
8. For power amplifiers, turn up the generator output-level control until the sine wave displayed on the 'scope screen shows signs of clipping (on either or both peaks). For amplifiers other than separate power amplifiers, turn up the amplifier's gain or volume control until clipping occurs. Then, carefully reduce the signal level to just below the point where clipping occurs.
9. Record the voltage indicated on the a.c. voltmeter, both in volts and dB (sum of dB scale and range markings on the voltmeter). This is the maximum 1-kHz output voltage. The maximum power represented by this voltage can be determined from the conversion chart in Table I.
10. Reduce the signal level by around one-third, and change the audio generator frequency to 20 Hz.
11. Repeat Step 8.

**If you measure wide-band damping factor, make sure your DVM is usable from 20 Hz to 20 kHz. Many low-priced DVMs do not function well past 1 kHz.**

*Table I—Power, voltage, and dBmW conversions.*

| Power (8-Ohm Load) | Power (4-Ohm Load) | Voltage | dBmW* |
|---|---|---|---|
| 500 | 1000 | 63.2 | 38.2 |
| 450 | 900 | 60.0 | 37.8 |
| 400 | 800 | 56.6 | 37.2 |
| 350 | 700 | 52.9 | 36.7 |
| 300 | 600 | 49.0 | 36.0 |
| 250 | 500 | 44.7 | 35.2 |
| 220 | 440 | 42.0 | 34.7 |
| 200 | 400 | 40.0 | 34.2 |
| 180 | 360 | 37.9 | 33.8 |
| 160 | 320 | 35.8 | 33.3 |
| 150 | 300 | 34.6 | 33.0 |
| 140 | 280 | 33.5 | 32.7 |
| 130 | 260 | 32.2 | 32.4 |
| 120 | 240 | 31.0 | 32.0 |
| 110 | 220 | 29.7 | 31.7 |
| 100 | 200 | 28.2 | 31.2 |
| 90 | 180 | 26.8 | 30.8 |
| 80 | 160 | 25.5 | 30.3 |
| 75 | 150 | 24.5 | 30.0 |
| 70 | 140 | 23.7 | 29.7 |
| 65 | 130 | 22.8 | 29.4 |
| 60 | 120 | 21.9 | 29.0 |
| 55 | 110 | 21.0 | 28.7 |
| 50 | 100 | 20.0 | 28.2 |
| 45 | 90 | 19.0 | 27.8 |
| 40 | 80 | 17.9 | 27.3 |
| 35 | 70 | 16.7 | 26.7 |
| 30 | 60 | 15.5 | 26.0 |
| 25 | 50 | 14.1 | 25.2 |
| 20 | 40 | 12.7 | 24.3 |
| 15 | 30 | 11.0 | 23.0 |
| 12 | 24 | 9.8 | 22.0 |
| 10 | 20 | 8.95 | 21.3 |
| 8 | 16 | 8.00 | 20.3 |
| 4 | 8 | 5.65 | 16.2 |
| 2 | 4 | 4.00 | 11.8 |
| 1 | 2 | 2.82 | 11.2 |
| 0.5 | 1 | 2.00 | 8.2 |

*0 dBmW = 0.775 V (1 mW into 600 ohms)

$$\text{Voltage} = \sqrt{\text{Power} \times \text{Resistance}}$$

$$\text{dB} = 20 \log \frac{\text{Voltage}}{0.775}$$

12. Record the voltage indicated on the a.c. voltmeter.
13. Reduce the signal level by about one-third, and change the audio generator frequency to 20 kHz.
14. Repeat Step 8.
15. Record the voltage indicated on the a.c. voltmeter.
16. Take the lowest voltage reading recorded in Steps 9, 12, and 15, and convert it to power using Table I. This power level is the measured 20 Hz to 20 kHz power output of the amplifier for the channel measured.
17. Repeat Steps 8 to 16 for each of the other channels.

*Power Bandwidth.* After setting up the equipment and measuring 1-kHz output voltage and power as described under Basic Measurement Procedure, proceed as follows:

1. Reduce the amplifier output level to 3 dB less than the voltage recorded in Step 9 of the preceding procedure. For example, if the Step 9 voltage recorded was 26.8 V (+30.8 dBmW), then reduce the level to 19 V (+27.8 dBmW).
2. Change the audio generator frequency to about 100 Hz, then slowly lower the frequency until signs of clipping appear on the oscilloscope. Record the lowest frequency at which non-clipped power output is obtainable at the −3 dB level. Make certain the amplifier output is maintained at the Step 1 level.
3. Change the audio generator frequency to about 10 kHz, then slowly increase the frequency until signs of clipping appear on the 'scope. Record the lowest frequency at which non-clipped power output is obtainable at the −3 dB level. Make certain the amplifier output is maintained at the Step 1 level.
4. The frequencies recorded in Steps 2 and 3 represent the measured −3 dB power bandwidth of the amplifier under test.

## Damping Factor

Damping factor is the measure of an amplifier's output voltage regulation, and an indirect measure of its output impedance. The higher the damping factor, the better the regulation and the lower the output impedance.

*Equipment Needed.* An audio generator, a.c. voltmeter, and load resistors are all the items necessary for this procedure. However, an oscilloscope is also recommended.

The audio generator and a.c. voltmeter need operate at only 50 Hz to 1 kHz. However, wide-band damping factor is measured over a range from 20 Hz to 20 kHz, requiring a generator and voltmeter capable of operating over this range. In either case, the a.c. voltmeter must have extremely high resolution. This rules out the ordinary analog a.c. voltmeter. Instead, a digital voltmeter must be used, preferably one that displays a minimum of four digits at all times. This means either a 4½-digit DVM, or a 3½-digit DVM used with power-scaling resistors (see Fig. 4). As the Table accompanying Fig. 4 shows, these resistors change an output voltage to the 10 to 20 V range, where a 3½-digit DVM displays four digits. Note, however, that this device can only improve the *resolution* of a low-cost instrument. If the DVM has a very limited frequency response (characteristic of low-cost DVMs), it cannot be used for measuring wide-band damping factor.

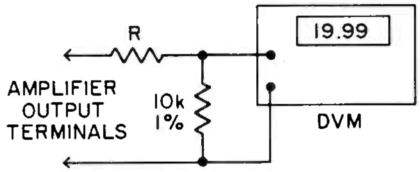
The load resistors must dissipate the full rated output power of the amplifier under test, so a high-power load bank like that used for the maximum output power measurement is needed here.

An oscilloscope (nearly any kind will do) is recommended to make sure that the amplifier under test is not clipping when driven to full rated output during the measurement. But if you know the amplifier is capable (from prior tests) of delivering its rated output, forget about the 'scope.

*Basic Measurement Procedure.* To measure damping factor, proceed as follows:

1. Turn on all equipment and allow an appropriate warmup time, about 5 minutes for semiconductor equipment

*Fig. 4—Power scaler for 3½-digit DVM. Select value for 1% resistor R from accompanying Table.*




| R (1%) | DVM Range (Volts) | Power Range (Watts) 8 Ohms | 4 Ohms |
|---|---|---|---|
| 0 | 10-20 | 12.5-50 | 25-100 |
| 10k | 20-40 | 50-200 | 100-400 |
| 30k | 40-80 | 20-800 | 400-1600 |

In the phono mode, much amplification takes place before the volume control, so it is important to know how much input causes overload.

and 15 minutes for vacuum-tube equipment.

2. Set any filters, equalizers, and tone, boost or loudness controls on the amplifier to their flat-response positions. Set the amplifier's volume or gain control to minimum, and its balance control for equal outputs.

3. Set the audio generator frequency to 1 kHz (old equipment) or 50 Hz (new equipment). If measuring anything other than a separate power amplifier, set the generator output level to 0.5 V. If measuring a separate power amplifier, set its level control (if any) to maximum, and the generator output level to minimum.

4. Connect the audio generator output to a high-level input (AUX, tuner, or tape) of *each channel*. Both right and left channels of a stereo amplifier must be driven; all four channels of a 4-channel amplifier must be driven. Set the amplifier's function selector to match the input selected.

5. Connect high-power load resistors to the speaker terminals of each channel. This connection, and that to the a.c. voltmeter, must be done in a special way to make a valid measurement. Do *not* connect the voltmeter across the load resistors. Do *not* connect the voltmeter anywhere on the wires connecting the speaker terminals to the load. Connect the DVM to the excess wire protruding past the speaker terminals, as shown in Fig. 5. Clean the portion of the wire under the post, and make sure the post is tightened.

6. Set the DVM range switch to a range appropriate for the amplifier's rated power output. If using a 3½-digit DVM, set its range switch to 20 V, and select the appropriate scaling resistors (see Table in Fig. 4).

7. For power amplifiers, turn up the audio generator's output-level control until the DVM indicates the voltage corresponding to the amplifier's rated power output (see Table I). For integrated amplifiers and receivers, turn up the amplifier's gain or volume control. Record the indicated voltage to *four decimal places*.

8. Disconnect one of the leads going to the load from the channel you are measuring. Measure the no-load voltage to four places and record it.

9. From the full-load and no-load voltages measured in Steps 7 and 8 respectively, you can determine the damping factor, percent regulation, and output impedance of the amplifier. The formulas are as follows:

$$\text{Damping Factor} = \frac{\text{Step 7}}{\text{Step 8} - \text{Step 7}}$$

$$\text{\% Regulation} = \frac{100\,(\text{Step 8} - \text{Step 7})}{\text{Step 7}}$$

$$\text{Output Impedance} = \frac{\text{Load Resistance}}{\text{Damping Factor}}$$

*Wide-band Damping Factor*. Wide-band damping factor is the minimum damping factor measured at a number of frequencies over the rated bandwidth of the amplifier. This generally means making damping factor measurements (per the Basic Measurement Procedure) at a number of different frequencies between 20 Hz and 20 kHz, unless the manufacturer claims a different bandwidth for rated power output.

If you measure wide-band damping factor, check the instruction manual of your DVM to make certain it is usable in the 20 Hz to 20 kHz range. Many low-priced DVMs do not function well (or at all) past 1 kHz.

**Maximum Input and Output Voltage of Preamps**

For the same reasons cited in the previous measurement procedure, this is *not* the method normally used to determine maximum output voltage. In this procedure, the onset of clipping is used instead of a specified distortion level as the criterion for maximum output.

*Equipment Needed*. A signal generator, a.c. voltmeter, load resistors, and oscilloscope (or equivalent) are needed for maximum output-voltage measurements. The signal generator and a.c. voltmeter should cover 10 Hz to 100 kHz as a minimum. The voltmeter accuracy should be no worse than 3% over this frequency range.

The load resistors are the same as those used for S/N ratio and frequency response measurements, discussed in last month's issue: 10-kilohm, 5%, ¼-watt carbon-film resistors paralleled by 1,000-pF capacitance.

Nearly any oscilloscope will suffice for this procedure. If you don't have access to a 'scope, use the clipping indicator described at the beginning of this article for the Basic Measurement Procedure.

A step attenuator having 20- and 40-dB outputs is needed for the phono overload voltage measurement procedure. The homemade one described in last month's article is ideal.

*Basic Measurement Procedure*. To

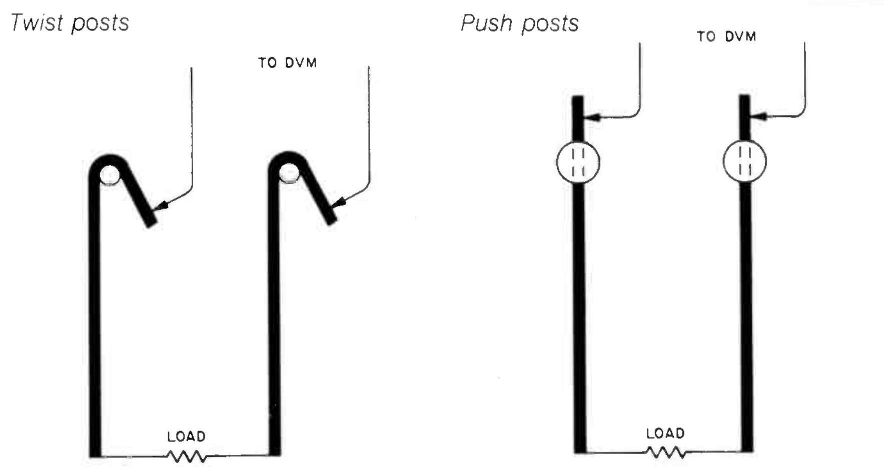



*Fig. 5—Connection techniques for damping-factor measurement. Note that DVM is* not *connected between the amplifier and load resistor.*

Crosstalk is the leakage of an unselected signal (such as tuner, when you're in phono mode). Separation is signal leakage between stereo channels.

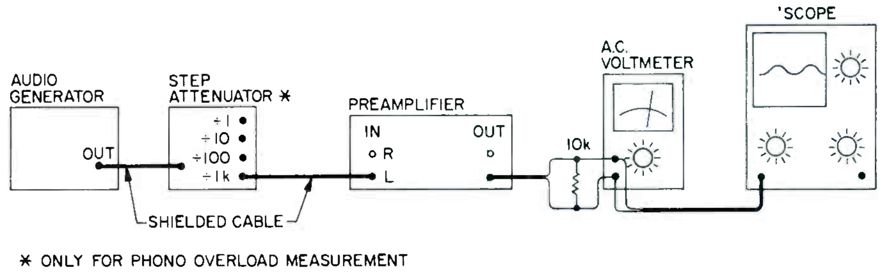



*Fig. 6—Equipment setup for measuring preamp maximum input and output voltages. Note that step attenuator shown here is only for phono overload voltage measurement.*

measure maximum output voltage, proceed as follows:

1. Turn on all equipment (Fig. 6) and allow an appropriate warmup time, about 5 minutes for semiconductor equipment and 15 minutes for vacuum-tube equipment.

2. Set any filters, equalizers, and tone, boost or loudness controls on the amplifier to their flat-response positions. Set the amplifier's volume or gain control to maximum, and its balance control for equal outputs.

3. Set the audio generator frequency to 20 Hz, and its output level at minimum.

4. Connect the generator output to a high-level input (AUX, tuner, or tape) of one of the channels. Set the amplifier's mode or function switch to match the input selected.

5. Connect the a.c. voltmeter and oscilloscope (or equivalent) to the output jack of the measurement channel. Connect the load across the a.c. voltmeter input terminals.

6. Set the a.c. voltmeter range switch *one range higher* than is appropriate for the amplifier's *rated* output voltage.

7. Turn up the audio generator's output level until clipping occurs on either peak, as displayed on the oscilloscope. Note: Clipping is often not symmetrical in voltage amplifiers, so if you are using the clipping indicator instead of a 'scope, do this step twice (once for each position of the polarity switch) and look for the lowest output voltage at which clipping occurs.

8. Readjust the a.c. voltmeter range switch (if necessary) for an on-scale indication. Record the voltage indicated.

9. Disconnect the a.c. voltmeter from the preamp's output terminals, and reconnect it to the audio generator output. Note: If your generator has low output impedance, there is no need to disconnect the 10-kilohm load from the voltmeter input terminals.

10. Measure and record the generator output voltage (preamp input voltage) with the a.c. voltmeter.

11. Repeat Steps 3 to 10 at 1 kHz and 20 kHz. The *lowest* Step 8 voltage recorded is the measured 20 Hz to 20 kHz maximum output voltage for that channel. The lowest Step 10 voltage recorded is the measured 20 Hz to 20 kHz maximum high-level input-signal voltage for that channel at full gain.

12. Repeat Steps 3 to 11 for the other channel.

*Phono Overload Voltage.* In the phono mode, considerable amplification takes place before the amplifier's volume or gain control, so it is important to know how much input voltage can be applied before the phono preamp overloads. Because of the equalization involved in the phono circuitry, measurements are made at 1 kHz only. Note: This variation of maximum input voltage also applies to receivers and integrated amplifiers.

1. Turn on all equipment (Fig. 6) and allow an appropriate warmup time, about 5 minutes for semiconductor equipment and 15 minutes for vacuum-tube equipment.

2. Set any filters, equalizers, and tone, boost or loudness controls on the amplifier to their flat-response positions. Set the amplifier's volume or gain control to minimum, and its balance control for equal outputs.

3. Set the generator frequency to 1 kHz, and its output level to 0.5 V.

4. Connect the generator's output to the attenuator input. Connect the appropriate attenuator output jack to the phono input you wish to measure. Use the −20 dB output for a high-level (MM) phono input; use the −40 dB output for a low-level (MC) phono input.

5. Connect the oscilloscope to the output jack of the measurement channel. Connect the load across the 'scope terminals. Note: A 'scope is mandatory; the substitute clipping indicator is not usable in this procedure.

6. Connect the a.c. voltmeter across the attenuator output. Use a T- or Y-connector to feed the attenuator output to both the a.c. voltmeter and the phono input. Set the voltmeter range switch to 1 V.

7. Turn up the amplifier's volume or gain control until clipping occurs on either peak, as observed on the 'scope. At this point clipping is due to limiting in the amplifier output stage.

8. Reduce the volume or gain control setting until clipping disappears, then increase the generator output level until clipping reappears. Continue doing this until reducing the volume or gain control setting *no longer prevents clipping*.

9. When you have precisely determined the lowest generator output level at which clipping occurs regardless of the amplifier's volume control setting, adjust the a.c. voltmeter's range switch for maximum on-scale deflection, and record the voltage in millivolts. This is the phono input overload voltage.

10. Repeat Steps 3 to 9 for the other channel.

**Crosstalk and Separation**

Crosstalk is the leakage of an unselected signal source into the signal chain (e.g., tuner signal leakage when the function selector is set to phono). Separation is the leakage of one channel's signal into the other channel. These specifications are only occasionally given in manufacturers' specifications for amplifiers, so I've saved this test procedure for the end of the series. Still, crosstalk symptoms are a common occurrence in complex audio systems, so these procedures are very useful in isolating their cause.

*Equipment Needed.* Crosstalk and separation measurements require an

Channel-to-channel separation can be measured on power amps as well as on preamps, receivers, integrated amps, and equalizers.

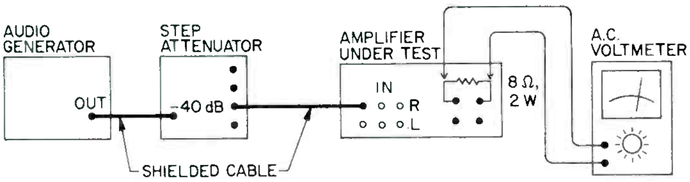



*Fig. 7—Equipment setup for measuring crosstalk and separation (shown for integrated amplifier or receiver).*

audio generator and a.c. voltmeter operable at 1 kHz, load resistors, and input terminations. For measurements involving phono inputs, an attenuator is also required.

The a.c. voltmeter must be equipped with dB scales if you wish to avoid excessive calculations and dB conversions. Ideally, its most sensitive range should be −80 dB (100 μV, full scale). Since voltmeters of this type are expensive, a −40 dB (10 mV, full scale) voltmeter preceded by a 40-dB amplifier is a good substitute. The filter/amp described in last month's article is highly suitable for this purpose.

The input terminations are 1 kilohm for most inputs, and 100 ohms for MC phono inputs. You can make these yourself, as described last month.

The load resistors needed are a pair of 16-ohm, 5%, 1-watt carbon resistors, connected in parallel, for each power-amplifier output, and a 10-kilohm, 5%, ¼-watt carbon resistor paralleled by 1,000-pF capacitance for each preamp output. However, if you use the filter/amp as a voltmeter preamplifier, its own input impedance will serve as a suitable load for preamp outputs.

A 40- or 60-dB attenuator (such as the homemade one described in Part I) is needed only if a phono input is driven.

*Crosstalk Measurement Procedure.* To measure crosstalk between inputs of the same channel, proceed as follows:

1. Turn on all equipment (Fig. 7) and allow an appropriate warmup time, about 5 minutes for semiconductor equipment and about 15 minutes for vacuum-tube equipment.

2. Set any filters, equalizers, and tone, boost or loudness controls on the amplifier to their flat-response positions. Set the amplifier's volume or gain control to minimum, and its balance control for equal outputs.

3. Connect the audio generator output to the attenuator input, and the appropriate attenuator output jack to one of the amplifier's input jacks. Use the 0-dB output (or no attenuator at all) if driving the AUX, tuner, tape, etc. inputs, the −40 dB output for high-level (MM) phono, and the −60 dB output for low-level (MC) phono.

4. Insert input terminations in the undriven inputs of the channel being measured. Use 1-kilohm terminations for AUX, tuner, tape and MM phono, and 100-ohm for MC phono inputs.

5. Set the generator frequency to 1 kHz, and its output level to 0.5 V.

6. Connect the appropriate loads across the amplifier output terminals. Use 8 ohms, 2 watts (minimum) for receivers and power amplifiers, and 10 kilohms for preamps. Connect the a.c. voltmeter input terminals across the load resistor of the channel being measured.

7. Set the a.c. voltmeter range switch to 0 dB for preamps, or +10 dBmW for receivers.

8. Set the amplifier's function or mode selector to match the driven input. Then, adjust the amplifier's volume or gain control for a 0-dB indication on the a.c. voltmeter. Use 2.45 V (+10 dBmW) for receivers and 0.775 V (0 dBmW) for preamps.

9. Set the amplifier's function or mode selector to one of the terminated inputs.

10. Down-range the a.c. voltmeter until you get a usable indication. If necessary, add additional amplification between the amplifier output and a.c. voltmeter. (If you use the filter/amp described in last month's article, select C-weighting.)

11. Record the a.c. voltmeter indication in dB. The crosstalk between the driven and the selected terminated inputs is the difference between the reference level and the sum of three dB figures: The meter range, the meter scale, and the filter/amp gain (if used). For our calculations, use the plus or minus signs of the meter scale and meter range switch as marked, and consider the filter/amp gain as negative. For example, if we were measuring crosstalk between two *preamp* inputs (0-dBmW reference), the meter scale might indicate −6.5 dB when the meter range switch is set to its −20 dB position and 40-dB extra amplification is used. We then simply add these figures like so:

−6.5 −20 −40 =
−66.5 dB crosstalk.

However, if we were measuring a receiver or integrated amplifier, the extra 10-dB for the Step 8 reference level must also be algebraically subtracted. Assuming the same numbers, the crosstalk is:

−6.5 −20 −40 −(+10) =
−76.5 dB crosstalk.

12. In turn, reset the amplifier's function or mode switch to each of the other terminated inputs, and repeat Step 11.

13. Repeat Steps 3 to 12 for the other channel.

*Separation Measurement Procedure.* Channel-to-channel separation can be performed on power amplifiers as well as on preamps, receivers, integrated amplifiers, and equalizers. This measurement procedure is very similar to Steps 1 to 11 of the Crosstalk Measurement Procedure. The exceptions are as follows: In Step 4, terminate the corresponding input of the undriven channel. In Step 9, do *not* disturb the amplifier's function or mode selector setting. Instead, switch the a.c. voltmeter to the load resistor of the *undriven* channel.

I hope that these relatively inexpensive methods of checking the basic performance parameters of your stereo system will prove of value. Bear in mind that these approaches will not yield measurements of utmost accuracy. However, being able to make the tests at all, without the investment of thousands of dollars, is certainly worth consideration.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# HARMAN/KARDON CD491 CASSETTE DECK


**Manufacturer's Specifications**

**Frequency Response:** 20 Hz to 24 kHz, to 26 kHz with metal tape.

**Signal/Noise Ratio:** 66 dB with Dolby B NR, 75 dB with Dolby C NR.

**Input Sensitivity:** Mike, 0.8 mV; line, 40 mV.

**Output Level:** Line, 420 mV.

**Flutter:** 0.025% wtd. rms, ±0.04% wtd. peak.

**Fast-Wind Times:** 70 S with C-60.

**Dimensions:** 17-7/16 in. (443 mm) W × 4-13/16 in. (123 mm) H × 14 in. (355 mm) D.

**Weight:** 15.9 lbs. (7.2 kg).

**Price:** $785.00.

**Company Address:** 240 Crossways Park West, Woodbury, N.Y. 11797.

For literature, circle No. 90

Harman/Kardon calls the CD491 an "ultra-wideband linear-phase cassette deck," which certainly sounds good and arouses the curiosity of testers and users alike. The front panel is a very light beige, and the black designations are easy to read under any normal lighting. When the power switch is pushed on, "Wait" appears in red on the meter/display panel. After 7 seconds, it turns off, and "0" appears in the counter readout to the left. The counter displays up to four digits ("2310" for one side of a C-90), but leading zeros are blanked out—a nice touch. Counting below zero in rewind is from "9999" down. A push of "Time," and the counter will show play or record time in minutes and seconds, which is a very helpful feature. The time/position reference is not maintained during fast-wind modes; instead, the display automatically switches to normal counter mode. Therefore, you can't locate passages on tape by their timing, or estimate remaining time if you start in mid-tape.

With "Rewind" alone pushed in, the deck will rewind to the beginning of the tape and stop. If "Replay" is actuated at the same time, the deck goes into play instead, and the process continues until interrupted. If "Memory" is enabled, the basic action is the same, but the stop on rewind is at "0000."

There are three pushbutton switches of the same design for noise-reduction settings: "Off/On," "B/C" and multiplex filter "On/Off." Status indicators for "B" (green) and "C" (yellow) are located at the opposite end of the display panel, to the right of the meters. The filter is off when its


switch is pushed in, the reverse of what I had expected. Just below the NR pushbuttons is the tape monitor switch, which latches in for tape playback, turning on a red LED at the same time.

To the right of the noise-reduction switches are "Bias/Equalization" controls. Three interlocked tape-select switches are on the top row, for "LN" (Type I), "$CrO_2$" (Type II), and "Metal" (Type IV). Just below are momentary-contact "Bias Tone" and "Rec Cal" pushbuttons, both used in the calibration procedure. With "Bias Tone" pushed in, 400 Hz is fed to the left channel and 12.5 kHz to the right. "Bias Fine Trim," to the left of the button, is adjusted to match the indicated channel levels in playback. This trim control has a center detent, and labels remind the user that rotation to the left reduces the highs, while rotation to the right boosts them.

When "Rec Cal" is pushed in, 400 Hz is fed to both channels. A supplied adjustment tool is put into the "Left" and "Right" holes, in turn, to set the indicated levels to meter zero, thus ensuring good Dolby tracking. The interlocked "Play/Off/Rec" switches for timer operation are just above.

The horizontal bar-graph-type meters have 16 segments. They cover from −30 to +10 dB, with light green LEDs from "−30" to "−1," yellow from "0" to "+2" and red for "+3" to "+10." Dolby level is at meter zero, which helps to minimize confusion, in my view. The "HX PRO" logo, just to the right, announces the incorporation of this latest version of circuitry for high-end extension. Normally, the peak-responding meters do not hold peak readings, but with a push of "Peak Hold," maximum indications will be held about 2 seconds, which aids in the level-setting when recording. The unique "Meter Weighting" button equalizes the meter amp to the inverse of the saturation curve of tapes recorded on the CD491. In the weighted mode, the first red meter LED ("+3") indicates the tape overload point. The effect, as with the more common scheme of metering the signal after record EQ, gives a much better indication of the possibility (or probability) of reaching high-frequency saturation. The switch also allows for so-called normal metering.

Along the bottom of the front panel are four level-control knobs of medium size with very fine knurling for easy turning. The left and right "Rec Level" pots control only the line inputs. The "Mic Level" control affects both channels, providing full mixing, and there is a soft detent at the "Off" position—to help prevent it from being turned up inadvertently. The "Output Level" pot controls both line and headphone outputs, but it has no effect on meter indications.

The "Master Fader" sets the level for the two-channel mix. This large knob makes for very easy setting at any point up to its maximum rotation, which is just 180°—different from most pots, but just fine in practical use.

The transport-control switches, beneath the cassette compartment, have light-touch plates with status lights for all functions (except "Stop"). The logic allows you to change directly from any mode to any other mode, including going into record mode while in play. In "Pause" or record/pause mode, the indicator on "Play" flashes, telling the user that it is the button to push next. Simultaneously pushing "Play" and either fast-wind switch engages "Auto Search," which finds the beginning (or end) of the current selection, then automatically resumes play.

Immediately to the right of the transport controls are momentary-contact switches labelled "Rec Mute" and "Auto Space." The latter provides an automatic muting for 5 seconds and then a switch into record/pause. Whenever there is muting, the "Record" indicator flashes (instead of glowing), reminding the user that no signal is being recorded.

The cassette-compartment carrier swings down briskly with a push of "Eject," at the upper left corner of the front panel. Loading and maintenance are easy tasks, as they are for most front loaders these days.

The "Headphones" jack is on the front panel (at the lower right corner), but the two microphone jacks are on the back, The bias adjustment range extended far enough down for even non-premium tapes, but not quite high enough for tapes needing high bias for their type.

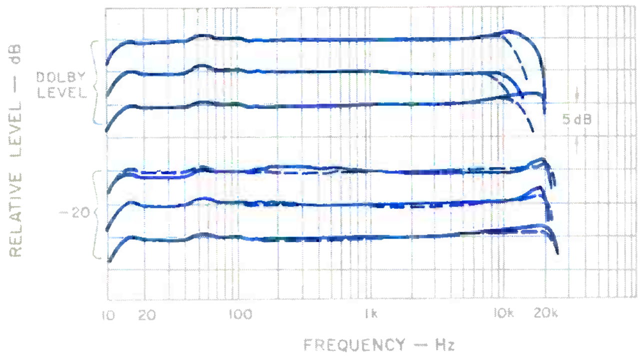



**Fig. 1—Frequency responses with (solid lines) and without (dashed lines) Dolby C NR, using Type I (BASF Pro I Super), Type II (Sony UCX), and Type IV (Fuji FR Metal) tapes.**

which seems unnecessarily out of the way. A single microphone plugged into either jack is fed equally to both channels, which gives a little more convenience than having just one jack provide the mono function. The line in/out jacks, of course, are also on the back panel.

My internal inspection found two large p.c. boards that combined to fill the chassis, with a metal partition between them acting as both shield and heat-sink. Soldering was excellent, with slight flux residue at a couple of points. All parts and adjustments were labelled, and the components were of high quality and well laid out. There were two fuses in clips. A listening check proved the quietness of the dual-capstan drive. The removed top-and-side cover had what appeared to be vibration-damping pads on its interior surface, an unusual attention to detail to minimize distracting noises.

**Measurements**

The playback responses were checked using TDK and BASF alignment tapes. Most points were within ±1.5 dB, but there was some additional boost at the low end from fringing effects, and the high end was down almost 3 dB at 10 kHz and more at higher frequencies. It appeared likely that there would be some benefit from a touch-up azimuth alignment, which is actually a good idea for any deck about to be put in use. Playback level indications were close, within the resolution of the meter segments. Playback tape speed was just 0.2% slow.

The CD491 record/playback performance was checked with many different tape formulations of all types, except Type III (ferrichrome). The bias adjustment range extended far enough down to handle even non-premium Type I tapes, but it did not quite reach high enough for tapes whose bias requirements are relatively high for their type, such as Maxell XL I-S, Sony AHF and TDK AD-X (all Type I), and Memorex HBII (Type II). Results were excellent with the manufacturer's reference tapes, Maxell XL I and TDK SA and MA, but I had a slight preference for the response shapes of BASF Pro I Super, Sony UCX and Fuji FR Metal, so I used them for the detailed testing that followed.

Figure 1 shows the swept-frequency responses at Dolby level and 20 dB below that for these three tapes, both with and without Dolby C NR. As the data in Table I demonstrates, the responses are extended at both ends of the band under all conditions, certainly improved at the high end by HX Pro. The responses are outstanding, both for their flatness from below 20 Hz to 10 to 20 kHz and for their excellent Dolby NR tracking. This latter result proves the success of the Harman/Kardon deck's two-tone calibration. With Sony UCX tape, the 400-Hz (403-Hz actual) level could be set anywhere from −4 to +2.5 dB relative to meter zero. The bias control varied this tape's output of the 12.5-kHz (actually 11.6-kHz) tone from −2 to +4.3 dB on the meter. Both test tones had distortion of about 1%, plenty low enough for the purpose.

Table II lists the excellent results of other record/playback tests. The 70-dB erasure figure at 100 Hz held true even with metal tape, definitely better than most decks can do.

Third-harmonic distortion ($HDL_3$) was measured from 10 dB below Dolby level to the limit of 3% distortion for the three tapes with Dolby C NR. The results are uniformly excellent and quite superior to those from the great majority of decks. Since noise is measured relative to the signal level at which this 3% limit is reached, with the CD491's low distortion, raising this level effectively raises the signal-to-noise ratios. This is indicated by the excellent results shown in Table IV for all three tape types. The distortion was also measured as a function of frequency with Fuji FR Metal tape at −10 dB, from 30 Hz to 6 kHz. The low distortion at all points is judged to result from the success of HX Pro as well as the basic low-distortion performance.

Table VI lists the input and output characteristics at a test frequency of 1 kHz. All of the results were equal to or better than specification. The line-input overload level was above the 30-V limit of the driving amplifier. The output test loads were 10 kilohms for line and 50 ohms for headphones. There was high volume to all headphones tried, easily controllable with the output pot. If a single microphone input was used, the left-channel level was 1.5 dB higher than that of the right channel, which would shift this mono image slightly to the left. The sections of the mike input pot tracked within 1 dB for up to 60-dB attenuation from maximum gain. The master pot, on the other hand, tracked for just 20 dB to the same 1-dB limit. It would be best to keep it near maximum when matching channel levels. The deck had low sensitivity to internal overload at meter zero, even with the master set at lower clockwise rotation than the channel pots. This is a good feature of this deck, but it's still normally good practice to keep the master at least as open as the channel pots when operating. The output polarity was the same as the input, whether in source or tape monitor, which is the preferred configuration.

The peak-responding meters were truly that, as they met the requirements of IEC Standard 268-10 for peak-program meters. The thresholds for most of the segments were very close to their designated values, particularly from "−2" to "+10." The lower segments turned on at levels much higher than designated, however, with "−30" at −21 actual and "−20" at −15 actual, for example. With meter weighting out, the response was 3 dB down at 10.7 Hz and 40.0 kHz.

For its sizable price, the CD491 provides performance comparable to decks at twice the price.

With weighting switched in, the high-frequency boost was 5 dB at 5 kHz, 10 dB at 10.6 kHz, 13 dB at 15.5 kHz and the maximum +17 dB at 26.6 kHz. I prefer metering with this post-EQ boost, for it is much more indicative of saturation and distortion limitations across the band.

The flutter measured on the Harman/Kardon deck varied a bit with the cassette selected. It was possible to find some that met the specifications of 0.025% wtd. rms and ±0.04% wtd. peak, which are very low figures indeed. More typical figures in my measurements were 0.032% wtd. rms and ±0.044% wtd. peak, which are slightly higher, but *excellent*.

Tape play speed varied very slightly with changes in line voltage, up less than 0.01% at 130 V. There were fairly regular speed variations of a minor nature, always less than 0.025%. The fast-wind times for a C-60 were 71 S. Most changes in transport mode were accomplished in 1 S or less.

## Use and Listening Tests

The owner's manual has good, lucid text with nice detailing on recording, setting levels, bias trimming, and record-sensitivity calibration. The illustrations are good, but there's no block diagram, which would have been nice. Maintenance was basically easy to do, although I wished the thumbscrews for the door cover were captive. All controls and switches were completely reliable during the testing. After a number of decks with automatic tape-type sensing, I did have to remind myself to push the tape-matching selector switch. As I usually check bias trim and record calibration, this was really no inconvenience.

The metering was excellent in use, certainly one of the best for dynamic responses, and further improved with the weighting switched in. It was possible to set maximum levels very quickly and with more assurance than when metering without the weighting. The peak-hold feature was a further aid to getting the maximum out of the tapes. A check of record, pause and stop clicks showed that they were very low, just a bit out of tape noise with Dolby C NR. There was no evidence of any Dolby mistracking at any level with any of the tapes, showing what can be done with good deck setup and excellent responses to start with.

I enjoyed much pleasurable listening, from sources such as *The Empire Strikes Back* (Charles Gerhardt and the National Philharmonic Orchestra, dbx version of Chalfont SDG 313) and Mobile Fidelity's Kim Carnes' *Mistaken Identity* (MFSL 1-073) and *The Planets* by Holst (Solti and the London Philharmonic Orchestra, MFSL 1-510). The time function of the counter was helpful in fitting certain pieces onto partly recorded tapes.

The Harman/Kardon CD491 lacks a number of sophisticated microprocessor-controlled features, and it doesn't have automatic tape calibration or tape-type sensing, but recorders with such a collection of features cost a lot more. For its sizable price, this deck provides superb frequency responses, a convenient and accurate calibration scheme to match most tapes, excellent Dolby NR tracking, very low noise and distortion with all three tape types, very low flutter, good mike/line mixing, and excellent metering. Where the final tape is the criterion, the CD491 is worthy of comparison to other decks at up to twice its price. *Howard A. Roberson*

### 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 |
| BASF Pro I Super | 10.2 | 17.2 | 10.2 | 22.1 | 10.2 | 12.4 | 10.0 | 24.1 |
| Sony UCX | 10.1 | 12.8 | 10.0 | 21.1 | 10.1 | 10.5 | 10.0 | 22.2 |
| Fuji FR Metal | 10.0 | 21.4 | 9.9 | 25.0 | 10.0 | 15.9 | 9.9 | 25.2 |

### 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 |
|---|---|---|---|---|---|
| 70 dB | 43 dB | −80 dB | 20° | 6° | −35.4 dB |

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

| | | Record Level | | | | | |
|---|---|---|---|---|---|---|---|
| Tape Type | NR | −10 | −8 | −4 | 0 | +4 | $HDL_3$ = 3% |
| BASF Pro I Super | Dolby C | 0.06 | 0.10 | 0.15 | 0.32 | 1.1 | +6.5 dB |
| Sony UCX | Dolby C | 0.05 | 0.09 | 0.19 | 0.45 | 1.3 | +6.5 dB |
| Fuji FR Metal | Dolby C | 0.09 | 0.16 | 0.29 | 0.47 | 1.1 | +7.8 dB |

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

| | IEC A Wtd. (dBA) | | | | CCIR/ARM (dB) | | | |
|---|---|---|---|---|---|---|---|---|
| | W/Dolby C NR | | Without NR | | W/Dolby C NR | | Without NR | |
| Tape Type | @ DL | HD=3% | @ DL | HD=3% | @ DL | HD=3% | @ DL | HD=3% |
| BASF Pro I Super | 67.5 | 73.7 | 50.5 | 56.5 | 66.7 | 72.9 | 47.9 | 53.9 |
| Sony UCX | 70.4 | 76.5 | 54.5 | 60.4 | 70.8 | 76.9 | 52.4 | 58.3 |
| Fuji FR Metal | 69.2 | 76.8 | 53.3 | 60.6 | 69.8 | 77.4 | 51.2 | 58.5 |

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

| | | Frequency (Hz) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Tape Type | NR | 30 | 50 | 100 | 400 | 1k | 2k | 4k | 6k |
| Fuji FR Metal | Dolby C | 0.22 | 0.18 | 0.19 | 0.09 | 0.14 | 0.10 | 0.03 | 0.10 |

### 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 | 33 mV | >30 V | 19 | Line | 422 mV | 389 mV | 900 | +12.7 dB |
| Mike | 0.5 mV | 29 mV | 4.9 | Hdphn. | 430 mV | 225 mV | 46 | |

2

# TECHNICS SH-8055 GRAPHIC EQ/RTA

**Manufacturer's Specifications**
**Frequency Response:** 5 Hz to 100 kHz.
**Rated Sensitivity/Output Voltage:** 1 V.
**Harmonic Distortion:** 0.003% from 20 Hz to 20 kHz.
**Maximum Output:** 8 V.
**Filter Center Frequencies:** Two sets at 25, 40, 63, 100, 160, 250 and 500 Hz, 1, 2, 4, 8 and 16 kHz.
**Control Range:** ± 12 dB.
**Pink-Noise Output:** 50 mV.
**Dimensions:** 16-15/16 in. (430 mm) W × 4¼ in. (108 mm) H × 10⅝ in. (270 mm) D.
**Weight:** 9 lbs. (4.1 kg).
**Price:** $340.00; optional RP-3800E microphone, $60.00.

**Company Address:** Panasonic, One Panasonic Way, Secaucus, N.J. 07094.
For literature, circle No. 91


Technics calls the SH-8055 a stereo graphic equalizer, but that title fails to do justice to this unit, which includes a most-useful RTA (real-time analyzer) and a built-in pink-noise generator. The SH-8055 is configured with 12 bands of equalization and analysis, two more for each channel than the typical octave-band unit. The RTA display, at the left of the front panel, shows the 12 band levels with bright, bluish-white fluorescent bar-graphs, which are very easily seen under any ambient lighting. At the right of the display, there is a somewhat wider bar-graph that shows the overall average level. Below the display are a horizontal slider for "Display Level" and two on/off pushbuttons for left and right inputs to the RTA, fed from the corresponding channel outputs after the equalizer section. To the left of the display are the power on/off switch and a phone jack for an optional microphone. When plugged in, it is fed directly to the RTA, disconnecting the other inputs.

In operation, particularly in a somewhat dim room, the SH-8055 catches the eye because its narrow slider knobs have small red LEDs mounted in their ends. The graphic character of the equalization is thus shown in a rather intriguing and attractive way. The Technics unit has most of its filters centered on the normal octave-band frequencies, but replaces the usual 31.5- and 125-Hz filters with four filters at 25, 40, 100 and 160 Hz. This additional resolution in the region of poor speaker response and room standing waves is potentially very useful, and so it proved under test.

Below the sliders are three large pushbuttons for input selection: "Source" or input, "Tape 1" and "Tape 2." These are interlocking, although the buttons do not stay in: The black designation changes to orange with actuation. There is also an EQ in/out button of the same design. A small, orange "Rec Mode" pushbutton selects "EQ" (in) or "Straight" (out). This switch inserts the selected equalization into the signal path to the recorders. Equalizing the playback is done with the "Tape" switches mentioned earlier (which also make automatic connections for dubbing, if that is desired). Having connections for two recorders will be useful to many these days, and the automatic connection for dubbing is a further plus. There are also two small on/off pushbuttons, for the pink-noise generator and a 20-dB microphone attenuator.

On the back panel are in/out stereo pairs for line and two tape recorders as well as an unswitched a.c. outlet. Examination of the interior showed that the majority of the circuitry was on one large p.c. board, almost chassis size. There was also a medium-sized card with the RTA driver circuitry. With limited disassembly, it was impossible to examine most of the soldering, but what could be seen was excellent. All parts were identified, and functional areas were also labelled. The main card was supported at a number of points, but it was still somewhat springy. No fuses were noted, but a couple of resistors could have been fusible types.

### Measurements

The first series of tests were conducted on the equalizer section of the Technics unit. The frequency responses were within less than 0.2 dB (−0.17 dB maximum deviation) from 20 Hz to 20 kHz, with or without EQ in. The responses were 3 dB down at about 1.1 Hz for both conditions, with the high-end limit at 110 kHz with EQ and about 1.9 MHz without. As the EQ out position is a bypass, also used when the 8055 is switched off, the 1.9-MHz limit, high as it is, is probably from stray capacitance to ground.

The filter center frequencies were fairly accurate, with an average offset of 3.2%. Figure 1 shows the responses of each filter section and the maximums obtained with all sliders at the extremes. Figure 2 is of the swept responses, with the 63-Hz, 2-kHz and 4-kHz filters set for 2-dB steps from −12 to +12 dB. With the exception of the first steps away from zero, the boosts and cuts are quite accurate and the steps are very even. Note also that, regardless of the amount of boost or cut, the region between 150 and 400 Hz stayed at zero level. This relates to the fact that the SH-8055 filters have fairly high Q (narrow bandwidth) starting at ±4 dB. This is also reflected in the relatively small increase in maximum levels in Fig. 1 when all filters are at maximum, compared to single-filter peaks. Figure 3 displays another facet of how filter responses add together. The topmost trace is that with a 1-kHz tone and the 1-kHz filter at its maximum boost. The middle waveform is with just the 500-Hz filter slider at maximum, and the bottom trace is the result with just the 2-kHz filter at maximum. For all three, the oscilloscope was locked to the source. With the lagging phase in the 500-Hz filter and the leading phase with the 2-kHz one, the amplitudes are not directly additive, hence the relatively small additional boost from adjacent filters.

The maximum boost and maximum cut values were very consistent from filter to filter, with a total spread of less than 0.7 dB at either extreme. Tests on just the 500-Hz filter

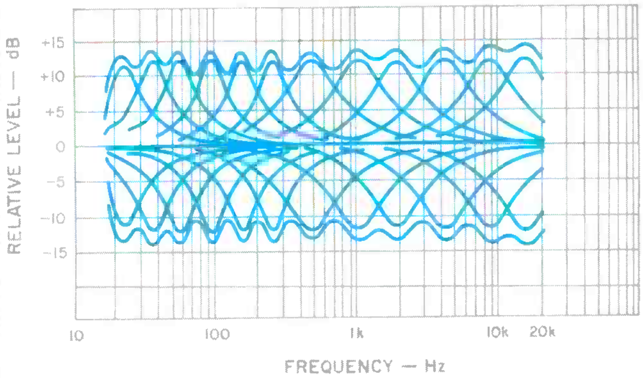



**Fig. 1—Swept frequency responses with each filter at maximum boost and cut and with all filters at maximum boost and cut.**

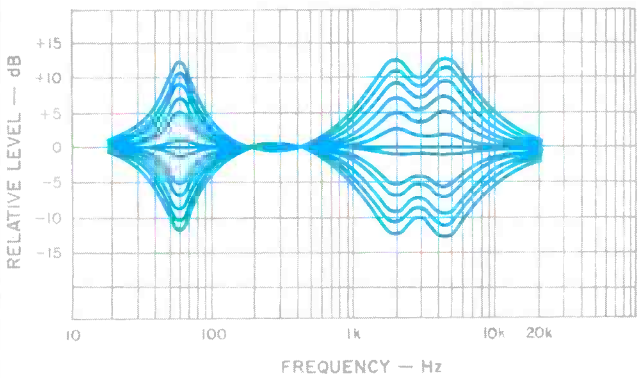
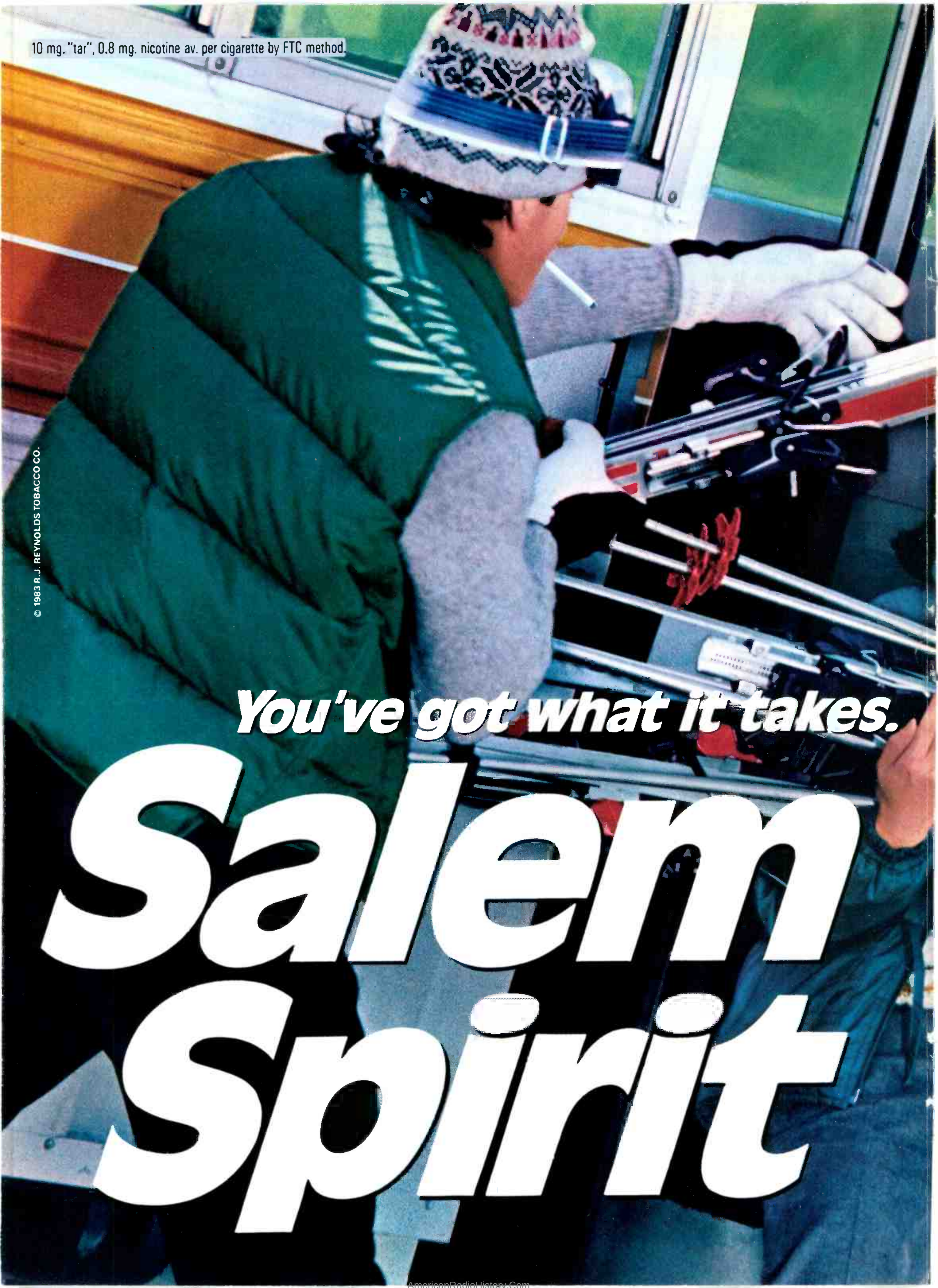



**Fig. 2—Swept-frequency responses with 63-Hz, 2-kHz and 4-kHz filters set successively for 2-dB steps from −12 to +12 dB.**



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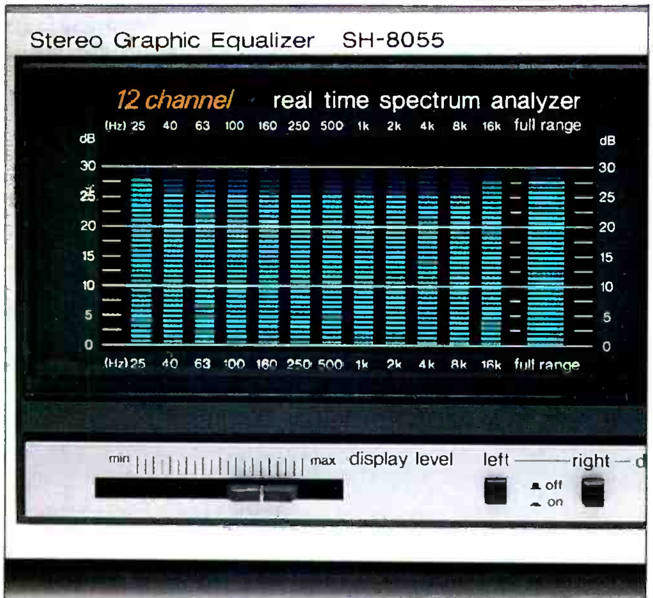
In equalizing a simulated system response, I found the extra bass filter channels instrumental in pulling down low-frequency peaks while retaining bass.




The RTA display shows extra bands below 250 Hz.

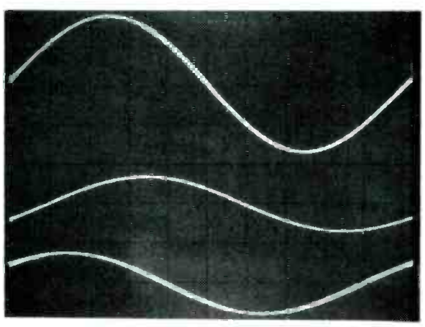


Fig. 3—One cycle of a 1-kHz sine wave, showing differing phase and amplitude of maximum boost from each of three filters: 1 kHz (top), 500 Hz (middle) and 2 kHz (bottom). Horizontal scale: 0.1 mS/div. with sweep locked to source.

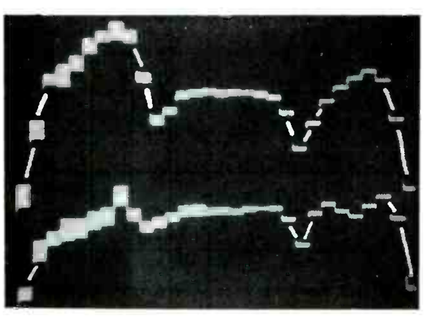



Fig. 4—One-third octave RTA display of simulated loudspeaker response (top) and response after adjusting EQ (bottom).

revealed that a bandwidth of 1 octave was reached with a boost of 10.9 dB. A bandwidth of 1.4 octaves (for a non-ringing Q = 1) was reached with about 5 dB of boost, with rather gentle narrowing above that point.

With all sliders in the gentle center detent, the gain change between EQ in and EQ out was only 0.04 dB. The maximum input/output voltage was 8.9 V open circuit and 7.1 V with a 10-kilohm load from 20 Hz to 20 kHz—for the right channel only. The left channel was the same at low frequencies, but some sort of current starvation (not clipping) became progressively worse above 1 kHz, limiting the maximum to 4.0 V. (I suspect that a simple device replacement would bring that channel up to spec.) The input impedance was about 45 kilohms across the band, and the output impedance was 230 ohms, rising somewhat at 20 kHz.

With a 2-V test signal, THD was 0.0031% or less from 20 Hz to 20 kHz; including noise, the figures were 0.0064% for right channel and 0.018% for left channel—not as good, but still very low. I expected to find that the left channel would show more slew-rate limiting, but both channels were very close, just starting to show limiting at 75 kHz with a 2-V drive signal. The signal-to-noise ratio was greater than 100 dBA relative to 1 V, right at my test equipment's 10-$\mu$V minimum voltage limit. With various settings of the sliders, there was an indication that the ratio would be about 94 dBA relative to 0.5 V for typical operating conditions.

A series of tests were also performed on the RTA section of the Technics unit. The center frequencies of its filters were within nominal values to better than 2.5%, on the average. The display filter sections' responses to discrete tones at their center frequencies were rather uneven: The 25- and 40-Hz filters were more sensitive, and the 250-Hz, 500-Hz, 8-kHz and 16-kHz filters were less sensitive than the reference 1-kHz band. A check of and with its own built-in pink noise, however, showed that, in the main, these display deviations were compensating for deviations in the pink-noise spectrum. The level of a 1-kHz tone in adjacent bands was 18 dB down, and in the second adjacent bands, it was about 30 dB down. The crossover points were 11.5 dB down. These characteristics all serve to reject out-of-band energy, and that is good, but the response within the band is sharply pointed, rejecting energy near the crossovers. Overall, I would have preferred less pointing, with greater response at the crossover points, even at the cost of lower adjacent-channel rejection.

The vertical display had steps of 2.5 dB, with each step consisting of three, fine horizontal bars. The accuracy of the steps was sufficient to keep all steps within each ladder within 1 dB of nominal, with the exception that the last steps, between "25" and "30," were compressed. My conclusion was that "20" was a good reference level for equalization tasks. At the lower frequencies, the time to get to a "20" indication was about 800 mS, and the decay time to zero was 1.7 S. At higher frequencies, the charge time was about 400 mS, and the decay time was 850 mS. The output level of the built-in pink-noise source was 67 mV rms.

The optional (but supplied) microphone is 0.353 inch in diameter, not a standard for easy calibration, but it fit my ⅜-inch calibrator close enough to determine that good RTA

The Technics SH-8055 is a very good value for audiophiles and semi-pros, though it should not be used in portable systems.

displays were possible from 55 dB SPL up to 100 dB or so. The display level slider had a range of 33 dB, with a "20" indication with pink noise settable anywhere from 18 to 800 mV. With indications at "25," the upper limit would be 1.4 V, probably needed for some systems. The microphone response was acceptably flat, especially when angled 45° or more away from a loudspeaker.

### Use and Listening Tests

The owner's manual is better than most, with a number of detailed connection diagrams and a collection of suggestions on equalizing for specific purposes, such as making tapes for use in cars. I would have liked more emphasis on listening to the effects of adjustments. The manual should also include statements on microphone usage, including the desirability of scanning the listening area to check for possible response variations.

All of the controls were easy and straightforward to use. I had a small problem with the EQ in/out button, but only because its latching was soft in sound and feel, and the "EQ" illuminated before the mechanical latch was made. The black designations on the brushed aluminum panel were easy to read, and the RTA display and the illuminated equalizer sliders were a pleasure visually and an aid when using the SH-8055. The dB offsets of the sliders were difficult to read in dim light, but as the sliders were adjusted to get the desired RTA display, there was no problem in practice.

The averaging response of the RTA worked very well for EQ tasks, but it was too slow for watching the dynamics of music. The 2.5-dB steps were judged slightly coarse, but the thresholds were good and consistent; with the bar-graph display, adjustments could be made quickly without confusion.

Figure 4 shows a simulated system response (top) and the results (bottom) after equalizing with the SH-8055. All adjustments were made using the Technics RTA, without reference to the ⅓-octave displays shown. Take note of the fact that improvements made include reductions of the boosts at 125 Hz and 10 kHz and the notches at 250 Hz and 3 kHz. Deviations were reduced from about +8, −7 dB to +2, −4 dB from 40 Hz to over 16 kHz. The extra channels of the unit were instrumental in pulling down the low-frequency boost while retaining response to 40 Hz.

The Technics SH-8055 is a very good value for audiophiles and semi-pros, with the constraint that it should not be used in portable systems. The higher Q of its filter sections and the accuracy of its slider settings make it one of the very few equalizers with accurate graphic indications. There is no match-level scheme, but the overall-level band of the RTA will help. And, get the optional microphone; it's well worth it.

*Howard A. Roberson*

# 3

# ALPINE 7347 CAR STEREO

**Manufacturer's Specifications**

***FM Tuner Section***

**Usable Sensitivity:** Mono, 16.3 dBf (1.8 μV, 75 ohms).

**50-dB Quieting Sensitivity:** Mono, 20.7 dBf (3.0 μV, 75 ohms).

**S/N Ratio:** 60 dB (70 dB with Dolby B NR).

**AM Suppression:** 45 dB.

**Selectivity:** 80 dB.

**Stereo Separation:** 35 dB at 1 kHz.

**Capture Ratio:** 2.0 dB.

***AM Tuner Section***

**Sensitivity:** 12 μV.

***Tape Section***

**Frequency Response:** Normal tape, 40 Hz to 16 kHz, ±3 dB; $CrO_2$ or metal tape, 40 Hz to 18 kHz, ±3 dB.

**S/N Ratio:** 55 dB without noise reduction, 64 dB with Dolby B, 72 dB with Dolby C, 86 dB with dbx.

**Wow and Flutter:** 0.09% wtd. rms.

**Stereo Separation:** 40 dB at 1 kHz.

***General Specifications***

**Output Voltage:** 500 mV at 1 kHz.

**Treble Control Range:** ±10 dB at 10 kHz.

**Bass Control Range:** ±10 dB at 100 Hz.

**Chassis Dimensions:** 7⅛ in. (18 cm) W × 2 in. (5 cm) H × 5⅛ in. (13 cm) D.

**Nose-Piece Dimensions:** 4⅛ in. (10.45 cm) W × 1¾ in. (4.45 cm) H × 1-5/16 in. (3.3 cm) D.

**Knob Shaft Pitch Dimension:** 5¾ in. (14.7 cm), horizontally between centers.

**Price:** $599.95.

**Company Address:** 19145 Gramercy Place, Torrance, Cal. 90501.

For literature, circle No. 92

I can remember a time, not too long ago, when I used to dread having to test and discuss car stereo equipment. In the main, it was so inferior to even the most minimal home high-fidelity components that there wasn't much I could talk about, either from a measurement or a listening point of view. All of that has changed, of course, and today you can find car audio components that rank with the best home gear. A good example is Alpine's handsome 7347, a frequency-synthesized AM/FM tuner/cassette player combination which houses an impressive array of features in its compact chassis.

Noteworthy among these features are the incorporation of Dolby B, Dolby C and dbx NR. Alpine wasn't playing favorites when it came to noise-reduction circuitry; the Dolby B circuit does double duty, as it is operative for both tape play and FM reception. Alpine's Programmable Music Sensor is similar to some of the music search systems found on home cassette decks. It allows you to fast-forward or rewind to any one of nine selections on a tape. After you have programmed the search function, the selection number appears on a digital readout and continues to flash while the tape is being scanned.

Mechanically, the tape section is a superb example of human engineering. An automatic cassette glide pulls the cassette gently into play position and locks the tape against the playback head for precise alignment. A locking mechanism allows hands-off fast-forward or rewind at more than 20 times normal speed. Having to keep a finger on the fast-forward button in some car cassette players is one of my pet peeves, and it's nice to see that Alpine has done away with this often-endangering requirement. The soft illumination of the cassette slot is also a welcome touch, reducing the time you have to take your eyes off the road while hunting for that slot. The player features automatic replay at the end of the rewind function. And, as you might expect from a well-engineered car cassette player, this one has an ignition-key off/eject feature to protect tape heads and tapes.

As for the AM/FM tuner section of the 7347, it, too, is extremely well designed. An auto-seek feature tunes to the next usable higher frequency signal received, locking onto that signal. Manual up-down tuning is available in 200-kHz increments for FM, 10-kHz increments for AM. There's a 10-station preset capability (five FM and five AM), and, of course, preset frequencies are retained in "memory" even with the ignition switch turned off. Automatic muting reduces interstation noise while manually tuning the FM band. If your car is equipped with a power-retractable antenna, there's a lead emanating from the 7347 to activate the antenna motor. If you match the Alpine 7347 with Alpine amplifiers or with other modern car stereo components, interconnection is made simple through the use of a new 8-pin DIN connector, which provides all power and signal connections in a single plug.

## Control and Panel Layout

Three concentrically mounted rotary control knobs at the left of the panel handle power on/off-volume, bass, and treble adjustment. Three similarly mounted knobs at the right end of the panel take care of manual tuning, channel balance and front-rear fade. The manual tuning control,

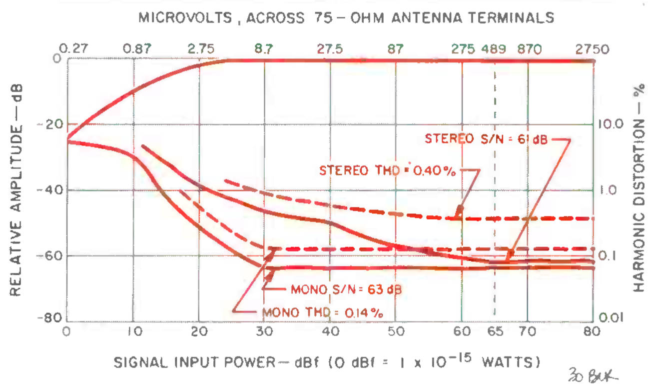



Fig. 1—Mono and stereo quieting and distortion characteristics, FM section.

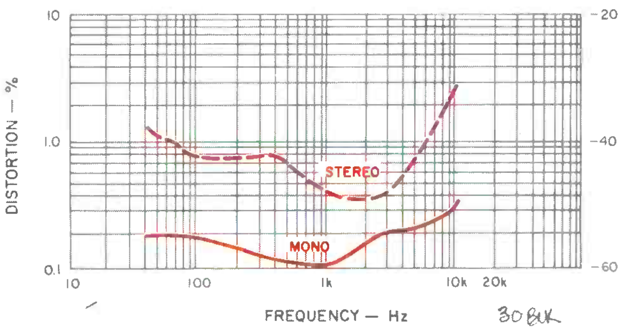



Fig. 2—THD vs. modulating frequency, FM tuner section.

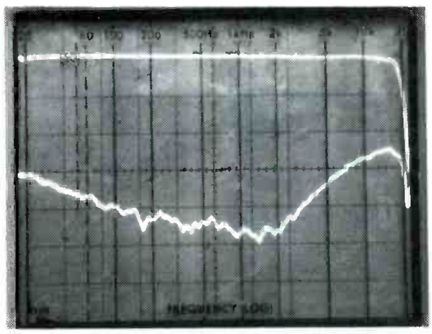


Fig. 3—FM frequency response (upper curve) and separation (lower).

Mono usable sensitivity was a shade better than Alpine claimed. Stereo sensitivity, though, was even more impressive—a mere 19 dBf.

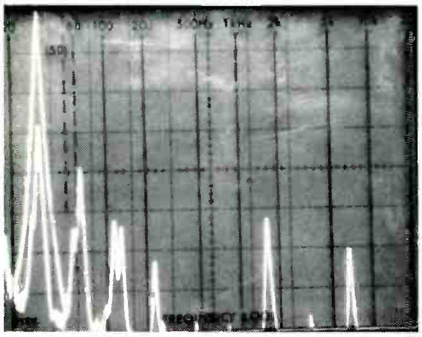


**Fig. 4—FM stereo crosstalk and distortion components, 5-kHz modulating signal.**

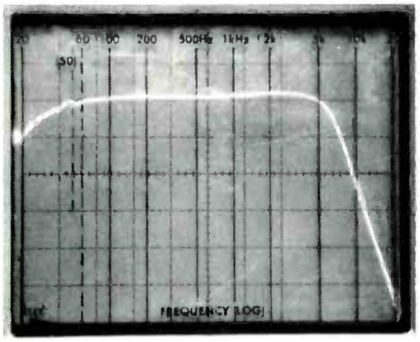


**Fig. 5—AM frequency response.**

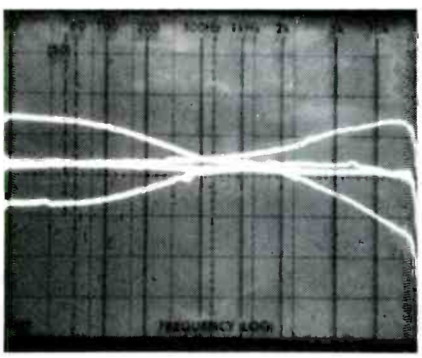


**Fig. 6—Bass and treble boost and cut characteristics.**

when pushed, activates the automatic seek control in the radio mode, and cassette eject in the tape mode. A novel rectangular pad at the lower center of the panel serves several functions, depending upon which one of its corners is depressed. Touching one corner selects "Metal" ($CrO_2$) playback characteristics. Other corners of this pad are used to activate Dolby B, to select Dolby C, and to activate dbx noise reduction. In the radio mode, the corner used for selecting metal/high bias tapes becomes a local/distance switch. How's that for economical use of limited front-panel space? Other touch buttons along the lower section of the front panel include five numbered touch buttons for preset station selection, a "Memory/Clear" button, an FM/AM band selector, the programmable music-sensor selector, and fast-forward and fast-rewind buttons.

The cassette loading slot is located near the top edge of the panel, as is the frequency display (which also doubles as the programmable music-sensor counter). Just about all of the special functions described have associated indicator lights which come on when that function is activated, leaving no doubt in the driver or passenger's mind as to whether the desired switching occurred.

**Tuner Measurements**

Mono usable sensitivity for the tuner section of the Alpine 7347 measured a shade better than the manufacturer claimed, 16 dBf. Even more impressive was the stereo usable sensitivity (which Alpine chose not to specify), measuring a mere 19 dBf; that's equivalent to only 2.45 $\mu$V across 75 ohms. Sensitivity for 50-dB quieting in mono also surpassed Alpine's published claim, measuring 20 dBf; for stereo, the 50-dB quieting signal required was 42 dBf. Signal-to-noise ratio in mono, with strong (65 dBf) input signals was 63 dB, while for stereo, the signal-to-noise ratio reached 61 dB. Harmonic distortion measured 0.14% for a 1-kHz modulating signal in mono, increasing to 0.40% in stereo. A graph showing quieting and harmonic distortion levels as a function of signal strength for both mono and stereo operation is plotted in Fig. 1. Figure 2 is a plot of harmonic distortion versus modulating frequency, for both mono and stereo FM reception at strong signal levels.

Figure 3 is my usual plot of stereo FM frequency response (upper trace) and stereo FM separation versus frequency (lower trace) using a spectrum analyzer display in which the sweep is from 20 Hz to 20 kHz and vertical sensitivity is 10 dB per division. Separation measured between 40 and 44 dB at mid-frequencies, depending upon which channel was measured. At 100 Hz, separation was 38 dB from left to right and 36 dB from right to left. At 10 kHz, channel separation was 26 dB in either direction. Frequency response was unusually flat for the FM section of a car receiver (or even for a home tuner, for that matter), with a maximum roll-off of only −0.4 dB at 15 kHz and a slight boost of 0.5 dB at 50 Hz with both tone controls set to their center positions.

Figure 4 is a linear frequency plot (from 0 Hz to 50 kHz, 5 kHz per horizontal division) of a 5-kHz modulating signal on one channel (tall spike at left) and crosstalk and distortion products appearing in the unmodulated channel. Capture ratio measured exactly 2.0 dB, as claimed, while alternate-channel selectivity was 82 dB, against 80 dB claimed.

Frequency response was unusually flat for the FM section of a car receiver (or even for a home tuner, for that matter).

Stereo threshold was set at a very low 10 dBf. Image, i.f. and spurious response rejection were all in excess of 85 dB for this very fine car FM tuner section.

Before going on to the tape player and its performance measurements, I must compliment the people at Alpine for the excellent AM tuner section they incorporated in the 7347. Take a look at the frequency response characteristic (Fig. 5) obtained for this AM circuit. When's the last time you remember seeing anything that good on a home AM tuner section, let alone a car unit? Response is absolutely flat out to beyond 5 kHz. This, while it may not sound like much to a dyed-in-the-wool hi-fi enthusiast, offers remarkably better sound quality than is typically obtained from most "hi-fi" AM tuner sections, which usually roll off at between 2 and 3 kHz. Kudos to Alpine for realizing that long-distance travelers often have no choice but to tune to an AM station when they've run out of good music tapes and can't get a decent FM signal between cities.

Figure 6 is a plot of the maximum boost and cut characteristics of the audio stages of this tuner/player. Again, spectrum analyzer sweep is logarithmic, from 20 Hz to 20 kHz (as it was in Figs. 3 and 5). These are no simple "losser" type of roll-off tone controls, but true bass and treble cut *and* boost tone controls such as one would expect to find in a home stereo receiver, integrated amplifier, or preamplifier.

Figure 7 illustrates the response at progressively lower and lower listening levels when the Dolby B circuitry is activated (in this case, via the FM tuner). As anyone familiar with Dolby would expect, at lower and lower listening levels, highs are attenuated in the "sliding-band" characteristic associated with Dolby noise-reduction systems. In that connection, I must nit-pick just a bit. In their otherwise excellent installation and operating folder, Alpine adds a note at the very end of the brochure suggesting that "Use of Dolby noise reduction . . . is not recommended when receiving non-Dolby-encoded FM broadcasts or playing non-Dolby-encoded tapes, as it only intensifies the high frequency response while serving no other purpose." Wrong! Playing a non-Dolby program or tape with Dolby turned on doesn't intensify high frequencies; it diminishes them, as is clearly evident from Fig. 7. Fix it in the next printing, okay?

**Tape Player Measurements**

As plotted in Fig. 8, playback frequency response at a −20 dB level, with 120-µS equalization and normal-bias reference tape, was down by 3 dB at approximately 13 kHz. While this falls somewhat short of the 16-kHz figure claimed by Alpine, it is a satisfactory result, since the small discrepancy could well be due to differences in azimuth alignment between my standard playback response tape and the tape head in the sample player. If you want to be precise, it could be argued that the tolerance of ±3 dB offered by Alpine suggests that perhaps I should lower my "reference" 0-dB point by a couple of dB, since the lower curve of Fig. 8 hardly goes to the plus side of zero. In that case, the response could be judged to extend out to 16 kHz as claimed.

The wow-and-flutter analysis of Fig. 9 reveals that the tape-transport mechanism of the Alpine 7347 is superbly

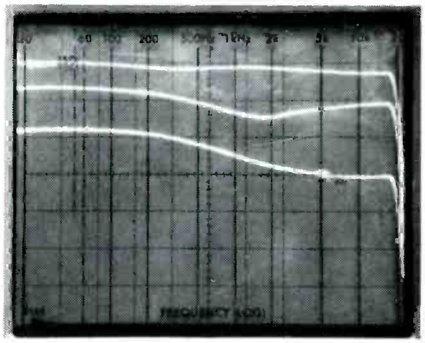


Fig. 7—Effect of Dolby B noise reduction on frequency response at different loudness levels, FM tuner section.

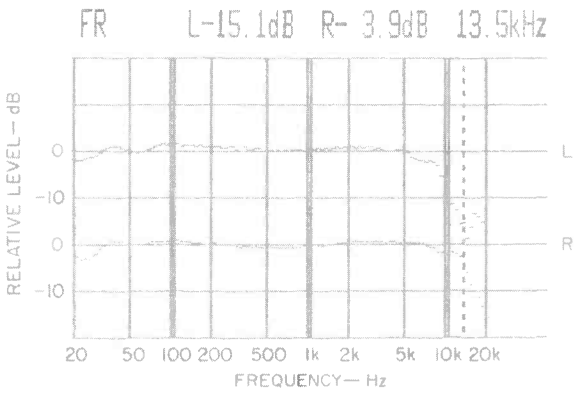



Fig. 8—Frequency response with Type I tape.

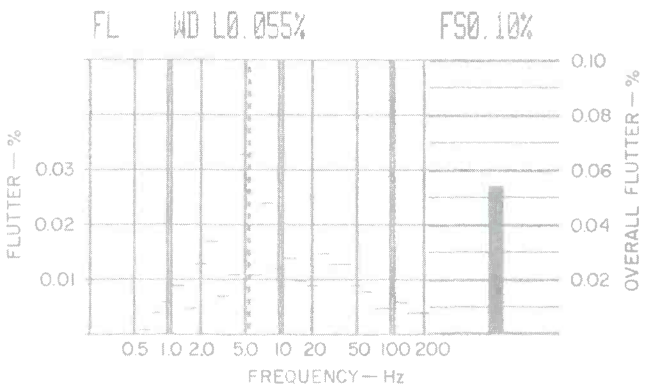



Fig. 9—Wow-and-flutter analysis.

**When's the last time you saw this good a frequency response curve for a home AM tuner section, let alone a car AM unit? It's flat past 5 kHz.**

designed and precision-machined. Wow and flutter was only 0.055% wtd. rms (as against Alpine's claimed 0.09%), and the major component of wow occurred at 5 Hz, contributing 0.033% to the composite overall reading.

Figs. 10A, 10B, 10C, and 10D are plots of signal-to-noise characteristics of the tape player taken under four different conditions—without any noise reduction (Fig. 10A), with Dolby B (Fig. 10B), with Dolby C (Fig. 10C) and with dbx (Fig. 10D). Results are as you might expect, with overall weighted S/N readings of 58.0, 66.8, 71.9, and 87.6 dB for the conditions named. All of these results equal or exceed the claims made by Alpine for the player's signal-to-noise capabilities. (I won't quibble about my 71.9 dB reading as against Alpine's 72.0 dB claim.)

**Use and Listening Tests**

Unfortunately, I am not in a position to install every car stereo system I measure into my car for a hands-on subjective evaluation of the system under road conditions. My listening tests with the Alpine 7347 were confined to hooking up the tuner/player to a conventional a.c.-powered amplifier and judging the system much as I would judge a home tuner or cassette tape deck. If anything, this form of evaluation may well be overly severe in some respects, since road noises (absent in my type of test) tend to cover up a great many sins. On the basis of this atypical test, I would rank the Alpine 7347 as among the very top car stereo systems I have ever tested. The tuner performed extremely well, picking up the same number of usable signals that I would expect from a sensitive, well-designed home tuner. I have already discussed the unusually fine AM tuner response, and its superiority was again evident during my listening tests.

Fortunately, Technical Editor Ivan Berger *is* in a position to judge car stereo equipment in the environment for which it was designed. He has been riding around, in and out of town, with the Alpine 7347 installed in the dashboard of his own car. His comments are appended to this test bench report, and from them I would gather he agrees with me—that Alpine has done much to advance the science and art of car stereo equipment design with their Model 7347.

*Leonard Feldman*

**Behind the Wheel**

Human engineering counts for more in car stereo equipment, where the operator is simultaneously engaged in the important task of driving. The 7347 comes off reasonably well in this regard.

The features are all useful ones—no frills for the sake of frills. Tuning is simple: Turn the tuning knob one click to move up or down one channel, push it to "Scan" up to the next station, or push one of the five station buttons to get a pre-selected station. The "Scan" works fine in FM, but my sample has problems on the AM band: With the local/distance switch on "Local," it finds almost no stations; with "DX," it stops almost everywhere, station or no.

The five station buttons are clustered with a sixth, which is used to memorize new stations (in tuner mode) or clear the tape search function (in tape mode). I found that, after a day or two, I never poked this button by mistake—a problem I had long had with my previous Alpine. That's a surprise, as the only difference between the two is the button layout—the 7347's is horizontal, with two lines of three buttons, while the 7136 had them vertically laid out, in three lines of two (the memory button was the upper right in both cases).

Pushing the volume control turns the tuner on and off. If you insert a tape with the tuner off, or turn it off while the tape is playing, you will not be greeted by the usual jarring blast of radio when you withdraw the tape. That cures one of my major gripes about car stereo design. The display can be read in normal daylight but becomes almost entirely illegible on those rare occasions when the sun strikes it directly.

The tape slot only illuminates when the 7347 is turned on, which can make tape loading hard at night if the tuner is off. It would have been better to have hooked this light to the dashboard lighting line. I find that, when loading in the dark, I often accidentally hit the AM/FM selector, a minor nuisance.

The Programmable Music Sensor tape search works fine, though with the usual slight tendency to read quiet passages in classical music as blank spots signifying the start of new selections. To use it, you press the "P.M.S." button as many times as the number of selections you want to skip, then press the fast-forward or rewind button. The display shows what number you've entered (if you enter too high a number, the station-memory button clears it and lets you start over) and counts down as you pass intermediate selections, reading "0" just as it stops. As my listening habits are broadening from symphonies and such to jazz and other short works, this feature comes in very handy.

The four-way rocker that selects normal/metal tape and the three noise reducers is a mixed blessing. The more I use it, the more I like it, but it takes some getting used to—and still requires a confirming glance at the indicator LEDs in each corner (all but invisible in daylight, but fine at night) to make sure I pressed the right ones.

Of the three noise-reduction systems, I use Dolby C most, nowadays, and dbx least. My Dolby B tapes are audibly hissy in the car—which may be giving that NR system a bad rap; a recent non-Dolby tape I got from audio pioneer Emory Cook was quieter than my "B" tapes are, which leads me to suspect my home deck makes noisy recordings (as did the decks that made my older tapes). But even with the noisy deck, my "C" tapes come out quiet. I'm not currently equipped to make dbx tapes at home, but the ones I've gotten from dbx sound sensational. Unfortunately, their dynamic range is too much for listening on the road, where the ambient noise level is so high that quiet passages are buried; even with non-Dolby tapes, I find myself twisting the volume up and down as the music level or the road noise changes.

The 7347 has the best FM performance of any car stereo I've yet used (which is not to say I wouldn't welcome even better). Distant reception was excellent, with New York stations audible on hilltops on the Wilbur Cross Parkway near New Haven, Conn. (about 75 air miles away), though fading in the valleys, and with some stations also audible in parts of the FM wasteland of Long Beach Island, N.J., also some 75 miles off. In the latter location, I also found no sign of

Distant FM reception was excellent. Under the worst of New York City's multipath and overload, signals stayed audible, if not always listenable.

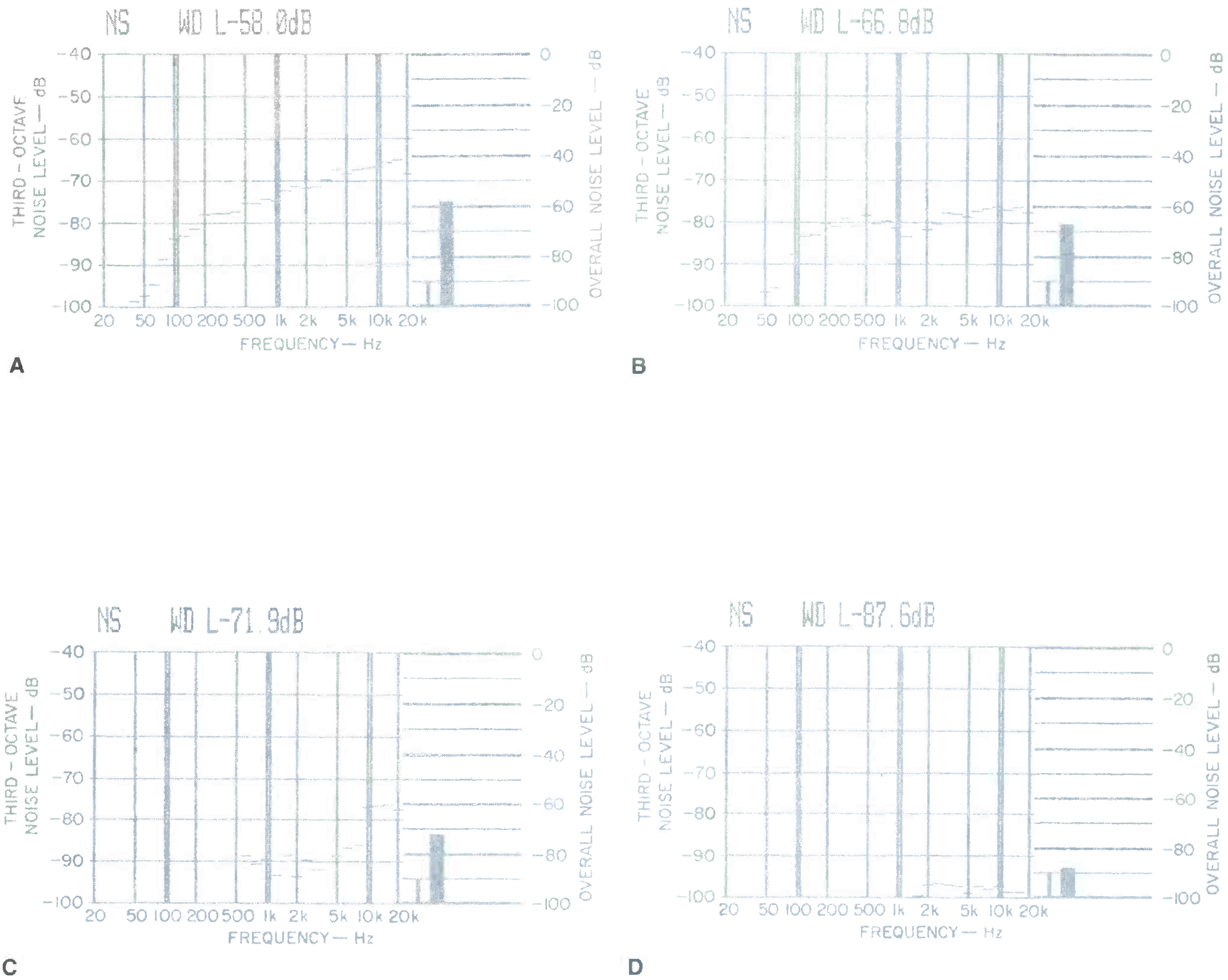



**Fig. 10—Tape signal-to-noise analysis without noise reduction (A) and with Dolby B (B), Dolby C (C) and dbx (D) NR.**

"picket-fencing" (sound popping in and out as you move), a common problem with other radios I've tried there. In a few patches between cities, I could have used even better capture ratio and selectivity than the Alpine already has—though it would do fine in those same locations as a home tuner, where you could aim the antenna a bit.

In New York City, resistance to multipath and signal overload is high, but not absolute. Even under the worst conditions, though, signals stay audible, if not always terribly listenable.

Tape performance is equally good. Really rough roads cause only the faintest tremors in the tape transport. The 7347 adds no noise that I can notice to the tapes I play.

AM performance is better than that of any previous FM/AM unit I've driven with, but still not up to the AM-only radios of 25 years ago. Frequency response is wide enough to prevent my feeling that my tweeters had died when I switch to AM, but not so wide as to be full of buzzes. Reception is generally clean, in fact. But the sensitivity—while at least as good as that of any other car unit I've used recently—is insufficient for a band whose main function, today, is long-distance reception. Driving through my old home town of Naugatuck, Conn. (about 70 miles from New York), I could get no New York AM stations at all; when I used to live there, I got several, routinely enough to set my Delco's buttons to them.

*Ivan Berger*

4

# MICRO-ACOUSTICS 630 PHONO CARTRIDGE


**Manufacturer's Specifications**
**Type:** Electret.
**Stylus:** Micro Point II diamond.
**Frequency Response:** 5 Hz to 20 kHz, ±1.0 dB (measured with CBS Labs STR-170 test record and supplied with individual calibration curves).
**Separation:** 30 dB at 1 kHz, 25 dB at 10 kHz.
**Recommended Tracking Force:** 0.7 to 1.4 grams.
**Output:** 3.5 mV.
**Output Rise-Time:** 4.5 μS.
**Cartridge Mass:** Variable, 2.5 to 4.0 grams.
**Dynamic Compliance:** 40 × $10^{-6}$ cm/dyne.
**Price:** $265.00.
**Company Address:** 99 Castleton St., Pleasantville, N.Y. 10570.
For literature, circle No. 93

Micro-Acoustics' Model 630 is next to their top-of-the-line model and one of the few cartridges on the market that does not use a changing magnetic field as a transducer. As in their earlier models, Micro-Acoustics uses a pair of electrets, permanently polarized dielectric devices. The basic principle was invented by a Japanese scientist, Eguchi, in 1925. He allowed melted wax mixtures to harden in strong electric fields and found that the resulting wax cakes carried a dielectric charge which remained relatively undiminished over a period of years. About 1960, scientists at Western Electric improved the electret so that it would hold its charge indefinitely, and this was the basis for the electret microphone.

The stylus Micro-Acoustics uses is dubbed the Micro Point II, and they say it is an analogue of the Micro Point recording stylus which they supply to the recording industry. According to the firm's literature, the stylus is precision-lapped and laser-aligned. It is attached to a 0.01-inch-diameter cylindrical cantilever made of beryllium. My first inspection of the cartridge did not reveal the platinum-iridium damper their literature mentioned being attached near the back of the cantilever; a phone call to the company enabled me to identify the damper, which is just 0.015 inch in diameter. It is located between the two cylindrical elastomers, near the center of Fig. 1. The resolver assembly is the pyramidal-shaped device which rests on two elastomeric bearings. The two buttons at the upper corners press against two tiny elastomeric pads which rest directly on the electrets. The stylus cantilever can be seen protruding from the apex of the resolver through a hole in the case.

The output of the electrets is connected internally to a resistor-capacitor network IC which converts the linear amplitude response of the electrets to the velocity-responsive output required by phonograph preamps. This circuit makes the output insensitive to variations in preamp input capacitance and resistance, and the outputs of the circuits are connected to the output pins with 24-karat gold wires. The cartridge shell is made of low-mass carbon fiber.

The cartridge comes in a fairly standard case with an assortment of spacers, small weights, nuts, bolts, washers, and a stylus brush. Three half-gram Vari-Balance weights come located under the hinged lid of the cartridge body, so the tonearm's counterweight can be properly adjusted for this lightweight cartridge.

Micro-Acoustics' 630 is next to their top-of-the-line model, and one of the few cartridges which uses the electret principle.

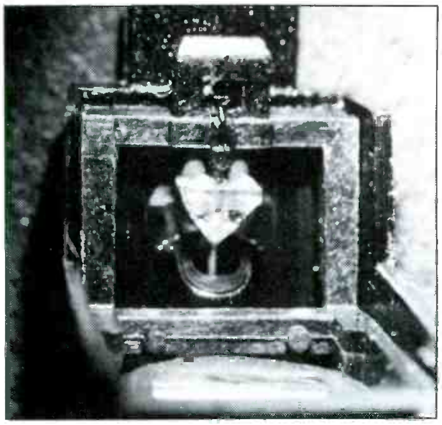


Fig. 1—Close-up view of the Model 630 mechanism, taken from above.

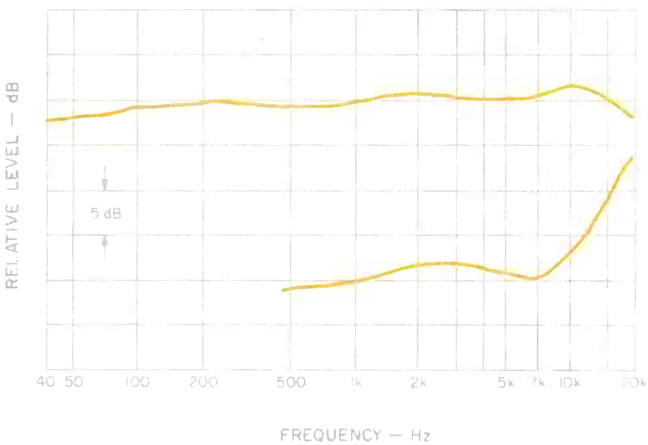



Fig. 2—Frequency response and separation.

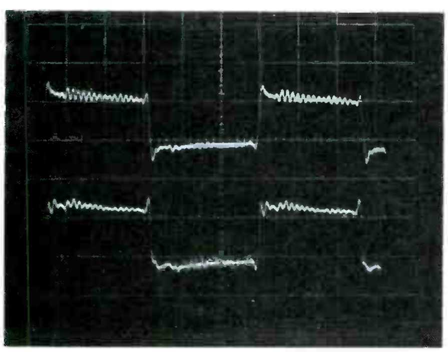


Fig. 3—Response to a 1-kHz square wave from CBS STR-112.

**Measurements**

The Micro-Acoustics 630 cartridge was mounted in the headshell of a Pioneer PL200 turntable, an older unit with good basic design. As a note to mounting this cartridge, I found that the 630 could not be mounted with the stylus guard in place. I therefore recommend that the complete stylus assembly be removed prior to installation of the cartridge in the headshell, so as not to damage the cantilever. To reduce mass, Micro-Acoustics uses a removable stylus guard, rather than a hinged guard; there is, then, less protection when the guard is not in position, as required during mounting.

As is the practice of this magazine's phono cartridge reviewers, measurements are made on both channels, but only the left is reported unless there is significant variation. During the test period, temperature was 70° F, ±2° and the relative humidity was 60%, ±10%. The following test records were used in making the reported measurements: CBS STR-100 and STR-112; JVC TRS-1007; Deutsches HiFi No. 2, and Shure Brothers TTR-103, TTR-110, TTR-115, and TTR-117. The tracking force determined as optimum and used for all subsequent tests was 1.0 gram with an anti-skating force of 1.25 grams. The load resistance was 47 kilohms, and load capacitance was 200 pF. Cartridge weight was 2.7 grams, while tonearm/cartridge resonance in the Pioneer PL200 was at 10 Hz with a rise of 8 dB.

As shown in Fig. 2, the frequency response was within ±2 dB from 40 Hz to 20 kHz, as measured with the CBS STR-100. Channel separation measured 20 dB at 1 kHz and dropped to 5 dB at 20 kHz. Static vertical compliance measured 38.4 $\times$ $10^{-6}$ cm/dyne, while dynamic vertical compliance was 21.5 $\times$ $10^{-6}$ cm/dyne. The lateral compliance was 64.6 $\times$ $10^{-6}$ cm/dyne. With a vertical tracking force of 1 gram, the vertical tracking angle was found to be 15°. Output was 3.4 and 3.54 mV (0.96 and 1 mV/cm/S) for the right and left channels, respectively, and balance between channels was within 0.35 dB.

The output impedance is a pure resistance of 5.15 kilohms, and the square-wave response was unaffected until a total capacitance of 1,000 pF was placed across the output terminals. Changing the resistive load on the cartridge from the standard 47 kilohms affected only the output amplitude and not the wave shape (as observed on a 'scope).

Figure 3 shows the response to a 1-kHz square wave using the CBS STR-112 test record. The rise-time was found to be 13 µS. Micro-Acoustics rates the rise-time of the 630's output as 4.5 µS, which is lower than most high-quality moving-magnet cartridges but not as fast as some moving-coil cartridges. Since I was puzzled over the discrepancy, I telephoned Norman Dieter, Chief Engineer of the 630 project, who told me that the STR-112 test record has a built-in rise-time of 8 µS, so the 13 µS I found was not unreasonable. As Fig. 3 shows, this cartridge is very well damped, showing approximately a half cycle of moderate overshoot followed by ultrasonic oscillations at a frequency of approximately 37 kHz. As has been pointed out by Messrs. Pisha and Long in these pages, these oscillations are on the test record and apparently the result of a ringing of the cutterhead assembly.

Using the 3.54-cm/S, 45°, 1-kHz signal from the CBS STR-

> Imaging was quite good, with bass tight and solid. The Micro-Acoustics 630 should be a strong contender in this price range.

100, the total harmonic distortion was 0.3%. IM distortion, using CBS STR-112, with a 4-to-1 mix, was as follows: +9 dB lateral, 400/4000 Hz, left—2.0%, right—2.1%; +6 dB vertical, 400/4000 Hz, left—1.2%, right—1.2%. Deutsches HiFi No. 2 300-Hz test band was tracked cleanly to 90 microns (0.009 cm) lateral at 16.9 cm/S at +9.9 dB and to 50 microns (0.005 cm) vertical at 9.4 cm/S at +4.8 dB.

No mistracking was evident in either the output of the left or right channel when tracking the highest (+18 dB) 300-Hz lateral band of the CBS STR-112. The +18 dB band approximates the maximum excursion found on recorded music material. An X/Y plot revealed good linearity and phasing between the two channels.

I also checked output and crosstalk at 16 kHz by using the CBS STR-100's band 3 on side two. Separation between channels was about 16 dB, which is in good agreement with the value obtained from measurements on the stripchart recorder.

The Shure Obstacle Course Era V test disc was tracked up to +11.1 dB (re: 5 cm/S) which corresponds to a peak velocity of 40 cm/S. There was slight distortion of the 'scope display of the 17-kHz component, though this was not audible. The cartridge was also able to negotiate all the musical tracks of this record up to level 5 of the harp and flute test, where a slight mistracking was heard. Using Shure's TTR-103, there was some mistracking evident on side one, band 8, which is composed of 1 and 1.5 kHz mixed at equal levels and recorded at 40 cm/S, peak velocity.

**Use and Listening Tests**

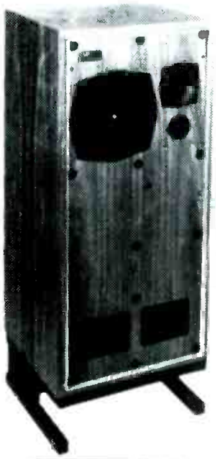
The Model 630 was used to audition several digitally mastered and direct-disc recordings in conjunction with a Pioneer PL200 turntable. The following discs were among those used in the listening tests and are to be recommended: *The King James Version*, Harry James and his Big Band (Sheffield Lab 21/22); Beethoven: *Symphony No. 6 "Pastorale,"* The Y Chamber Symphony of New York, G. Schwarz, cond. (Delos D/DMS 3017); Mozart: *Symphonies Nos. 40 and 41*, Los Angeles Chamber Orchestra, G. Schwarz, cond. (Delos DMS 3012); Dvořák: *Serenade in E, Op. 22*, Los Angeles Chamber Orchestra, G. Schwarz, cond. (Delos DMS 3011) and Tchaikovsky's *Symphony No. 6 in B Minor, Op. 74 "Pathétique"* (Mobile Fidelity MFSL 1-512).

Two other records used in the listening tests and of special noteworthiness are the Hitachi release, HCR-7301-SC, of the Vienna Chamber Ensemble playing Mozart's *Divertimento No. 17 in D Major, K. 334*, and Rudolf Serkin playing Beethoven's *Piano Concerto No. 4 in G Major, Op. 58*, with Seiji Ozawa conducting the Boston Symphony Orchestra (Telarc DG-10064).

As one would expect from the measurements, the cartridge performed very well in the listening tests. It was particularly good in reproducing sharp percussion sounds such as cymbals and snare drums. Individual vocals, both male and female, were faithfully reproduced with no sense of objectionable unnaturalness in either. Stereo imaging was quite good, with instruments firmly placed, and front-to-back imaging was also very good. Bass was solid and tight, with reproduction going as low as the rest of the reproducing chain allowed. I was particularly impressed with the sonic detail, clarity, and the transparency of reproduction of the strings on the Hitachi recording of the Vienna Chamber Ensemble. In addition, superb reproduction of piano was evidenced by the Micro-Acoustics cartridge on the Telarc recording of Beethoven's *Piano Concerto No. 4*.

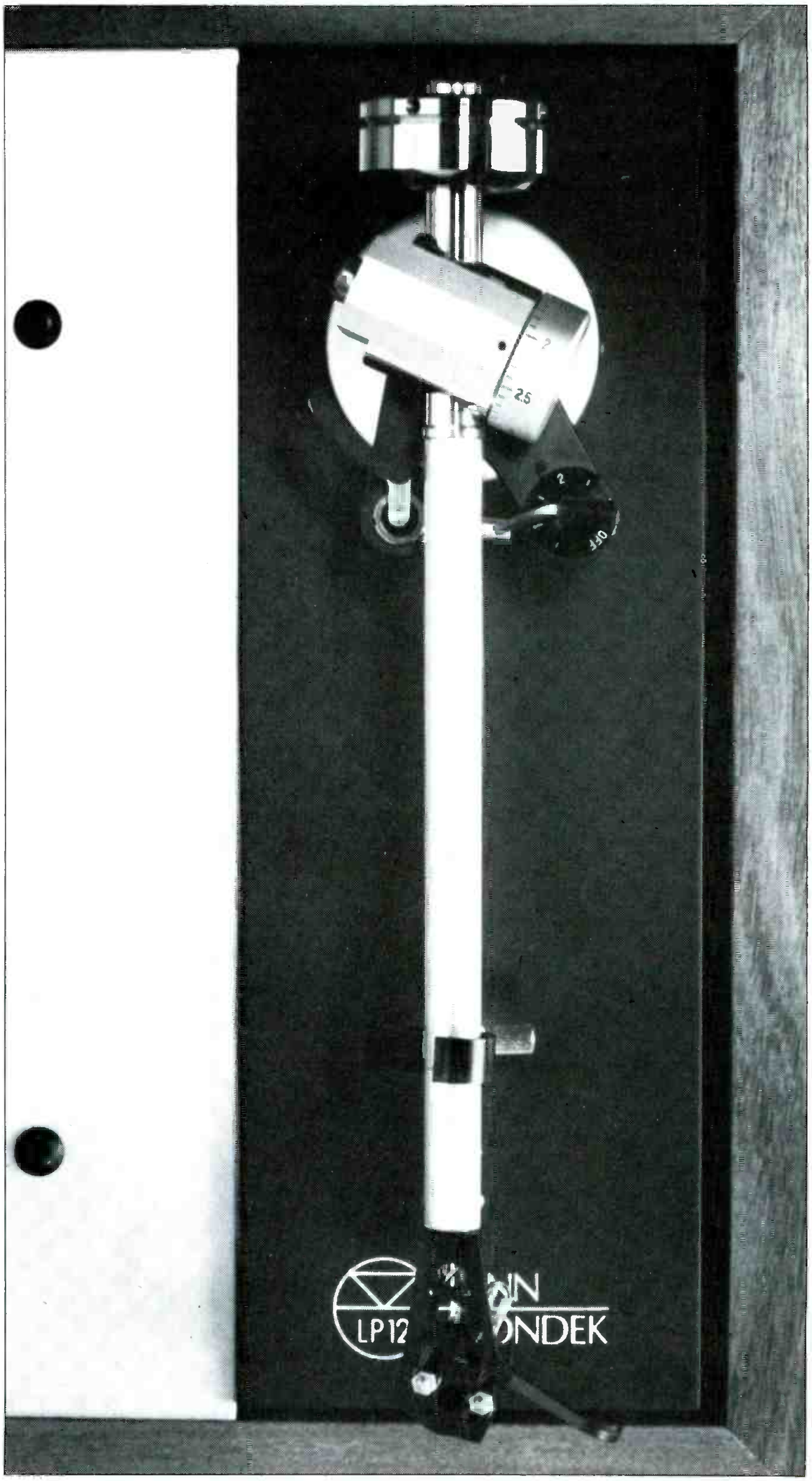
To sum up, then, the Micro-Acoustics 630 should be a strong contender among cartridges in the $200 price range.

*George Shellenberger*



5

# LINN ASAK CARTRIDGE AND ITTOK LVII TONEARM




***Linn Asak Cartridge***
**Manufacturer's Specifications**
**Type:** Moving coil.
**Frequency Response:** 10 Hz to 50 kHz, ±3 dB.
**Output Voltage:** 0.2 mV.
**Channel Balance:** ±0.5 dB.
**Channel Separation:** 27 dB.
**Impedance:** 3.5 ohms.
**Compliance:** $12 \times 10^{-6}$ cm/dyne.
**Tracking Angle:** 20°.
**Stylus Type:** 0.2 × 0.8 mil elliptical diamond.
**Weight:** 6 grams.
**Price:** $425.00.

***Linn Ittok LVII Tonearm***
**Manufacturer's Specifications**
**Overall Length:** 284 mm (11-3/16 in.).
**Effective Length:** 229 mm (9 in.).
**Overhang:** 18 mm (11/16 in.).
**Length Behind Pivot:** 50 mm (1-15/16 in.).
**Friction:** Less than 20 mg.
**Effective Mass:** 11.5 grams.
**Cartridge Weight Range:** 2 to 10 grams with main weight only, 5.5 to 15 grams with additional weight.
**Recommended Stylus Force Range:** 0 to 3 grams, in 0.1-gram steps.
**Price:** $520.00.

**Company Address:** Audiophile Systems, 6842 Hawthorn Park Dr., Indianapolis, Ind. 46220.
For literature, circle No. 94

Linn Products, Ltd. is a Scottish company which is probably most famous for their Sondek LP12 turntable (*Audio*, Nov. 1983). The LP12 has earned a reputation for excellent performance when used with high-quality tonearms, but Linn felt that they could design a tonearm which combined the best of modern design ideas and advances in precision manufacturing. The Ittok LVII tonearm and Asak cartridge are made in Japan to Linn specifications. Since this combination of arm and cartridge was meant to complement the LP12 turntable, I used this turntable during my evaluation. The Linn Ittok LVII tonearm has some features similar to those of the Sumiko MDC-800, which I reported on in the Sept. 1983 issue. The Sumiko tonearm provided exceptional performance, so I expected great performance from the Linn Ittok LVII; I wasn't disappointed.

The Ittok LVII has a straight arm tube with the necessary offset provided by slots in the headshell. The Asak cartridge is a moderate-output moving-coil type which is designed to be mounted in a tonearm with a wide, rigid mounting surface in the headshell, such as the Ittok. While both the arm and cartridge may be purchased separately, there is every indication that they are designed to complement each other.

Although the names of these Linn products appear strange, they do have a rationale, based on persons, places and companies which were significant to the products' design and development. "Asak" comes from Asakura Brothers, who build the cartridge. "Ittok" comes from Mr. Ito, the Japanese engineer from the company which makes the arm; the "k" was added to harmonize with "Sondek" and "Asak." The "LVII" designation stands for the design specification meeting between the people from Linn and the Japanese manufacturing company, which took place in Las Vegas during a Consumer Electronics Show (it appears more goes on at these shows than one might imagine); the "II" stands for Ito and Ivor Tiefenbrun, Linn's Managing Director. (And you thought audio people had no sense of humor!)

## First Impressions

The appearance of the Ittok LVII is one of simplicity and style. It gives the immediate impression that it is a well-executed, no-nonsense tonearm that will do exactly what it is designed to do, without being fussy in operation. The bearings feel smooth and friction-free, without any excess play, and the finish is quite good. The headshell appears a bit strange at first, since it lacks the usual offset, but closer examination reveals that the offset is supplied by the cartridge mounting slots. The tonearm retainer is separate, and must be mounted on the front of the tonearm base. The instructions for the Ittok are very detailed, and it is evident that Linn is more than a little concerned that you obtain the best possible performance from their tonearm. The use of both a counterweight to balance the tonearm, and a calibrated spring tracking-force control, means that the Ittok LVII can be dynamically balanced. This provides good isolation from outside forces which can adversely affect performance.

The Asak cartridge reminds me a bit of European cartridges of the past, such as the ELAC, and has a bulky appearance even though it is actually quite small and com-

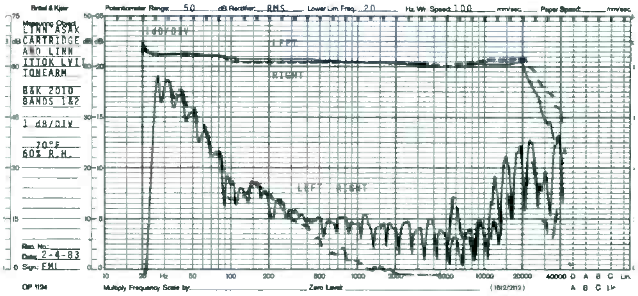



Fig. 1—Frequency response and interchannel crosstalk of arm and cartridge, using B & K 2010 test record.

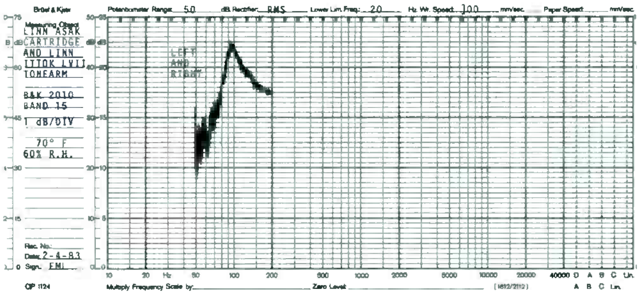



Fig. 2—Low-frequency tonearm/cartridge resonance is at 9.5 Hz, with a "Q" of 3.8 (B & K 2010).

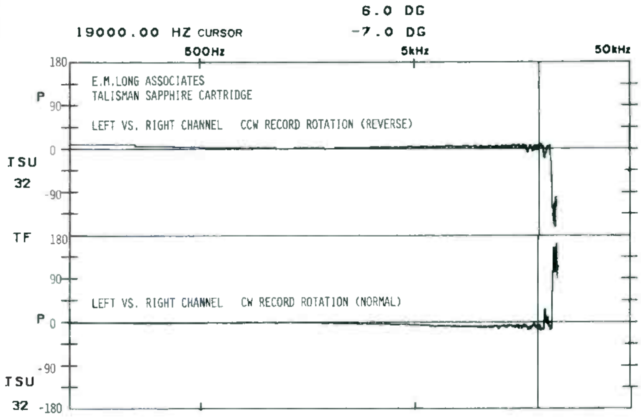



Fig. 3—Interchannel phase of Talisman Sapphire cartridge of previous report. This test was run to determine if the phase difference between channels could be zeroed out (see text).

The Ittok's instructions are very detailed. It is evident that Linn cares that you get the best possible performance.

## MEASURED DATA

**Linn Asak Cartridge**

| Parameter | Measurements/ Comments |
|---|---|
| Coil Inductance | 5 µH |
| Coil Resistance | 1.9 ohms |
| Output Voltage | 0.038 mV/cm/S (lateral modulation) |
| Tracking Force | 1.8 to 2.2 grams |
| Cartridge Mass | 6.1 grams |
| Microphony | Very low |
| Hum Rejection | Very good |
| High-Frequency Resonance | 24.4 kHz |
| Rise-Time | 12 µS |
| Low-Frequency Resonance | 9.5 Hz |
| Low-Frequency "Q" | 3.8 |
| Recommended Load Resistance | 10 ohms or greater has no effect |
| Recommended Load Capacitance | 1 µF or less has no effect |
| Recommended Tracking Force | 2.0 grams |

pact. The front of the cartridge has a little red indicator that looks like an LED—one almost expects it to light up!

### Features

The bearing system is probably the single most important part of the Ittok LVII design. The goal of stability between the cartridge stylus and the record surface dictated the use of the same material for the bearings, bearing housing, and arm pillar. Since the coefficient of expansion is the same for all three parts, changes in temperature affect them identically and therefore are cancelled. The tonearm tube is relatively large in diameter but is made of very thin aluminum. This gives the tube great rigidity while requiring less mass than smaller tubes with thicker walls.

The headshell is made of magnesium/aluminum alloy, and it is permanently attached to the tonearm tube. While admitting that this makes rotational adjustment of the headshell impossible, Linn feels that rigidity is more important than being able to make such an adjustment, and that the Ittok's design makes such an adjustment unnecessary. This is because the arm's bearing axis is not perpendicular to the shaft, but is offset at the same angle as the axis of the cartridge mounting screws. According to Linn, this allows the stylus to remain perpendicular to the record even when arm height is changed to adjust vertical tracking angle, provided that the cartridge is mounted parallel to the headshell.

## MEASURED DATA

**Linn Ittok LVII Tonearm**

| Parameter | Measurements/ Comments |
|---|---|
| Pivot to Stylus | 9.0 in. (22.9 cm) |
| Pivot to Rear of Arm | 2.0 in. (5.1 cm) |
| Height Adjustment Range | 1.5 to 3.0 in. (3.8 to 7.6 cm) |
| Tracking Force Adjustment | 0 to 3 grams, with knob |
| Tracking Force Calibration | 0.1 gram low at 2.0 grams |
| Cartridge Weight Range | 2 to 15 grams |
| Counterweights | Two, for different cartridge weight ranges |
| Counterweight Mounting | Compliant ring inside counterweight |
| Sidethrust Correction | Spring type with calibrated knob |
| Pivot Damping | None |
| Lifting Device | Finger lift on headshell plus damped lever |
| Headshell Offset | Slots in headshell to set offset |
| Overhang Adjustment | Slots in headshell to set overhang |
| Bearing Alignment | Excellent in both planes |
| Bearing Friction | Less than 40 mg; too low to measure accurately |
| Bearing Type | Gimbals with stainless steel bearings |
| Lead Torque | Negligible |
| Arm Lead Capacity, pF | Internal, 14; external, 92; total, 106 |
| Arm Lead Resistance, ohms | Internal, 0.9; external, 0.12; total, 1.02 |
| External Lead Length | 36 in. (91 cm) |
| Structural Resonances | Very dead; slight click when tapped |
| Base Mounting | 1.0-in. diameter hole plus three flange screws |

The counterweight has two parts. The main weight is used alone when cartridges weighing less than 6 grams are mounted. For cartridges over 6 grams, a smaller ring is attached to the main weight, and locked in place with two hex screws. The counterweight is used to adjust the balance of the tonearm, not to apply the tracking force. Since

The goal of stability between stylus and record dictated the use of the same material for the arm's bearings, bearing housing and pillar.

the tracking force is applied separately by a spring, the arm can be dynamically balanced. This means that the tracking force is not a function of gravity and that a record could be played with the turntable upside down, or even by astronauts in outer space! The use of a dynamic balancing scheme like this has a more practical advantage, however, since it isolates the tonearm from other outside forces besides gravity. This means that external vibrations will have little effect upon performance. The spring that applies the tracking force is controlled by a calibrated knob. The side-thrust compensation is also applied by a spring controlled by a calibrated knob.

The arm height can be adjusted to compensate for different turntable platter heights by sliding the arm pillar in the arm base. The tonearm pillar has a slot running up one side. A large setscrew in the tonearm base is locked against the outside ridges of this slot after the proper height is set. A right-angle connector plugs into a keyed socket on the bottom of the arm pillar, and the shielded signal cable is carefully dressed and clamped along the path to the exit point, which is at the center rear of the turntable base.

The Asak cartridge is designed to couple any excess energy from the record groove which is not used by the stylus, cantilever and coils directly to the tonearm and into the mounting base, where it can be dissipated. To accomplish this, the cartridge body has a flat upper mounting surface which is wider than usual. Instead of mounting ears, such as are found on other cartridges, the Asak has mounting holes which run directly through the cartridge body. This allows the cartridge mounting screws to be tightened very securely.

Mounting the Asak cartridge to the Ittok LVII tonearm is very simple, but, as Linn recommends, this should be done while the arm is removed from the turntable. Changing cartridges therefore is not simple, but for most users this will not be a major consideration. Mounting the tonearm to the turntable is also relatively simple, but the detailed instructions should be followed carefully and patiently in order to obtain the best performance. There are a number of small details in the process which can affect performance, and these are well covered by the instructions.

### Measurements and Listening Tests

I am convinced that pursuing the relationship between audible effects and technical measurements is very worthwhile. Since it is difficult to remain objective, especially if one is trying to prove one's own hypothesis about something, I always use a listening panel to evaluate the sound quality of the components upon which I report. The panel consists of persons who are used to listening to excellent sound reproduction and who also attend live musical events. Many scientific investigations of sound phenomena are conducted using untrained listeners, in order to determine effects which can be perceived by average persons. When testing high-quality audio equipment and attempting to correlate subtle audible effects with technical measurements, I feel that the use of experienced listeners is as important as the use of the finest test equipment.

The object of a technical report, such as this one, is to supply valid information about the equipment, including the

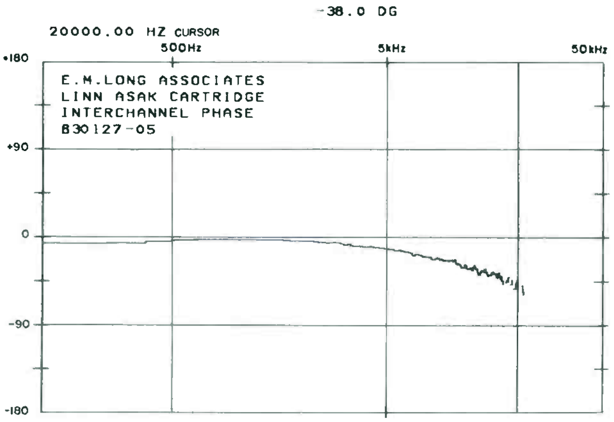


**Fig. 4—Interchannel phase of Linn Asak cartridge and Linn Ittok LVII tonearm vs. frequency (B & K 2011, pink noise). Maximum phase shift is 38° at 20 kHz, equivalent to 5.3 µS.**

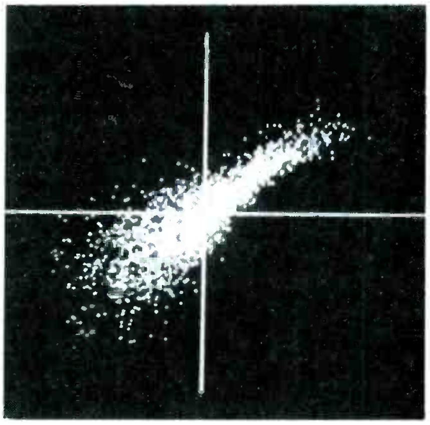


**Fig. 5—Interchannel phase of arm and cartridge, left vs. right channel (B & K 2011, band 7, pink noise).**

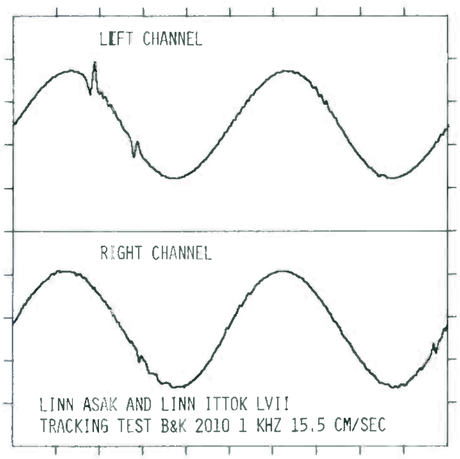


**Fig. 6—Mistracking of a 1-kHz signal begins at 15.5 cm/S lateral modulation, with 1.8-gram tracking force (B & K 2010).**

Since the Ittok's tracking force is applied by a spring, the arm can be dynamically balanced for isolation from gravity and other outside forces.

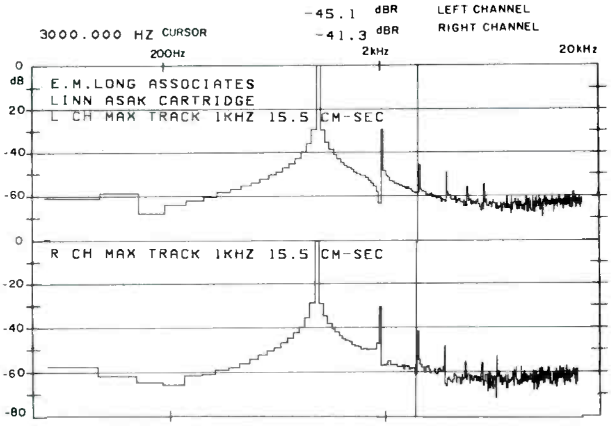



**Fig. 7—Spectral components caused by slight mistracking of 1-kHz signal in Fig. 6. Level of third harmonic (3 kHz) is 0.56% in left channel, 0.88% in right. Note low levels of upper harmonics.**

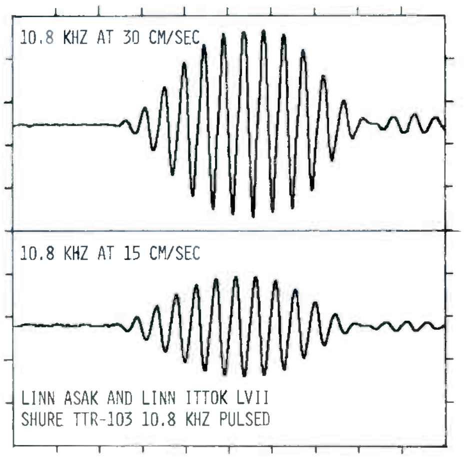



**Fig. 8—Arm/cartridge response to 10.8-kHz pulse test (Shure TTR-103) at 30 and 15 cm/S.**

subtle details. The most rational way to do this is to try to correlate the comments about the sound quality by a listening panel with various artifacts in the data gathered from measurements. Since it is always easier to find things wrong with equipment, no matter how excellent it is, the reports tend to emphasize the faults rather than the virtues. (*Editor's Note:* This is true to a great extent with all reviews, and it is an unfortunate fact of an editor's life that we will have very little to say about the very best equipment.—*E.P.*) It should be remembered, when reading my reports, that the listeners are experienced and that the reference system used is considered to be of the highest quality.

The amplitude versus frequency response and interchannel crosstalk curves of Fig. 1 indicate that the Ittok-Asak combination is well-matched, and only a slight discontinuity at about 90 Hz is evident. This is probably due to the headshell-to-arm-tube connection which, while it is very good, is not perfect. Any mechanical discontinuity in the path between the cartridge and the base of the tonearm can cause delayed energy to be reflected back to the cartridge stylus, where it is mixed in with direct signal. This can cause the sound to be muddy or unclear. During the listening sessions, no negative comments were made by anyone on the panel that could be attributed to this discontinuity.

The crosstalk of the left channel into the right channel is down by at least 30 dB from 500 Hz to 10 kHz, which is excellent. The crosstalk of the right channel into the left channel, while it is even lower through most of this same range, does show a sharp increase around 5 to 6 kHz. During the listening sessions, comments were made, after playing certain types of program material such as solo guitar, about an upper-midrange "brightness"; this puzzled me, because it didn't seem to be consistent. On other program material, such as the Sheffield *Drum Record*, some of the panel members would comment that the reference system was "brighter." This bundle of crosstalk energy around 5 to 6 kHz may only be heard sometimes, and at other times not be triggered at all by the program material.

Figure 2 shows the tonearm/cartridge resonance, which is relatively very well controlled. It occurs at 9.5 Hz with a "Q" of 3.8, which is very good. This is probably an area of tonearm and cartridge design where effort to lower the "Q" would most likely result in improved performance. The subjectively perceived results of this rise in low-frequency output can be correlated with comments about the difference in the bass range compared to the reference system. The reference system has a slightly lower and much more narrow rise in output at about the same frequency. Some panel members commented that the Ittok/Asak combination had more bass when playing such discs as the Sheffield *Drum Record* and Pink Floyd's *Dark Side of the Moon*.

I have done more investigating since I first began to measure the interchannel phase of phono cartridges. The first phase data was shown in the report on the Sumiko Talisman S cartridge, and although I thought that the amount of interchannel phase differential was a little high (130° at 20 kHz), it represented only a 19.2-µS difference, which would probably be very difficult to hear. The interchannel phase differential measurement is for the complete system, including the pre-preamp used between the cartridge and the magnetic phono input. The input of the pre-preamp is very low in impedance; in the case of the Talisman S and the Asak cartridges it was set at 100 ohms. Prior to testing the tonearm/cartridge combination, the complete system was tested electrically by feeding a signal from a 600-ohm generator into the pre-preamp's input. Under these conditions, the interchannel phase difference was less than 2°. It was discovered later that, when the extremely low impedance of a moving-coil cartridge was connected to the pre-preamp's inputs, there was an increase in the interchannel phase differential. This was traced to a difference in capacitance at these inputs. After this was corrected, the

A peak at 5 to 6 kHz in the crosstalk curve caused inconsistent results, making some—but only some—material sound "bright."

interchannel phase was tested using an even more elaborate procedure, which included running the turntable in forward and reverse directions. The total difference for the Sumiko Talisman S is 13° (1.8 μS) and is shown in Fig. 3. Since investigating interchannel phase differential in more detail, I have been even more careful in setting up phono systems, particularly with regard to determining the proper offset angle and checking the effects of input loading upon low-impedance moving-coil cartridges.

Figure 4 shows the interchannel phase difference for the Linn Asak moving-coil cartridge and the complete system, which includes the B & K 2011 test record, the pre-preamp, and the control preamplifier. It is quite good, since 38° represents a time differential of only 5.3 μS at 20 kHz. Figure 5 is a measurement over a period of 2 S, using the same record, displayed as left versus right channel. A perfect cartridge and system would show a straight line at 45°. The amount of "blooming" is an indication of the amount of interchannel phase differential. This pattern is considered very good and indicates that the coherence between channels is excellent. The listening panel was very impressed by the way the Linn Ittok LVII and Asak cartridge presented the stereo images on well-recorded program material. Some multi-track and/or multi-microphone-type recordings were presented in such a clear way that their faults were not hidden, and comments regarding poor stereo could be traced to the recordings and not to the playback system.

Figure 6 shows the effects of slight mistracking in the left and right channel when playing a 1-kHz tone at 15.5 cm/S. This is a fairly high level, indicating that the Ittok LVII and Asak will reproduce most recordings without difficulty. Figure 7 shows the harmonic distribution of the distortion under the same conditions. The cursor at 3 kHz indicates that the third harmonic distortion is 0.56% (45.1 dB) and 0.88% (41.3 dB) for the left and right channels, respectively. The seventh harmonic in the right channel is 0.22% and might be heard if not masked by the program material. Perhaps this could be a partial explanation for the comments made about the sound of the guitar, which some panel members considered a little bright.

Figure 8 indicates a slight amount of compression when reproducing the extremely high-level, 30 cm/S, 10.8-kHz tone burst of the Shure TTR-103 test record. Figure 9 shows the amount of low-frequency output which is present at this level. The listening panel made comments about a very slight "congestion" or "lack of clarity" when reproducing crescendos in symphonic-type program material. This might be related to the production of lower frequency energy by the Ittok/Asak combination when trying to reproduce high-level, high-frequency energy from cymbals, etc.

The 1-kHz square waves shown in Fig. 10 corroborate the amplitude versus frequency response data shown in Fig. 1, since the high-frequency roll-off is shown as an upward slope on the top of each positive cycle.

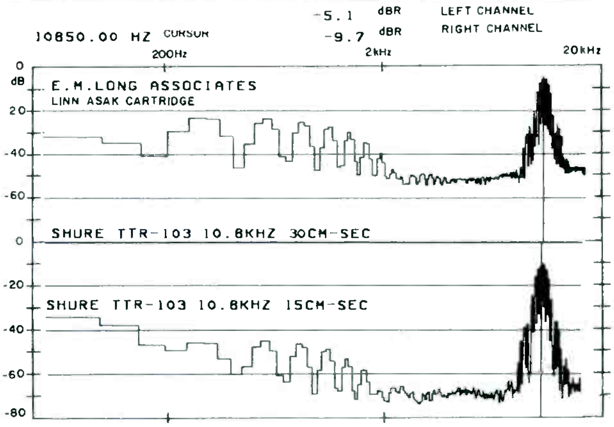
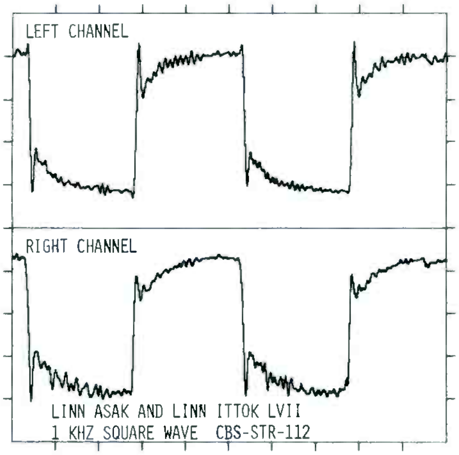



**Fig. 9—Spectrum of distortion products for 10.8-kHz tone bursts of Fig. 8, for 30- and 15-cm/S signals. Frequencies between 200 Hz and 2 kHz are down 20 dB, even with 30 cm/S signal.**

**Fig. 10—Arm/cartridge output for 1-kHz square wave, CBS STR-112, 5 cm/S lateral modulation.**




### Conclusions

The Linn Ittok LVII tonearm and Asak cartridge is an excellent combination, and I definitely recommend that they be used together. The Ittok LVII tonearm seems particularly well suited to medium-compliance cartridges and should also offer excellent performance with cartridges other than the Asak. There is some indication that the Ittok performs best when mounted on the Linn Sondek LP12 mounting base, which tends to absorb some unwanted energy, preventing it from reflecting back into the tonearm. Mounting the Ittok LVII to a base made of different material, especially of metal, would certainly change the sound character. The comments of the listening panel and my technical measurements both indicate that the combination of the Ittok LVII tonearm and Asak cartridge, when mounted on the LP12 turntable, is worthy of its excellent reputation.

*Edward M. Long*

# EQUIPMENT PROFILE

6

# LUXMAN KX-102 CASSETTE DECK

**Manufacturer's Specifications**

**Frequency Response:** 20 Hz to 18 kHz, to 20 kHz with metal tape.

**Harmonic Distortion:** 0.7%.

**Signal/Noise Ratio:** 61 dB, 68 dB with Dolby B NR, 94 dB with dbx NR (CCIR/ARM).

**Input Sensitivity:** Mike, 0.25 mV; line, 100 mV.

**Output Level:** Line, 500 mV; headphone, 1 mW (8 ohms).

**Flutter:** 0.04% wtd. rms.

**Dimensions:** 17.8 in. (453 mm) W × 5.8 in. (147 mm) H × 14.4 in. (365 mm) D.

**Weight:** 20.9 lbs. (9.5 kg).

**Price:** $999.95.

**Company Address:** Luxman Division of Alpine Electronics, 3102 Kashiwa St., Torrance, Cal. 90505.

For literature, circle No. 95

The KX-102 is Luxman's top stereo deck, featuring a Computer Tuning System (CTS) to match the deck's recording parameters to the specific tape in use, plus dbx and Dolby B noise reduction, and three heads.

At the left edge of the front panel are the "Power" and "Eject" buttons, plus the CTS controls. The clear compartment door swings out for drop-in tape loading, making it easy to see how solid the support bar for the combination-mount record and playback heads is, and making the heads accessible for cleaning. Phone jacks for headphones and left and right microphones are below, inset a bit from the main panel.

Just to the right of the tape compartment is a vertical column of small light-touch buttons—one for "Rec Mute" and four for the counter and memory system: "Clear" resets the three-digit fluorescent display to "000," "Store" enters the counter reading into memory, "Call" displays the stored reading (even if the deck is in fast wind), and "Execution" (with a red status light) stops the deck at the stored reading in either wind direction.

To the right of these are the transport control buttons: Large, clear-plastic push bars with fairly small red indicators for "Play," "Pause," "Stop" and the two fast-wind directions. Logic circuits allow switching from any mode to any other, including directly into recording from play, or even from fast wind.

The lower right panel area contains the knobs for NR selection, tape selection, "Output Level," "Rec Balance" and (larger) "Rec Level." This area uses Luxman's motorized Servo Face technology, a motor system which brings the front panel out flush with the front surfaces of the knobs when the power switch is turned off. When the power is turned on, the panel section moves back about 15 mm, making all knobs accessible for adjustment, and restoring full access to the row of seven small pushbuttons just below.

The rotary NR-selector switch has positions for "Off" and "Dolby NR" plus two positions for "dbx NR"—one each for "Tape" and "Disc." In the latter position, discs can be decoded with the KX-102 in stop, pause or wind modes. There is also a very sensible interlock system which ensures that the deck will be in dbx tape mode during recording or playback, even if the switch is at "Disc." Small, reminder LEDs just to the left of the horizontal bar-graph meters show which NR mode has been selected.

Record levels are set with the large master "Rec Level" and smaller "Rec Balance" knobs, and monitored on a bright, fluorescent bar-graph meter (peak-responding, to facilitate accurate level setting). The display panel also includes the electronic tape counter and LEDs indicating whether the deck's monitor switch is in "Tape" or "Source" position.

The monitor switch is one of seven buttons at the bottom of the panel. The others are: "MPX Filter" (on/off), "Line/Mic" input select, and four for auto transport functions ("Auto Play," "Auto Rew," "Auto Repeat" and "Off").

With the "Execution" switch turned off, these functions are fairly self-explanatory. "Auto Play" puts the deck into play mode as soon as the tape is rewound; "Auto Rew" does the opposite, rewinding the tape once play is completed, while "Auto Repeat" cycles continuously through both.

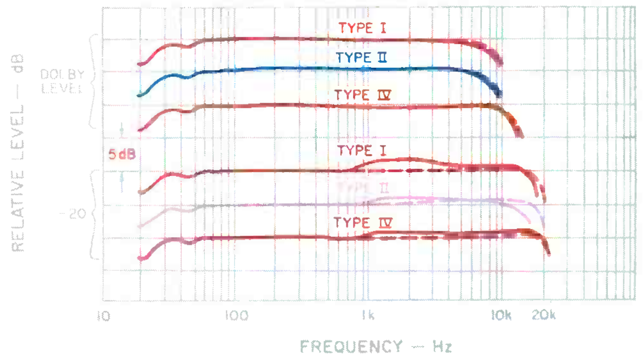



**Fig. 1—Frequency responses with (solid lines) and without (dashed lines) Dolby B NR, using Nakamichi EXII (Type I), Memorex HBII (Type II) and Yamaha MR (Type IV) tapes.**

With the "Execution" mode on, the possibilities grow more elaborate. With only the "000" point in memory, all functions act as if that point were an end of the tape, running only up to that point or from that point to the end, depending on where you start. If you have also stored another location in the memory, the functions will treat both memorized points as start/end points. (This lets you endlessly repeat one passage on the tape, if you desire.) This is just a summary, of course—the full-page diagram in the owner's manual shows 43 different possibilities!

The Computer Tuning System, by contrast, is pretty much a straight pushbutton process. Once a tape has been loaded, and the "Tape Selector" on the Servo Face panel has been set (to "Normal," "$CrO_2$" or "Metal"), a push of "CTS Start" initiates the automatic process. A series of illuminated blocks show exactly what is being done: "Cal" first, then "Bias," back to "Cal," and then back and forth between "Cal" and "EQ." If the adjustments yield a response within the built-in criteria, "OK" is illuminated, and the tape is wound back to the calibration start point. Then, the information can be entered into memory by a push of "CTS Memory Write." There is one user-set memory position for each tape type; each insertion erases any previously stored data from that memory. If the tape does not meet the adjustment criteria (for example, if the tape selector is in the wrong position), CTS will do its best, but the "Error" block will light. A "Rec Data Selector" button chooses either "CTS Memory" or "Standard," the latter providing fixed bias and EQ to match common tapes of each type.

A red LED bar indicates battery status. If it is on, the battery voltage is high enough to maintain data in memory with the recorder off, while a blinking display tells the user that the batteries should be replaced. Above this group of indicators and switches are three LED bars that show which tape type has been selected.

The back panel has the expected line in/out phono jacks, plus a jack for an optional remote control and the battery compartment for the CTS memory system. There is also a

Recording at purposely high levels showed, immediately and emphatically, how much distortion dbx II NR can prevent.

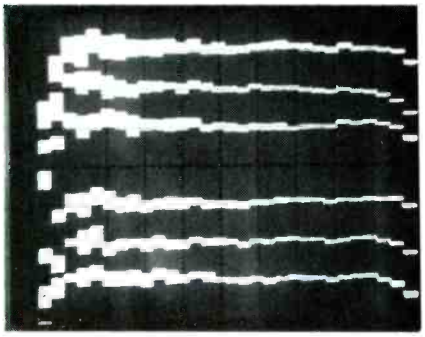


**Fig. 2—Record/playback responses to pink noise, using dbx II NR, at Dolby level (top traces) and at −20 dB, for Nakamichi EXII, Memorex HBII and Yamaha MR tapes (top to bottom in each set). Vertical scale: 5 dB/div.**

phono jack for interconnection with a Luxman turntable, to use their auto-disc pause for initiating recording when the arm sets down.

With the removal of the heavy steel side and top cover, I could see the high-quality components contained. A large p.c. board was almost full chassis size, and it also served as the mother board for two good-sized vertical boards, which were well-supported and braced. All of the parts were identified, with many adjustment pots in evidence. The soldering was excellent, and interconnections were with multi-pin cabling. Worthy of note were the rigid drive assembly and the large, shielded transformer. The control-panel drive/cam system worked smoothly, and it was certainly well made, but I did wonder about its value to most users.

#### Measurements

The playback responses with standard alignment tapes were well within ±2 dB for both 70- and 120-μS equalizations, except for the 120-μS low-end point and the 70-μS high-end point. The playback level indications were correct, within the resolution of the meter segments. Tape play speed was 1.6% high, more of a deviation than measured on most decks in any price category. Checks of the KX-102's responses using the built-in "Standard" tape settings indicated that the deck parameters did not match the IEC reference tapes as closely as they did some of the hotter tapes (Sony UCX-S, TDK SA-X, etc.). The CTS system was evaluated with a wide range of tapes, and responses were also checked using dbx and Dolby NR. CTS usually took less than 20 S, sometimes less than 10, but a couple of tapes required about 45 S. As a generality, all of the responses with dbx NR and without NR were very flat. With Dolby B NR, however, most tapes had some high-end roll-off and a boost around 2 kHz.

The tapes showing the least of such deviations were Nakamichi EXII, Memorex HBII and Yamaha MR, which were used for the remainder of the tests. Other tapes, substantially as good with the KX-102, were Fuji FR-I and FR Metal, Loran High Bias, Maxell XL I-S, Nakamichi ZX, TDK SA-X and MA and Yamaha CR-X.

The record/playback swept-frequency responses with and without Dolby B NR are shown in Fig. 1, and the responses with dbx NR and pink noise are shown in Fig. 2. (The responses with dbx II NR cannot be measured correctly with a sweeping sinusoidal signal.) All of the responses are very flat, particularly between 60 Hz and 13 kHz or more at −20 dB. There is some evidence of boost at 2 kHz (Type I) and high-end roll-off (Type II), but these deviations are moderate. The 3-dB down points with the two NR systems are listed in Table I. The exact high-end limits could not be determined for dbx NR with the pink-noise/RTA combination, but they did appear to be at least 20 kHz in most cases. The 25 to 30 Hz low-end limit appeared to be a limitation of dbx NR, as the Dolby NR results were notably closer to the 20-Hz specification.

The results from measuring a number of record/playback properties are listed in Table II. In general, the figures are excellent: Note in particular that dbx II NR decoding improved the effective erasure and crosstalk greatly. The 10-kHz phase jitter was fairly low, but the interchannel error was just average.

The level of third-harmonic distortion was measured for the three tapes, with both NR systems, from 10 dB below Dolby level to the points where $HDL_3 = 3\%$. Table III shows clearly that although the level of distortion was close for all combinations at −10 dB, there were increasing differences between NR-system results above the lower limit. An associated test check indicated that the dbx unity-gain level (no compression in encoding and no expansion in decoding) was at −10 dB. Thus, it was not surprising to see that the distortion was obviously lower for dbx NR at the zero level. The continuing benefit of the compression lowering the distortion led to very high 3% points, substantially at the output-level limits of the deck.

With such high record-level limits, it doesn't seem so surprising to find the very high signal-to-noise ratios listed for dbx II NR in Table IV. Those for Dolby B NR are quite good, even though they seem a bit gentle in comparison. $HDL_3$ was measured for both Dolby B NR and dbx II NR at 10 dB below Dolby level from 50 Hz to 5 kHz. In this comparison, we can see that there was fairly low distortion in either case from 400 Hz up, but that with Dolby B NR it was less below 400 Hz, significantly at 50 and 100 Hz.

The results from measuring input and output characteristics are shown in Table VI. Most of the entries are equal to or better than the specifications, although the line output level was slightly low. The two sections of the input-level pot tracked within 1 dB for 55 dB down from maximum, which is excellent. The output-level pot sections tracked within 1 dB for about 40 dB—fairly good and quite acceptable for this function. The output polarity matched that of the input, both in "Source" and in "Tape." The bar-graph level meters responded fully to bursts as short as 10 mS, and were just 3 dB down with a 3-mS burst, meeting criteria for peak-responding meters. The meter decay time of 150 mS was actually on the short side, as 1.4 to 2.0 S is preferred. The frequency response of the meters was 3 dB down at 17.8 Hz (just fine) and 75.9 kHz (unnecessarily high). The scale calibrations were excellent, with all thresholds from "−20" to "+8" within 0.3 dB. The display was very bright and easy to read under a wide range of lighting levels.

Flutter was consistent throughout a C-90, with excellent

**The Luxman KX-102 has very flat responses where it counts the most, low flutter and excellent signal-to-noise ratios, especially with dbx II NR.**

figures of 0.035% wtd. rms and 0.057% wtd. peak. The tape play speed appeared to be quite constant with changes in line voltage, but variations in speed with time—amounting to a total spread of 0.1% (just fair)—confused the assessment. The wind time for a C-60 cassette was 88 S, longer than most decks.

### Use and Listening Tests

The owner's manual gets across most of the basic information, but there should be more information on the noise-reduction systems and setting record levels. The discussion on CTS is good, and there is a helpful illustration on the auto-function wind/play modes. Loading was simple (just drop in), and maintenance on the heads and tape path was easy, particularly with the door cover removed. All controls and switches were completely reliable, with no malfunctions noted. I did notice that after some time of use, the cassette shell felt quite warm on removal, but no detrimental effects were found.

CTS did its calibration quite consistently: The differences from one time to the next were not detectable by ear. I did try to fool the system by trying to calibrate TDK D in the metal tape position and to do Yamaha MR in the normal position. Sometimes I got away with it, and sometimes I got "Error." My conclusion is that the user should not rely on CTS to point out bad choices: Make certain that the tape selector is set correctly.

The transparent transport-control buttons looked good, but gave me a slight problem: Unless I looked at them straight on, I could not always tell which button was illuminated. On the other hand, I liked the recording level-control setup, with its "Rec Master" control (for overall level) and "Rec Balance" (for relative level between channels) slightly better than the usual individual-channel controls or the combination of individual-channel pots plus a master.

Levels were easily set with the peak-responding meters, but a slower decay time would have been helpful. Listening tests utilized pink noise as well as the normal collection of selected discs. There really seemed to be a sweeter sound with Dolby B NR, even at fairly high levels, compared to operation without noise reduction. The general character was very close, with Dolby B NR perhaps slightly brighter. Recording at purposely high levels and switching back and forth showed, immediately and emphatically, how much distortion dbx II NR *prevents* under such high-level conditions. Record, pause and stop sounds were all very low, even with Dolby B NR.

The Luxman KX-102 has responses that are very flat where it counts the most, low flutter and excellent signal-to-noise ratios, especially with dbx II NR. Its CTS system does a consistent and excellent job of adjusting bias, record sensitivity and EQ, but particular tape choices may best ensure the maximum performance from Dolby B NR. The deck has quality parts and solid construction, indicators of future reliability. The Servo Face front panel did not seem that beneficial to me; I would have traded it for more accurate play speed. The potential user would be advised to concentrate on its performance features when comparing the KX-102 to other decks in its price range.

*Howard A. Roberson*

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

| | With Dolby B NR | | | | With dbx II NR | | | |
|---|---|---|---|---|---|---|---|---|
| | Dolby Lvl | | −20 dB | | Dolby Lvl | | −20 dB | |
| Tape Type | Hz | kHz | Hz | kHz | Hz | kHz | Hz | kHz |
| Nakamichi EXII | 23 | 8.8 | 22 | 17.0 | 30 | 20+ | 30 | 20+ |
| Memorex HBII | 23 | 9.0 | 21 | 16.0 | 25 | 18 | 29 | 20+ |
| Yamaha MR | 22 | 12.0 | 21 | 21.2 | 30 | 20+ | 28 | 20+ |

**Table II—Miscellaneous record/playback characteristics.**

| NR Type | 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 |
|---|---|---|---|---|---|---|
| Dolby B | 70 dB | 50 dB | −77 dB | 50° | 20° | −31.1 dB |
| dbx II | >90 dB | 58 dB | < −110 dB | | | |

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

| | | Record Level | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Tape Type | NR | −10 | −8 | −4 | 0 | +4 | +8 | $HDL_3$ = 3% |
| Nakamichi EXII | Dolby B | 0.14 | 0.19 | 0.27 | 0.60 | 3.0 | | + 4.0 dB |
| | dbx II | 0.09 | 0.11 | 0.14 | 0.17 | 0.22 | 0.56 | +18.4 dB |
| Memorex HBII | Dolby B | 0.14 | 0.22 | 0.47 | 1.50 | | | + 3.1 dB |
| | dbx II | 0.15 | 0.18 | 0.25 | 0.36 | 0.54 | 0.79 | +18.4 dB |
| Yamaha MR | Dolby B | 0.13 | 0.16 | 0.40 | 0.89 | 2.2 | | + 5.2 dB |
| | dbx II | 0.14 | 0.16 | 0.22 | 0.30 | 0.42 | 0.60 | +24.6 dB |

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

| | IEC A Wtd. (dBA) | | | | CCIR/ARM (dB) | | | |
|---|---|---|---|---|---|---|---|---|
| | W/Dolby B NR | | W/dbx II NR | | W/Dolby B NR | | W/dbx II NR | |
| Tape Type | @ DL | HD=3% | @ DL | HD=3% | @ DL | HD=3% | @ DL | HD=3% |
| Nakamichi EXII | 61.4 | 65.3 | 78.0 | 96.4 | 60.8 | 64.4 | 78.3 | 95.2 |
| Memorex HBII | 63.8 | 66.6 | 78.3 | 96.7 | 63.6 | 66.4 | 79.2 | 95.5 |
| Yamaha MR | 62.7 | 67.4 | 79.2 | 101.7 | 61.9 | 66.6 | 77.5 | 100.0 |

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

| | | Frequency (Hz) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Tape Type | NR | 50 | 100 | 400 | 1k | 2k | 4k | 5k |
| Yamaha MR | Dolby B | 0.32 | 0.18 | 0.13 | 0.20 | 0.15 | 0.28 | 0.31 |
| | dbx II | 1.9 | 1.0 | 0.14 | 0.14 | 0.20 | 0.38 | 0.36 |

**Table VI—Input and output characteristics at 1 kHz.**

| Input | Level | | Imp., Kilohms | Output | Level | | Imp., Ohms | Clip (Re: Meter 0) |
|---|---|---|---|---|---|---|---|---|
| | Sens. | Overload | | | Open Ckt. | Loaded | | |
| Line | 71 mV | 31 V | 29.0 | Line | 452 mV | 429 mV | 595 | +21.8 dB |
| Mike | 0.16 mV | 19.7 mV | 1.1 | Hdphn. | 2.0 V | 1.0 mW | | |

# AUDIOPHILE RECORDINGS

## FRANKOPHILIA


**The Sinatra Collection**
**Mobile Fidelity SC-1,** 16-record set, $350.00.

A lavish 16-record collection arrived a short while ago, Mobile Fidelity's monumental *The Sinatra Collection*. The scope of coverage and the attention to the details of quality are what we have come to expect from them.

The set chronicles the nine years Sinatra spent as a Capitol artist, 1953 to 1962. These were the crucial transition years from mono to stereo, and it is interesting to hear the evolution of recording techniques from a concern for balance only to a concern for both balance and spatial relationships. But first, the music.

Sinatra's first collaborator was Nelson Riddle, that fine arranger who is still busy today, some 30 years later. Riddle's work abounds in skillful tone painting, subtle musical nuances which answer and embellish the lyrics. Mono—and Riddle—take us through the first five discs. Gordon Jenkins takes over the arranging tasks for the first stereo release, followed by arranger Billy May. From that point on to the end of the collection, we find all three of these arrangers sharing the work.

Sinatra's early voice, still in evidence in the mono discs, had an effortless quality, and his pitch was right-on all the time. However, by the time we reach the end of the collection, and that is a lot of singing later, the voice is showing signs of aging, if not wear and tear. In this regard, it is interesting to compare the first and last discs.

There is no question that Sinatra established the first postwar male vocal style, and for this alone his place in popular music is assured. In my opinion, his up-tempo songs are far ahead of his ballads, many of which tend to drag. But if you are a Sinatra fan, you will like them all.

Studio practice in the pre-stereo days evolved from radio practice. Not many mikes were used, and the all-important aim was to keep the soloist to the fore. Often, the bass line was a bit laid-back in an effort to keep the soloist up front. With the coming of stereo, there was a continuing move away from the older ribbon and dynamic microphones to the brighter capacitor (condenser) types, and we hear, in addition to spatial information, the extended range of the newer designs.

The first few stereo recordings present the orchestra pretty much in a symphonic pickup, with only a little highlighting through accent microphones. Later, we witness a tasteful transition toward more mikes deployed for more presence and control of leakage in the studio. In this kind of recording, it helps to have lots of strings. Most of the big string dates had 16(!) violins, something today's pop budgets will rarely allow. Finally, we find the spectrum being fleshed out, with a healthier bass line underpinning it all.

Mobile Fidelity has done a superb job in assembling all of this material. The records are contained in a sturdy cardboard box, with slots inside for each pair of discs. Each disc is accompanied by a folder which presents, on one side, the original cover and back liner artwork. Inside each folder is a breakdown of all the orchestra personnel for each song, along with the recording dates and individual song master numbers. (Remember that the pop record industry grew up on 3½-minute singles, and an LP was, to start with, just a collection of singles.) Unfortunately, there is no listing of the recording engineers. It is quite likely that such information was never recorded on the official take sheets.

The orchestra personnel rosters read like a *Who's Who* of Hollywood musicians. We also note that many of them went on to bigger things. For example, some of the violin players on the early sessions include Paul Shure, currently the concertmaster of the Los Angeles Chamber Orchestra, and David Frisina, retired concertmaster of the Los Angeles Philharmonic. At one time or another, all the members of the legendary Hollywood String Quartet played in the orchestra or performed, as a quartet, in certain arrangements.

All in all, this is a superb production, and we should be thankful Mobile Fidelity chooses to issue these unique packages. Their position in the industry is an important one. *John M. Eargle*

**Baroque Brass: Bach, Gabrielli, Purcell, Handel, Palestrina and Others.**
Empire Brass Quintet
**Sine Qua Non Seven Star Series 79006,** cassette, $6.98.

Performance: B – Processing: D –

This is a potpourri of some familiar and unfamiliar music scored for brass. In some cases the music was recorded for brass quintet. The performances are average, with a less-than-perfect French horn. It's difficult to judge accurately because the recording and processing seriously interfere with proper evaluation. The balances, though, are poor, and the acoustic perspective is distorted in that some instruments sound much more removed than others. The French horn and trumpet, for example, are very closely miked and their seating arrangement within the group is grossly exaggerated. To make matters worse, the entire top end is rolled off in my cassette copy. *C. Victor Campos*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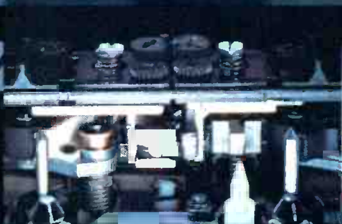
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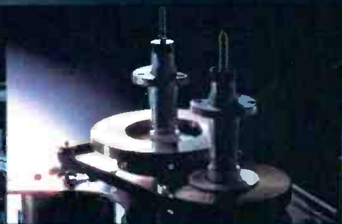
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MICHAEL TEARSON
JON & SALLY TIVEN

# SIMON SAYS


Illustration: Rick Tulka

**Hearts and Bones:** Paul Simon
**Warner Bros. 23942,** $8.98.

Sound: A Performance: A+

Really, I've had an awful time bringing myself to write about this new Paul Simon album. It's because I kept finding myself too emotionally intertwined with it, as one song after another spoke to me directly while I was going through one personal problem or another. And that tells me one thing: Paul Simon is working very effectively in *Hearts and Bones*.

There are two different versions of "Think Too Much" on the album. They have completely different arrangements and lyrics and even different copyright dates. The first "Think Too Much" is the more lighthearted one, while the second version is more somber, but both reflect on the dilemma of being too self-conscious, a theme that has been critical to Simon's songs at least as far back as "I Am a Rock." It is the central theme of *Hearts and Bones*, resounding comically at first, in the opener "Allergies," then ever more seriously in "Hearts and Bones" and "When Numbers Get Serious." "Song About the Moon" faces this, too, as Simon addresses Songwriters everywhere (his capitalization) on how to write about the moon or a face, things Songwriters have only been writing about for a few millennia. "You want to write a spiritual tune," he sings, "*Then do it*/Write a song about the moon."

Perhaps he deals with it most directly in "Train in the Distance," which tells the common story about a man and a woman, the love and the child they shared, how it fell apart and how they coped afterwards. The song closes with Simon stepping out from the narrative to ask, "What is the point of this story?/What information pertains?" To this he replies, "The thought that life could be better/Is woven indelibly/Into our hearts/And our brains." He may write some somber songs, but Paul Simon has found an optimism to underpin them.

Accordingly, after "Train" he segues to a lighter, more joyous tone in "Rene and Georgette Magritte with Their Dog After the War." Simon finds them slow-dancing nude in their hotel room to their "deep forbidden music," namely The Penguins, The Moonglows, The Orioles and The Five Satins. Backing vocals here are appropriately by The Harptones, who weave a lovely counterpoint excerpting the catch phrases of those groups' hits. Next, "Cars Are Cars" is a giggle about (what else?) cars and all their implications.

The album closes sadly with "The Late Great Johnny Ace," a song Simon first performed publicly at the infamous Simon and Garfunkel reunion concert in Central Park. This starts with a very young Paul Simon listening to the radio in 1954 and hearing the announcer break the news of Johnny Ace's death by Russian roulette and how he sent away for a photo which came signed The Late Great Johnny Ace. It moves ahead to England in 1964, a time of Beatles and Stones and "a girl from the summer before." It ends in New York on a cold December night when a fellow on the street breaks the news of John Lennon's assassination, after which the two go to a bar and drink till closing. It is a riveting work with a perfectly quiet afterthought of a coda, composed by Philip Glass, recalling the cellos of "Eleanor Rigby."

Simon's writing has never been better or more literate. He makes words one rarely finds in songs, words like "indelibly," ring with the music. This has always been one of his greatest gifts, and he has never been more in command of the language than he is here.

The production of the album is stunning. The musicians are, as ever, the cream of two coasts. They are people who do what must be thousands of sessions, but when they work with Paul Simon something magical happens. Perhaps it is out of mutual respect or Simon's obvious intelligence and musical skill, but he brings the best work out of his sidemen with intangible, little subtleties in the performances.

Simon's use of backing vocals is what astonishes me the most. In several selections, notably "Hearts and Bones," both versions of "Think Too Much" and especially in "Train in the Distance," he has layered voices doing countervocals and answering parts into almost percussive effects. In "Train" he makes the voices sound like far-off trains. With this in mind I can understand how he suddenly decided, at the last moment, not to release this as a Simon and Garfunkel album and wiped off Art's voice completely. He evidently felt that this was too personal an album to share, and I agree. Except for relatively novelty-oriented songs like "Allergies" and "Cars Are Cars," I don't see where Garfunkel would have even fit into these arrangements with any comfort at all. He could easily have seemed an intruder here.

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Ohm Walsh 4

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| Weight | 29 lbs. | 63 lbs. |
| Sensitivity | 87dB at 1 meter with a 2.83 volt input and all controls at maximum | 87dB at 1 meter with a 2.83 volt input and all controls at maximum |
| Finish | Genuine wood veneer, walnut and oak standard. Scandinavian rosewood and black or white lacquer on oak finishes available on special order. | Genuine wood veneer, walnut and oak standard. Scandinavian rosewood and black or white lacquer on oak finishes available on special order. |
| Inputs | Press connectors accepting "banana plugs" or bare wire up to 12 gauge | Press connectors accepting "banana plugs" or bare wire up to 12 gauge |
| Controls | 2 — low and high frequency each with 3 positions | 3 — low, high and perspective each with 3 positions |
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I am never comfortable when I wind up raving about an album, but I really do believe that *Hearts and Bones* is very possibly the best album Paul Simon has ever done, solo or not. There is commitment, maturity, intelligence, and artistry here in abundance.
*Michael Tearson*

**Under a Blood Red Sky:** U2
**Island 7-90127-1 B,** mini LP, $6.98.

Sound: C– Performance: B+

In case there was any confusion about it, this live mini LP makes it clear that U2 is neither a synthesizer band nor a trendy, fashionable band. Captured here in mid-1983 concert performances, the band has arrived at its fullest confidence and strength.

As is usual for live albums, most of the selections comprise a greatest hits collection. That's why "Gloria," "I Will Follow," "Sunday Bloody Sunday" and "New Years Day" are all here. Staples of their live set, like "The Electric Co." and the perennial closer, "40," are also included. So are two that have not been on previous albums, an early single, "11 O'Clock Tick Tock," and a new song, "Party Girl."

The performances burst with real energy and joy. Jimmy Iovine's production is designed to coordinate three separate, live recordings into one coherent whole and to display U2 as a mainstream rock act. Consequently, no trickery is used to hype up performances, which remain personal and emotional. The raw sound is serviceable at best; the album could have sounded less cavernous and a bit closer.

Face it. U2 is for real. I eagerly await their next full album. *Michael Tearson*

**Rescue:** Clarence Clemons and The Red Bank Rockers
**Columbia BFC 38933.**

Sound: B– Performance: C+

This fine, fun party record came about from the incredibly long periods of inactivity between Bruce Springsteen's albums and tours. Even in his free time, the Big Man on the sax, Clarence Clemons, loves to play. He got up a hot R&B band called The Red Bank Rockers, with a hot lead singer, Philadelphian John "J. T." Bowen. J. T. is a perfect frontman, with a shouting style that brings to mind Wilson Pickett's great '60s Atlantic sides.

For this album, Clarence assembled some crackerjack New York players and gathered some original and little-known material. The playing is classy and tight, with lots of electricity, but the songs are mostly pretty slight, from the party jive of "Rock 'N' Roll DJ" to a new Springsteen tune, "Savin' Up," to the 1970 oldie "Resurrection Shuffle."

The big thing here is the energy. See, this is not a record to be analyzed. It's a record for rolling back the rug, pushing back the chairs, and having a good time. And it does that just fine. *Michael Tearson*

**Pipes of Peace:** Paul McCartney
**Columbia QC 39149.**

Sound: A– Performance: C–

The current headline concerning Paul McCartney is that he's the richest man in show business, which may be true in a strictly financial sense. Artistically speaking, Macca's dry as a bone, ready to file creative bankruptcy. Aside from the single "Say Say Say" (one of two collaborations with Michael Jackson), *Pipes of Peace* doesn't have much of anything to offer in the way of the familiar McCartney tunes.

In songs like "The Other Me," McCartney seems to be trying hard to be thoughtful and introspective, contemplating his own midlife crisis, but this doesn't make for inspired fare. The

Artistically speaking, Paul McCartney is as dry as a bone, ready to file creative bankruptcy.

only energy one finds here is in the jam tune with Stanley Clarke, "Hey Hey," which doesn't have any lyrics. Part of the problem comes with McCartney's choice of accompanists; the invisible Denny Laine has been replaced by 10 C.C.'s Eric Stewart, whose specialty is perfection rather than inspiration.

There is an extremely sterile quality to the production that also was present on 10 C.C. records, where every note was too clean, as if the whole record was made in a vacuum chamber.

This might have something to do with the way this ex-Beatle has totally retreated from the world (particularly since the assassination of John Lennon), and with nothing to write about but himself, he draws a blank. There is another consideration here—Paul supposedly is none too pleased with his record company (this is his last record owed to CBS), and this kind of relationship usually makes for bad records.

Excuses like these are simply to fight the fear that the muse has simply deserted Paul McCartney, and his best records are behind him. The flip side of the single "Say Say Say," "Ode to a Koala Bear" (not included on the LP), is better than just about anything on *Pipes of Peace* and seems to dispute this theory. But it's hard to remember when McCartney has made an album this easily dismissible (*Wildlife*, although thin and inconsistent, had high points which beat out anything here). One can only hope that talent this great and cultivated over so long a period of time doesn't simply disappear forever. *Jon & Sally Tiven*

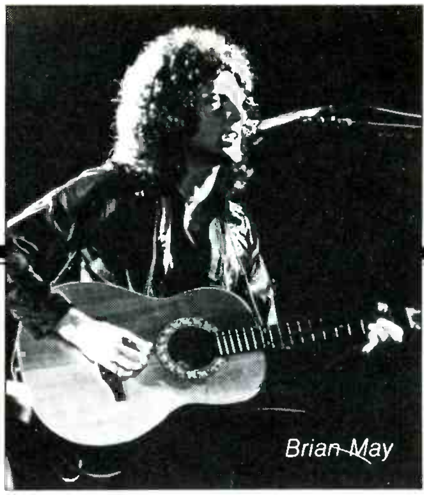
**Starfleet Project:** Brian May & Friends
**Capitol MLP 15014,** mini LP, $5.98.

Sound: B Performance: A–

For fans of the guitar hero, there hasn't been a whole lot of music of interest recently. The majority of 1983 Heavy Metal was bluster and production, and the majority of great guitarists of the '70s are either past it or not playing rock/blues anymore. And saddest of sad news, the two most exciting players of recent note, Brian May and Eddie Van Halen, are in groups (Queen and Van Halen, respectively) which don't showcase their particular talents in a blues/rock way.

Fortunately, the two of them did

Guitarists Brian May and Eddie Van Halen have a unique rapport which shows a shared respect for the good old days of rock/blues.



Brian May

manage to get together for some jamming, and the result is this taste of fire that's not particularly tuned into the current AOR/DOR music scene but which is *very* hot indeed. There are three songs: An entertaining remake of a kiddie show theme (sort of silly but with some fine playing), a structured blues song that Brian sings, and a side-long instrumental blues intended as a re-creation of Eric Clapton's early work with John Mayall's Bluesbreakers. These songs show not only that these two guitar monsters have a cache of highly unlikely riffs but that they have a unique rapport which shows a shared respect for the good old days of rock/blues. With Peter Green and Jimmy Page in semi-retirement, Eric Clapton more a singer than a guitar player, and Jeff Beck content to release an album every other year, it's nice that these two can carry on the tradition of getting together and having a jam. Fortunately, they have the chops and the innovative touch, thus enabling them to make such an outing as easy to listen to as it must have been to record. Certainly more of these kind of offbeat, informal records would be a welcome change from the crass, overblown productions most records (especially Heavy Metal and corporate-rock records) have become.

*Jon & Sally Tiven*

**Strip:** Adam Ant
**Epic FE 39108.**

Sound: B Performance: C

From those come-hither looks on the cover photo and on into the music, it is clear that what Adam Ant makes is fashion and style, which aren't necessarily music.

Adam still works with his chubby alter ego, Matco Perroni, writing all the songs together, but they have brought in new producers to complete the sound. Phil Collins takes leave of Genesis long enough to produce and drum on a pair. For the rest, Richard James Burgess, who handled the first two Spandau Ballet albums, produces, drums and plays keys. Burgess' tracks sound lusher than the Collins tracks, due to his orchestral arrangements, but Collins' pair are, in turn, punchier.

The problem I have with *Strip* is that I don't hear any songs jump out and grab me, with hooks that won't let go, like several songs did on *Friend or Foe*. What that leaves is Adam Ant's supreme belief in his own importance, which may be attractive, but by itself probably isn't enough to keep the whole show afloat.

*Michael Tearson*

The previous album by Was (Not Was) just didn't bring their bizzare humor home to me. *Born to Laugh* does, in spades.

**Born to Laugh at Tornadoes:** Was (Not Was)
**Geffen GHS 4016,** $8.98.

Sound: B    Performance: B+

This is a veritable zoo. The Was Bros., Don and David, have concocted an album of lampoons deadpan enough to be mistaken for serious.

Quite an array of guest singers populates the album, as does a wide array of styles. Sweet Pea Atkinson takes lead for the Journey/Loverboy-esque "Knocked Down, Made Small (Treated Like a Rubber Ball)." The Was version of the great sound of The Detroit Wheels surfaces on "Bow Wow Wow Wow" complete with Mitch Ryder in top form. The former leader of The Knack (remember "My Sharona?"), Doug Feiger, is the voice of two real poppy songs. Harry Bowens sings two, the funky "Professor Night" and the Stevie Wonderish "(Return to the Valley of) Out Come the Freaks." The Was Bros. even get to take lead on two.

Hang on, because now it really gets weird. Ozzy Osbourne tackles the spoken/sung muscle jive of "Shake Your Head (Let's Go to Bed)" in a manner surprisingly cool. The Oz is downright convivial and funny. Then there's the guest vocalist of the finale "When Zaz Turned Blue," none other than Mel Torme. This delicious and wicked mock cocktail piece is the most offbeat piece of the collection, but it isn't at all ill-suited to the proceedings.

The sound on *Born to Laugh* is an accomplishment. Through often dense layering, economy and a sunny, bright and lively sound reign. This album's success depends on sonic clarity more than usual. The enclosed lyric sheet is a welcome plus.

David and Donald Was (no, they are not really brothers, nor is either's name really Was) are a real find. Their previous album just didn't bring their bizarre humor home to me. This one does, in spades.

Where is the Bonzo Dog Doo-Dah Band now that we really need them? Right here in the form of Was (Not Was) and their big cast.

*Michael Tearson*

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# MAHLER A LA MODE

**Mahler: Symphonies Nos. 5 and 6.** The Vienna Philharmonic Orchestra, Lorin Maazel.
**CBS/Sony 90DC 100-102,** three-disc set; **CBS D3 87675,** three-LP set.

Both versions, CD and LP, arrived a few weeks ago for a comparison review. Lots of listening, but lots of fun, too.

Like many of my generation, I overdosed on Mahler during the '60s, mainly through the excesses of Bernstein. Maazel, fortunately, probes this music to greater depths than Bernstein, and what results is delineation of the formal structure of these works rather than a preoccupation with the textural aspects of the writing. The music unfolds with purpose and not as a series of emotional episodes. Nobody conducts these essentially tragic works any better, and no orchestra is likely to outdo the Vienna Philharmonic.

The good news extends into the technical area, too. According to the notes, the Calrec sound-field microphone is used as the principal pickup. This implies that there are other microphones for highlighting various sections of the orchestra, but they are tastefully used. In a nutshell, the sound-field microphone is a compact array of four microphone elements that capture the pressure and velocity information at a single point in space. Through post-processing, these four signals can produce some of the most realistic surround sound that I have ever heard. Processed for stereo, as in these recordings, the microphone works pretty much like a conventional two-element stereo microphone, except that it maintains its single-point integrity much farther out in frequency than any of the rest of them.

More than anything else, the fact that the producer and engineer opted for the sound-field microphone shows that, basically, they espoused a hands-off approach to recording these massive works. There is absolutely no trace of harshness in tutti passages, and imaging is precise and natural.

As would be expected, most of the time the LP version sounded very much like the CD. Only in soft passages and in inner-groove tuttis was there a clear sonic advantage to the CD.

Let's hope that Maazel will receive similar treatment with other Mahler works with the same orchestra.

*John M. Eargle*

**Burnin': Don Menza's '80s Big Band RealTime RT-3001.**

Take 20 top musicians, well schooled in the big band tradition, mix well with a good recording engineer, lay their art down on digital tracks, and the result is exciting music-making.

This original material is unknown to me, but decidedly upbeat, with lots of screaming brass and explosive percussion. The recording is close-up, highly detailed, in a rather dry acoustic perspective. If you are a big band devotee, this CD offers good playing in a clean-sounding recording with plenty of presence.

*Bert Whyte*

**J. S. Bach: Organ Works.** The Great Organ at Methuen, Michael Murray.
**Telarc CD-80049.**

Even the most vociferous critics of digital sound readily admit that, in terms of extension and low distortion, digital bass response is markedly superior to that available from analog sources.

Nowhere is this better illustrated than in this Telarc recording of Bach organ works played by Michael Murray on the Great Organ at Methuen. This magnificent instrument, built by the Walcker Organ Co. of Germany between 1857 and 1863, was installed in the Boston Music Hall. It was dismantled in 1884. Methuen Hall was built to house this organ and, in 1909, it was rededicated. The organ has gone through a number of changes since then, including a revoicing by famed G. Donald Harrison of the Aeolian-Skinner Co. Presently, it has 84 stops, 115 ranks and more than 6,000 pipes.

Michael Murray is an organist who combines brilliant technique with eloquent, expressive playing and a clear touch which ensures good articulation. His readings of the "Fantasia" and "Fugue in G Minor (The Great)," the "Toccata in F Major," the monumental "Passacaglia" and "Fugue in C Minor" and two chorale preludes are masterful. He does not indulge in fustian display, but neither are his readings dull or pedantic. Murray is, above all, musical and highly listenable.

The sound is extraordinary. The acoustics and reverberation period of Methuen Hall display the organ on a properly grandiose scale. There is plenty of detail and projection in the higher register

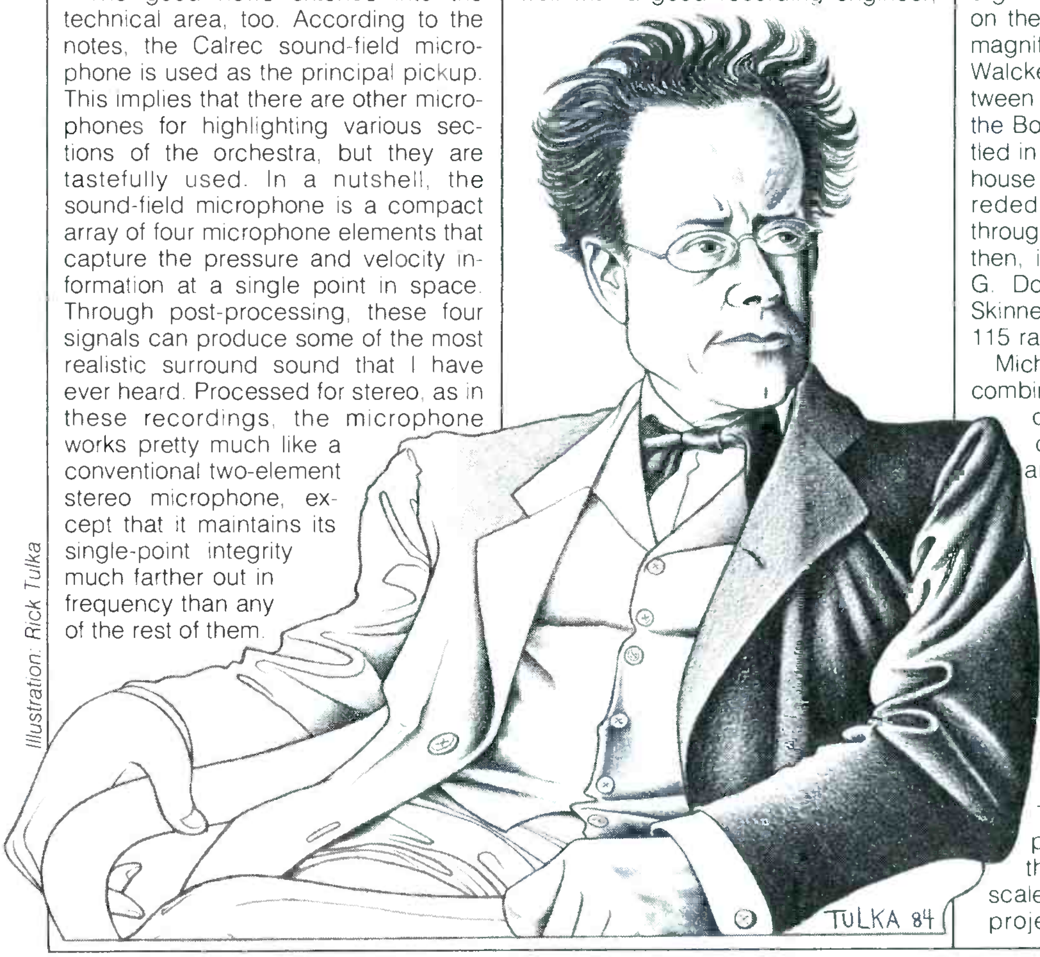


Illustration: Rick Tulka

Chorzempa is one of the most highly regarded organists on the European scene, and these excellent performances show why.

stops, and the thunderous sonority of the 32-foot principal and contra-bombarde pedals is awesome—if you have a good subwoofer to reproduce them properly. In the opening passages of the "Toccata in F Major," these great pedals are continuously sustained for 63 seconds at quite a high level. Caution is indicated with some amplifiers and loudspeakers! For organ buffs, this Compact Disc is a must.

*Bert Whyte*

**Bach: Toccata & Fugue in D Minor; Prelude & Fugue in E Flat; Prelude, Largo & Fugue in C.** Daniel Chorzempa, organ.
**Philips 410 038-2.**

Daniel Chorzempa is one of the most highly regarded organists on the European scene. On this CD, he plays the magnificent old organ in De Boverkerk, a church located in Kampen, The Netherlands. While the organ has the typical reedy sound of instruments of that period, it has a much fuller sound

*Daniel Chorzempa*

of surprising weight. One of the 16-foot Bourdon pipes dates from 1676, and several of the 16-foot pedal pipes date from 1743 and 1790! Needless to say, the wind-chests were pressurized by the sweat of honest brows in those days.

Chorzempa shows his mastery of this old organ in excellent performances of the ubiquitous J. S. Bach's "Toccata & Fugue in D Minor," the "Prelude & Fugue in E Flat" and the "Prelude, Largo & Fugue in C." The reverberation period of the church is a bit more than 3 seconds, and Chorzempa adjusts his tempos to this period. The sound is bright and clean, highly detailed, and though there is not the thunderous bass which might have come from 32-foot pedal stops, the 16-foot stops still provide a solid bass foundation.

*Bert Whyte*

**The John Dentz Reunion Band RealTime RT-3004.**

Here is another in the RealTime jazz series of CD recordings. This time, we have a quartet with leader John Dentz on drums, the well-known Chick Corea on acoustic piano, Andy Simpkins on acoustic bass and Ernie Watts on tenor and alto saxes. Imagine that! Not a synthesizer in sight!

The result is some first-class, straightforward, scintillating music-making, a refreshing return to the type of sound we used to enjoy before pop music came to rely so heavily on electronics. Dentz furnishes fine drum work

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The sound of Meyer's clarinet is quite smooth, and the overall sound is clean and well detailed.

with sharp, explosive transients on snare drum and cymbal with stick. Chick Corea shows off his distinctive piano styling, which this closely miked recording displays with crystalline clarity. Exaggerated, of course, but very well done. There is more close miking on the acoustic bass, which gives forth very articulate thrums and darkly resonant pizzicatos. Ernie Watts furnishes a melodic base with some cool, up-front sounds from his tenor and alto saxes, nicely anchored as a phantom image between the loudspeakers. Overall sound is very clean and bright, recorded fairly dry—which suits the music style. Ten tracks here, but except for "Night and Day," "My One and Only Love," and "Bud Powell," they are originals and unknown to me. Strictly for jazz aficionados, this CD is from a digital original and is a superior recording.
*Bert Whyte*

*Sabine Meyer*

**Mozart: Clarinet Quintet; Weber-Kuffner: Introduction, Theme & Variations.** The Berlin Philharmonic Quartet; Sabine Meyer, clarinet.
**Denon 38C37-7038,** $19.95.

These delightful works are miked rather closely, but their sonic contours are softened by a fairly spacious acoustic perspective. Sabine Meyer's clarinet is quite smooth and firmly positioned in the phantom center channel. Projection is just about right, slightly forward of the quartet. However, the clarinet sound makes it appear as if it were in a slightly more reverberant field than the quartet. Overall sound is clean and well detailed. The performances are very well done and, with the total lack of noise, fall very pleasantly on the ears. *Bert Whyte*

**Horowitz at the Met.** Vladimir Horowitz, piano.
**RCA RCD-14585.**

These recordings were made under rather noisy conditions at the Metropolitan Opera House some three years ago. The pickup is a little distant, and the edge we are used to on Horowitz's piano is somewhat rolled off.

While there are sonic flaws, they can all be ignored when the music starts. The program begins with a set of Scarlatti sonatas, transformed into virtuoso miniatures as only Horowitz can. The high point in the program is doubtless the Chopin "Ballade in F Minor." This staggeringly difficult piece becomes truly heaven-bound in its final pages. What follows is a Chopin waltz, the Liszt "B Minor Ballade," and the Rachmaninoff "G Minor Prelude (Opus 23, No. 5)."

It is almost a certainty that these recordings were edited from both performances and rehearsals prior to the main event. This is standard procedure in producing albums of this nature and is perfectly justified.

Get this one if you are a Horowitz fan. There won't be many more performances like these. *John M. Eargle*

**Antonio Vivaldi: Quatre concertos Pour Orgue et Orchestre.** Pierre Bardon, organ.
**disques Pierre Verany PV79801.** (Available through AudioSource, 1185 Chess Dr., Foster City, Cal. 94404.)

This is still another of those high sound-level CDs from the Pierre Verany company.

Here are four Vivaldi organ concertos, played by Pierre Bardon on a historic organ at Roquemaure. This is a typical, reedy-sounding Baroque instrument with very little bass. It is predominantly in the phantom center channel, somewhat recessed in perspective as compared to the up-front recording of the Pro Arte Orchestra of Munich. The hall has fairly spacious acoustics, with reverb time on the order of 2.5 to 2.8 seconds. Nonetheless, the sound is generally clean, with good definition, although there is a bit too much brightness on the first and second violins. The performances appear to be well done if somewhat pedantic. "Interesting music-making," was my reaction on hearing the first concerto—but four in a row is a bit much! *Bert Whyte*

**Beethoven: Piano Concerto No. 5, "Emperor."** The Boston Symphony Orchestra, Seiji Ozawa; Rudolf Serkin, piano.
**Telarc CD-80065.**

This recording of the Beethoven "Emperor" concerto is part of Telarc's ambitious program to record all five of the Beethoven concertos with Rudolf Serkin, Seiji Ozawa and the Boston Symphony Orchestra.

The Beethoven Piano Concerto No. 5 is a stalwart warhorse in the piano repertoire. Serkin has performed it countless times and recorded it many times over the last few decades, yet familiarity has not bred contempt. His performance in this recording is splendidly crafted in a traditional mode. No flashy *Wunderkind*, Serkin emphasizes the grandeur and majesty of this great work, and although he's in his mid-'70s, he still commands the power and the essential lyricism to make his performance memorable.

On Serkin's many recordings of the "Emperor," he has been rather poorly served in matters of sound. In this recording, Telarc has furnished him a clean, spacious, well-balanced sound worthy of his talents. Transient response is excellent, and the piano sound, which is acoustically projected just slightly forward of the orchestra, is nicely articulated. The Boston Symphony Hall acoustics dictated a fairly close-up placement of the three omni Schoeps microphones, so at times the high strings are slightly wiry, and orchestral textures can get a bit thick. Nonetheless, there is a blend of orchestral detail, with spacious acoustics. As one would expect, Ozawa and his Boston Symphony Orchestra have this familiar music at their fingertips, and their accompaniment is entirely sympathetic and splendidly played.
*Bert Whyte*

How nice, via this CD, to hear the magnificent Silbermann organ, a full-throated instrument of tremendous power and great refinement.

**Beethoven: Sonatas, Op. 57 and 111.** Carol Rosenberger, piano.
**Delos D/CD 3009,** $17.98.

Difficult to contain on a conventional LP, the unique sound of the Bösendorfer Imperial concert grand has met its match in the capabilities of the Compact Disc. No instrument has such power in the lower registers, and its wide sonic range is aptly exploited by Ms. Rosenberger in these intelligent performances. As I have remarked many times previously, the ability of this instrument to support a crescendo without clanging is an important ingredient in projecting so many of the bigger pieces. Beautifully played and beautifully recorded. *John M. Eargle*


**J. S. Bach: Die Grosse Silbermann-orgel.** Des Domes Zu Freiberg; Hans Otto, organ.
**Denon C37-7004,** $19.95.

Another CD recording of J. S. Bach organ music played on the Great Silbermann Organ in Freiberg Cathedral, Freiberg, Germany.

I was in this cathedral in 1958, and at that late date it was still undergoing repairs for bomb damage from World War II. Only the antiphonal organ had been restored. How nice now, via this CD, to hear the magnificent main Silbermann organ—a full-throated instrument of tremendous power and great refinement.

Organist Hans Otto begins his recital with the almost obligatory "D Minor Toccata and Fugue," followed by some chorales, several trios, preludes, and fugues, as well as a fantasia. The reverb period in the cathedral is between 3.5 to 4 seconds, so the recording has been miked rather close-up, but with plenty of detail and without losing the sense of the large acoustic space. Overall sound is very clean, with great sonority from the pedal ranks. Good performances and a great, glorious organ sound make this CD a winner. *Bert Whyte*

**Bartok: Concerto for Orchestra, Dance Suite.** The Chicago Symphony Orchestra, Sir Georg Solti.
**London 400 052-2.**

One of the problems with CDs is that there is a tendency to play them, or try to play them, at too high levels. This CD easily points up the problem. The "Concerto" opens with a whisper. If it were an LP, you would be warned by the rumble and other low-frequency noise that your playback setting was a bit too high. With the CD, there is none of this, and you go merrily on your way until the high strings come in with a dreadful screech. However, if you readjust your listening level at this point, and then go back to the beginning, all will be well.

You will need plenty of headroom to hear these works realistically. The dynamic range is quite wide, and the bottom end is awesome in the same sense that many of the Telarcs are.

Solti's performances of Bartok are legendary, and this CD probably contains the definitive recordings of these electrifying works. *John M. Eargle*

**Mozart: Piano Concertos Nos. 23 and 27.** The Philharmonia Orchestra, Vladimir Ashkenazy.
**London 400 087-2.**

The protean Ashkenazy conducts as well as performs as soloist here. The piano is heard with a reverberant bloom that sometimes blurs rapid passages. This is no real problem, however, and the benefit is that the cantabile passages sing out all the more because of it. With a slightly elevated playback level, there is some stridency to the strings, so be prepared to roll off some high end.

There is no question that Ashkenazy plays these works as well as any pianist active today, and I highly recommend this CD. *John M. Eargle*

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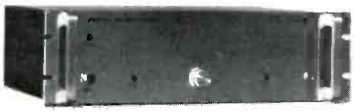

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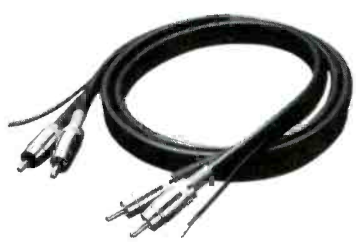

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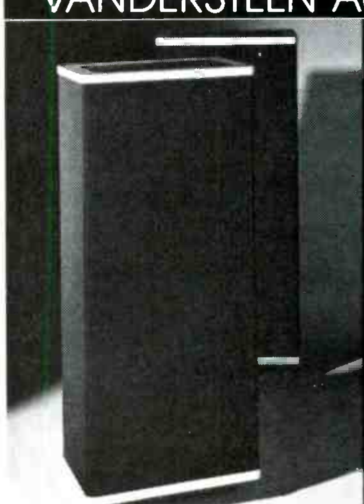


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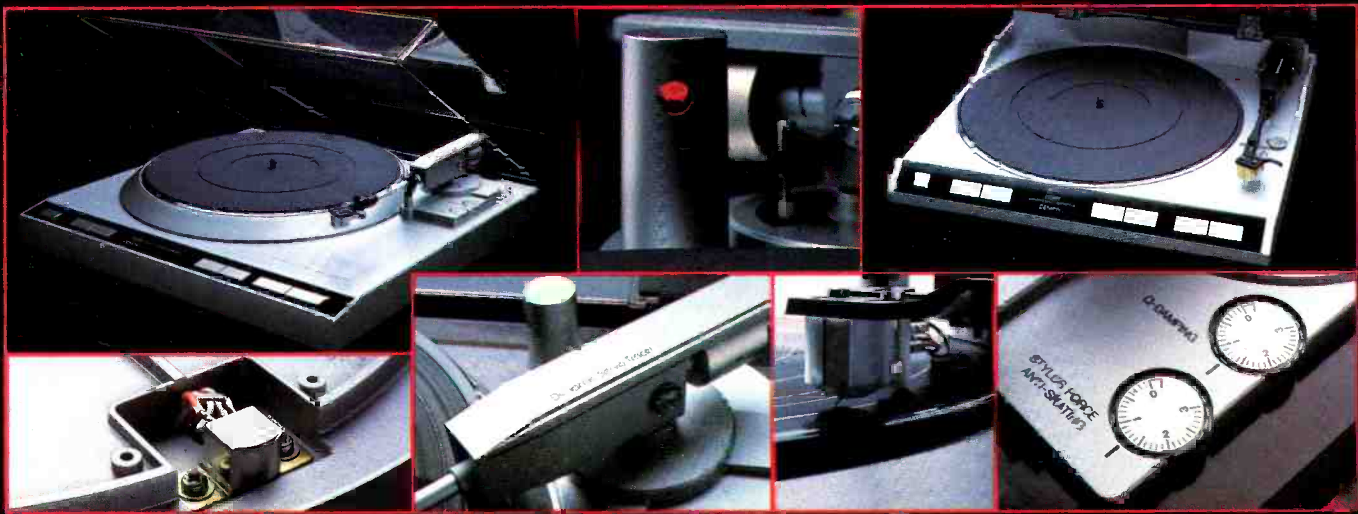



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