# Audio®

THE AUTHORITATIVE MAGAZINE ABOUT HIGH FIDELITY • MAY 1978 $1.25

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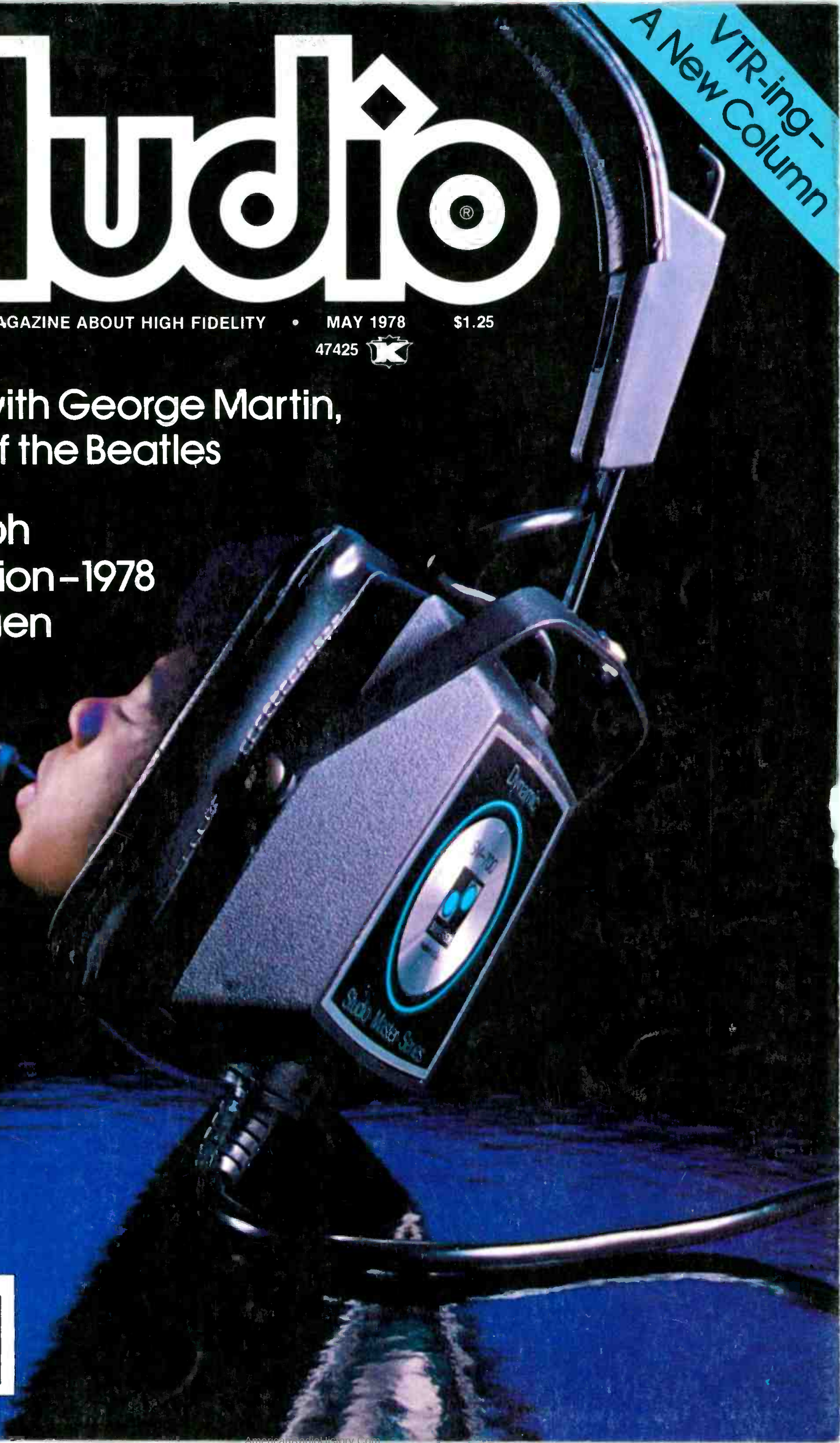
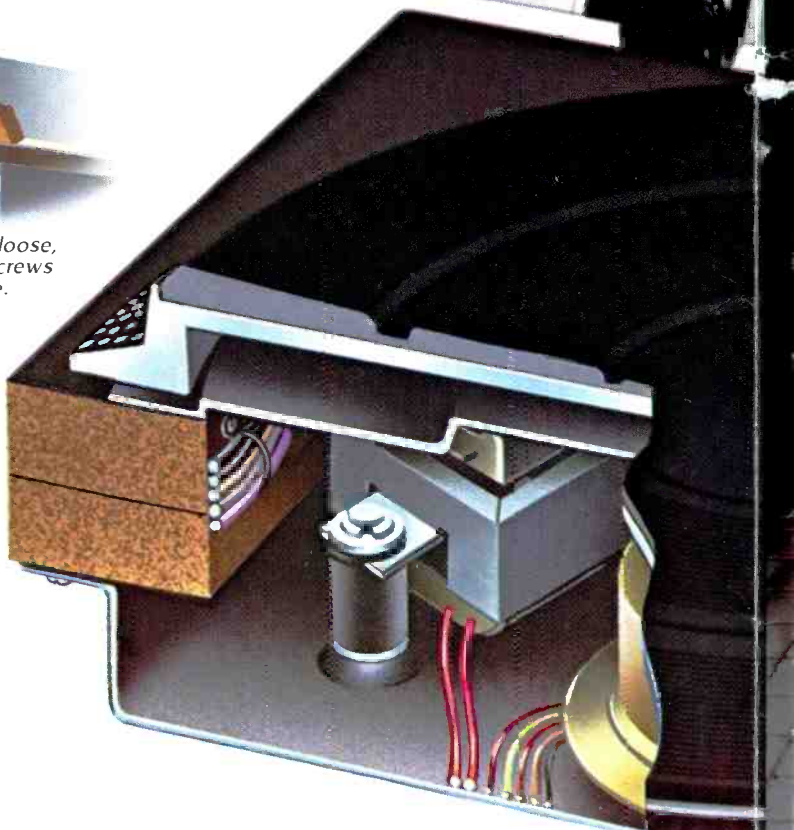
VTR-ing-
A New Column

## Interview with George Martin, Producer of the Beatles

## Phonograph Reproduction–1978 by Jim Kogen



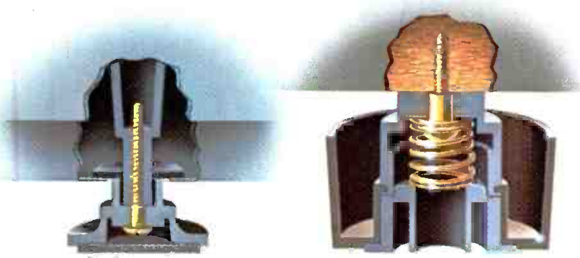


ined it not only gives
e base greater density,
e glue between the
eces acts to damp
bration. So when you're
tening to a record, you
on't hear the turntable.

*Common staples can work themselves loose, which is why Pioneer uses aluminum screws to mount the base plate to the base.*

## THINKING ON OUR FEET.

Instead of skinny screw-on plastic legs,
oneer uses large shock mounted rubber feet
at not only support the weight of the turntable,



*Stiff plastic legs merely support most turntables, Pioneer's massive spring-mounted rubber feet also reduce feedback.*

t absorb vibration and reduce acoustic
edback. So if you like to play your music loud
ough to rattle the walls, you won't run the risk
rattling the turntable.

## FEATURES YOU MIGHT OTHERWISE OVERLOOK.

Besides the big things, the PL-518 has other
ss obvious advantages.

Our platter mat, for example, is concave to
ompensate for warped records.

The platter itself is larger than others in this price range, which means it stays at perfect speed with less strain on the motor.

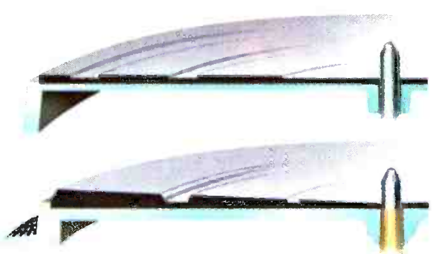
Even something like our spindle is special. It's .8 microns larger than most, so that the record is always perfectly centered.

And instead of flimsy staples, we use sturdy aluminum screws to seal the base plate to the base.

It's details like these as well as advanced technology that gives the PL-518 an incredibly high signal-to-noise ratio of 73 decibels. And an extremely low wow and flutter measurement of 0.03%. Performance figures you'd be hard pressed to find on any other turntable for this kind of money.

So if you want to get the most out of every piece of music, you should have the turntable that gets the most out of every part that goes into it.

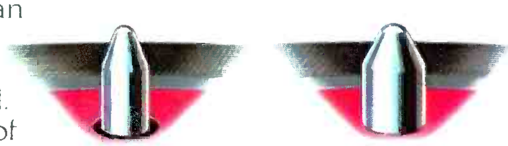
**PIONEER**
We bring it back alive.



*The ordinary platter mat is flat. Ours is concave to compensate for warped records.*

*Smaller, conventional platters are more subject to speed variations than our massive platter.*

*ollow plastic base, particle board base ss susceptible vibration.*



*Our spindle is .8 microns larger than others, to keep your records perfectly centered.*

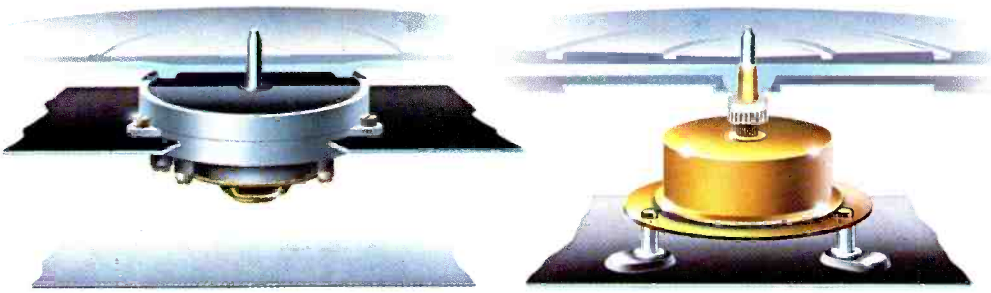
# T BUY A BETTER TURNTABLE FOR UNDER $175.


# TO FULLY APPRECIATE PIONEER'S NEW DIRECT-DRIVE TURNTABLE, YOU HAVE TO TAKE APART THE COMPETITION.

All turntables are pretty much the same on the outside.

But if you look carefully inside, you'll see the things that separate Pioneer's new PL-518 from others.

Things that add up to a turntable that can reproduce music perfectly, free of audible distortion, acoustic feedback and rumble.



*Instead of suspending the motor, Pioneer has anchored it so vibration can't affect the music.*

## A REMARKABLE DRIVE SYSTEM.

Obviously, all direct-drive turntables have an extremely accurate drive system.

Each offers an immunity to fluctuations in line voltage, pitch control, and a built-in strobe unit to help you regulate the speed of the platter.

But we believe the drive system of the PL-518 is the most accurate found on any turntable selling for under $175. Because the 16-pole, 24-slot brushless DC Servo motor is much the same as those found in turntables selling for $250, if not more.

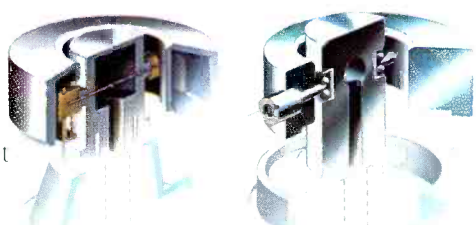
Equally important is the fact that this motor is anchored to a metal bottom plate, instead of suspended from the base, where vibration can affect your music.

## SOMETHING YOU RARELY SEE IN A TONE ARM: THINKING.

To give you further insight into the virtues of our PL-518 you only have to look at the way some tone arms are mounted. On piano wire. Or cheap plastic casings.

Instead, ours is gimballed on steel pivot bearings. So it can't vibrate.

A great deal of thought also went into developing an auto-return mechanism with fewer moving parts. It imposes less load on the motor and is more reliable than the auto-return on most turntables.



*Many tone arms are mounted on piano wire that vibrates, which is why our tone arm floats on steel pivot bearings.*

*Some rely on 3 ball bearings for stability in the tone arm shaft, but Pioneer uses 34.*

Then there are two separate ball bearing assemblies used in the tone arm for greater stability as it passes over the record.

A plastic headshell is good enough for most tone arms. It's nowhere near good enough for the PL-518. Tests show plastic tends to resonate at frequencies between 75 and 300 hertz. By using a glass fiber shell, resonance above 75 hertz is all but eliminated.

*Flimsy plastic and metal headshells can distort music, so Pioneer's is made of glass fiber, which eliminates all resonance above 75 hertz.*

In fact, nothing vibrates on the tone arm with the exception of the stylus. So nothing comes through the tone arm but music.

## A SOLID ARGUMENT FOR THE 2-PLY PARTICLE BOARD BASE.

The base on many turntables is nothing more than a hollow plastic shell. Or worse, sheet metal neatly hidden beneath imitation wood veneer.

Both seem harmless enough, but they tend to vibrate and cause acoustic feedback when the volume is turned up.

The base on the PL-518, however, is made of two solid blocks of compressed wood, each 20 millimeters thick. When the two are

*Unlike the h... our solid 2-ply ... is far le... to*

# WHEN YOU PUT IT ALL TOGETHER, YOU CAN'



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STROBE
PIONEER
DIRECT DRIVE
AUTOMATIC RETURN
MODEL PL-518
THE PL-518.

# Audio

May, 1978 — Vol. 62, No. 5

## Feature Articles



## Equipment Profiles



## Record Reviews



## Audio in General



**About The Cover:** Music hath charms, it says someplace, to soothe the savage beast, but—a good set of headphones will make the music seem as though it's being played right there. Photo: Photographic Illustrations, Ltd.

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# "The Dual 939 cassette deck at $550 is best described as 'beautiful.' It performs well, is notably easy to use ...and it has features most of us thought were impossible to get."

This quote, from a test report in *HiFi/Stereo Buyers' Guide*, is hardly alone in its appreciation of the 939. For example, *Radio-Electronics* reported:

"Superlatively low distortion, high signal-to-noise ratios, smooth tape transport action ... fit in nicely with the very best high-fidelity component systems."

*High Fidelity's* measurements for flutter "suggest that the performance level may be beyond not only your ability to perceive any flutter, but the lab's ability to measure it."

And this from *Stereo*: "Obviously loaded for bear, the 939 is one of the most feature-laden cassette decks we've encountered."

**When they say "loaded for bear" here's what they mean:**

The 939 reverses automatically in playback. (C-90 cassettes will play 90 uninterrupted minutes.) There's continuous play too. And recording is bi-directional. You never have to flip the cassette at the end of the tape.

Instead of slow-moving meter needles, there are instantaneous-reacting LED record-level indicators—twelve of them per channel. They're switchable from VU to peak reading and are visible from across the room.

Fade/edit control is another Dual exclusive. Unwanted sounds on a tape can be faded out gradually and smoothly, and the music faded back in. *While you're listening*, because it's all done during playback.

**Still more operating features.**

The list of features goes on and on. Line/microphone mixing; Dolby NR plus calibrated Dolby FM decoding; memory stop; separate output and headphone level controls; and an overload limiter that doesn't compress dynamic range.

**Unique drive system and tapeheads.**

The 939's drive system contains Dual's powerful Continuous-Pole/synchronous motor, two capstans, and special gear drives for fast wind in both directions. (C-90 cassettes fast-wind in just over a minute, the time other decks need for C-60's.)

Hard permalloy tapeheads provide extended life and superior magnetic linearity. The four-track record/playback head switches electronically when the tape changes direction; it never shifts position. Result: perfect tape alignment in both directions at all times.

**Six ways to install.**

You can install the 939 for front load or top load, plus three other angles. And you can also hang it on a wall.

**One last quote.**

Now you can appreciate why *High Fidelity* ended its report with: "We can think of no cassette deck that even approaches the 939's unique personality and range of features."

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Model AT15Sa/H Dual Magnet Stereo Cartridge pre-mounted in Universal tone arm head shell.

# To find out how much better our cartridge sounds, play their demonstration record!

There are some very good test and demonstration records available. Some are designed to show off the capabilities of better-than-average cartridges...and reveal the weaknesses of inferior models. We love them all.

Because the tougher the record, the better our Dual Magnet™ cartridges perform. Bring on the most stringent test record you can find. Or a demanding direct-to-disc recording if you will. Choose the Audio-Technica cartridge that meets your cost and performance objectives. Then listen.

Find out for yourself that when it comes to a duel between our cartridge and theirs...we're ready. Even when *they* choose the weapons!

What you'll hear is the best kind of proof that our Dual Magnet design and uncompromising craftsmanship is one of the most attractive values in high fidelity. For their records...and *yours!*

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**Subscription Rates:** United States only, 1 year for $9.00; 2 years for $16.00; 3 years for $22.00; outside the U.S., 1 year for $11.00; 2 years for $20.00; 3 years $28.00. All rights reserved. Entire contents copyrighted 1978 by North American Publishing Co. second class postage paid at Philadelphia, PA and additional mailing office. Back issues, $2.00 each.
**World Library Congress Number:** ISSN 0004-752X
**Microfilm Copies:** University Microfilms International, 300 North Zeeb Rd., Ann Arbor, MI 48106.
**Dewey Decimel Number:** 621.381 or 778.5
**National Sales Office:** Jay L. Butler, Publisher, 545 Madison Ave., New York, NY 10022. Telephone (212) 371-4100.
**West Coast Sales Office:** Jay Martin, 17000 Ventura Blvd., Encino, CA 91316. Telephone (213) 788-9900.
**Continental European Representative:** V. B. Sanders, International Publishers Advertising Service, Raadhuisstraat 24, P.O. Box 25, Graft-De Ryp, Holland: Telephone, 02997-1303; telegrams, Euradteam — Amsterdam.
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ST461

# Audioclinic

Joseph Giovanelli

## Bedroom System

*Q. I have added a bedroom system to my home stereo system. My main system has a spare set of tape outputs and I would like to connect the systems from the tape output of the main system to the AUX inputs of the bedroom system. Can you recommend a method? I believe that a low impedance transformer is required but I'm not quite sure as to the specifications.*

*Also, can I run a stereo front channel pair of speakers in the same cable (four conduit under one shield) without crosstalk or loss of separation, or is there a cable with two pairs of conductors, each independently shielded?*—Stephen M. Shirley, Sierra Madre, Cal.

A. You can run a shielded cable from the main system to the bedroom system with few complications. However, we must first be certain that the tape outputs provide signal regardless of the setting of the *Normal/Monitor* switch. Assuming that this is the case and the impedance is relatively low, about 2 or 3 kilohms, no transformers will be required. However, if the tape output circuits are high impedance, 10 kilohms and up, it would be best to use a step-down transformer so the impedance can be reduced to about 2 kilohms or less. In the event that a transformer is used there will be a loss of signal voltage, and you must be sure that there is enough voltage to drive your bedroom system.

However, there are two alternatives to this use of step-down transformers. You could devise an emitter follower mounted at the main system through which you would feed the bedroom system, or you could use low capacitance cable to offset the high frequency losses which would otherwise be the case.

Because crosstalk is not a problem, you could use multi-conductor cable with no difficulty.

## Phono Cartridge Deterioration

*Q. I would like to know if phono cartridges can wear out in time?*—Adam Steiner, Livingston, N.J.

A. Moving-coil cartridges are delicate and can develop a number of problems. Even so, when properly constructed, you can expect years of trouble-free performance from such cartridges. Moving-magnet or variable-reluctance cartridges are quite rugged because the coils are not moved by the stylus and so need not be lightweight. Rochelle-salt or ceramic cartridges can fail over a period of time because of a gradual accumulation of moisture which ultimately dissolves the crystal element. Strain gauge cartridges, though rather early to be certain, appear to be very reliable.

Styli of any kind can either wear out or be damaged by misuse.

In general, with the exception of the seldom used rochelle salt, today's cartridges will provide, virtually, a lifetime of service. However, when most cartridges do fail, it is catastrophic rather than a slow deterioration.

## Gauge of Speaker Wire

*Q. The owner's manual for my speakers recommends 20-gauge wire for runs not exceeding 20 feet, 18-gauge wire for runs up to 30 feet, and 16-gauge for runs up to 50 feet. My speakers are positioned 20 and 50 feet from the receiver, and my dealer told me that 18-gauge wire would be completely satisfactory for both speakers. Am I using the correct gauge wire, or would you recommend using 18-gauge wire for the shorter run and 16-gauge wire for the longer run? Will my performance be compromised?*—Robert Armen, Bay Village, O.

A. It is never wrong to use wire gauge larger than the minimum required. I would use 16-gauge wire for both speakers; if I was installing the system for you I might even use 14-gauge wire. The 14-gauge wire is more difficult to handle than the lighter gauges, but I have obtained better bass quality by using it. The performance will not be compromised by the difference in wire length as long as the wire gauge is great enough.

---

If you have a problem or question on audio, write to Mr. Joseph Giovanelli, at AUDIO, 401 North Broad Street, Philadelphia, Pa. 19108. All letters are answered. Please enclose a stamped, self-addressed envelope.

# THE MOST IMPORTANT FEATURE IN THESE DECKS IS BASED ON A TIMELESS IDEA.


The features and specifications of TEAC decks have changed, but the timeless constant has been TEAC reliability. Every improvement we've made has added to this reliability. It's our most important feature.

Every TEAC cassette deck from the least expensive to the most expensive is built to last a long, long time. That's been true since the first TEAC was built more than 25 years ago.

Take the new A-103, one of the least expensive TEAC's you can buy.

Despite its low price, the A-103 is manufactured to the same tolerances as decks costing three times as much. And, where most decks have a maze of hand-wired switches, harnesses and boards inside, the A-103 boasts an innovative design which replaces all that with a single circuit board directly coupled to the front control panel.

TEAC's more expensive A-640 brings engineering sophistication to a new high with plug-in circuit boards, two motors and electronically operated push buttons for feather-touch, maintenance-free reliability.

People who work with tape recorders know TEAC tape recorders work and keep on working. That's the reason people whose living depends on sound judgement, depend on TEAC. You can, too.

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**A-103** Specifications:
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Signal-to-noise ratio:
50dB (without Dolby)
55dB (with Dolby at 1kHz)
60dB (with Dolby over 5kHz)
Frequency Response:
30-14,000Hz (CrO2/FeCr)
30-11,000Hz (Normal)

**A-640** Specifications:
Wow & Flutter:
0.06% (NAB weighted)
Signal-to-noise ratio:
57dB (without Dolby)
62dB (with Dolby at 1kHz)
67dB (with Dolby over 5kHz)
Frequency Response:
30-16,000Hz (CrO2)
30-14,000Hz (Normal)




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# Audio etc.

**Edward Tatnall Canby**

Peter Scheiber's cost-no-object 360° Spatial Decoder, selling for thousands, has been sitting in my living room for several months, acting transparent. Though it is perhaps the final decisive word of the SQ sort and the end of an era, half the time I don't even know I have the thing in my system. Two signals go in and four come out, variously, yet this unobtrusive rack-sized black box with chrome handles and four meters is the very embodiment of that ancient observance that an amplifier should be a wire with gain. This one doesn't even have gain, though it does have internal amps. It acts like a wire, period.

And yet—as I discovered at last autumn's AES meetings in New York, where I attended the Scheiber lecture on this ultra-decoder, his device has about the most complex insides of anything in electronics short of a space vehicle. Picture after picture was thrown onto the screen, diagrams section by section as we followed the signals from the dual input to the four-way outputs, Scheiber meanwhile apologetically remarking that he'd just have to skip from page 8 to 19 in his prepared text and then to page 25, so sorry. Some people are really absent-minded perfessers! But the message came over: This is an incredibly sophisticated converter of two audio channels into four, with dozens of sensors (speaking non-technically) attuned at every point to the real demands of musical space and, more particularly, to the requirements and abilities of the human ear. I was duly impressed. If genius, as has been said, is the infinite capacity for taking pains, then Peter Scheiber has taken them.

But first of all, Scheiber keeps emphasizing, this is a device to provide near-absolute transparency in a most unlikely situation. I won't bother to cite the details, in the millions, but everything is done in the most ingeniously expensive manner possible and after plenty of listening I can vouch for the result . . . astonishing. Through all those thousands of densely packed circuit elements the over-all figures come out fabulous: IM for the entire unit, in to out, is less than 0.05 per cent, of which less than 0.01 per cent is contributed by the numerous op-amps in various segments of the signal path, this with a tactful passive, upper-end filter to limit the response to a mere 50 kHz all the way through. The entire machine is made up of junction FET and IC op-amp elements and, naturally, the switching and controls are of the finest, with LEDs, click stops, and what have you.

Well, of course, an even better transparency would be observed by removing the machine entirely from the circuit, so we must give a thought or two to function, of which there is plenty. This is an advanced parametric decoder based on SQ encoding, but with flexibility well outside of that system so as to suit practical conditions today. Which means "decoding" a million or so standard stereo recordings every one of which contains large, if variable, amounts of useful phase-orientated diversity, for incipient directionalities and, as the sum of these, hall ambience of many sorts, both natural and synthetic. Quite aside from SQ, Scheiber has plenty to work on and, reasonably enough, he thus includes three quite different signal treatments, one being the ultimate parametric SQ decoding, in addition to plain two-channel stereo and a feed-through for extra external sources into four channels.

These alternatives are neither radical nor sensational. I found them soberly, sensibly different, the sort of difference that grows on you quietly, with familiarity over a good stretch of time. The five LED color-coded key switches are marked *STE, AMB, SYN, SQ,* and *EXT,* self-explaining more or less—but Scheiber adds an excellent booklet explaining each in terms of the two essentials, coded and non-coded recordings. What happens to an SQ disc in each playback position? A plain stereo disc, the same? (Other codings are unmentioned. CD-4 of course won't do a thing beyond the basic stereo in its major channels; QS will "decode," no doubt, in interesting ways, though not quite the ways the designers of that system intended. Indeed, for this, the QS folks have their own advanced decoder designs, quite sophisticated ones, and it seems probable that they do for QS what the Scheiber unit does for SQ.)

On the Scheiber unit's *SYN* (synthetic) position, for example, a stereo image is expanded spatially into a 270° panorama (I am quoting the Scheiber booklet) extending from left back through the front positions to right back. "This panoramic aural display permits closer observation of instrumental deployment than conventional stereo playback." On the other hand, when an *SQ*-encoded disc is played via *SYN,* there is a wholly

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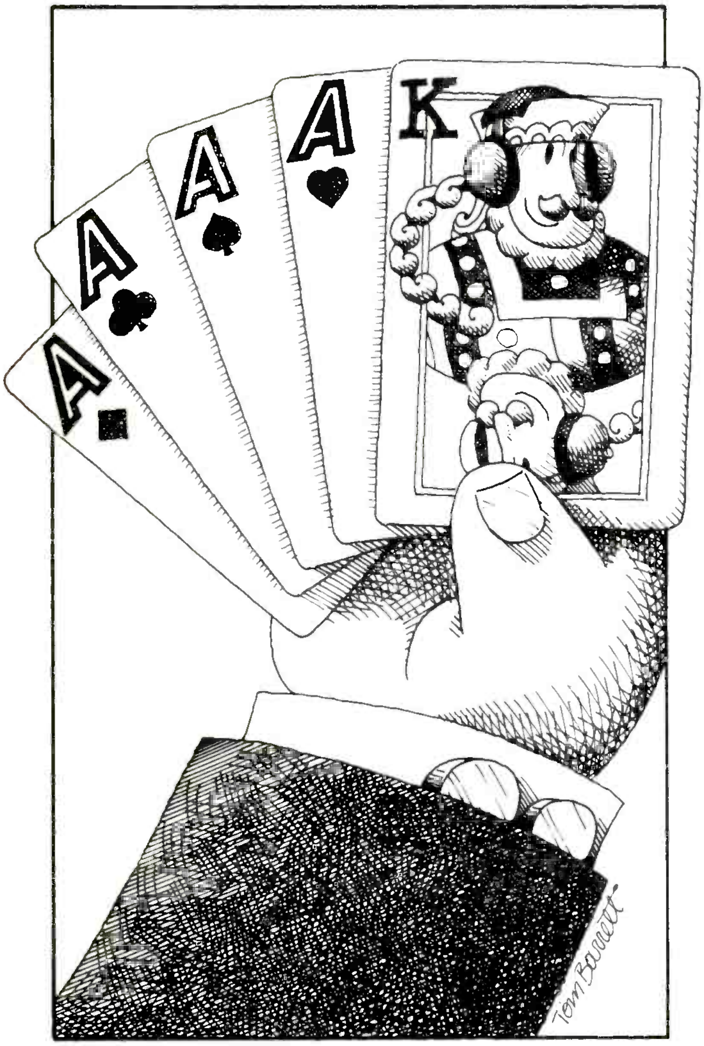

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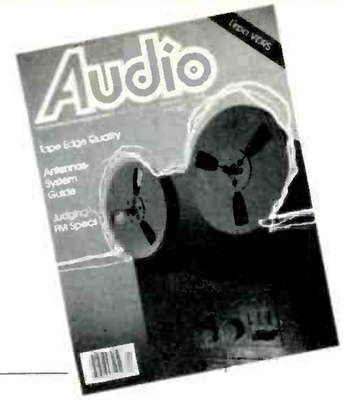


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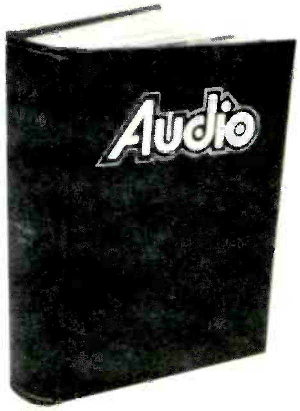


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freakish sonic dispersal—the front center and the back center stay in place, but the corner sounds are interchanged in space. All of this corresponds very nicely with the sound I have actually experienced; *SYN* is the bold, semi-sensational option among those Scheiber offers. I often use it because it throws more sound into the back speakers, which are nearer to my kitchen work place. Why not? Anything that sounds good *is* good.

Then there is *AMB*, for ambience. This is primarily a sober and very useful treatment for stereo discs, not sensational but definitely expanding their built-in characteristics; direct sounds remain localized in front, quite reliably, while reverberant information is directed more to the sides and back, for an enhanced hall effect. As Scheiber points out, the *AMB* effects vary widely with the recordings, since there is no precise coding involved and a vast variety of ambient material (variously delayed in phase) is found from one record to another. *AMB*, however, has another usefulness. It is an alternative to the SQ position for encoded discs, offering a more conservative, up-front effect for those SQ records which have a pronounced "surround" encoding, putting the musical instruments, as Scheiber says, "back on the stage" where they presumably belong in a well-ordered musical world. If you really don't want the trumpets in back of you and strings in front, then this *AMB* is good.

### Traditional Ambience

In some personal correspondence with Scheiber, I have gathered that he is distinctly disillusioned with surround-sound classical music, all the way around—or perhaps pop music, for that matter. After all, the man began as a professional musician, a bassoonist. A yen for the traditional sound, orientated towards a frontal focus, would be no more than natural for him, though perhaps many of our more experimental recordists will not agree. As for myself, I go along with him provisionally; in the long run I do find it easier to listen to music where music ought to be, and that is *not* behind the ears. What belongs back there is ambience—important enough. So a device which can, at will, provide frontal music with good backside ambience out of records of any sort that are "too much" surround style is bound to be a good tool in home fi.

As for the most essential (maybe) position, the Scheiber decoder's *SQ* circuitry, indicated with a bright red LED, it puts the sounds where the SQ recording engineers intended, perhaps more specifically and precisely than any decoder has done before. I remember, some years back, watching meters in CBS's parametric decoder, never put into commercial public distribution. (Predictably, the system was too expensive.) Amazing. Decode a signal to right back, and that meter went straight up to 0 dB, while the other three meters never so much as moved at all. Scheiber gets 35-dB separation and—a thing that has long bothered me in theory—this does NOT depend on a one-corner-only signal. The parametric circuitry allows for functional independence in four directions and points between. Moreover, the circuit localization is "20 times as fast" as earlier decoders, which still operated within the ear's "fusion" time.

In other words, we have here just about the ultimate degree of four-way separation out of two coded signals. It is not, we must remember, an objective 100 per cent discrete separation. But it comes far closer to that ideal than anyone might have imagined seven or eight years ago, when Peter Scheiber was the first to introduce the "matrix" concept of spatial sound distribution from two-channel sources.

Today being today, I myself have been using the Scheiber almost exclusively for standard stereo discs, non-encoded. What else? But I cannot and will not now try to get along without at least four channels and I will not revert under any circumstances to one-sided stereo, if there is any way I can avoid same. If there had never been an SQ or QS or CD-4 disc, I would feel the same. Indeed, I sometimes wish that quadraphonics had never been launched—but had managed somehow to donate the accumulated knowhow to our recording art! That being a contradiction, I can only say that a decoder like the Scheiber contributes so much to stereo listening, so easily, that I, for one, could not survive without the things it does. When the Scheiber goes back to its designer, I will revert to one or another of the earlier decode/enhance devices I still have on hand.

Prior to writing this, I dug out a pile of SQ discs. I have quantities of pop SQ (I received most of them), and they make a more decisive test of a system than most classical recordings. I have always been disturbed by the matrix tendency towards blurring and indecisiveness as between spatial sources, most particularly that dense feeling of mono, overhead, that results from too much overlap in the not-very discrete four channels. True ambience is *never* mono, always a subtle composite of differing reflections. To the extent that there is a mono redundancy from the four speakers of a sur-

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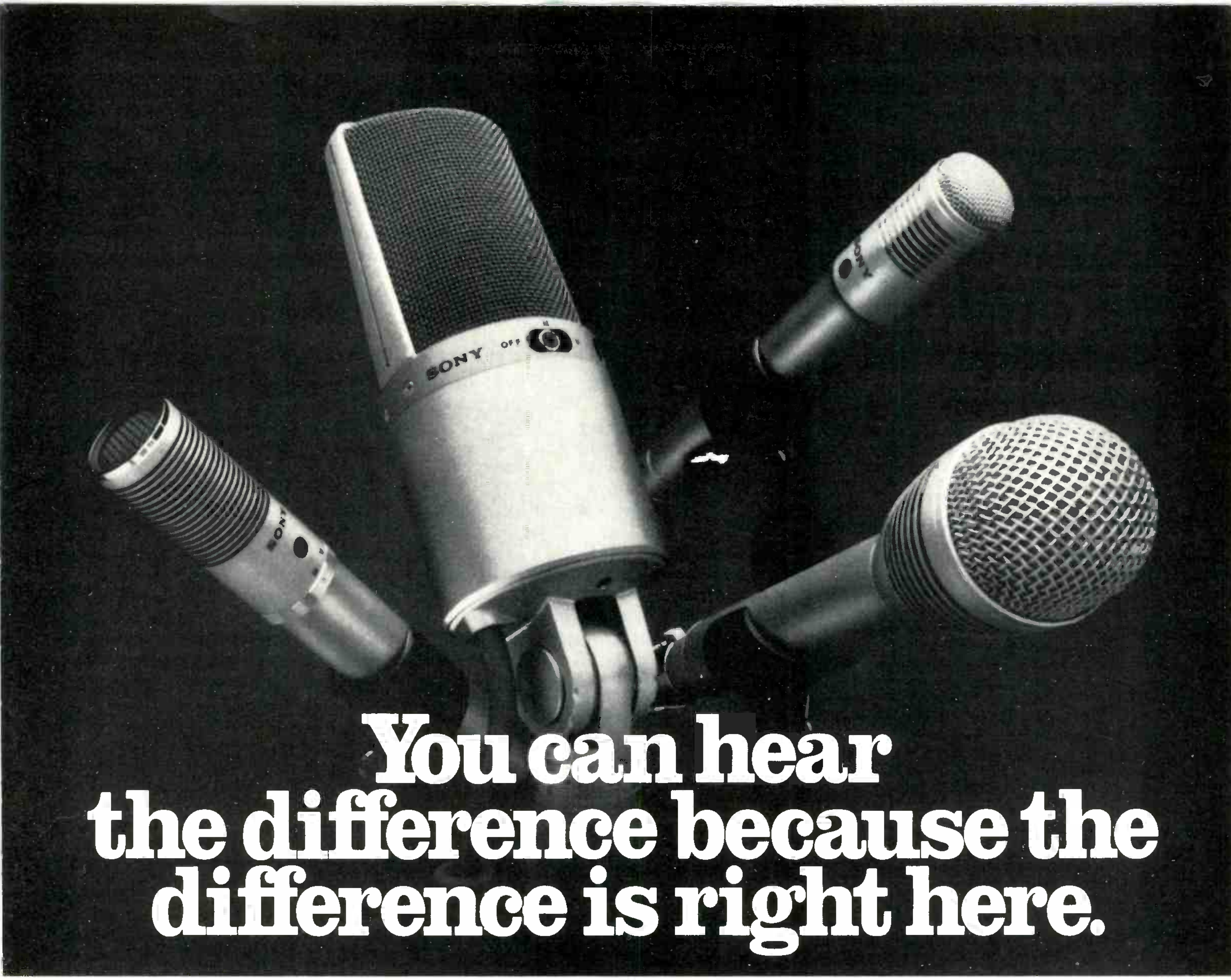
round system, the magic effect of real ambience is damaged or destroyed. (And yet it can be synthetically simulated, as we know!) I have rarely heard really free ambience from a matrix recording. Too often, I hear that dense, closed-in effect that is the unwanted summation of too much mono. It can be in the decoder, the record itself, or even in the "original" sound—when that sound is given the synthetic reverb treatment.

So I tried a brace of pop records, just to see. The first (nameless) was most discouraging. Scheiber or no, the effect was unimpressive, with no more than stereo-style front separation, a vague mumbling from the back speakers and a distinctly oppressive mono compression of space. No real ambience spread, no real surround sources. Was Scheiber a lot of hot air? I tried another, and it was worse. Ugh. Then a third—and suddenly, space opened up and spread out! I assure you, I let out a sigh of relief. I was rooting for Scheiber. The problem, and no two ways about it, was *in the recordings*.

I do not know the ins and outs of how SQ worked during those intense times when four-way recordings were being made separately from stereo, in the mixdown and, sometimes, in the original microphoning too. All I can say now is that entirely too many of the pop records I have tried seem to me to be unimpressive in the decoding via this sophisticated ultimate decoder. Am I digging up skeletons? No, because all of a sudden—a good job, and Scheiber is vindicated! The old becomes new. As they say, better than ever. The mono density is gone, space is big and free, instruments are easily set out here and there. Good stuff. As a teaser, here are two: Dave Mason **Split Coconut,** Columbia PCQ 33698. The Manhattans **It Feels So Good,** Columbia PCQ 34450. Look in your dealer's back closet; he has 'em.

The Scheiber Spatial Decoder has a few minor eccentricities—why expand on them? Its four meters are heavily weighted and slow moving, which annoys me, an old meter reader who "reads VU" and likes to see the needles dance. It has no adequate all-mono setting with which to balance sound levels in front and back speakers (the meters read "line out" regardless of amp volume). Minor quibbling. If you want the very best and state of the art in this important and enduring area of "passive" enhancement of the two-channel recording, *and* if your equipment is up to its quality, then the Scheiber is definitely for you. One thing's for sure. It will never be your weakest link. A



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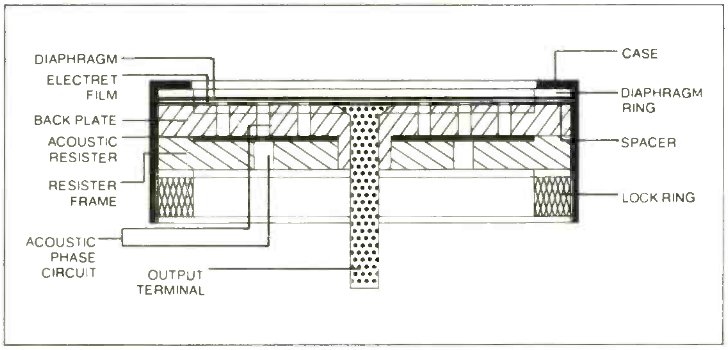


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# Tape guide

Herman Burstein

## Dolby Addition

*Q. I have a Sony tape deck which I like very much, except that I have a severe signal-to-noise problem with it. I have been thinking about buying a new deck in the $500.00 range. On the other hand, I was wondering whether I can use a Dolby noise reduction system with my present deck?*—Philip Semeca, Astoria, N.Y.

A. The Dolby units can achieve appreciable noise reduction, particularly when used with tape machines producing a good deal of noise. However, you might find that by the time you add the cost of a good Dolby unit to your system, you haven't spent much less than if you had bought a top-flight deck to begin with.

## Tone Controls in Recording

*Q. Why don't the tone controls affect my tape deck while recording? Can the circuit be changed so these controls can be used?*—Aaron Holley, Pacifica, Cal.

A. A receiver or amplifier is so constructed that the feed to the input of tape recorders connected to it occurs at a point in the circuit before the volume and tone controls, consequently these controls cannot affect the recording.

The output of the recorder, however, feeds into the equipment just before the volume and tone controls, thus the playback has both the volume and tone controls available for use by the listener. The idea behind this is that the listener should make tape recordings which are flat, and any alterations to the sound of these tapes should be made during playback only.

The simplest way by which one can alter the frequency response prior to taping is to introduce a graphic equalizer between the amplifier *Tape Out* jacks and the input of the recorder.

## Minimizing Print-Through

*Q. Some time ago you stated that one can minimize print-through by not recording at excessively high levels and by rewinding the tape prior to playing it. I was under the impression that the higher the recording level, then the lower the background noise of the tape. Could you please enlighten me on this point?* —Michael Cinelli, Scarsdale, N.Y.

A. Recording at a high level results in a high ratio between the audio signal and noise due to the tape and tape machine electronics. Also, a high level signal on the tape tends to magnetize the adjacent layers of tape on the reel which results in a low ratio between the audio signal and the print-through signal (sound of the adjacent layers).

## Recorder Mike Matching

*Q. I own a Roberts 17258L reel and cartridge recorder, and when I wanted better microphones I purchased the Sony ECM19B condenser microphones. After purchasing them I found out that my set calls for high-impedance mikes, whereas the Sony ones are low impedance. Somebody suggested that I buy preamps which I did. Am I getting full benefit out of the microphones with the use of the preamp?*—Charles Keoseian, Fitchburg, Mass.

A. To adapt a low-impedance microphone to a high-impedance input, one customarily uses a matching transformer, which can either be obtained from the microphone manufacturer or he can recommend one. You can also use a preamp of the type made for phono pickups and tape heads, but this may require removal of the equalization network for phono and tape, or the unit may have a switch for bypassing the equalization circuit so it can be used with the microphone. However, the preamp may add appreciable noise and is not a desirable way of matching a low-impedance mike to a high-impedance input.

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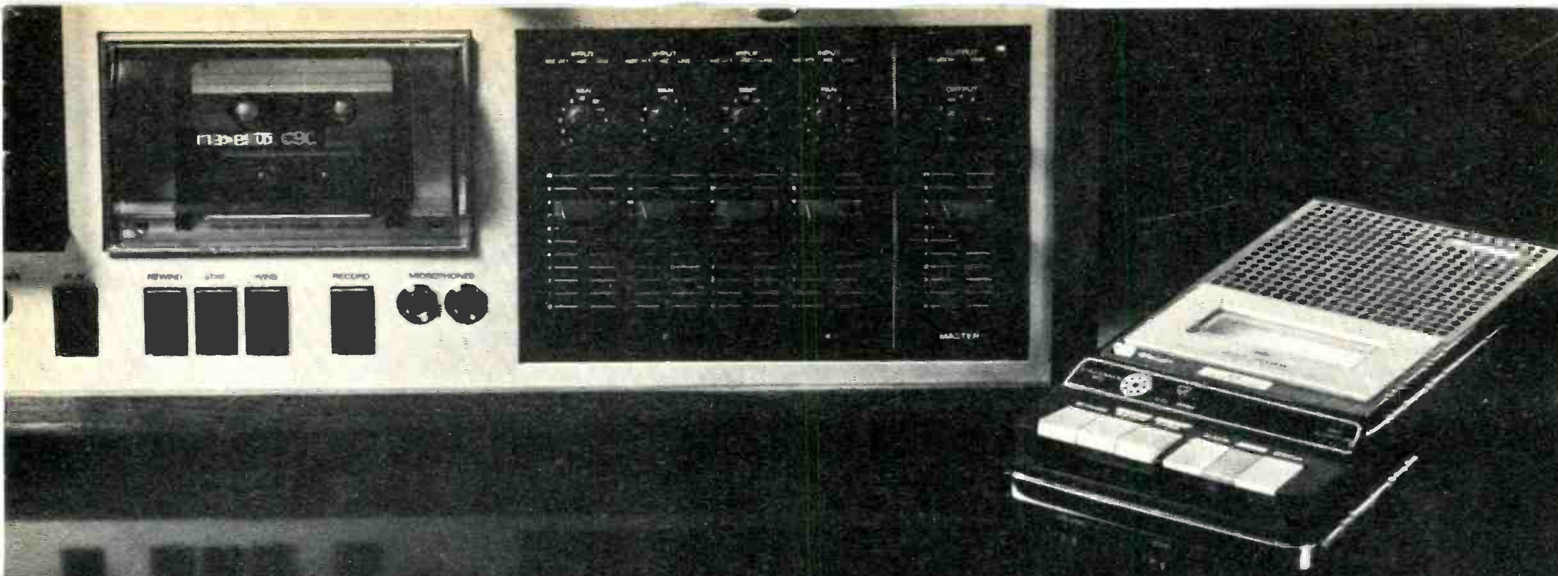
**If you have a problem or question on tape recording, write to Mr. Herman Burstein at AUDIO, 401 North Broad Street, Philadelphia, Pa. 19108. All letters are answered. Please enclose a stamped, self-addressed envelope.**



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# Behind the scenes

**Bert Whyte**

On any given Sunday, you can look at the "entertainment" or "cultural" sections of newspapers across the country, and you will see page after page of advertisements for the sale of audio equipment, or "stereo," to use their catch-all terminology. For the most part, what is advertised are "beginners packages," which consist of low- to medium-powered receivers from such well-known manufacturers as Pioneer, Kenwood, Sansui, Marantz, Harman-Kardon, Sony, Technics, etc.; low-end models of turntables from the likes of B•I•C, Garrard, Dual, BSR, Technics, etc., and magnetic phono cartridges from Pickering, Stanton, Shure, Empire, etc. The packages are completed with loudspeakers, which may be low-end models from the full-line manufacturers themselves, or from Advent, AR, KLH, JBL, or the "private label" speakers of a particular retailer. Most of the packages are attractively low-priced at less than the cost of the individual components. Generally, whatever combination of components a store puts together gives the customer a fairly well-balanced stereo system at that particular level of quality. It must be said, however, that far too often the low price of the package is achieved by the inclusion of the "private label" speakers, many of which are of extremely poor quality.

Allowing for that unfortunate situation, in a world of shrinking values, shoddy merchandise, almost non-existent quality control, and indifferent service, these stereo packages represent a level of quality and integrity of fabrication that makes them an incredible bargain in today's market. For an average of $500.00, these stereo systems offer low levels of distortion and other performance specifications well beyond what was available for twice the money just 10 years ago. That, in itself, is quite unique in this inflationary world.

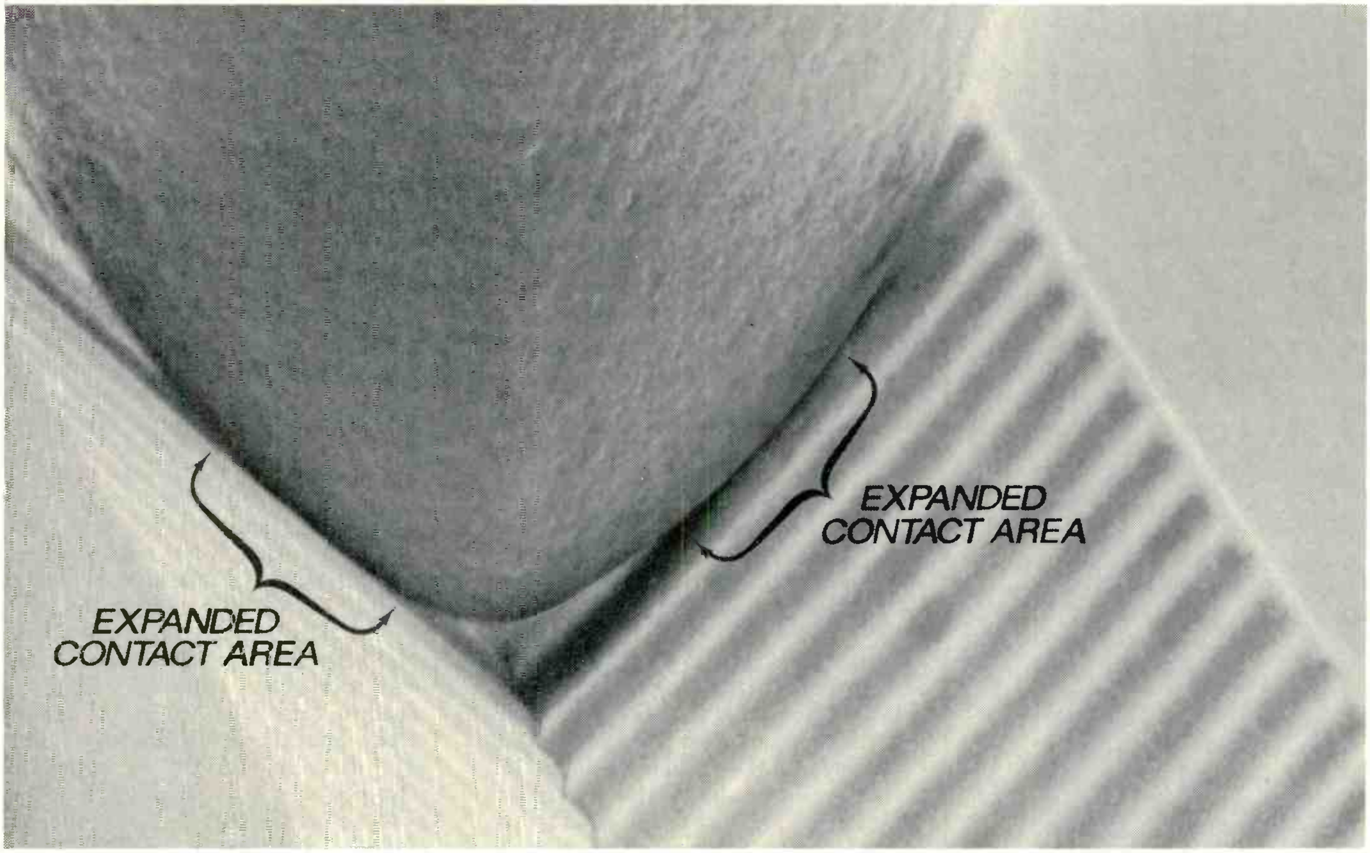
The point I am making is that for a relatively modest outlay, even the fledgling stereo enthusiast gets a system of remarkably good quality. A good many people are content with the quality of this kind of system and do not have that *personal* commitment to music to justify expansion of their system beyond this level. Fortunately for the hi-fi industry, quite a number of people have become "smitten" with the audio "virus," and it is remarkable how quickly they develop a considerable degree of aural discrimination. Their growing sophistication usually manifests itself in an awareness of the sonic deficiencies of their loudspeakers. So they hie themselves to their local audio emporium, resolutely plow through a myriad of A/B speaker comparisons, and ultimately bring home some better sounding loudspeakers. For a while, they revel in the superior sound the new speakers afford, only to discover discrepencies in the new speakers or anomalies in the rest of the system revealed by the new speakers . . . or a combination of both! Thus, the cycle begins all over again, as it has since the dawn of hi-fi; that is how audiophiles are born, and that is why we have today's huge audio component market with all of its infinite permutations.

The audio component market is unique in that it has a broad base of relatively good-quality stereo systems, plus a fairly substantial percentage of the market which is continually upgrading the quality levels of their systems. Needless to say, whatever the quality level of the stereo systems, the *raison d'etre* for these systems is the enjoyment and appreciation of music, and this is largely done through the medium of phonograph records, plus pre-recorded cassettes, cartridges, and open-reel tapes. Very early on in his involvement with these various types of "software," the discerning audiophile learns that he must embark on a never-ending quest for high-quality, technically superior records and tapes that will do justice to the stereo system he has assembled. As everyone knows, this can be a maddening and highly frustrating experience. Let us take a look at the "state of the software" in today's market.

**Software Synopsis**

In any discussion about the quality of the modern long-playing phonograph record, a distinction must be made between the physical characteristics of the record, i.e. does it exhibit dish warp, pinch warp, or any other kind of warp . . . is the record eccentric, causing wow . . . is the record "hissy," full of "pops" and "ticks" . . . are the surfaces "grainy" and cause a continual "crackling" sound, etc. . . . and what are the sonic characteristics of the recording itself? Does the recording have full-spectrum frequency response . . . wide dynamic range . . . good signal-to-noise ratio . . . clarity, brilliance, and good transient response . . . good instrumental and musical balances . . . is the acoustic perspective proper for the particular type of music? A further distinction must be made between pop and classical recordings. In fact, for the purposes of this discussion, I am really relating the subject of recording quality to the classical genre. Pop recordings certainly do suffer from the physical defects outlined above, but the quality of their recorded sound is subject to so many variables, the sound itself is a contrived product . . . really an "art form" unto itself, and the music usually is of such a transitory nature, that the quality per se cannot be related to some "idealized" standard. Quite the contrary is true with classical recordings, which of course do have an "ideal standard" . . . the live concert hall sound. For comparative purposes, I will restrict my discussion to classical, large-scale recordings. As a rule, the major American record companies record their orchestras via the multi-track/multi-mike technique. Now please don't get me wrong . . . I don't condemn this technique out of hand . . . I've heard some fine recordings made with this method. But, in the opinion of many people, this type of recording is too contrived and artificial. One of the principal complaints is that the recordings lack depth . . . instruments sound like they are strung on a line across the stage . . . the acoustic perspective is fore-shortened, there is artificial "spotlighting" of various instruments, wherein they sound larger than life . . . for example, a clarinet or oboe producing more sound than the entire orchestra. There

# Better stereo records are the result of better playback pick-ups

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Scanning Electron Beam Microscope photo of Stereohedron Stylus; 2000 times magnification. Brackets point out wider contact area.



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is another problem inherent in the multi-mike technique in that, by the nature of the pickup, cardioid-pattern mikes must be used and they have a tendency to start rolling off early in the bass spectrum, usually having little response below 40-45 Hz. While there isn't too much musical energy at those frequencies, there are circumstances when this *could* be detrimental.

## Multi-Miking

It should be understood there are several variations on the multi-mike technique, and I suppose some of these variations shouldn't be called "multi-mike" in the strictest sense of the word. For example, Marc Aubort of Elite Recording generally uses two omnidirectional microphones to pick up better than 95 per cent of the musical information, with a minimum of other mikes to "touch up" sections of the orchestra or specific instruments. No recording hall is perfect, and Marc uses the "touch-up" mikes when the score indicates certain instruments are not of sufficient amplitude in the overall recording. With his technique, Marc produces recordings of outstanding realism. Another successful practitioner of the multi-mike technique is Bob Auger, who operates out of London, and his fine work can be heard on the Unicorn and other labels. Bob uses more of the "traditional" multi-mike technique, including use of an 8-track recorder, but he pays very close attention to the avoidance of instrumental spotlighting. It may surprise many of you, who equate DGG, Philips, and London/Decca sound with "purist" minimum-number-of-mikes technique, that they quite often use some variation on the multi-mike technique, according to the acoustic characteristics of a particular hall. For recordings made with the "purist" minimum-number-of-mikes technique, the companies most often opting for this are EMI-HMV in England and German Electrola. The recordings made this way have a very natural acoustic perspective, devoid of any spotlighting. The sense of orchestral depth is splendidly achieved and instrumental positioning is very accurate, while bass response is very extended and has great power without being obtrusive in perspective. Unfortunately, these recordings are released in this country (at least the EMI/HMV) through Angel Records, and far too often they have different equalization and other parameters when remastered from the original tapes, so many of the desirable attributes of the original recordings are missing.

The answer to this is that you must buy the EMI/HMV recordings, and they are not easy to come by. A fair stock of them are carried by the King Karol record store in New York and by Rose's in Chicago. Without question, Philips produces records with the most consistently quiet surfaces, and they prove beyond any doubt that it can be done! On an overall basis, I must sadly report that one is forced to turn to imported recordings for the most consistently satisfying and realistic sound and for records with the least number of physical blemishes.

Those who hunger for new quadraphonic recordings will get little encouragement from the CD-4 camp, which is at a very low ebb at the moment, with just an occasional release from RCA. There is also a reduced release program of SQ from Columbia. Here again you must turn to the imports, especially EMI and HMV, which have an evergrowing catalog of classical SQ recordings, mostly of the ambient variety, and the examples I have heard have been superb.

As to direct disc recordings . . . yes, they are the highest quality sound you can buy . . . but by no means all of them. Direct disc recording is not a panacea for all recording ills. In fact, the direct disc medium is so revealing that many sonic deficiencies are glaringly spotlighted. In many I have listened to, I can hear distortions due to mikes and recording consoles, and high frequency distortion from the tendency to pile on as much level as possible on the record, up to and including overcutting!

As to the tape mediums, the quality picture here is somewhat different from the discs, since it is a matter of duplicating existing sound qualities with a minimum of operational difficulties. Nonetheless, compression is often used, along with weird equalization in American cassettes, with lamentable results. Cassettes from DGG, Philips, and London/Decca have approached their counterpart discs in quality and are of consistently good processing. Open-reel tape is making a dramatic comeback with the superb processing by Barclay-Crocker in New York, with staples from the Musical Heritage Society, Vanguard, Desmar, Unicorn, and other labels, while Stereotape in Los Angeles is a bit variable in its output from the RCA, DGG, and London catalogs, but nevertheless has many fine sounding examples.

In summing up, high-quality recordings are made with many different techniques . . . you've got to pick and choose . . . and in this context, the pickings are best among the imports. *A*

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So, if some of the engineering "indulgences" of our top units aren't really necessary to you, you can still enjoy the sonic excellence that distinguishes LUX components... because now you know about our moderate-priced components. Your LUX Audio dealer will be happy to spend as much time as you need helping you to appreciate them.

Luxman T-88V AM/FM stereo tuner. Our least expensive tuner, yet includes FET front end with four-section tuning capacitor. Linear-phase ceramic filters in IF section. Features include FM interstation-noise muting, variable output level control and oscilloscope jacks for viewing multipath distortion, etc. Usable FM sensitivity; 2 microvolts (11.2 dBf) IHF and 2.8 microvolts (14.1 dBf) for 50 dB quieting. Stereo separation: 43 dB at 1,000 Hz. $345.00

Luxman L-80V integrated stereo amplifier. 50 watts minimum continuous power per channel, with total harmonic distortion no more than 0.08 per cent, both channels driven simultaneously into 8 ohms, 20 to 20,000 Hz. Frequency response, 10-50,000 Hz, within 1 dB. Phono S/N better than 77 dB (re: 10 mV input). Bass and treble controls each have 3 turnover frequencies; high and low filters each have 2 cut-off frequencies. $475. (Luxman L-85V, similar except 80 watts per channel, $765.)

# LUX Audio of America, Ltd.

160 Dupont Street, Plainview, New York 11803 • In Canada: White Electronics Development Corp., Ontario

# Dear editor

## Pre-Preamplifier Addendum

Dear Sir:

The moving-coil pre-preamplifier which I described in the February, 1978, issue of *Audio* has a gain that seems to be dependent not only on the manufacturer of transistors Q1 and Q2, but also on the particular batch of transistors from a given manufacturer. The parts list and specifications for the article were based on a set of 25 transistors each for Q1 and Q2 from a particular batch manufactured by Motorola.

It is a simple matter to re-bias the circuit for any pair of transistors for Q1 and Q2. The value of R2 should be selected to give a battery current of 150 to 160 microamperes with a *fresh* battery for B1. Once the proper value for R2 has been selected for each channel, it will not be necessary to change it again unless the transistors are changed. My experience has shown that R2 should be between 330 kilohm and 560 kilohm, depending on the parameters of the transistors. It is a simple matter to determine the correct value for R2 by substituting a 1 Megohm potentiometer for this resistor. After adjusting the potentiometer for the correct battery current, it can be removed and measured with an ohmmeter. A standard 5 per cent carbon-film resistor is sufficient for R2. The battery recommended is an Eveready No. 522 alkaline battery which measures exactly 9 volts when new.

The kit supplier for the pre-preamplifier will supply the correct value for R2 with each kit. Matched N-P-N/P-N-P transistor pairs will be supplied with the correct value of R2 specified for each pair.


W. Marshall Leach
Georgia Institute of Technology
School of Electrical Engineering
Atlanta, Georgia 30332


## Preamp Plaudits

Dear Sir:

*Audio* Magazine is to be complimented for publishing the W. Marshall Leach construction articles on the audio preamplifiers and pre-preamplifiers. The preamplifier is a particular success. I have constructed several copies of this preamplifier and found it to be as good as, or better than, any commercial preamplifier that I have had the opportunity to use and test . . . this includes units costing $1000.00 and more.

This circuit can be built for under $50.00 and works excellently. I have made a version to replace the preamplifier circuit board of the older Marantz 7T, as well as using the unit as an independent preamp to feed other control and power amplifiers.

The circuit has low noise, matches the RIAA curve very well, will put out over 35 volts peak-to-peak at all frequencies up to 120 kHz, and overloads in a symmetrical and well-controlled manner. The overload at the input is as close to perfect as can be made with the current state of the art.

I would not like to leave the impression that a $500.00 preamplifier is not worth the money . . . but one should realize that he is not paying for some secret or magical engineering breakthrough (that defies the laws of physics and electricity) but rather for the quality of the parts, the labor to assemble them, the packaging and the profit for the manufacturer, the wholesaler, and the retailer, in addition to the warranty and repair services.

Essentially the same technology is available to everyone. This includes parts, active devices, and the rest. Thus, the good construction articles *Audio* magazine has provided enable the serious constructor of circuits to take advantage of the engineering work done by the author of those articles. This is a service I would like to see *Audio* magazine expand.


R.A. Greiner
Professor of Electrical Engineering
Univ. of Wisconsin
Madison, Wis.


*Editor's Reply: Thank you for your kind words about Mr. Leach's construction articles. We would like to publish more of these quality construction pieces, but this has been hampered by the increasing sophistication of designs offered commercially, as well as the inability of the home constructor to match the sophisticated construction techniques of the large manufacturers. In any case, we do intend to continue to offer such articles, and we welcome inquiries from potential authors and suggestions from those interested in particular projects. — E.P.*


Mike McNelly

# FCC's 4-Channel Listening Tests

Alfred W. Myers

Just a few years ago it was impossible to pick up a copy of any audio journal without some advertisement for a new piece of four-channel equipment or read of how quadraphonics was overtaking stereo and would soon replace all two-channel reproduction. Obviously, this didn't happen, and today quadraphonic sound is largely dead in the hi-fi marketplace. No, it is not totally obsolete, but it certainly is not the thriving success that was predicted. The three main competing systems are still fighting it out down to the last tooth and nail. And work still is progressing on both the matrix and discrete formats, but, except for the recent introduction of the long-awaited Tate SQ ICs, system improvements and "breakthroughs" most usually remain in audio laboratories and are seen only at professional audio exhibitions.

The reasons for quadraphonic's near-demise are many and varied, and it is impossible to lay the blame at any one specific door. Suffice to say that three competing systems were introduced before final fruition and that the public was told an awful lot about a "wonderful new listening experience" to which performance capabilities did not fully measure up. Indecision and inaction on the part of many hardware and software companies helped to stunt quadraphonic's growth. Finally, the total absence of standards for quadraphonic FM broadcasts only added to the public's confusion, helping to cement the "wait and see" attitude that most consumers adopted. Today the systems have improved and the FCC has completed a series of tests in an attempt to standardize on one four-channel format for FM broadcasts.

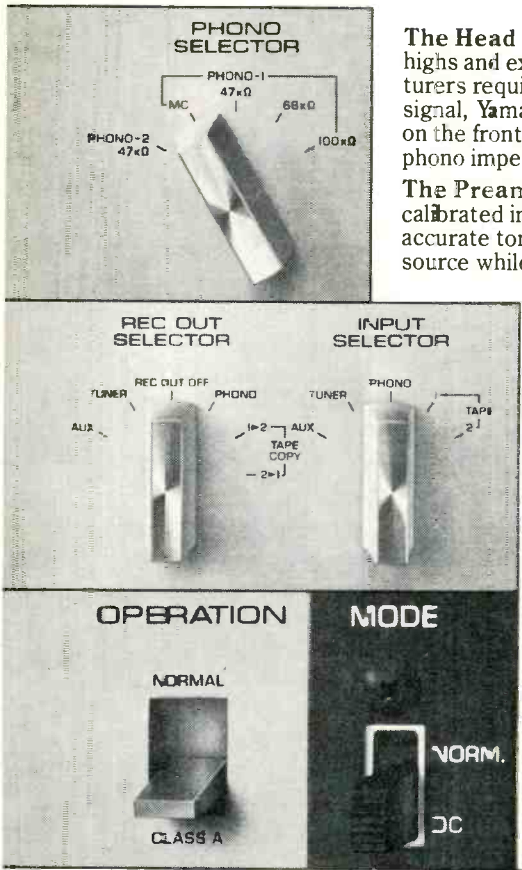
In 1972 the National Quadraphonic Radio Committee (NQRC) set out to determine which of the many competing systems would be best for quadraphonic FM. Although the original NQRC tests were meant to compare *all* formats, the two leading matrix systems (SQ and QS) were withdrawn from testing at the requests of CBS and Sansui. So, the NQRC evaluations were generally limited to discrete (4-4-4) and discrete/matrix (4-3-4) systems. One matrix format (the BMX from Nippon/Columbia—no relation to CBS) was used in the NQRC tests, but it was never commercially used in this country and is not a first-rank contender. The primary difference between 4-4-4 and 4-3-4 (aside from equipment used) is the number and allocation of subcarrier signals used to unscramble the quadraphonic composite signal.

Between the time of the NQRC's tests and the present, major advances have been made in matrix technology. Sansui developed their Variomatrix decoder, while SQ sources came up with a family of logic circuits culminating in the phase-cancellation technique used in the Tate, Scheiber, and CBS' own paramatrix decoders. Seeing the improvements in matrixing, the FCC made the decision to conduct a new series of tests to determine if these matrix advances negated the need for "going discrete." In addition, the FCC received a petition from CBS to adopt SQ as the standard and a counter-proposal from Sansui in support of their own QS matrix. To add a bit more confusion to the whole quadraphonic FM scene, England's BBC came up with their own system (termed "Matrix H") and that too was tested.

In their laboratories in Laurel, Maryland, the FCC constructed a room measuring 15 feet wide and 22 feet long. One wall was covered with foam rubber, while one adjacent wall consisted of wood folding doors. The two remaining walls were of sheetrock. The FCC admits that such a room is far from acoustically ideal, but felt that such materials are representative of what might be found in an average living room—or at least would simulate the acoustic properties of average living rooms. Four Technics' SB-700A "Linear Phase" speakers were driven by a pair of Crown D-150A stereo amplifiers which, in turn, connected to a Bose 4401 four-channel preamp. Crown and Ampex tape equipment was used as well as the various matrix encoders and decoders: SQ (phrase cancellation paramatrix), QS (Sansui QSD-1 Variomatrix), and experimental BBC-H gear. RCA provided the components for the 4-3-4 demonstrations. To represent a discrete 4-4-4 broadcast, the FCC simply played a discrete open-reel tape, feeding the audio chain directly—a sore point with the matrix advocates, who say that no 4-4-4 broadcast will ever equal a master tape. But, right or wrong, that is the way the tests were performed.

Other than the complaint about the 4-4-4 simulation, there can be no doubt that the tests were conducted with the utmost fairness. The various system representatives selected and supplied the equipment used for their tests, ran their own tests to see that it was performing properly, and were given the option to check out their gear throughout the duration of the tests (not, of course, while actual listening tests were being made). At no time

# The one alternative to separates: The Yamaha CA-2010 Integrated Amplifier.




**The Head Amplifier.** Discerning music lovers all over the world are discovering the transparent highs and extended frequency response of the moving coil phono cartridge. While other manufacturers require the addition of an expensive preamp or step-up transformer to boost the low output signal, Yamaha included a special head amplifier in the CA-2010. It's available with the flip of a switch on the front panel. And to help you get the most out of moving magnet cartridges, there's a 3-position phono impedance selector.

**The Preamplifier.** To assure exact, repeatable bass and treble settings, the controls are precision calibrated in ½dB steps. Dual turnover frequencies for both ranges double the versatility of these accurate tone controls. Completely independent Input and Output Selectors let you record one source while listening to another. And the power meters are easily switched to REC OUT readings in millivolts, so you can monitor the actual output level to your tape deck for cleaner, distortion-free recordings.

**The Power Amplifier.** 120 watts RMS, with no more than 0.03% THD 20Hz to 20,000Hz into eight ohms.

For tighter, cleaner bass response, the amplifier can be switched to DC operation.

Class A operation is switchable on the front panel, delivering 30 watts RMS, with no more than 0.005% THD 20Hz to 20,000Hz into eight ohms.

The twin power meters are fast-rise, peak delay—they can track even the briefest of transient bursts. Plus they can respond to levels from 1mW to 316W (into eight ohms).

**Real Life Rated.™** The specifications of the individual components of the CA-2010 are superior to many separates. Individual specifications alone, however, can't possibly reflect actual in-system performance. That's why Yamaha measures overall performance from phono in to speaker out, rather than at designated points along the signal path. Furthermore, we measure noise and distortion together over a broad output range, rather than individually at the optimum output.

Our Real Life Rated measurement is called Noise-Distortion Clearance Range (NDCR). On the CA-2010, NDCR assures no more than 0.1% combined noise and distortion from 20Hz to 20kHz at any power output from 1/10th watt to full-rated power.

**Superb tonality from a musical tradition of technical excellence.** The tonal accuracy of our audio components is referenced to the same standards used to evaluate the tonal accuracy of our world-renowned musical instruments. The result is a rich, clear tonality that is unknown elsewhere. You really must hear it.

You really must hear the same resolutely accurate music reproduction available from all four Yamaha Integrated Amplifiers and four superb tuners. All are made to a single standard of excellence—a standard rooted in a 90-year tradition of musical perfection.

For a personal audition of the new Yamaha CA-2010, as well as the rest of our complete line of components, just visit your nearest Yamaha Audio Specialty Dealer. If he's not listed in your Yellow Pages, drop us a line.

**.03%**
**-96 dB S/N**

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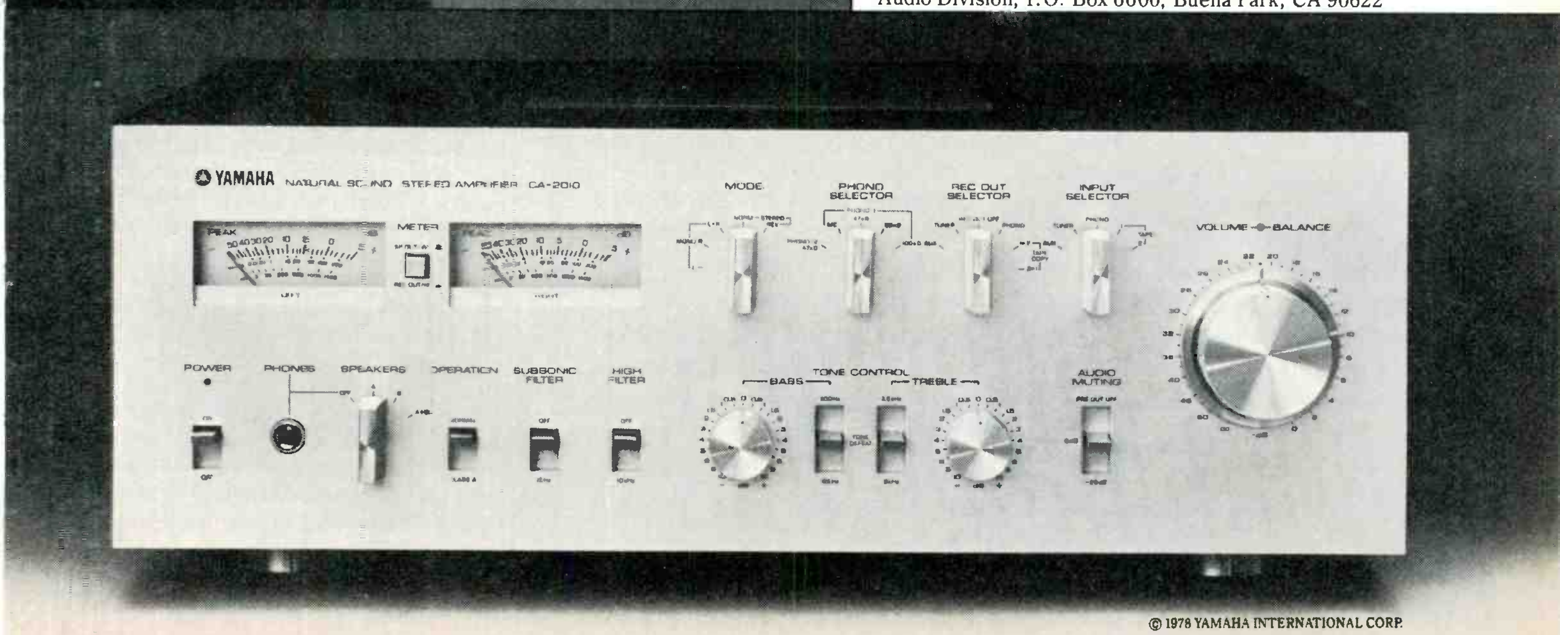
Audio Division, P.O. Box 6600, Buena Park, CA 90622



were the listeners (auditors) told which systems they were hearing, and in the case of system-to-system comparisons, they were told simply to choose between "A" and "B." Upon completion of the tests, the scorecard results were fed into the FCC's own Honeywell computer. After the test results were compiled and made public, the system proponents were given several months to make comments and defenses about their own systems and the overall test results. Naturally, the FCC commissioners will take all of this into consideration.

## Quadraphonic Localization

Discrete quadraphonics has always been recognized as the "ideal" for channel separation, directionality, and localization. To determine how the three matrix systems stack up against a four-channel master tape, the FCC conducted two quadraphonic localization tests, simple and complex. Twenty-five numbered cards were placed around

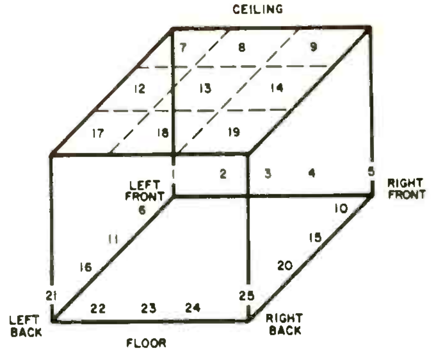



**Fig. 1—In the FCC's quadraphonic localization tests, the auditor was seated in a room similar to the representation above. Facing the front of the room (number 3 represents center front) he was asked to indicate which of the numbered cards placed around the room and ceiling approximated the apparent source of particular sounds (pink noise and electronic "chirping" sounds). Auditors were instructed to remain facing the front during the bursts of sound, but were permitted to swivel in their chairs to see which numbered card corresponded with the sound's source.**



the listening room—16 at eye level around the room's perimeter and nine overhead. The auditor was seated in the center of the room and asked to determine which numbered card approximated the apparent source of the test signals. Both "real" signals (direct from a single speaker) and "phantom" signals (sounds seeming to emanate from a point between speakers) were applied. The simple tests consisted of pink noise from various points, while the complex tests involved electronic "chirp" sounds superimposed over pink noise coming from all four of the speakers. Although these tests are important, their degree of importance is open to question. Naturally, we listen to music—not pink noise and chirping sounds. In relating some of the auditors' comments, the FCC states that many of them prefer that the rear channels be reserved for ambient and reverberant sounds—in which case precise localization (for areas other than the front speaker array) would not be of prime importance. As expected, the 4-4-4 tape won the most "points" in quadraphonic localization.

## Quadraphonic Musical Preference

This test is one that many people feel is the most important in dealing with quadraphonic FM reproduction as it is representative of the four-channel performance consumers can expect to

# Presenting the JVC MusicTowers.


JVC LX-3000 MusicTower with JVC components, as shown, from top to bottom: T-3030 Digital FM Stereo Tuner; P-3030 Control Preamplifier; SEA-7070 10-Band S.E.A. Graphic Equalizer; KD-95 Stereo Cassette Deck; QL-10 Quartz-Locked Turntable; M-3030 DC Stereo Power Amplifier; SK-1000 3-Way Speaker Systems.


# JVC MusicTowers give you total convenience and flexibility.

As you can see from the suggested JVC systems shown, your choice of components and MusicTowers depends on your own special requirements and budget. And regardless of which combination you select, one thing you can be certain of: all JVC components are designed to complement each other to produce the best possible sound reproduction.

So if you agree that a good music system should be heard—and seen—visit your JVC dealer. Select your JVC system from the most innovative collection of quality components we've ever offered. Then match it up with a JVC MusicTower. And you'll see how beautifully JVC lends a hand to component handlers.

JVC LK-12 MusicTower (from top to bottom) JL-A20 Semi-Automatic Turntable; JR-S61W AM/FM Stereo Receiver; KD-25 Stereo Cassette Deck

JVC LX-2000 MusicTower (from top to bottom) JT-V77 AM/FM Stereo Tuner; JA-S77 DC Integrated Stereo Amplifier; QL-A7 Direct Drive Quartz Turntable with automatic lift; KD-85 Stereo Cassette Deck; SEA-50 Stereo Graphic Equalizer

JVC LK-1000 MusicTower (from top to bottom) QL-5 Direct Drive Quartz Turntable; JT-V22 AM/FM Stereo Tuner; JA-S55 DC Integrated Stereo Amplifier; KD-55 Stereo Cassette Deck; SEA-50 Stereo Graphic Equalizer. Protective glass door for components and record compartment.

JVC LK-44/MK-44 MusicTower (from top to bottom) QL-A2 Direct Drive Quartz Turntable with automatic return; JT-V22 AM/FM Stereo Tuner; JA-S22 DC Integrated Stereo Amplifier; KD-25 Stereo Cassette Deck; SEA-20G Stereo Graphic Equalizer. Glass panelled record compartment.

JVC LK-500 Horizontal MusicTower-QL-5 Direct Drive Quartz Turntable; KD-S201 Stereo Cassette Deck; JR-S301 DC Integrated AM/FM Stereo Receiver; SK-700 3-Way Speaker Systems. Extra-wide record compartment.

JVC

JVC America Company, Division of US JVC Corp., 58-75 Queens Midtown Expressway, Maspeth, N.Y. 11378 (212) 476-8300
Canada: JVC Electronics of Canada, Ltd., Scarborough, Ont.



# Because we think a good music system should be heard. And seen.

People who are into good music reproduction are proud of their high fidelity component system. They like to put it where everyone can see as well as hear it. And rightfully so, because visually, today's components are a tribute to the finest expression of contemporary design.

That's why JVC is introducing its series of MusicTowers.

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Take our LX-3000 MusicTower. This strikingly styled unit with gleaming walnut veneer sides, is designed for nineteen-inch rack-mounted components, and can house JVC's Professional Series. Each component represents the finest JVC offers.

And the great thing is that it's easier than ever to make the proper interconnections after each component slides securely into place. Then, because JVC believes distractions belong in the back, not the front, all interconnecting wires vanish from sight within each of the two vertical supports.

You can even move the whole works from one listening area to another; the LX-3000 MusicTower glides smoothly over any floor surface on heavy duty casters that lock into place. This JVC MusicTower takes the center spotlight in any listening room.

JVC

We build in what the others leave out.

get in their homes. In this test of system-to-system comparisons, one-minute segments of five musical programs were played and repeated through various system combinations. The five selections, commercially available on quadraphonic discs were:

**Swan Lake**—Leonard Bernstein & New York Philharmonic
**Young and Foolish**—Ray Conniff Singers
**Moon River**—Hugo Montenegro
**Gates of Love**—Mystic Moods Orchestra
**Stars and Stripes Forever**—Henry Mancini

These are the same musical selections that were used earlier in the NQRC listener evaluations. Instead of a simple A or B choice, listeners were given five ratings to apply to each comparison so that their degree of preference could be known:

A is greatly preferable to B
A is preferable to B
A is equal to B
B is preferable to A
B is greatly preferable to A

The general results of this test showed 4-4-4 ahead of the others, but in the case of 4-4-4 against SQ, the lead was *very* slight, with 52 per cent of the auditors preferring discrete and 48 per cent opting for the SQ matrix. SQ came out ahead of all the other systems with (suprisingly) the Sansui QS matrix finishing last.

## Stereophonic Compatibility

Because four-channel sound has not been such an overwhelming success, it is essential that any quadraphonic FM system be compatible with two-channel reproduction. Even FM broadcasters, who do make the switch to quadraphonics, don't want to lose their two-channel (and mono) listeners. In determining how well the competing systems did in a stereo folddown, the FCC again ran localization and musical preference tests. This time only two speakers were used, placed 12 feet apart along the 22 foot wall of the listening room.

There are two distinct schools of thought on quadraphonic-to-stereo folddown—undoubtedly brought about by the performance and limitations of particular systems. In both the discrete 4-4-4 mode and in Sansui's QS matrix, the rear channels are simply

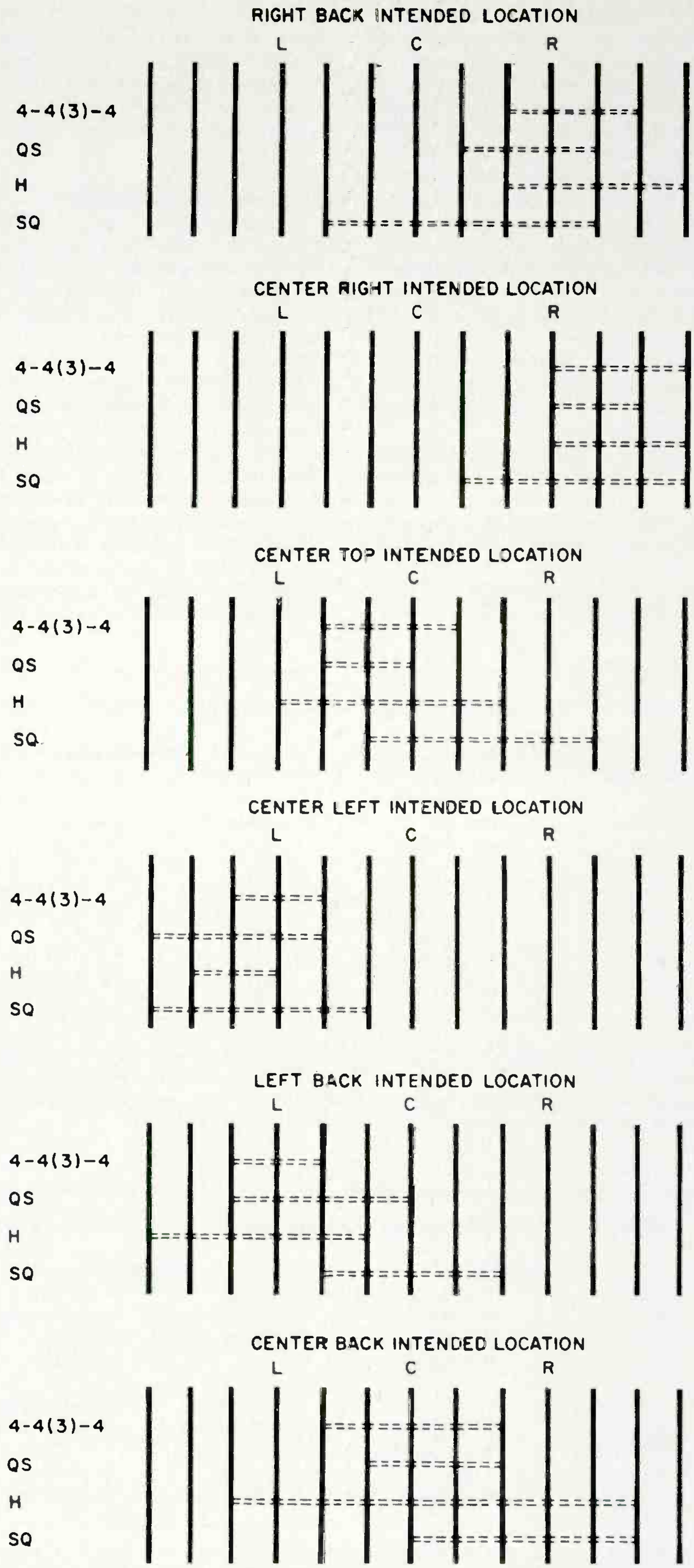



**Fig. 2—L and R are front speaker locations with C representing the center phantom channel. The horizontal marks (= = =) indicate where in the stereo speaker array the sound seems to come from.**

pushed forward, that is, right-back to right-front and left-back to left-front. The QS claim is that this type of fold produces the effect of widening the two-channel image. The CBS (SQ) claim is that such a fold causes an unnatural build-up at the two speakers and creates a hole-in-the-middle effect. In a two-channel fold of an SQ program, the rear signals are distributed to the phantom center-front area, which CBS claims provides a more natural and pleasing listening experience. Because of these differing philosophies, the FCC did not have a ranking for stereo localization, although the stereo-fold imaging effects are shown in the accompanying illustrations.

Again, it is necessary to point out that we listen to music and most attention has been focused on quadraphonic-to-stereo musical preferences (how a quadraphonic musical program sounds when played through a two-channel system). Unlike the four- channel musical preference tests in which 4-4-4 had a slight edge, in the stereo test SQ came out on top, followed by the 4-4-4 system, BBC's H, and again, in last place, QS. Because 4-4-4 and 4-3-4 systems have identical "folds," the 4-3-4 system was not tested.

### Monaural Compatibility

Because there is no localization possible in mono (with all sounds coming from one speaker), the mono compatibility tests consisted only of musical preference. The rankings were identical to stereo: SQ, 4-4-4, H, and QS.

The FCC commissioners have the test results and the responses from the representatives from the competing systems and formats. Now that all the shouting is over (some, at least, temporarily), it is simply a case of waiting to see which way the FCC goes. But, the FCC is not bound by test results. It has several other options, such as:

—Permit discrete FM quadraphonics and prohibit matrix.

—Permit discrete and one or more matrix systems.

—Permit one or more matrix systems and prohibit discrete.

—Allow only one matrix and no discrete.

—Tell the proponents that none of the systems are adequate and to come up with a better approach.

—Do absolutely nothing and allow things to remain in the state of confusion that now exists, saying that there is not enough public interest in four-channel sound.

We'll see what happens. One thing for sure—now is not the time to begin digging that hole in the backyard as a final resting place for quadraphonic equipment.

The accompanying charts and illustrations are taken from the FCC Project #2710-1 evaluation report on FM quadraphonic listening tests, published in August, 1977, by the Federal Communications Commission, Office of the Chief Engineer, Laurel, Maryland. A

**Table I — Quadraphonic Localization Results, Rank, Simple Localization.**

| Real Sources | | Phantom Sources | | Real & Phantom Sources | |
|---|---|---|---|---|---|
| Intended source location | Intended location plus nearest neighbors | Intended source location | Intended location plus nearest neighbors | Intended source location | Intended location plus nearest neighbors |
| 1. 4-4-4 (96%) | 1. 4-4-4 (100%) | 1. 4-4-4 (51%) | 1. 4-4-4 (85%) | 1. 4-4-4 (71%) | 1. 4-4-4 (92%) |
| 2. SQ (92%) | QS (100%) | 2. 4-3-4 (49%) | 2. 4-3-4 (84%) | 2. H (62%) | 2. 4-3-4 (90%) |
| 3. QS (90%) | H (100%) | 3. H (45%) | 3. H (77%) | 4-3-4 (62%) | 3. H (87%) |
| 4. H (84%) | 4. SQ (99%) | 4. QS (34%) | 4. QS (72%) | 4. QS (59%) | 4. QS (84%) |
| 5. 4-3-4 (79%) | 5. 4-3-4 (98%) | SQ (34%) | 5. SQ (61%) | SQ (59%) | 5. SQ (78%) |

"Simple" quadraphonic localization tests consisted of bursts of pink noise. "Real" sources refer to actual speaker locations such as left front or right back. "Phantom" sources refer to locations where there is no speaker, such as center front.

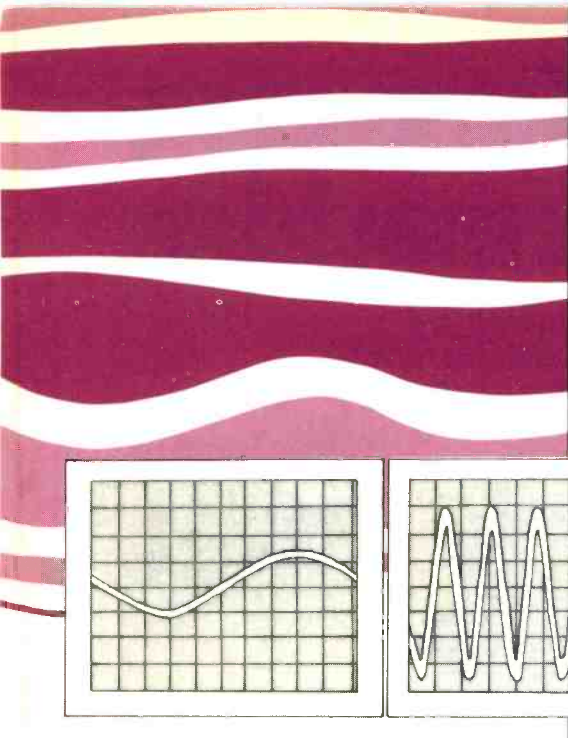
In cases where two or more systems scored equally, no numerical rating was given (as in three systems scoring 100% in the "real source" test shown above).

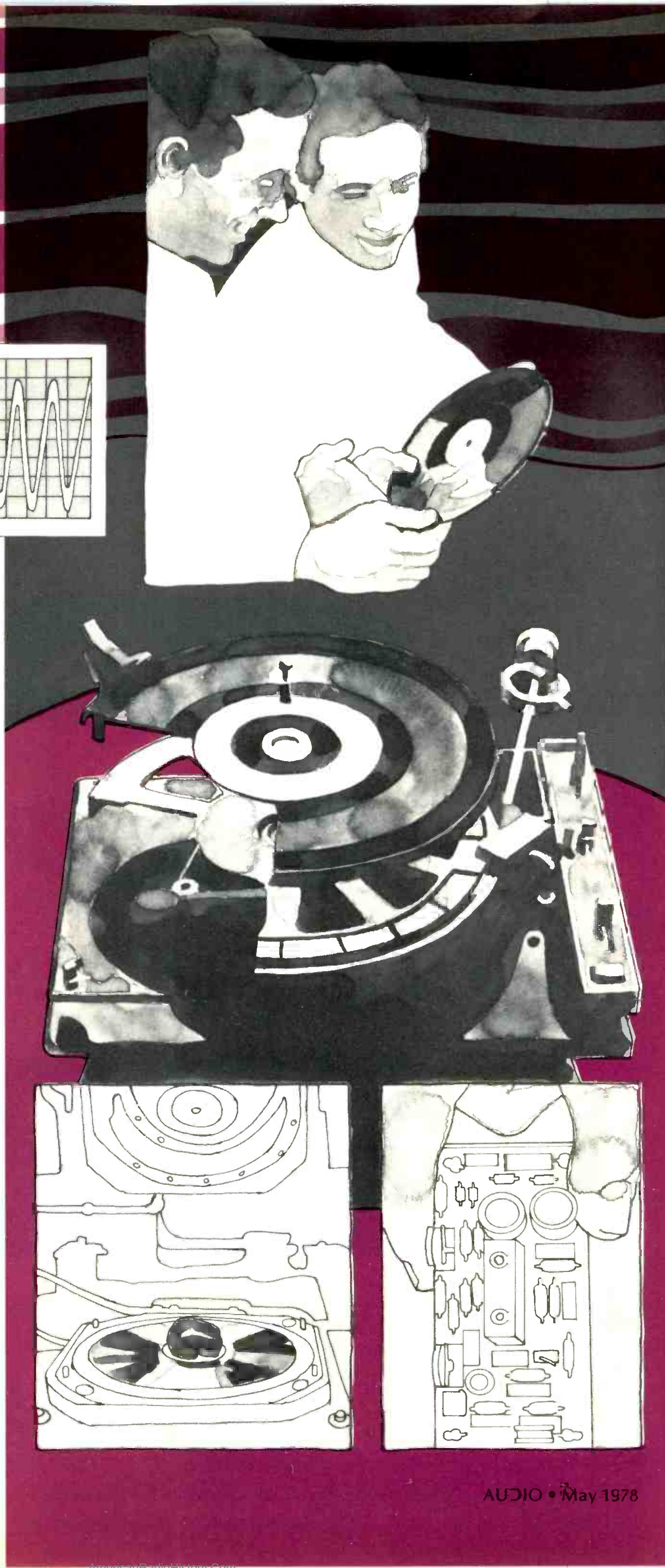


**Table II — Quadraphonic Localization Results, Rank, Complex Localization**

| Real Sources | | Phantom Sources | | Real & Phantom Sources | |
|---|---|---|---|---|---|
| Intended source location | Intended location plus nearest neighbors | Intended source location | Intended location plus nearest neighbors | Intended source location | Intended location plus nearest neighbors |
| 1. 4-4-4 (76%) | 1. 4-4-4 (96%) | 1. 4-4-4 (28%) | 1. 4-4-4 (66%) | 1. 4-4-4 (49%) | 1. 4-4-4 (92%) |
| 2. SQ (51%) | 2. SQ (86%) | 2. 4-3-4 (27%) | 2. 4-3-4 (63%) | 2. 4-3-4 (36%) | 2. 4-3-4 (71%) |
| 3. 4-3-4 (46%) | 3. 4-3-4 (82%) | 3. QS (23%) | 3. QS (52%) | 3. SQ (33%) | 3. SQ (63%) |
| 4. QS (46%) | 4. QS (74%) | 4. H (21%) | 4. H (50%) | QS (33%) | 4. QS (61%) |
| 5. H (30%) | 5. H (65%) | 5. SQ (18%) | 5. SQ (45%) | 5. H (25%) | 5. H (57%) |

"Complex" quadraphonic localization tests consisted of electronic "chirps" being reproduced from real and phantom sources over a background of pink noise which comes from all four speakers simultaneously.





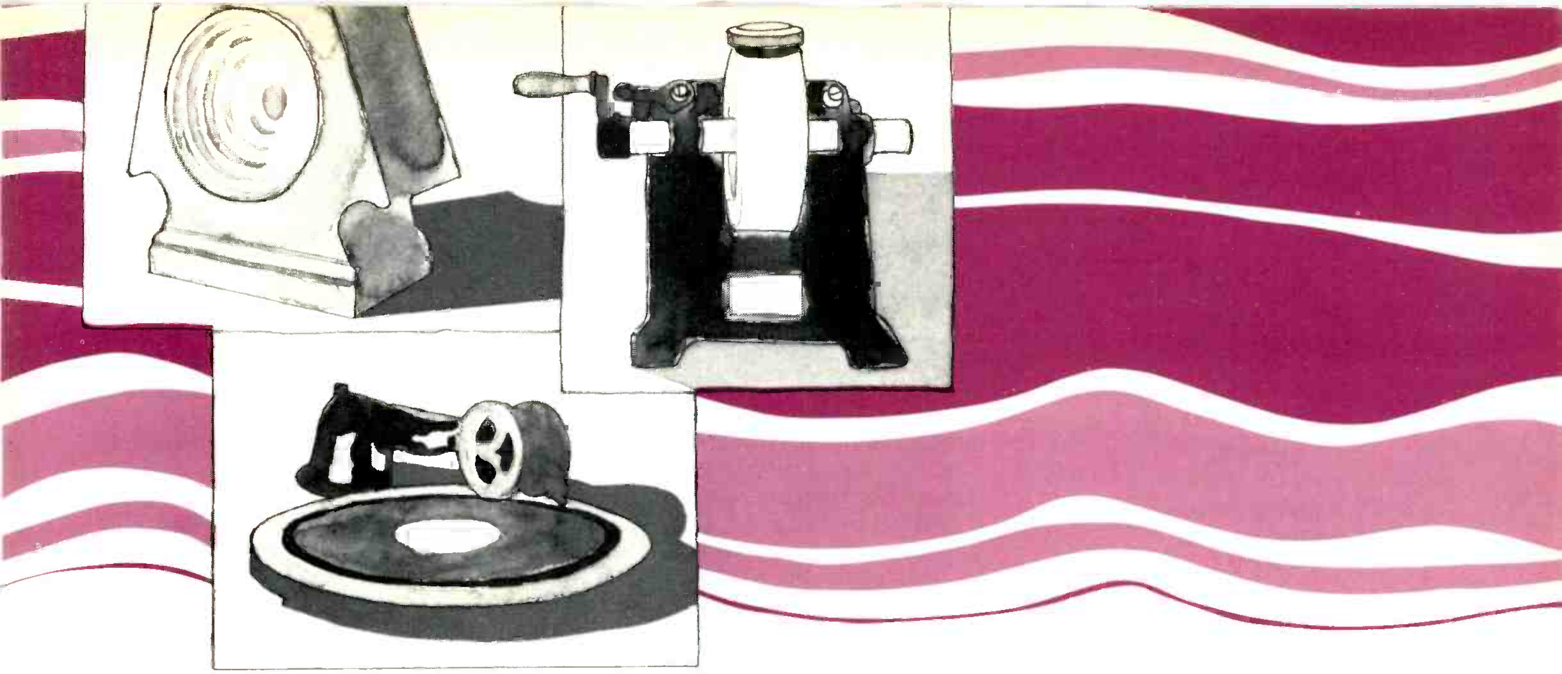
If records were perfect and playing conditions ideal, we would have little reason to write this article. As of 1978, such a state of perfection has not yet arrived. One hundred years after the invention of the phonograph the problem of playing a record continues to be a challenging one.



This challenge is created by continual improvements in the entire high-fidelity system. Noise, distortion, and other irritants, which were masked in yesterday's systems, today emerge as serious problems. For example, distortion of 1 per cent in one component is hardly of significance when another component has 5 per cent distortion. But if the distortion in the second component is reduced to 0.1 per cent, the distortion of the first component, although small, may become very important. As each part of the hi-fi system is improved a new challenge is created for other parts of the system.

This continual improvement in high-fidelity reproduction has emphasized a problem unique for the cartridge-tonearm system. Conditions under which the cartridge operates are almost always less than ideal. Warped records, static electricity, dust, and structure-borne noise are major factors

Den Schofield



that negatively influence the quality of phonograph reproduction. As the high-fidelity system improves these negative factors become more noticeable.

Recognition of the need to consider non-ideal playing conditions as a major factor in phonograph reproduction has led to a series of research projects at Shure. The objective was to determine the precise nature of these problems. For many years we have studied the requirements for phonograph reproduction assuming near ideal conditions. In this present research program, we supplemented that work by actually measuring the effect of non-ideal conditions on the playback process.

In this article we will review the development of phonograph reproduction as it relates to the two areas just indicated. First, we will recount some of the history and discuss more recent research into the major aspects of playing under assumed ideal conditions. We will then review the research findings of a number of phenomena which create non-ideal playing conditions. Most of the effects which will be discussed have been known for many years, but little, if anything, has been written to clearly identify or quantify them. Specifically, we will provide measured data so that the reader can develop some concept of the relative magnitude and importance of these phenomena.

We should point out that this article has been written by a group of engineers all of whom are serious listeners. Our objective is to improve sound quality. The ability to detect imperfections in the reproduced sound, however, is relatively useless unless the causes can be identified and measured. Thus, our primary objective has been to find and measure the cause of the imperfection and then to create a solution.

## Playback Under Ideal Conditions

We will review here briefly the major criteria in phonograph reproduction which are always specified under assumed ideal playing conditions. Performance will invariably be deteriorated when non-ideal conditions (warp, static electricity, dirt, etc.) exist.

*Frequency Response:* The need for a flat frequency response is recognized as the principal requirement to assure neutral sound reproduction. Earlier cartridges had a response peak somewhere in the audible range. Improvement in cartridge design required moving the primary stylus resonance to a higher frequency, ideally beyond the range of the human hearing. This has been accomplished in some of the better quality modern cartridges, by providing smaller, lighter styli and by other more sophisticated means which will be discussed later in the article.

*Separation:* This characteristic relates to the ability of the stereo phonograph cartridge to provide two completely independent signals. As separation decreases, the two channels become less independent. Separation is reduced by imperfections in the cartridge design and construction, and by the variability in the way records are cut. If records were cut to the ideal 45° modulation angle and the cartridge designed and constructed to match that angle, then separation in lower-frequency ranges would be large (Fig. 1). Separation at higher frequencies is a much more complex phenomenon which is related to the dynamic characteristics of the stylus and the interaction between the stylus and record. Although we will not discuss that subject here, it should be noted

* Anderson, Assistant Chief Engineer; Happ, Project Engineer; Jakobs, Director of Development and Application Engineering; Karlov, Manager of Electromechanical Development; Kogen, Vice President of Development and Design Engineering, and Mastricola, Senior Development Engineer, Shure Brothers, Inc., Evanston, Ill.



# Phonograph Reproduction-1978

* Roger Anderson, L.R. Happ, B.W. Jakobs, F.J. Karlov,
James H. Kogen, and S.A. Mastricola.

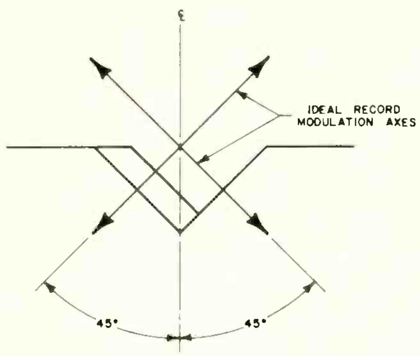



**Fig. 1 — The ideal 45° modulation angle for cutting records.**

that a decrease in high-frequency separation generally occurs near the resonance of the stylus. If that resonance is beyond 20 kHz, separation should not be a problem within the audible spectrum.

*Trackability:* We have emphasized the importance of trackability and have written many articles on the subject during the last 12 years (1, 2, and 3). The ability of the stylus to maintain contact with both walls of the record groove is a basic and obvious requirement for any phonograph cartridge. Inability to track properly has been shown to be the cause of serious and premature record wear, high noise levels, and often intolerable distortion. The means by which superior trackability can be achieved will be discussed later in detail.

*Tracing Distortion:* This form of distortion was first analyzed by Pierce and Hunt in 1938 (4). Tracing distortion results from the fact that the playback stylus has a radius which is larger than the sharp edge of the cutting stylus. This distortion can be reduced by decreasing the playback radius of the tip or by applying compensation in cutting the record. Reducing the tip radius has a limit because, if the radius is too small, the diamond will cut or otherwise damage the record. The desire to reduce the radius of the playback stylus has led to a variety of tip shapes such as elliptical, parabolic, hyperbolic, and so forth. None of the tip shapes offers a panacea because none can provide a playback radius the size of a cutting stylus radius without causing damage to the disc.

*Tracking Angle:* Distortion can result from two types of tracking angle errors, horizontal and vertical. Horizontal tracking angle is a function of the tonearm design and has not been considered a major source of distortion since the proper design criterion was established by Bauer in the 1940s (5). The importance of the distortion caused by vertical tracking errors was emphasized by Bauer and by Woodward in the early 1960s (6 and 7). This type of distortion is produced when the vertical tracking angle (VTA) of the playback stylus differs from that of the cutting stylus (Fig. 2). The simplistic solution would seem to be to design the phonograph cartridge to match the cutting system. The problem turns out to be much more complex since the VTA of a record cannot at present be independently measured with precision. Inventing a method of measuring the vertical tracking angle cut into a record has proved to be rather elusive. Work is now being done to provide a better method of measurement and, after that is accomplished, we hope to standardize on a cutting angle for records. Then it is expected that the desired matching of VTA by the phonograph cartridge can be made. Present practice calls for a 15° angle in the United States and 20° in Europe. However, there is little or no control over the cutting of records, and it is impossible to ascertain what angles are actually being cut in the majority of commercial discs.

*Skating Force:* This force results from the use of an offset tonearm and shows itself as an increase in force against the side of the groove towards the center of the record (the left channel). Skating force was recognized and explained by Percy Wilson in England in the mid-twenties (8) and expanded on by Ben Bauer in the United States in the middle-forties (5). When this force is uncompensated, uneven wear on the stylus tip as well as unbalanced tracking capability will result. All top-quality tonearms today are provided with a means of counterbalancing the skating force, with the exception of linear tracking arms for which skating force does not exist.

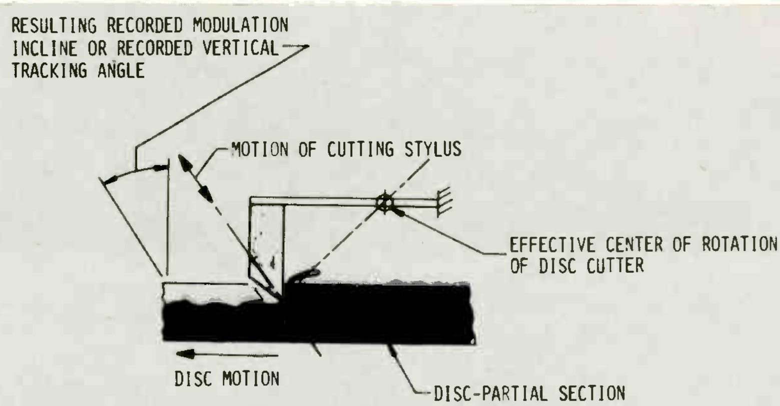



**Fig. 2a — Stylized disc cutting operation.**

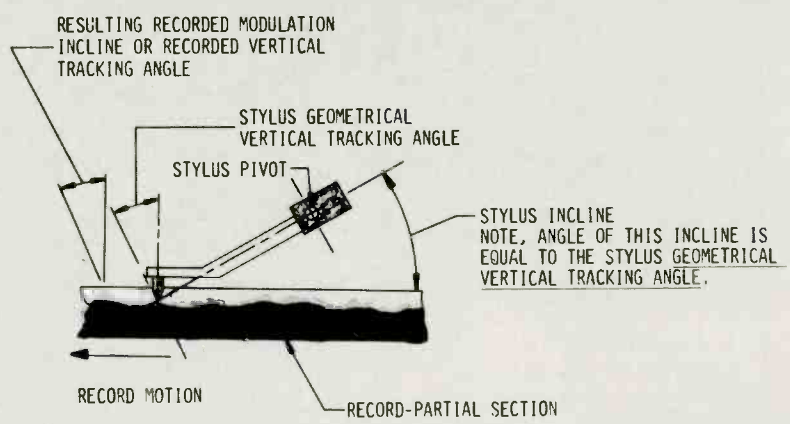



**Fig. 2b — Stylized phono playback operation.**

### Recognition of Playback Problems: Qualitative and Quantitative

The sound quality produced by a hi-fi system is the all-important end product. But sound quality in itself is not totally measurable. We must identify specific problems that affect the sound and most importantly, we must be able to measure those problems. In the following sections, we will discuss five factors which seriously affect the performance of a phonograph playback system.

1) Very high amplitude record modulation.
2) Mechanical noise, including that created by warped records, acoustical feedback, turntable rumble, and structure-borne noise from other sources.
3) The effects of low-frequency cartridge-tonearm resonance.
4) The effects of electrostatic charges.
5) The problems created by dirt and dust accumulation on the record.

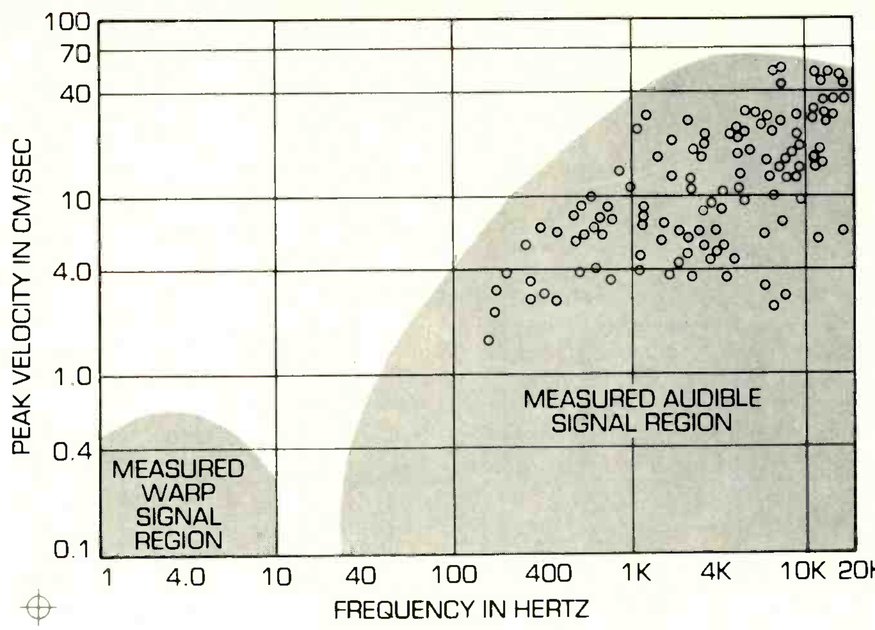



**Fig. 3—Signals on records.**

*The Level of Record Modulation:* The ultimate objective in creating a phonograph record is to incorporate all of the information which was contained in the original sound source. This means that all of the frequencies and their respective levels must be included. After a record is produced with whatever degree of perfection was achievable, it is necessary for the phonograph cartridge to recreate everything on that record. If recording equipment, in particular the cutter, is improved to allow more of the dynamic range of the original program material to be present, then the cartridge must be improved to reproduce that "hotter" information.

The article, "Trackability," *Audio*, Nov. and Dec., 1966, first showed the distribution of modulation levels vs. frequency on a large selection of commercial discs. That data has been reviewed (Fig. 3), and measurements indicate that the distribution of high-amplitude modulation remains similar to that which was originally described. If anything, there is a greater tendency to produce high-level modulation in the middle and higher frequencies; thus, the problem of tracking this high-level modulation has most certainly not disappeared and, if anything, has become more severe. In addition, the listener has become more discriminating, and the resolution of tracking problems has taken on more significance.

While nobody questions the importance of proper tracking, there are two major aspects where disagreement exists. The first is how to achieve suitable tracking and the second is what constitutes adequate or acceptable tracking.

*Methods of Achieving Acceptable Trackability:* There are two ways to attack the tracking problem. One is to increase tracking force . . . we term that the brute-force method. The second is to improve the dynamic characteristics of the stylus to achieve the optimum response at a minimum tracking force. The brute-force method works reasonably well, if one is not concerned about record and tip wear. Improving the dynamic characteristics generally involves lighter and more sophisticated stylus arrangements.

We assume that most users recognize the importance of reducing stylus tip and record wear. Extending the life of the record and stylus must, therefore, be a major objective, and a pure brute-force approach cannot be acceptable for most applications.

One solution offered has been that of using a stylus tip with a long contact area, a solution which does not change the playing radius, but does increase the area of contact. The theory (and we emphasize the word theory) is that by increasing contact area, one can increase record life. For lack of better information, we have tentatively, but with considerable reservation, accepted this hypothesis. We are very concerned that to date no one has provided measured data to prove the theory.

Our tests indicate that the wear phenomenon is an exceedingly complicated one. We have made and are continuing extensive studies on this subject, and have found it extremely difficult to produce repeatable test data. Nevertheless, since increasing the area of contact would seem to have merit, we have accepted this concept with one major provision. The major provision is that use of the larger tip contact area should in no way create other problems such as increased distortion.

The stylus tip with a larger contact area may be employed in one of two ways. One way is to design a cartridge to play at a higher tracking force and claim record life equivalent to that of a stylus with a smaller tip area playing at a lower tracking force. A second possibility is to design the cartridge to play at a lower tracking force and offer an extended record and tip life. It seems to us that the second of the two alternatives is by far the preferable, although much more difficult, of the objectives.

The small size of the playback stylus often misleads people to assume that the problems associated with the device are also small. The reverse is actually true in that the problems associated with the design and construction of the stylus increase as its size becomes smaller. Optimizing the phonograph stylus design requires a detailed analysis of the mechanical system. Determining the ideal combination includes many parameters such as the stylus length, the shank's outer diameter, its wall thickness, the material, and the shape of the stylus shank. The selection of transducer, design of bearings, and many other factors make this a very complicated

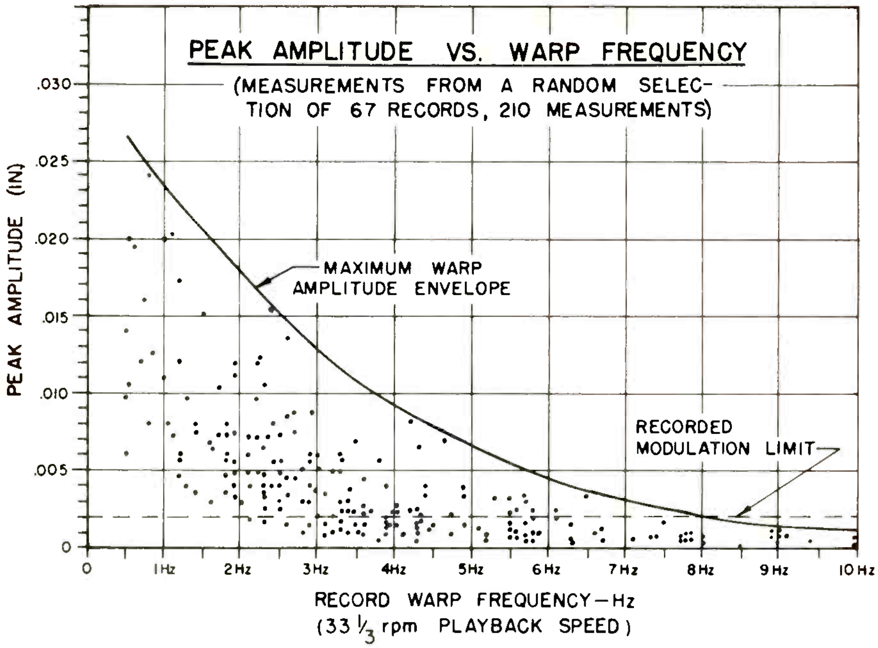



**Fig. 4—Maximum warp envelope.**

and challenging design task. If successful, however, a design which provides high trackability with low tracking force can be achieved. This combination, along with the possibility of increased record and tip life through a larger contact area, provides the best solution that can be achieved at this time.

*What Constitutes Acceptable Trackability?* The question of what constitutes "good" trackability cannot be answered in precise terms. At present, trackability sufficient to track the signals shown in Fig. 3 is needed to guarantee proper playback on all records. One must consider the fact that while Fig. 3 shows the maximum velocity of a signal at any given frequency, program material generally includes many frequencies simultaneously. Thus, the stylus must be able to track combinations of frequencies which may add to a tracking requirement greater than any individual frequency one might expect from the figure. The cartridge should offer a sufficient safety factor to handle the worst possible set of conditions.

Another consideration, which would lead toward maximizing trackability, is the deterioration of sound quality under conditions where the trackability is marginal. Sufficient safety factor in tracking capability should be provided to overcome this possibility.

Irrespective of how one approaches the solution, it is clear that trackability is a serious problem which must be properly resolved by the phonograph cartridge. Resolution of the problem should not be gained through an unnecessary compromise in the design and a resulting loss of possible advantages. Specifically, trackability should be achieved without increasing either record wear or tip wear. This can be accomplished only by optimizing the dynamic design of the stylus to play at low tracking force, certainly no greater than 1.5 grams.

*Mechanical Noise and Effects of Record Warp:* We have discussed the record groove modulation that constitutes the normally anticipated mechanical input that moves the stylus. The stylus must respond to and exactly follow that mechanical input. We will now discuss a variety of mechanical inputs which are not intended as part of the phonograph reproduction process and which constitute a hindrance to providing perfect reproduction. These mechanical inputs include record warp, and several types of what we will term "mechanical noise" that may enter the system. The mechanical noise is in the form of structure-borne vibrations which may enter either the turntable or the tonearm, or both. Three major forms of mechanical noise are turntable rumble, acoustic feedback, and structure-borne noise.

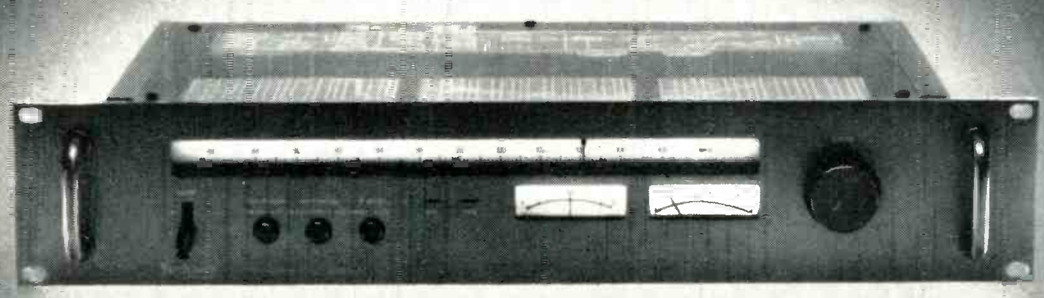
A detailed study of record warp was described by Happ and Karlov (9). Figure 4 taken from that article shows the distribution of warp amplitude vs. frequency for a large, random selection of records. (Note that Fig. 4 plots amplitude vs. frequency as compared to Fig. 3 which shows velocity vs. frequency.) Since that study was made in 1972, we have reviewed records regularly and have not found a reduction in the incidence of warps. Should the quality of records in terms of warp improve, we would still be confronted with providing phonograph reproduction systems for the millions of records that have already been produced. Warp continues to constitute a serious problem in phonograph playback.

Rumble from the turntable can be detected by the phonograph cartridge because the turntable motion moves the stylus while the tonearm remains stationary. This problem has been reduced significantly in recent years and even average turntables are very good. While the problem under normal conditions is not serious, the noise from this source could be magnified if the rumble frequency were the same as the cartridge-tonearm resonance frequency.

Acoustic feedback occurs when sound from the loudspeaker excites the cabinet, turntable, or tonearm. The situation is similar to that which we have all heard when the gain in a sound reinforcement system is set too high. The problem can usually be solved by properly isolating the turntable by putting it in a suitable enclosure or by providing vibration mounts. The tendency to oscillate can, however, be aggravated by an underdamped cartridge-tonearm system.

Structure-borne noise is any vibration that passes through the physical parts of the system to the tonearm or turntable. Typical causes of such noise are people dancing on wooden floors, passing trucks, nearby machines, or loudspeakers mounted on a wooden floor not properly isolated from the turntable system. The latter example may also constitute part of a feedback system which can result in excessive ringing of various notes, usually in the lower-frequency range. The solution to the structure-borne noise problem (as with the acoustic feedback problem) is to properly isolate turntables, cabinets, and loudspeakers. Again, as with the other forms of mechanical noise, the effects can be seriously aggravated by an improperly damped cartridge-tonearm resonance.

*Cartridge-Tonearm Resonance:* Users of phonograph equipment have long recognized that the conventional arrangement of a phono cartridge at the end of a pivoted arm has a built-in, low-frequency stability problem. Prior efforts to improve the situation have involved such devices as turntable shock suspensions, damped counterweights, viscous tonearm damping, and low-mass pickups and arms. The low-frequency stability problem is a



consequence of the resonance which is inherent in the conventional cartridge-tonearm arrangement. This resonance exists because the arm and pickup assembly behaves like an effective mass that is coupled to the record groove by means of a stylus assembly with its own mass, compliance, and mechanical resistance. For low frequencies, the mass of the stylus assembly can be ignored; however, that leaves its compliance and resistance as important coupling parameters. Just as a weight hanging from a spring has a natural resonance frequency, so do the compliance of the stylus assembly and the effective mass of the cartridge-tonearm assembly.

Ideally, frequencies well below the resonance, such as those produced by warps, eccentric grooves, and the spiral grooving itself will move the cartridge and arm with no relative motion of the stylus assembly. Frequencies well above the resonance will vibrate the stylus assembly but not the tonearm which remains centered above the groove. In other words, the system "floats" the cartridge over the groove, "reads" the program material on the sidewalls of the groove, and produces corresponding electrical signals. Frequencies well below the resonance cause the whole stylus and arm assembly to move as a unit, and consequently produce no electrical output. Thus, the system plays the useful program material and ignores the rest—all well and good—but what happens at the resonance frequency? One important characteristic of resonance is that motions are magnified considerably; in this case, typically from two to 10 times. In Fig. 5, we have diagrammed the situation for vertical motion and in Fig. 6, the lateral case.

In both situations, the output from resonance frequency signals in the groove will be increased from 6 to 20 dB. These numbers are just the dB equivalent of the magnification numbers previously mentioned. By itself, this might not be all bad, since this resonance peak determines the low-frequency response "limit" of the cartridge-tonearm system, and a bit of boost here may not be unpleasant. This was certainly true 15 years ago, when arm resonance frequencies of 30 to 50 Hz were common. However, with modern pickups and arms, these resonance frequencies are usually subsonic (below 20 Hz), so that reproduction by the loudspeakers may cause distortion. Additionally, preamp overload is most likely to occur at boosted low frequencies since the clipping level of most preamps is lowest here. Consequently, the arm resonance has lost whatever

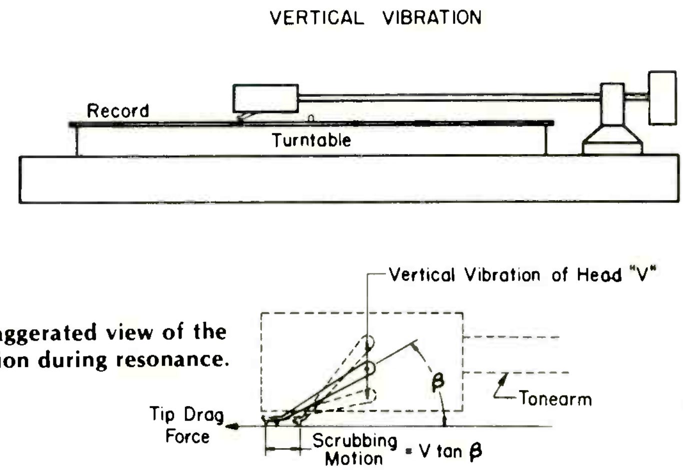



**Fig. 5—Exaggerated view of the stylus motion during resonance.**

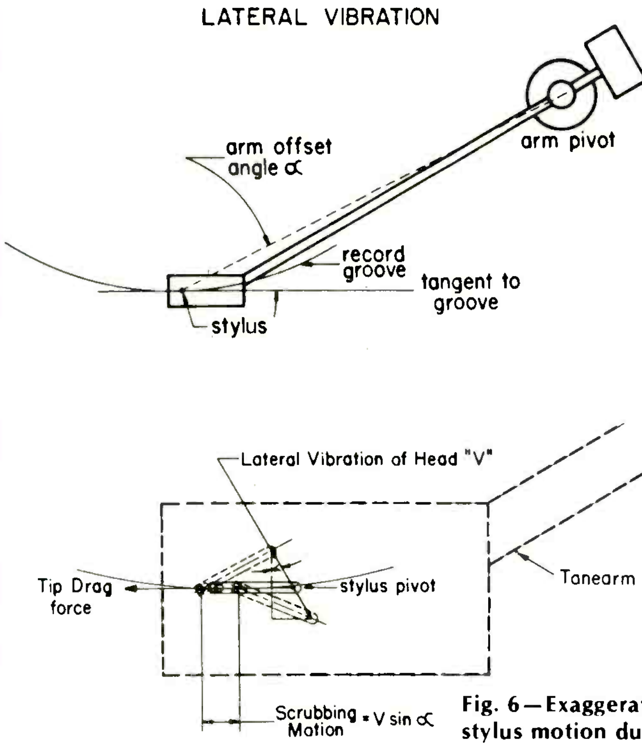



**Fig. 6—Exaggerated view of the stylus motion during resonance.**

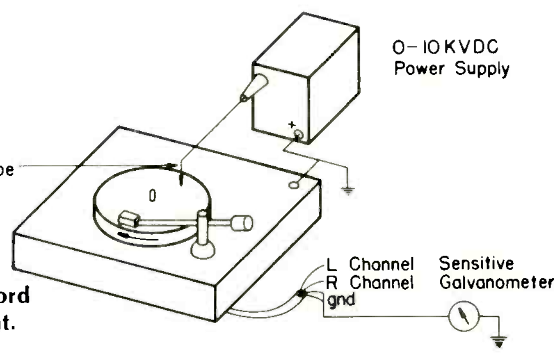
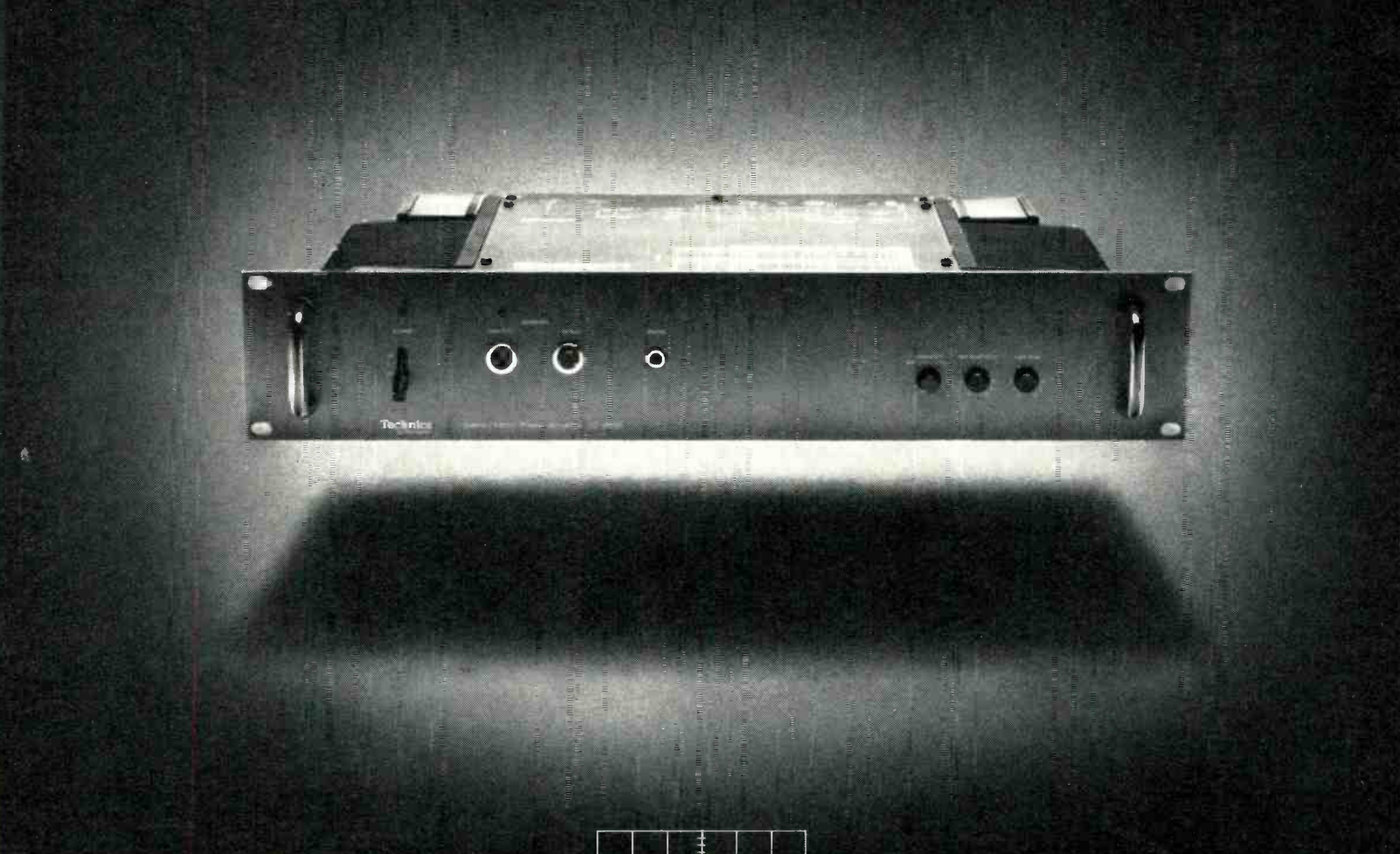



**Fig. 7—Apparatus for record charging and measurement.**

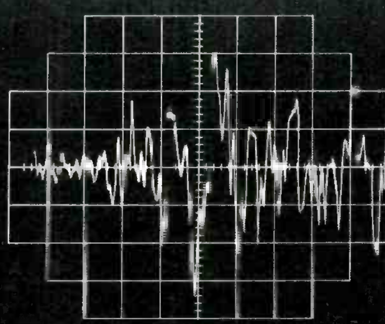
# What 0.02% THD doesn't tell you about the SE-9060, waveform fidelity will.



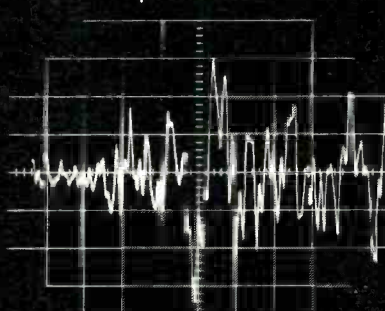
THD as low as 0.02% says a lot about any amplifier. But oscilloscope readings show it all. Look at the waveforms. The output waveform of the SE-9060 is virtually a mirror image of the input.

One way Technics achieved this goal was with dual FETs in the differential amplifier. They give the SE-9060 the DC stability necessary for the highest gain in the crucial first stage. While the constant current load and current feedback used in the voltage amplifier keep distortion to a minimum.

And since the SE-9060 is a DC amplifier, each amplifier section and the NFB loop are directly coupled without the use of any capacitors. So the SE-9060 not only has virtually nonexistent phase shift, it also boasts flat frequency response from DC to 100 kHz. And with completely independent power supplies for each channel, Technics eliminated all signs of transient crosstalk distortion.



Input Waveform.



Output Waveform.

Compare specifications. And you'll realize there's no comparison.

POWER OUTPUT: *70 watts per channel (stereo), 180 watts (monaural) minimum RMS into 8 ohms from 20 Hz to 20 kHz with no more than 0.02% total harmonic distortion.*

POWER BANDWIDTH: 5 Hz-50 kHz, −3 dB. S/N: 120 dB (IHF A). RESIDUAL HUM & NOISE: 100 µV. INPUT SENSITIVITY & IMPEDANCE: 1 V/47 kilohms. INTERMODULATION DISTORTION (60 Hz: 7 kHz, 4:1): 0.02%. FREQUENCY RESPONSE: DC ~ 100 kHz, +0 dB, −1 dB.

Technics SE-9060. A rare combination of audio technology. A new standard of audio excellence.

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usefulness it once may have had and must now be regarded as a liability.

A most pernicious effect of the resonance is shown in Figs. 5 and 6 by the "scrubbing" motion developed by the stylus in the groove. This causes program material to warble in pitch, just as if the turntable speed was fluctuating. In fact, the groove speed *is* changing (relative to the tip) because a fraction of the velocity of arm vibration is added to the groove velocity. The effect is that about ⅓ of the arm vibration velocity is alternately added to and subtracted from the groove speed. For example, at arm resonance, total amplitudes of $\frac{1}{32}$ in. are easily observed by eye. If the resonance frequency is 8 Hz (not atypical for high compliance pickups and average arms), the resonance velocity will be about 2 cm/sec. This velocity will produce a "scrubbing" velocity of 0.6 cm/sec along the groove axis. The groove speed at a 4.5 inch radius is about 40 cm/sec; so the frequency modulation will be about 0.6/40 or 1.5 per cent and easily audible.

Another less obvious but highly detrimental consequence of the arm resonance is that the stylus force is "used up" when the arm is vibrating. In the previous example, if the compliance of the pickup is assumed to be $20 \times 10^{-6}$ cm/dyne, 2.0 grams of stylus force will be required to accommodate the arm vibration alone. This is larger than the usual stylus force, so mistracking is quite certain at the extremes of the vibration.

*Sources of Excitation:* Having seen some of the consequences of the low-frequency resonance, let us next examine the various sources that might excite it. The most obvious possibility seems to be signals in the groove; however, these are generally limited to frequencies above 20 Hz. Since the resonance frequency is always below 20 Hz, the audio signals should not be a source of excitation.

A sure source of excitation is floor vibrations, which are predominantly vertical. An impact will have an extended low-frequency spectrum, which will be further modified in passing through the turntable mount. An ideal suspension will be tuned to below a few Hz, well below the usual arm resonance frequency, but some suspensions are tuned in the same range as the arm resonance and will cause serious trouble. Some of the impact energy may be translated into lateral motion in passing through the suspension. All vertical motion will tend to excite the vertical resonance, but only the component of lateral motion generally perpendicular to the arm will tend to excite the resonances laterally.

The most common source of excitation, however, is that of record warps. Figure 3 shows that warps occur in a broad low-frequency spectrum extending from 0.5 to 10 Hz, with maximum velocity around 3 or 4 Hz. This excitation is the major culprit, and it operates principally in the vertical direction. The combination of the super-compliant pickup and many arms yields a resonance right at the peak frequency of the warp excitation, and is a prescription for trouble. Figure 3 also shows that warp occurrence is minimal in the frequency range from 10 to 15 Hz, between the warp frequencies and the program material. A resonance located in this region has the least chance of excitation from the warp or program material. Analysis (9) showed that there is a general disparity between the highest compliance pickups on the market and the arms available to use them.

Record eccentricities where the hole is not perfectly centered form a source of lateral excitation, but these occur at a frequency close to ½ Hz

$$\left(\frac{33\text{-}\frac{1}{3}\,\mathrm{R/M}}{60\,\mathrm{s/M}} = 0.55\,\mathrm{R/s} \simeq \tfrac{1}{2}\,\mathrm{Hz}\right)$$

This frequency is low enough to be innocuous.

A previously unrecognized minor source of arm excitation is the change of stylus drag force with modulation. Signals which have a substantial angle at the axis crossing; i.e., a high recorded velocity, will increase the drag force considerably, and the arm offset angle or the vertical tracking angle geometry will cause a component of the drag force to move the pickup. This can be seen in Figs. 5 and 6. If the drag force varies, the pickup will move, and the "scrubbing motion" occurs.

It should be clear at this point that an under-damped cartridge tonearm resonance can create a serious problem when that resonance is excited. Obviously many potential sources of excitation exist, the most predominant being record warp. Thus, reducing the effect of resonance should be the primary objective in improving playback under practical conditions.

*Static Electricity on Phonograph Records:* To the audiophile who deals with high performance record playing equipment, static electricity charges are a perverse and irregular nuisance, usually producing annoyance, but occasionally causing calamities. The problems are usually worse in winter, when the humidity is low, but some effects can still appear in the middle of summer.

These effects show up in many forms, principally (a) crackling, popping, or frying noises during record playback; (b) brief popping sounds during arm setdown; (c) excess stylus force due to electrostatic attraction of the cartridge to the record being played; (d) in changers, attraction of the arm to the unplayed stack, interfering with setdown and reducing tracking force to induce mistracking, and (e) dust and dirt attracted to the playing surface, producing wear and playback noise. This is a formidable list, and some of these effects have not been fully recognized previously.

Static electricity was the first form of electrical effect to be noticed many hundreds of years ago, but the nature of the mechanisms producing charges are almost as obscure now as then. Any form of friction, motion, or contact is likely to produce charges, and vinyl is one of the most easily charged materials available. Hence, such common actions as removing a record from its jacket or wiping it with a cloth or brush, is certain to produce a charge that will be hard to remove. Unlike the "ordinary" electricity which produces useful effects in a closed circuit, static electricity lives in open circuits. If the air is dry and the surface resistance high, a charge may take days or even weeks to disappear. In the meantime, it is just waiting for a chance to cause trouble.

The classical method of measuring charges is the electroscope, a simple instrument in which the mutual repulsion of two gold leaves causes them to stand apart, the angle being related to the voltage which is being measured. This device endears itself to users for its habit of self-destruction when exposed to strong charges. Fortunately, special instruments have now been developed to measure static charges, since ordinary voltmeters are not suitable.

A few minutes of experimentation with such an instrument will show how tenacious and easily produced the charges are. Even wiping the record with a *damp* cloth may produce charges rather than neutralizing them.

Incidentally, measurements with these instruments have shown that electrification from the direct friction between the diamond and vinyl is, oddly enough, negligible.

The results shown in Table 1 illustrate several interesting points. First, it verifies the observation that placing a charged record on a grounded turntable (Col. B & C) re-

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Incredible for the price? You're right. But what's even more incredible is that variable center frequency is just one of the SH-9010's advantages. Variable "Q" or bandwidth is another. With it you can broaden or narrow any frequency band. Independently or both at the same time. Which means you can balance an entire string section or eliminate an annoying little hum.

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THD: 0.02%. FREQUENCY RESPONSE: 10 Hz—20 kHz (+0, −0.2 dB). 10 Hz—70 kHz (+0, −3 dB). GAIN: 0 ± 1 dB. S/N 90 dB (IHF: A). BAND LEVEL CONTROL: +12 dB to −12 dB (5 elements x 2). CENTER FREQUENCY CONTROL: +1.6 oct. to −1.6 oct. BANDWIDTH (Q) CONTROL: 0.7 to 7.0. CENTER FREQUENCIES: 60 Hz (Variable 20 Hz ~ 180 Hz), 240 Hz (Variable 80 Hz ~ 720 Hz), 1 kHz (Variable 333 Hz ~ 3 kHz), 4 kHz (Variable 1.3 kHz ~ 12 kHz) and 16 kHz (Variable 5.3 kHz ~ 48 kHz). SUGGESTED RETAIL PRICE: $499.95.*

Technics SH-9010. A rare combination of audio technology. A new standard of audio excellence.

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duces the effect of the charge because the electrostatic field is concentrated between the turntable and the underside of the record, which reduces the original field. Another way to regard the situation is to recognize that the capacitance has increased greatly, and, since the charge is constant, the voltage must decrease in accordance with the equation $V = Q \div C$. Note that this does not eliminate the charge, but only reduces the external field. When the record is removed from the turntable, the original voltage reappears. The closer the record is to the conductive surface, the lower the external field produced, up to the 90 per cent reduction shown in the table.

The results also show that the static charges on records are always negative and that some records are less susceptible to charges than others. The 30,000-volt measurement in air was accompanied by a considerable crackling sound and seems to be a threshold voltage determined by the breakdown voltage of the air.

This investigation was started in winter, and there was no difficulty producing charges using cat fur and friction. As the season advanced and the humidity increased, the charging became much more erratic, and it was necessary to lightly rub a finger on the rotating record to produce a charge. Eventually, as the nature of necessary comparisons became clear, the charges would not cooperate at all! Consequently, to make repeatable measurements independent of humidity and rubbing techniques, a system was devised which uses continuous electrification via a high voltage d.c. supply to achieve a calibrated, reproducible charge. The arrangement is shown in Fig. 7.

**Table 1 — Measurement of Electrostatic Charges on Phonograph Records**

| Record | (A) Electrified on Turntable With Cat Fur Volts-Negative | (B) Lifted Off Turntable After (A) Volts-Neg. | (C) Replaced on Turntable After (B) Volts-Neg. | (D) Destaticized and Removed from Paper Sleeve; Meas. in Air Volts-Negative |
|---|---|---|---|---|
| CBS STR 100 | 3000 | 30,000 | 3000 | 10,000 |
| JVC TRS1005 | 2500 | 30,000 | 2500 | 5,000 |
| Shure TTR103 | 3000 | 30,000 | 3000 | 5,000 |
| RCA RL1624 | 4000 | 30,000 | 4000 | 10,000 |
| Acetate Blank | 0 | 0 | 0 | 0 |
| RCA Elvis-Hawaii | 2250 | 30,000 | 2250 | 3,000 |

The probe is a steel phono stylus of 0.006 radius supported 1 inch above the surface of the record. As the record rotates under the probe, it receives a charge which builds up to a saturation point. A calibration curve (Fig. 8) gives the relation between the probe voltage and the charge on the record. The measured charges are nicely encompassed by the calibration curve. As might be expected, it shows a knee which is the breakdown voltage of the charging point. Above the knee, the relationship between probe voltage and record voltage is linear. The only caution to be observed is that the curve can only be used in an increasing direction, i.e., one must start with a neutral record and increase the voltage during experiments.

If the record is fully charged and a lower voltage is then applied, the actual voltage on the record will be somewhere between the former and latter value and, hence, indeterminate. Discharges to the pickup can be detected by the means shown in Fig. 7, where a sensitive amplified microammeter is connected in the ground return circuit from the pickup. Thus, measurements can be made of both charging and discharging.

### Test Results

Typically, no discharge is noted until the charge voltage exceeds a particular value, which we call the threshold voltage, after which the current increases rapidly. Cartridges having a grounded metal shield and grounded stylus shank have threshold voltages in the region of 4000 to 5000 volts. Thus, charges below this voltage will not cause a discharge, but will exert an electrostatic force on the cartridges. When a record is charged above the

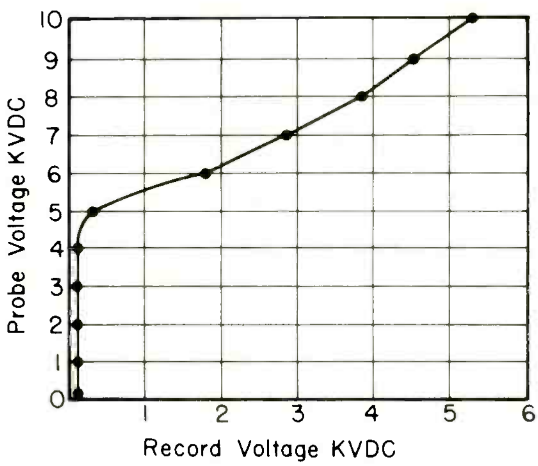


**Fig. 8— Voltage Calibration RCA RL1624.**

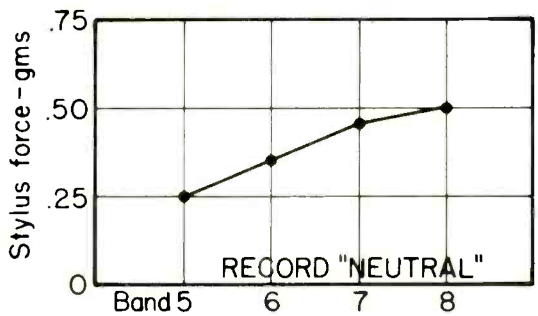


**Fig. 9—Trackability calibration of the TTR 103 test record, 33⅓ rpm @ 296 Hz with the V15 Mk III stylus assembly.**

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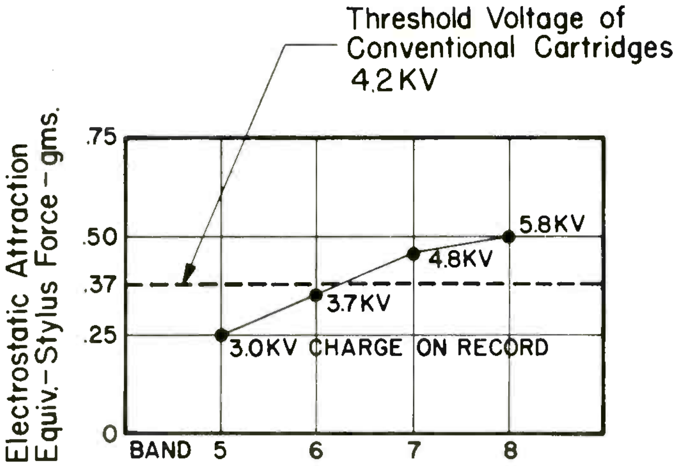



**Fig. 10—Trackability measurement using electrostatic force on the TTR 103 test record, 33⅓ rpm @ 296 Hz.**

threshold voltage, a playing will discharge it down to the threshold voltage of the cartridge but not to zero.

The electrostatic attraction force was measured by making a trackability calibration of a particular cartridge. This was done by playing the bands of the Shure Test Record TTR103 and noting the corresponding stylus force for marginal tracking (Fig. 9). The arm was then counterbalanced to zero. The record was charged and then played using the electrostatic force as the sole force. Adjusting the charging voltage for the same marginal tracking as before yields the results shown in Fig. 10. The points above 4200 volts (threshold voltage of cartridge) are not significant with a naturally charged record, because the record will discharge to this level. However, 4200 V can add an extra ⅜ gram to the stylus force! This additional force would increase wear and at least change the intended tracking conditions significantly.

Possibly of most importance is the fact that a natural charge will be nonuniform and cause cyclic wow or frequency modulation with record rotation. The result can be nonrepeatable and probably difficult to identify but would have a clearly discernable effect on sound quality.

Experiments with household dust also show that a record voltage of only 1000 or 2000 V is enough to make fine particles adhere to the record and resist brushing or blowing, especially out of the grooves, where ordinary bristles cannot reach.

**Fig. 11a—No lint on the stylus tip.**

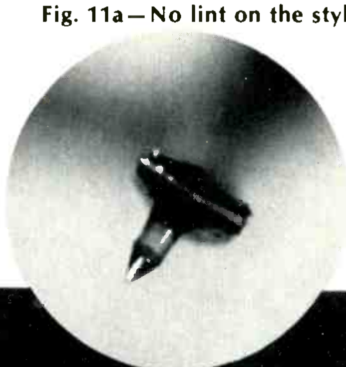
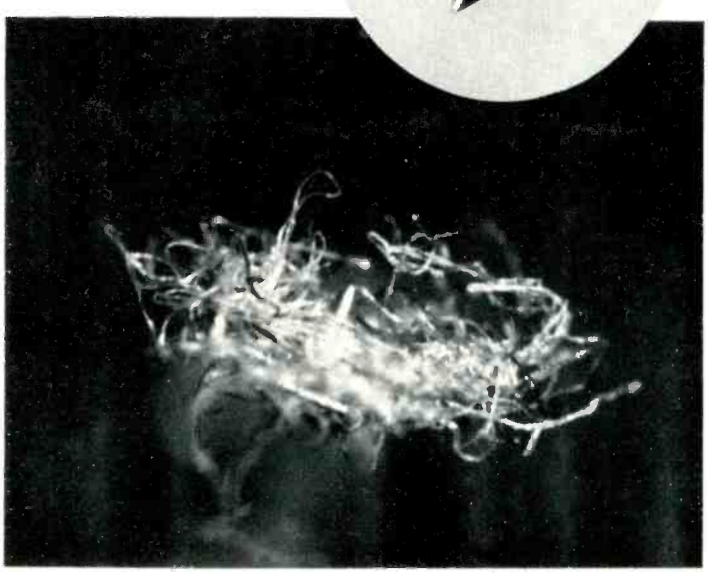


**Fig. 11b—Lint accumulation around the stylus tip.**



From this, we conclude that electrostatic charges can create some serious problems in tracking, distortion, noise, and dust accumulation. This most certainly is a phenomenon which at our present level of sophistication in high-fidelity record reproduction cannot be ignored.

### Dirt on the Record and Tip

The effects of dust and other contaminants on the playback process have been the source of study for many years. It has not been possible, as yet, to quantify the exact amount of dirt that would be acceptable, or even to completely spell out the process of dirt accumulation. Suffice it to say that records must be kept clean and that the more care one takes in maintaining cleanliness, the fewer problems will result. Proper brushing of the record before it is played, we feel, is essential for top-quality performance. While it is not the purpose of this paper to discuss methods of cleaning records, it should be noted that there are a large variety of methods, some of which are considerably better than others.

We have found that even the best of the record cleaning methods still leaves some dust and contamination on the record. The length of time one can play the record before a serious problem results is related to the initial cleanliness of the record, the amount of dirt accumulation on the record during the playing time, and on the stylus tip. Accumulation of dust and lint on the record results in the condition as shown in Fig. 11. As the dirt builds up, it finally reaches a condition such as that shown in Fig. 11b at which time proper tracking cannot be achieved. The length of time required to develop an accumulation which will create the condition of 11b will depend on the length of the stylus tip. Shure, for example, maintains a minimum distance of 0.014 inch from the bottom of the stylus shank to the end of the diamond. A shorter tip could be used, which would slightly reduce tip mass and offer some very minor advantages in trackability; however, our experience indicates that this would be an improper compromise. Even though excellent care is taken of the record, it is felt that some accommodation to the probability of dirt accumulation must be made.

Since some dirt will accumulate on the stylus, the objective is to provide a design which will avoid the necessity of cleaning the tip for as long as possible. The absolute minimum time would be the playing time for one side of a disc. This would not seem to be a reasonable or practical minimum since one should allow for the playing of a stack of records on a changer. A practical objective, therefore, would be to play at least six records; i.e., roughly two hours, assuming that the records have previously been cleaned properly and that a cover is used over the changer during the playing of the records.

### Summary

We have discussed several factors that affect the performance of a phonograph pickup. These factors have been divided into two groups: namely, those which must be considered under ideal playing conditions and the conditions that create practical problems of playback. In the first group, we include frequency response, separation, trackability, tracing and tracking distortion, and skating force. In the second group are the level of modulation, mechanical noise, arm resonance, static electricity, and contamination.

In the next portion of this article, we will describe means whereby the effects of non-ideal playing conditions can be countered and, in some cases, totally eliminated. Concurrently, significant improvements in playing under ideal conditions can also be achieved. ∆

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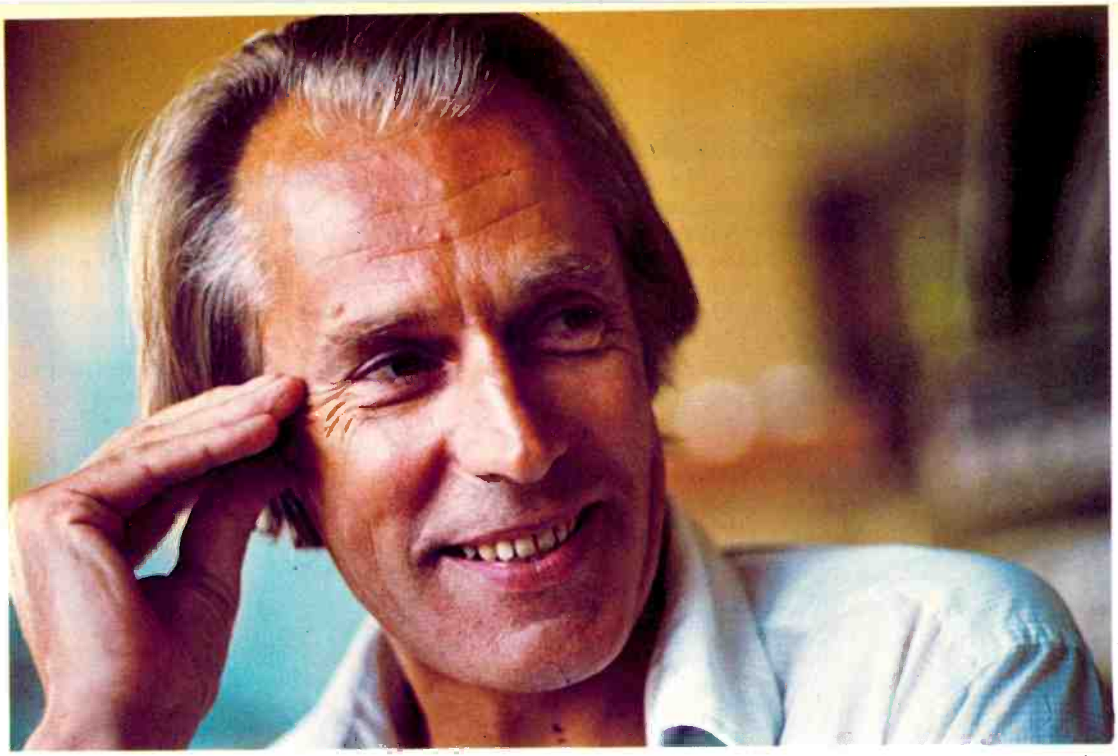

**A:** *I always thought that your having done the Goon Shows was probably the source of a lot of the crazy sound effects on the Beatles' records.*

**M:** Yeah. That, of course, was great fun to do, in those days. We had to create everything for ourselves. And it was like painting pictures in sound, which was great. And it was very useful experience. In fact, to be quite brutal about it, I don't think **Sgt. Pepper** would have existed without Peter Sellers.

Things always rub off, you know. And when the Beatles first came along, I think one of the things that *they* liked about *me* was the fact that they knew I made these kind of records. 'Cause they were pretty zany too.

**A:** *Do you have any "influences" as a producer? Did anybody's records stand out in any way to you?*

**M:** Well, obviously, I like lots of records, but I really don't think I've ever been influenced by another producer's record. Producing's a pretty lonely job—you know, you don't *know* what another guy does. You never see another guy producing. You just develop on your own lines. You know, it's no good sort of "studying" other people's techniques, because you can't really know for sure how it's done. Unless you're actually there. All you can do is . . . you know, if you like a record, you can think how those particular things were achieved, but I think it's much better *not* to inquire about other people's, but plow your own furrow. You try and find out things for yourself.

**A:** *How about your arranging? Would you say that you're of any particular school or orientation?*

**M:** Well, orchestration and arranging for instruments varies with the kind of performance that's going to be made. So, for example, you will do a different score for a pit orchestra behind the musical from the kind of score you will do for a film, or the kind of score you will do for a gramophone record. Each one depends upon how it's going to be performed.

There are some fantastic orchestrators of the past. Ravel, of course. Tchaikovsky was a great orchestrator. Debussy was pretty good. And these are the kind of people whose scores I studied. Stravinsky is fantastic. And I would find out how they did things . . . .

I mean, when I was 15, I was enormously turned on by going to a symphony concert in England, where they played *L'Apres-midi d'un Faune* by Debussy. I don't know if you know this particular piece of music . . . .

**A:** *I'm going to have to look up the spelling.*

**M:** *Afternoon in the Life of a Fawn.* And its just a tone poem—an orchestral tone poem—and the *sounds* that I heard, as this boy of 15 sitting in this auditorium, I could not believe what those ordinary human beings in front of me were making! It was just so beautiful, so fantastic—they were gorgeous. I was so enthralled by this I thought "Well, how does it work? How do they do it? How did the guy write that music? I must find out."

And I got the score of Debussy's *L'Apres-midi d'un Faune* and I studied it and I looked at all the notes and I saw what instrument was on which and so on. And even today, many years later, I can still listen to that same piece of music with awe, because I *know* how it works, I *know* what is done and I can write music just like it now, but I know exactly how beautiful and how brilliant they were.

**A:** *Can you name some other compositions that influenced you?*

**M:** Well, of course, Bach is an old favorite of mine, and he was a pretty pure guy—he didn't have orchestration techniques because there wasn't much of an orchestra in those days.

**A:** *Pure in what sense?*

**M:** Pure musically.

**A:** *Who would be "impure"?*

**M:** Well, that means two things in music, doesn't it? There's the way in which it is put over, i.e., orchestration—the coloring—and then there's the pure notes themselves, whether it's done on a harmonica, a synthesizer, or a symphony orchestra. The actual musical frequencies and notes that go out are the original musical creation, and what you do with it and the way you color it is another matter. They're two distinct things. The design—the actual design of the music—is like a blueprint. And you don't need to hear it—you can look at it and you can admire it. You can hear it in your mind by looking at it.

And Bach, of course, was a fantastic designer of music. The purity

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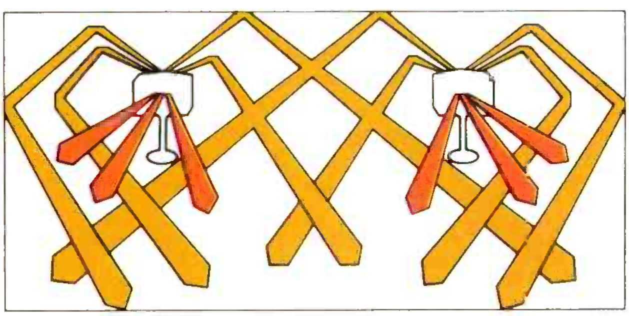

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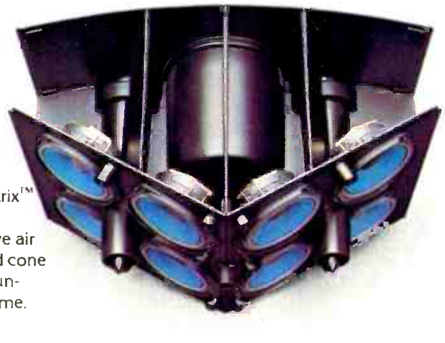

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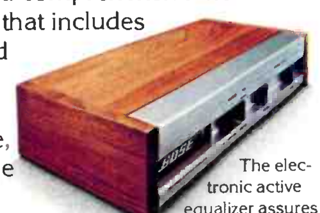

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of his music is incredible, and, in fact, it's so contemporary in many respects. A lot of the pop songs that we have today are based on Bach's ideas.

**A:** *Would you say that Paul Buckmaster has some Bach influences?*

**M:** Was he influenced by Bach, do you think? Possibly. I guess, like me, he's been influenced by pretty well everybody.

**A:** *I'd be interested to explore the string quartet as a form. Was that always a favorite permutation of yours?*

**M:** Well, I like four-part writing, and . . . string quartet writing does teach you something. It teaches you to be economical, for a start, when you've got four lines to play with. It teaches you the way to dispose those lines together, and, in fact, if you write well for string quartet, I believe you write well for strings.

A lot of people make mistakes when they start trying to write for strings by thinking in keyboard fashion. Because a lot of people play piano, and they look at their two hands and they think "Well, if I transpose that to strings, it's gonna sound okay." But it doesn't work that way. You've got to think in contrapuntal terms of four lines working together. And once you've got that into your system, then you can write, I think, very well for strings.

**A:** *Where might writing a string quartet on piano be wrong? Not as fluid an orientation?*

**M:** No, no, it's not that. It's a question of the grouping of the notes. That the tendency for a pianist, when he starts out, is to write a bass line and a group of things in the top. Like his two hands. The left hand is the bass line, and the right hand is a bunch of chords. And they tend to write like that—the violins and violas are up bunched together, and the cellos down by themselves. And that really doesn't work too well, I don't think. It doesn't make for an even-spread sound.

**A:** *Is there any order in which the parts of a string quartet traditionally are written?*

**M:** Not really. I mean, you've got to think of the music as an entity, without thinking too much of the instrument which is natural to you. I mean, if you are a pianist, or if you're a guitar player, you are . . . imprisoned by what you play, so you tend to think the way your fingers go. That's why so many pop pieces of music written by guitar players have kind of . . . whole-tone slides. Because they do that on their frets—they find a particular chord position, and by moving a couple of frets down, they get another whole tone of the same chord, and a lot of compositions are dictated by that.

**A:** *Well, just the physical aspects of the guitar will tend to give you degradations off D, G, and C chords, but not in B, say, because there's no B in the open position.*

**M:** That's right, exactly. And similarly, a pianist will do particular things that fit his hands which, in turn, influence his writing, but what I'm trying to say is that any guy who's writing music should try and free himself of those fetters. Because writing music is cerebral—it's something you *think* about—and you shouldn't really be influenced by the *physical* aspects of your body, you should think of your mind.

**A:** *Who are considered the pre-eminent string quartet writers?*

**M:** Oh, I don't know—I really couldn't answer that. You mean amongst classical people and all? Well, almost all the classical composers have written them. Beethoven's string quartets are probably the best of all.

**A:** *Let's talk about your horn arranging. I always saw, for what it's worth, "Beatles Brass" as sort of a subgenre of horn arranging.*

**M:** I mean, do you think that's distinctive? Do you think that the Beatle brass is distinctive?

**A:** *Yeah.*

**M:** Do you really?

**A:** *You know* It Don't Come Easy? *That was Beatles Brass.*

**M:** Mmm, I think it's very ordinary. I've never really regarded my . . . .

**A:** *You're not as staccato. I think you write longer, more melodic lines, rather than just "punctuating" like most people.*

**M:** Right. This probably, though, is a drawback rather than an asset, I don't know. I mean, it's just the way I tend to write. I've never been particularly proud of my pop brass writing. It works all right . . . .

**A:** *I always saw you as the standard there. You probably are. As far as horns go, don't you think?*

**M:** No. Well, I don't consider it my best aspect, put it that way.

**A:** *Well, whose brass influenced you? Anyone in particular?*

**M:** Not really, no. I don't play any brass instrument, and I just write, you know, in the way I think it should sound.

**A:** *All things considered, who do you think you write most like?*

**M:** Oh, I don't know. Like me, I guess. I really don't know the answer to that question. I guess one tries to have as distinctive a style as one can.

**A:** *Let's talk about EMI back then. How did the company work, basically? What was the A&R Department like?*

**M:** At that time? There wasn't an A&R Department of EMI—there was a label which had its own people. And EMI consisted of HMV, Columbia, Parlophone, and I guess Regal-Zonophone. And then the import labels like Capitol. Now HMV and Columbia were the big boys—they were the big labels—and their pop labels and their classical labels were handled by different people. The pop label was handled by the head of production—the guy who ran the label, in fact—and he was also responsible for importing stuff from, in the case of HMV, RCA Victor, and also making his own records. And the same with Columbia—they had input

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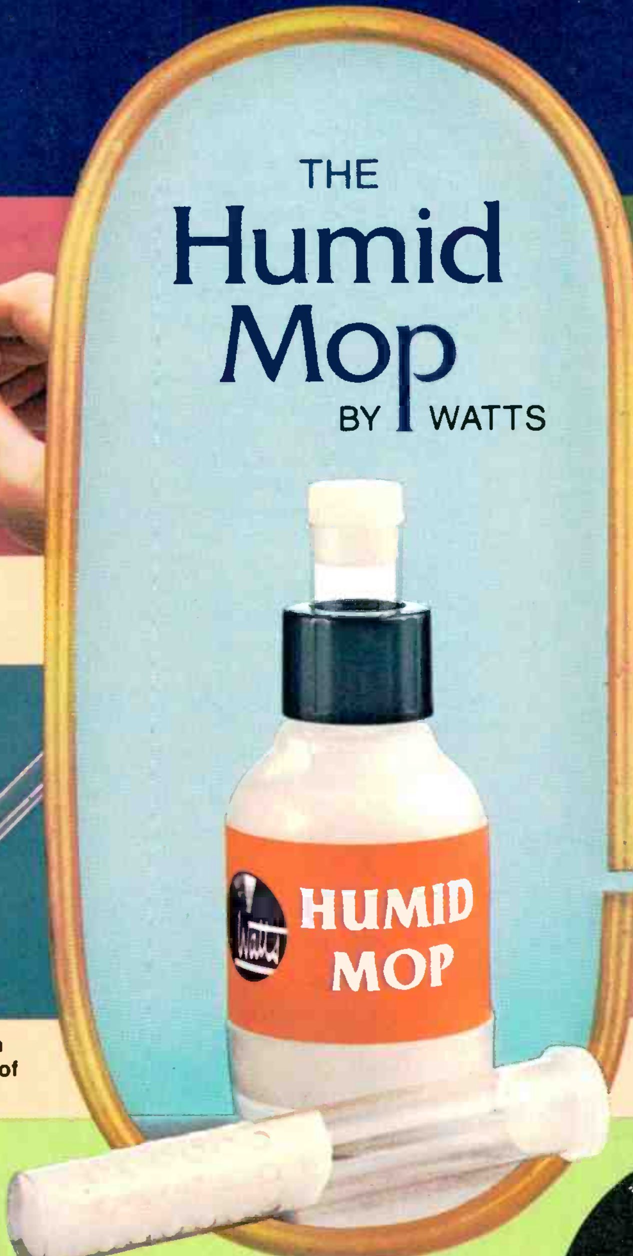


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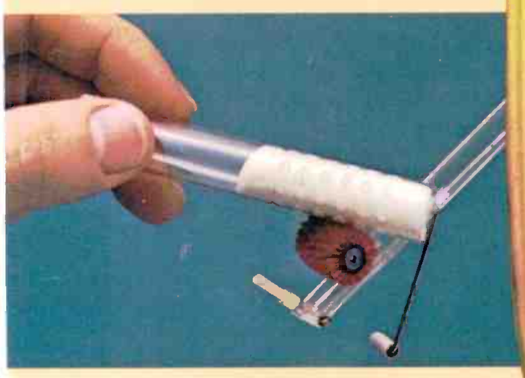

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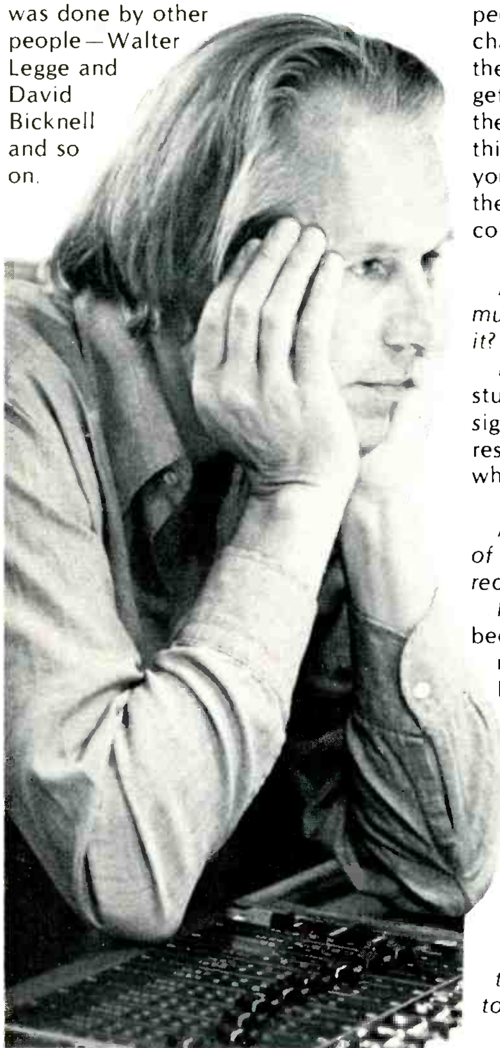
from CBS, and they also made their own records.

In the days when Oscar Preuss was my boss, Leonard Smith was head of Columbia, and Norman Newell was his assistant. And Wally Norman Newell became head of Columbia, and Wally Ridley was head of HMV on the pop side. The classical end of those two labels was done by other people—Walter Legge and David Bicknell and so on. On the Parlophone half, it was such a small label—much smaller than the big guys—that there was no other person for the classical end. *We* were the classical end, so we did everything. So that on our label, it was me, and that was it. And I had an assistant eventually, by the name of Ron Richards, who later became my partner. And the whole label was run by four people—me, Ron Richards, my secretary Judy Lockhart-Smith, and Ron's secretary Shirley Spence. And that was it.



**A:** *I'd be interested to know some of the specifics of the Beatles' deal with EMI.*

**M:** I signed them to Parlophone Records for four years. I actually signed them for one year, and with three options by EMI—on the EMI side—to sign them for a further three years. So it was a four-year deal.

**A:** *Were there any advances or guarantees?*

**M:** No. I mean, they were unknown people, and they were lucky to get a chance, you know. And the deal—for them—was pretty rough. They didn't get much money at all out of it. On the other hand, it was the kind of thing where *I* said that, you know, if you have anyone who shows promise, then obviously you change the contract. It was as simple as that.

**A:** *Your signing them was pretty much sticking your neck out, wasn't it?*

**M:** Well, if you ran a label, you stuck your neck out every time you signed anybody. You know, I had my responsibilities—I had to sort of sign who I thought was right.

**A:** *Weren't the Beatles like the first of those kinds of groups to get a record deal?*

**M:** Yes, and in fact they'd already been turned down by every other record company in the country. But that doesn't mean much, does it? I mean, the kind of deal I signed them to wasn't gonna break the bank if they didn't work. And I needed something, and I thought they were good. So I signed them.

**A:** *Were the Beatles considered the best Liverpool band at the time? Were they the logical band to be the first to be recorded?*

**M:** Not really. If you look at the bill posters of the time, they were kind of way down the list. You've got other people above them in the billing.

**A:** *Because I remember, an early question posed to them by American reporters was "Why you guys and not the other 148 bands?" and they always said "We don't know."*

**M:** That's right. Well, the answer is, of course, pretty obvious, but at the time we didn't know.

**A:** *I always saw a real musical unity in the so called "Mersey Sound." The Beatles, Billy J. Kramer, Gerry and the Pacemakers—there's a definite flavor and style to it. Would you characterize it at all?*

**M:** I wouldn't be able to analyze. . . . It's for *you* to analyze the things we do. But I think the answer—why Liverpool happened to be the place—was that Liverpool was probably the busiest port in England, outside of London. And these guys in Liverpool rubbed shoulders with all the sailors coming off the shore. It's very much a dock area, and it's very much a . . . seafaring town. It's also the sort of focus of all the Lancastershire industry—Manchester and Birmingham sell all that stuff through to Liverpool, and it's kind of a connection point, if you like. Rather like Hamburg was, and I guess influences came that way.

**A:** *What were the first tunes you ever heard of the Beatles?*

**M:** I can't remember.

**A:** *Were they on a demo?*

**M:** The very first demo I had was a tape which Brian brought to me, which I thought was interesting. And then I got them down for an afternoon in the studio—it was a recording test, in fact. And I spent an afternoon with them, and they played through some of the stuff they did. Which was sort of standard things. There weren't many of their own compositions—they were things like *Yer Feet's Too Big* by Fats Waller, and *Over the Rainbow* and things like that. I don't remember the actual tunes they played, but I know there were a lot of things that . . . were fairly recognizable.

**A:** *What did you think of their writing initially?*

**M:** It was okay, but I wasn't knocked out by it. It wasn't very good, actually. I mean, it . . . didn't show the enormous promise that came later.

**A:** *How did you use to hear their new songs?*

**M:** We would generally spend some time together, and John and Paul would just stand in front of me with their guitars and sing them to me.

**A:** *Do you think you influenced their writing, even if only by saying "Yes, that's good" and sort of reinforcing them to do more of this here as opposed to that there?*

**M:** I should think the only influence I had on them at that stage was to tell them to go and do better. Because after *Love Me Do*, I looked around for a hit song for them and I found one, written by Mitch Murray—who was one of the writers

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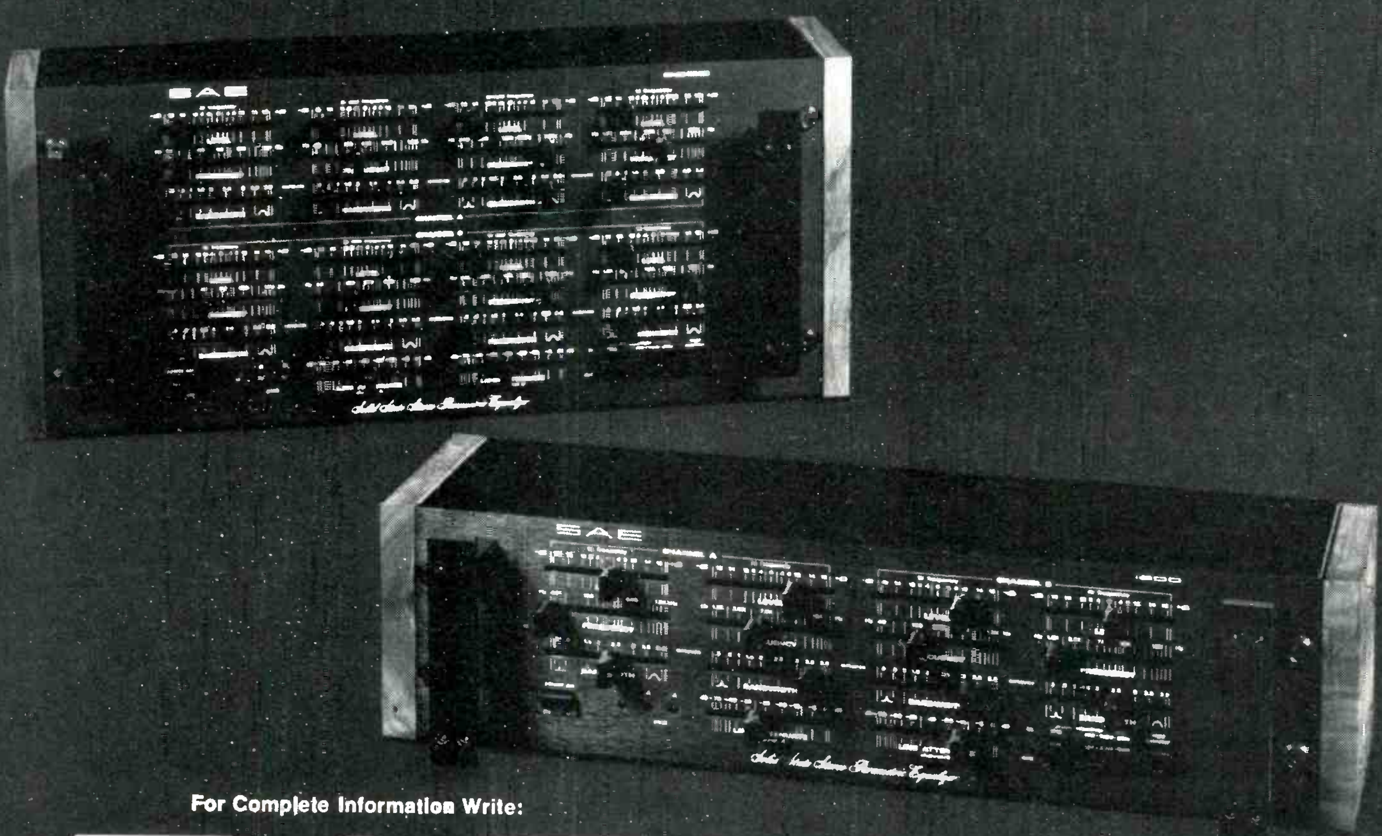


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of the day in Tin Pan Alley—and I told them to record it. And they weren't very happy about it. They did record it, and the tapes are still there. In fact, there was a radio station that had been playing it. *How Do You Do It* was the title, and they came to me after we made the track and they said "Look, we can do better than this," and I said "Well, I don't believe you can, but . . . show me". And they came back with *Please Please Me,* and I admitted that they had a super record, a super tune. *That* was what I was looking for.

**A:** *Did they have any kind of sense of their best tunes at all? Did you find that generally you and they would agree as to their strongest material?*

**M:** Oh, sure. I mean, when *Please Please Me* came along, we all . . . I mean, I knew it was a hit. And I told them so after we'd finished the thing—I said "You've got your first #1 record." And from then on, that spurred them on to writing more.

**A:** *Generally, how were the tunes selected for the first three or four albums?*

**M:** I would listen to what they had to offer, and I wasn't very impressed with it. I mean, the very first record I issued—which was *Love Me Do* and *P.S. I Love You*—was the best of the bunch they had. And it was okay, but I wasn't knocked out by it. I mean, it was good enough for a first issue, but it wasn't the big one I was looking for. And that was borne out by the success of things, 'cause it only reached #17 in the charts.

**A:** *Did you hear* One After 909 *back then?*

**M:** I think I probably did. I really can't remember. I think it's more than likely. I've no doubt it'd be written down somewhere.

**A:** *For the first album, about how many tunes were vaguely under consideration?*

**M:** Well, I already knew their material when we did the first album because I'd seen them up in the Cavern and I'd seen them performing. And their first album— a lot of which is issued on the **Rock 'n' Roll** album now—was a matter of expediency. 'Cause we had a #1 single hit, and I wanted an album out quickly to cash in on it. So I got them down to the studio and I said "Right. We're gonna do all the stuff you do at the Cavern. And I want you to knock it out quickly." And we started at 10:00 in the morning, finished 11:00 at night, and that was the album. Not much art in it, but it worked. It had that raw gusty thing that we wanted.

**A:** *How much recording experience did the group have before* Love Me Do*?*

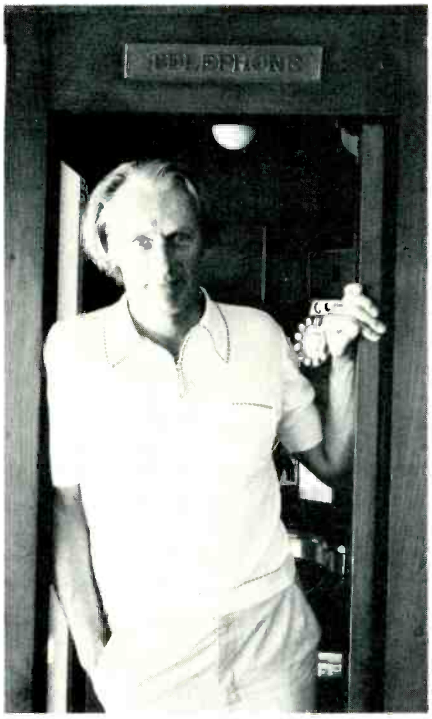
**M:** None.

**A:** *Well, they'd done that thing in 1961 with Tony Sheridan.*

**M:** That's right. With Pete Best. It was before Ringo came on the scene.

**A:** *Did they know pretty much what to do? Did they understand what was going on, or did they just say "Take care of it"?*

**M:** Well, they didn't know anything about recording at all in those days.




They knew that a microphone was a thing you sing into, and that was about it.

**A:** *Did they have any ideas before you started recording about who or what they should sound like?*

**M:** Well, they wanted a very driving sound, a very powerful sound, sure.

**A:** *Do you think the early records captured that?*

**M:** No.

**A:** *What ideas, if any, did you contribute to their early recorded sound?*

**M:** Oh, God, I don't know.

**A:** *Was that considered a lot of drums—level-wise—for those days?*

**M:** It's difficult for me to answer these questions, 'cause I'm not on the receiving side, you know. I don't know, you'll have to ask somebody in the street there. I didn't think so. It's difficult for me to answer. I don't know how it was received.

**A:** *I'm told there's a Capitol of Canada version of* Love Me Do *that's radically different from the one we got here.*

**M:** We *did* make several versions of *Love Me Do,* but . . .

**A:** *How did all of them get out, or as many as did get out, get out?*

**M:** Well, there couldn't have been more than about two or three. You say "many of them"—there weren't that many. I don't know, people pinched tapes, didn't they? Only one was issued, that's for sure.

**A:** *Were* Love Me Do *and* P.S. I Love You *actually recorded in mono? I don't think there are any stereo dubs of that.*

**M:** Every single was issued in mono. It was never thought of as being stereo, because there were no stereo singles in those days. But the facilities I had in the studios were very primitive. We didn't have 4-track—we had stereo machines and we had mono machines. And I used the stereo machine because it was better than the mono machine. And I used to use it as a twin track—I used to put all the backing instruments on one thing and all the voices on another.

**A:** *I see where you said those early sides were never intended for stereo release.*

**M:** That's right. We'd never think about it then, you know. I don't think people realize today how primitive life was in the recording studio in 1962.

**A:** *Why in England was it customary for the singles not to be included on the albums?*

**M:** Because we thought it was better value for money. First of all, if you're gonna make a single you should make a single, and if you're gonna make an album you should make an album. And if you *did* include a single in an album, it should be an *addition* to the album rather than part of the album. Right? So that if we included a single in an album, we would make it a 14-track album instead of a 12-track album, and the extra two tracks would be the single.

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**A:** *I thought 14 was the standard.*

**M:** Well, sometimes we used to do 14 anyway. But we always tried to make a single separate from the album, so that . . . . Because we thought people will buy both. And eventually, they would probably aggregate the singles into album form. But the singles market in those days in England was different from the album market.

**A:** *Why do you think that we in the United States got so many mono versions of tunes that appeared in England in stereo? As so many were also single sides, I always surmised that what happened was that Capitol would get the singles as mono dubs and not reorder the stereo dubs for inclusion on the albums.*

**M:** Well, in the early days, Capitol did some very strange things, and we didn't like what they were doing at all, but we had no control over it. And I got very uptight about it all.

**A:** *It's a wonder it went on as long as it did.* **Sgt. Pepper** *was the first album not to have been tampered with.*

**M:** Well, as I say, we had no control over it. Capitol then in those days was run by guys who thought that they knew all the answers. Anytime we'd complain, they'd say "Well, you don't know the American market. We do." And what can you do from England 7,000 miles away?

And whenever I came over I was an embarrassment to them anyway. I was sort of kept in the background.

**A:** *Capitol even went so far as to change running orders and B-sides. In England, the single was* I Want to Hold Your Hand/This Boy, *but in America it was* I Want to Hold Your Hand/I Saw Her Standing There—*both uptempo rockers—presumably to enhance its chances of hitting. And when the album came out, the first three songs were* I Want to Hold Your Hand, I Saw Her Standing There, *and* This Boy.

**M:** Well, I guess people were trying to justify their existence. As I say, we had no control over it—we didn't know what was being done. We knew later when it *was* done, but the answer always came back "We know this market better than you do. So stay out of it." And they took the credit for it too. I got very uptight when I'd see records that I'd produced, and I'd see an American version of it and it said "Produced by George Martin in England and Dave Dexter in America." Look at some of those early albums—you'll find it that way. In fact, on the first album it was just "Produced by Dave Dexter."

And Alan Livingstone, who was head of Capitol at that time . . . he would sort of hog all the limelight. I remember a press reception, and somebody kept me in a back room, 'cause I was there. And I was never introduced to any of the press or anything.

**A:** *It seems to me that the feeling at Capitol was that this was a transient sort of phenomenon, and we'd best cash in on it right now.*

**M:** Well, everybody thought it was a transient phenomenon anyway. Even at EMI—everybody did. They'd say "It couldn't last."

**A:** *At what point did you realize what you were on to?*

**M:** I never did realize . . . I mean, I just knew that I wanted to make something, and I didn't want it to stop. And I wanted to keep going. I didn't really think about it being a transient phenomenon at all. It was just something you did.

**A:** *In addition to different selections on the American Beatle records, wasn't there some re-EQing and remastering done as well?*

**M:** I never really heard the stuff until I came over and bought records. They never sent us the stuff. I didn't know what was going out.

**A:** *Can you talk about the Beatles' harmony sound? Did they generally supervise all the parts being worked out?*

**M:** They had their own basic sound, which I elaborated on. Whenever they wanted anything new worked out, we used to work it out together. It was a team. I mean, eventually, when it became as complicated a track as *Because*—which was three sets of three harmonies . . . . When we worked out those harmonies, I would sort of go down to the piano and say "Right. John, you sing this. Paul, you sing this." And Paul would then say "Well, can I sing such-and-such?" You know, that was the way we worked it out.

**A:** *Did you notice any sort of standard "slots"? When, say, John would take the lead—assuming a standard I-III-IV harmony—would George usually take the third and Paul the fifth? Did they have some basic starting point?*

**M:** The basic starting point was the song. It was a tune, and they would

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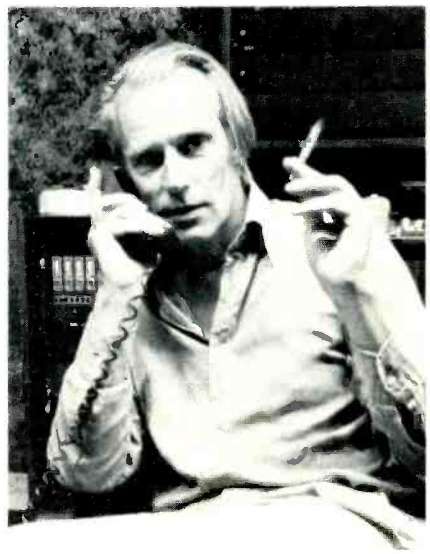
add harmonies to it. As they felt like it. I mean, depends on what period of their development you're talking about—10 years, you know. In the early days? Then it was obvious just to add a third above or below the voice—the main voice—according to which way the chords were. You know, it was very elementary stuff. But then, you don't need me to tell you this—you know, if you listen to the record, you can find out for yourself.

A: *What exactly is ADT? Isn't it just a high-speed tape delay?*

M: ADT is Artifical Double-Tracking. It was a thing that I wanted to be done in the early days, and it was developed by Ken Townsend, who's now the head of EMI Studios in London. At that time, he was a backroom boy—you know, one of the maintenance engineers—and he knew exactly what we wanted, and he worked out the way of doing it. Well, it's a pretty obvious thing now—it's done quite a bit. Although it isn't done much in this country. The normal thing over here when you go into a studio and you ask for automatic double-tracking—if you ask for a double-tracking voice without having to double-track the voice—they'll give you a digital delay. Which is not the same thing at all. Cooper Time Cube I don't like—it gives a very . . . . Well, it colors the sound, for a start.

The ADT that we use is taking the signal off the sync replay and bringing it into line with the recording head by means of another tape machine, and putting that tape machine on variable speed, so that you can bring it in and out of phase with the original signal. And by varying the time difference, it goes straight from being locked in exactly the same, through phasing, through a kind of funny "telephone box" quality, to a kind of ADT thing, to a tape delay sound. There's all those variations, depending on the range you get. You have to find the exact right space for a really good ADT sound, which is, in my experience, 'round about 27 or 28 milliseconds. And then, the sophistication of using tape rather than digital delay is you can then vary the speed of tape very slightly. So that it drifts between say 24 and 30 milliseconds all the time—constantly. You control that on the VSC, manually.



A: *Would you do this live?*

M: No, in the mixing. You can't do it live. you have to do it mixing, because you have to do it only after the thing's recorded—you can't do it any other way. And by doing that, you're varying the frequency as well as the time difference. In other words, you're altering the pitch of the voice—if it's a voice—as well as the actual timing. So that it actually does help, and it does make it a slightly different quality of voice.

A: *Do you think you were the first to use this?*

M: I think we were. As far as I know. I said to Ken "Wouldn't it be nice not to have to keep doing these

voices over and over again?" And he went away and thought about it and came up with this idea, which was great. Well, the strange thing is, working in this country, people don't know about it. Whatever studio I go to, I say "Let's do this," and they say "Really that's . . . . Wow, that's great." And they actually do it over here now.

The interesting thing is that that particular idea is very useful in stereo, because I hate having all the voices coming up center with the main voice—I like to spread them around a bit. So if you have an Artificial Double Tracking thing on the backing voice, you can put one each side. The other interesting thing is that when you do that, the one that is late by say 28 milliseconds is about 4 dB down in apparent sound. The ear always hears the earlier sound louder than the later sound. So you have to compensate for that by boosting the Artificial Double Track by about 4 dB.

**A:** *Just any kind of delay, the ear hears as behind—spatially—the original signal if it's noticeably lower in level.*

**M:** I've never noticed that. It certainly gives a very strange characteristic which I find very useful in recording. There you go—that's ADT.

**A:** *I'd be interested to hear you talk about the "wound-up piano."*

**M:** I used that basically on Billy J. Kramer—that was the kind of sound that we gave to him, when he came along. *I* call it "wound-up piano" because . . . . Everybody does it now occasionally. It's just taking the track down half speed, putting a piano an octave down, and then bringing it back to normal level. It gives you a kind of harpsichord-y effect, 'cause all the decay of all the notes is halved, and the vibrato is doubled.

**A:** *With some compression?*

**M:** With a lot of compression, and equalization.

**A:** *What kind of limiters were you using then?*

**M:** I think they were Fairchilds, I wouldn't be sure.

**A:** *Do you think you were the first to do non-standard speed recording?*

**M:** Probably, I don't know.

**A:** *Had you ever heard of anyone else doing it?*

**M:** No. Oh, yes, I had—Les Paul. *A*

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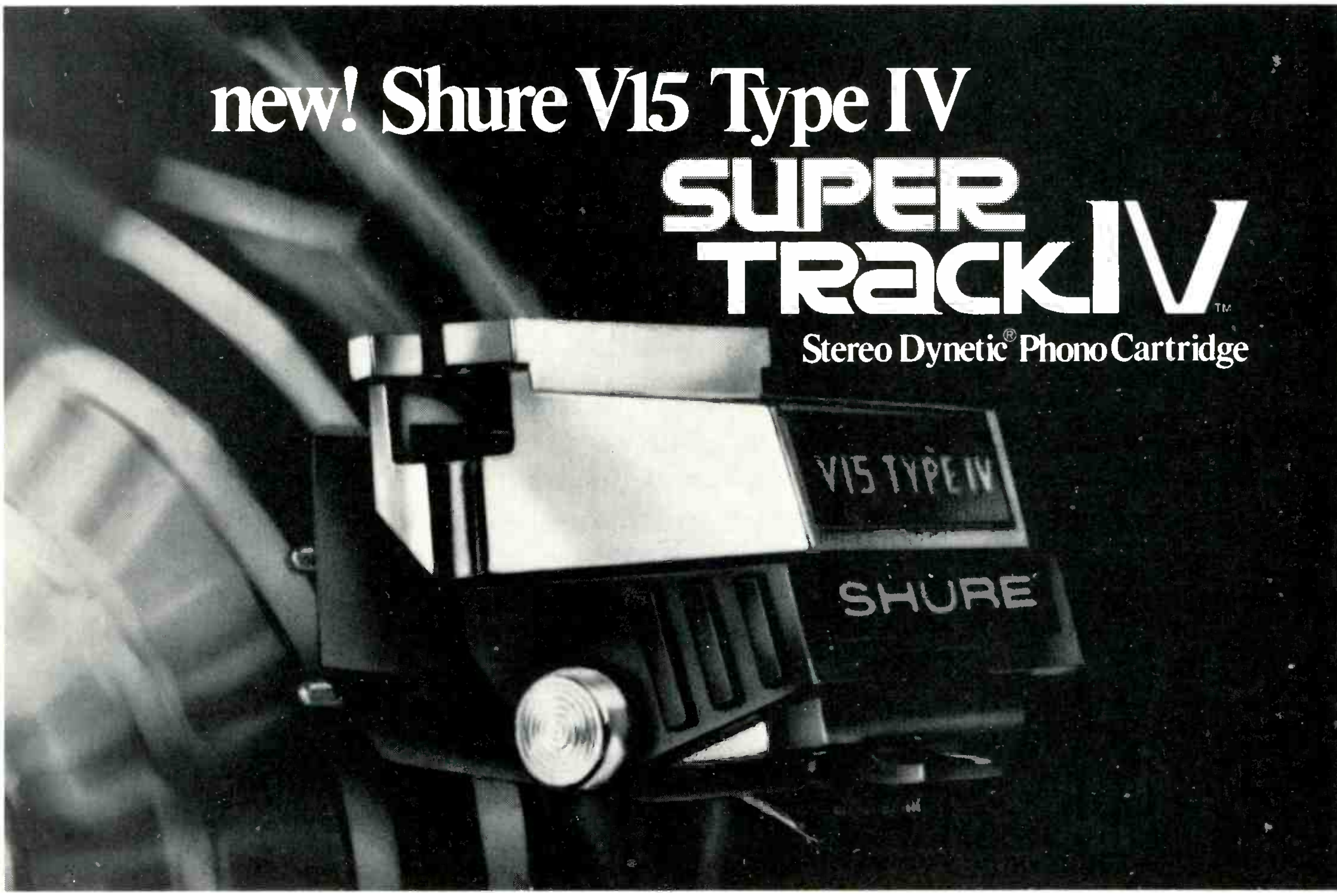


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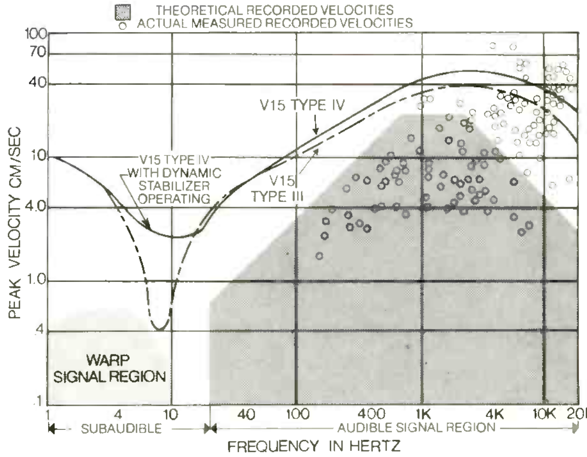


*Cartridge-tone arm system trackability as mounted in SME 3009 tone arm at 1 gram tracking force.

**See top of next page**

The shaded area at right in the Trackability chart on preceding page represents recommended theoretical limits of record cutting velocities. However, the scattered points are the "hottest" recorded velocities actually measured on today's difficult-to-track records. *The new V15 Type IV tracks far more of the "hottest" points at a low stylus force* than any other existing cartridge! (The curve shown is for 1 gram tracking force. By increasing this to 1¼ grams, even more of these points — which encompass virtually all records produced thus far — will be tracked.)

## Dynamically stabilized tracking that overcomes record warp problems

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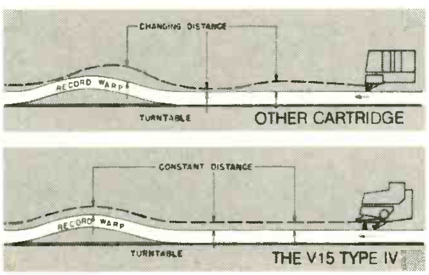



**The warp problem**

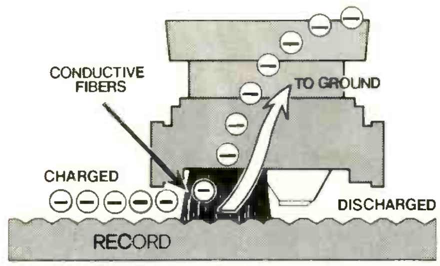
Note the shaded area (at bottom left of the Trackability chart at left) which represents actual warp signals found on records, and the revolutionary subaudible warp trackability characteristics of the SUPER TRACK IV. Reactions of the playback system to these very low frequency warps (between 0.5 and 8 Hz) existing on virtually all recordings can result in gross changes in the distance between the cartridge and the record. This distance change alters the stylus tracking force and the vertical tracking angle and can result in groove skipping, cartridge bottoming, signal wow, and even amplifier and/or speaker overload. Trackability at all frequencies is diminished by these warp-caused changes in tracking force!

Also, at some very low frequency (from 5 to 15 Hz), the tone arm-cartridge combination has a resonance frequency. When this resonance frequency is excited by the warp, all the above symptoms are intensified.

## The Super Track IV total design solution:

A viscous-damped Dynamic Stabilizer on the V15 Type IV combines with a new stylus assembly to minimize or completely eliminate warp-related problems. It raises the arm-cartridge resonance frequency and attenuates the arm-cartridge system resonance effect.

## An electrostatically-neutralized record surface




FRONT VIEW

**The static problem:**

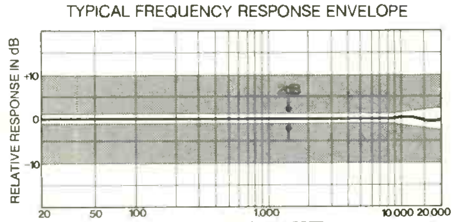
Static charges are omnipresent and unevenly distributed on all records. These charges can attract the cartridge unevenly and change the arm-to-record distance, the vertical tracking angle, and stylus tracking force. The result is wow and flutter. Also, static discharge through the stylus and amplifying system can be a cause of annoying pops and clicks.

## The Super Track IV total design solution:

Electrically conductive fibers in the Dynamic Stabilizer of the V15 Type IV ride on the surface of the record and continuously sweep the grooves just ahead of the stylus. This picks up the static electricity and discharges it to ground, much like a miniature lightning rod. The record surface is thus electrically neutralized. The static charge is prevented from affecting the arm-to-record distance, or from causing static noise in the system. Discharging the static stabilizes tracking force during the entire record playing process and does away with the electrostatic attraction of dust to the record surface.

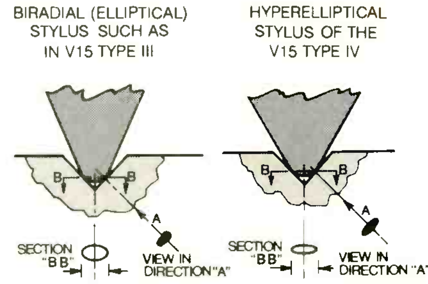
In addition, the conductive fibers effectively sweep the record surface to remove loose dust and lint.

## Ultra-flat response

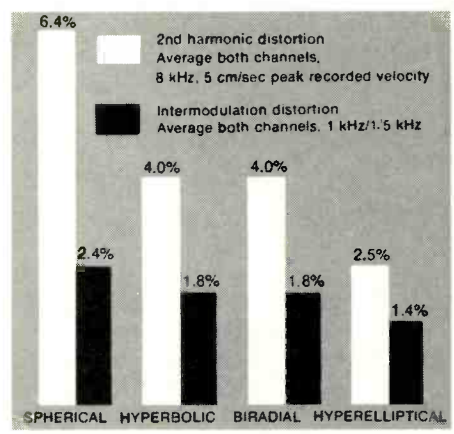



Each V15 Type IV cartridge is individually tested for frequency response that is well within the 2 dB envelope shown here.

## Dramatically reduced distortion




The Hyperelliptical nude diamond tip configuration of the V15 Type IV represents a significant advance in tip design for stereo sound reproduction. As the above figures show, its "footprint" (represented by the black oval) is longer and narrower than the traditional Biradial (Elliptical) and narrower than long-contact shapes (such as the Hyperbolic). This results in an optimized tip-groove contact area and dramatically reduces both harmonic distortion (white bars in graph) and intermodulation distortion (black bars).

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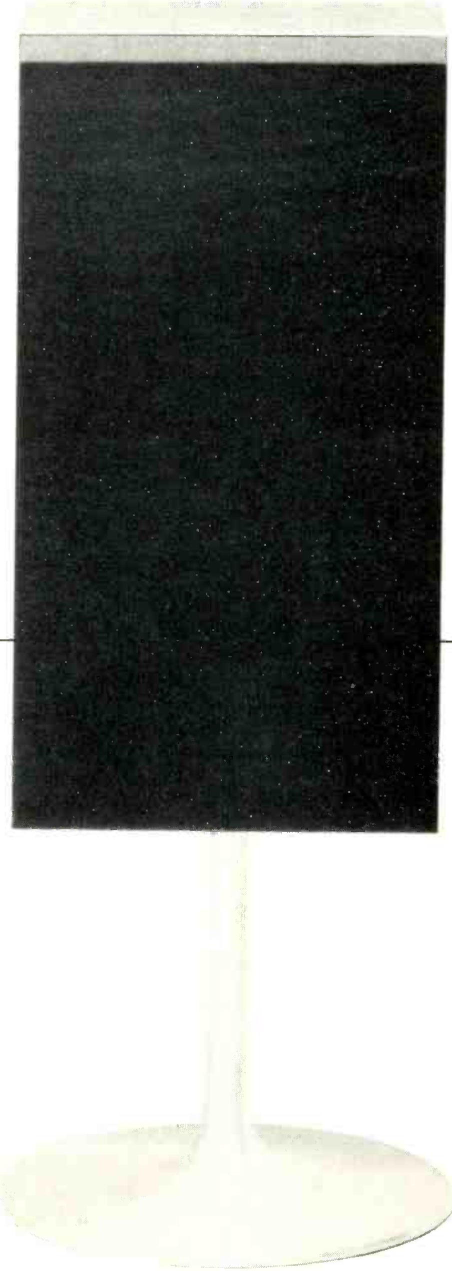
# Equipment profiles



## Bang & Olufsen Beovox Model M 70 Speaker System

**MANUFACTURER'S SPECIFICATIONS**
**Frequency Range:** 38-20,000 Hz, ±4 dB.
**Impedance:** 4 ohms.
**Music Load:** 100 watts.
**Woofer:** 10 in. (25 cm).
**Midrange:** 2½ in. (5.75 cm).
**Tweeter:** 1 in. (2.5 cm).
**Dimensions:** 13¾ in. (35 cm) x 25½ in. (65 cm) x 11½ in. (29 cm).
**Weight:** 55 lbs. (25 kg).
**Price:** $790.00 per pair.



Bang and Olufsen has designed the Beovox M 70 as a quality loudspeaker, paying special attention to acoustically correct reproduction. The M 70 is a three-way system, supplemented with a special purpose speaker and crossover network intended to provide smooth phase transition in the lower crossover region. This special driver gives the system its more commonly known name of "Phase Link." In addition, all speaker units are mounted in such a way as to allow all tones to reach the listener's ear simultaneously.

A 250-mm (10-inch) woofer crosses over to a 57.5-mm (2½-inch) midrange at 500 Hz. The midrange carries the spectrum up to 4500 Hz, where it crosses over to a 25-mm (1-inch) tweeter.

The speaker enclosure itself measures only 350 X 650 X 290 mm. A metal base is supplied which lifts the M 70 such that the middle of the enclosure is 650 mm off the floor. The physical design is quite attractive, with the brushed aluminum base accenting the wood enclosure.

Here I must caution the user who may have small toddlers about. Although the enclosure weighs only 55 lbs., the center of mass is raised sufficiently high that the entire system may be readily toppled. I recommend that the unit be placed well away from the pryings of small hands for safety reasons.

The Beovox M 70 is supplied with a detachable 14-foot cable which neatly plugs into the rear of the enclosure for ease of setup. However, connection to most American power amplifiers will require the purchase of a plug to adapt to the European connector.

The instruction sheet accompanying this system is small but thorough. Other than the special adaptor to match the amplifier, no difficulty should be experienced in setup.

### Technical Measurements

The measured impedance of the M 70 is shown in Figs. 1 and 2. The magnitude of this impedance reaches its maximum value at around 46 Hz, but remains below 5 ohms over most of the audio spectrum. This means that the length of the run of speaker hookup wire should be kept as short as practical and fairly large diameter wire should be used. The polar impedance plot shows a very large capacitive phase angle, on the order of 65 degrees. But since the frequency at which this occurs is below 70 Hz, this should cause no difficulty with most power amplifiers.

The one-meter axial sound pressure response is shown in Figs. 3 and 4 for amplitude and phase respectively. Both of these measurements were taken at one meter with the front grille in place, and I should point out that the grille on this

# So you're thinking about a subwoofer!

To obtain superior overall listening characteristics from a loudspeaker system, it is critical for the sound to progress smoothly from bass to midrange to treble. In order to achieve the smoothest possible transition, most designers have purposefully limited ultra-low bass response.

That's why supplementary subwoofers are becoming increasingly popular. And that's why you're thinking about a subwoofer.

The no-holds-barred way to extend the range of your system is to bi-amplify the low end with an electronic crossover and an additional amplifier.

**The problem**

The problem has been that this required routing the signal through circuits which produce electronic distortion, degrading listening quality.

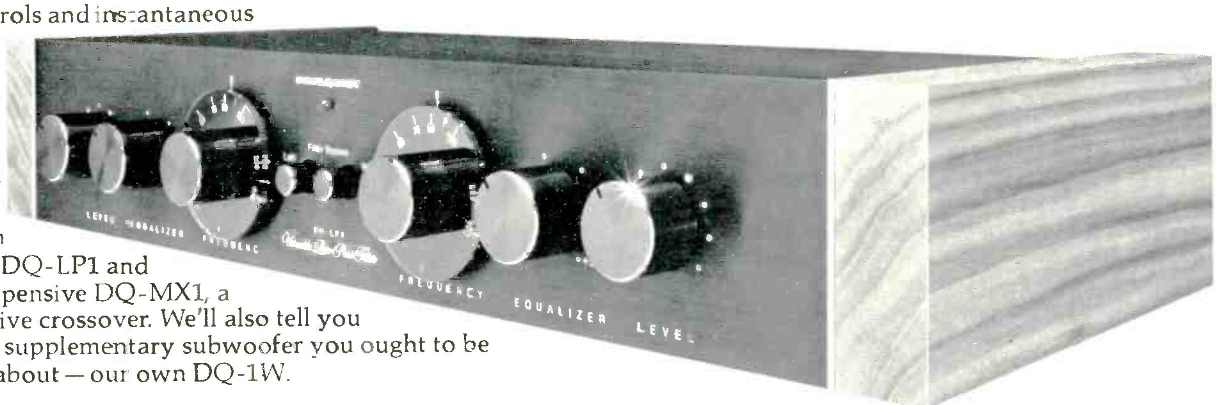
This problem no longer exists.

**The solution**

The Dahlquist DQ-LP1 crossover is a simple but elegant solution. It combines an electronic circuit for the low bass output and a passive circuit for the frequencies above the crossover point. Thus, the upper range emerges pure and undistorted, with no alteration whatever of clarity and depth imaging.

How has the DQ-LP1 been received? Without exception, the reviews haven't simply been good — they've been enthusiastic.

The DQ-LP1 delivers utterly clean performance through variable frequency electronic low-bass sections with 18dB/octave slopes; 3 cascaded stages, with staggered time-constants for non-ringing, low phase-shift curves at any frequency setting; completely passive high-pass sections easily adjustable to give you any desired bass rolloff frequency, but with no effect on midrange and high frequency quality. The DQ-LP1 features independent adjustments in each channel to compensate for room placement; separate output circuits for stereo and mixed center-channel bass modules, level controls and instantaneous AB comparison switches. Write to us. We'll send technical information about the DQ-LP1 and the less expensive DQ-MX1, a fully passive crossover. We'll also tell you about the supplementary subwoofer you ought to be thinking about — our own DQ-1W.

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system causes internal acoustic reflections above 1 kHz. The irregularities in response at 7, 9, and 15 kHz, as well as the drop above 16 kHz, are principally caused by the effect of the grille. I recommend that if one is willing to forego the cosmetic detraction, a more accurate sound can be achieved by removing the grille entirely. However, because most users will probably not want to take such a drastic action, the response is shown with the grille in place.

The mild peak at 90 Hz together with a gradually diminishing characteristic above 250 Hz may tend to give the impression of a bass dominance to the sound when heard in a highly absorbing room. Of unusual technical interest is the nature of the phase response. The M 70 is intended to provide a smooth phase transition in crossover; measurements indicate that the spectrum above 4 kHz arrives slightly earlier than the spectrum below 4 kHz. The equivalent air path distance between these two acoustic centers is about 1.7 mm. While the sound below 4 kHz is in phase with the drive voltage, there is a 90° degree phase shift for components above 4 kHz. Technically, this essentially uniform 90-degree phase shift with constant amplitude amounts to be a Hilbert transform operation on the uppermost register. I cannct state what the psychoacoustic effect of this constant phase rotation may be or whether it is audible in the presence of other response irregularities. However, this is a practical example that phase is not just 0 or 180 degrees after we subtract the air- path delay.

The three-meter room response is shown in fig. 5. This is plotted for a microphone position directly on axis and 30 degrees off axis in a configuration in which the speaker is a left-channel of a stereo installation. The curves are displaced 10 dB for clarity.

This measurement shows that the M 70 should be angled toward the listening area for the most accurate direct sound. As in the other measurements, the grille was left in place for this test. The substantial dip at 5 kHz appears to be associated with the crossover process, since it is strongly influenced by microphone placement vertically away from this nominal position one meter off the floor. This indicates that there will be some coloration of timbre in the upper register which depends upon seating location. Some top-end boost may be necessary to restore percussive sparkle to wide dynamic range material.

Horizontal and vertical polar-energy responses are shown in Figs. 6 and 7. There is a very small amount of left-right asymmetry which will make the right channel of a stereo installation slightly more dominant unless the speakers are directed toward the listening area. The vertical response shows that sound is launched slightly upward and nearly in line with a nominal one-meter off-floor position at three meters distance from the speaker. The M 70 should not be placed directly below or to the side of substantial objects which could reflect sound b back into the listening area.

Harmonic distortion for the tones of E1(41.2 Hz), A2(110 Hz), and A4 (440 Hz) rs shown in Fig. 8. The M 70 is an extremely good system from the standpoint of low harmonic distortion and should sound quite clean.

The extremely low distortion of the M 70 is also shown in the measured intermodulation of 440 Hz by 41.2 Hz A4 by E1), mixed one to one. The nature of the small crossmodulation present is that of almost a pure phase modulation. At 20 average watts, the 440 Hz is phase modulated five degrees peak to peak with less than one per cent amplitude modulation by the 41.2 Hz tone. This ratio of phase-to-amplitude modulation continues up to the highest measured average power of 100 watts. All in all, the M 70 has

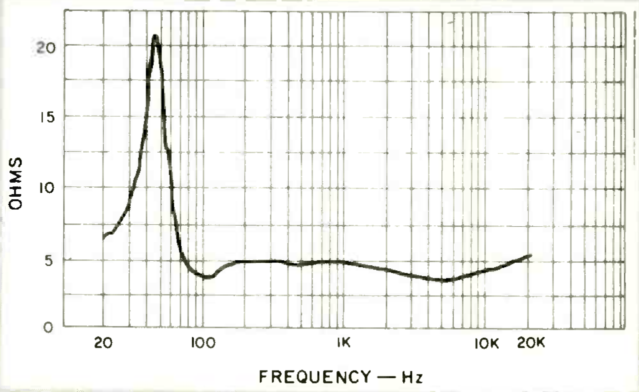


**Fig. 1 — Magnitude of impedance for the Beovox M70.**

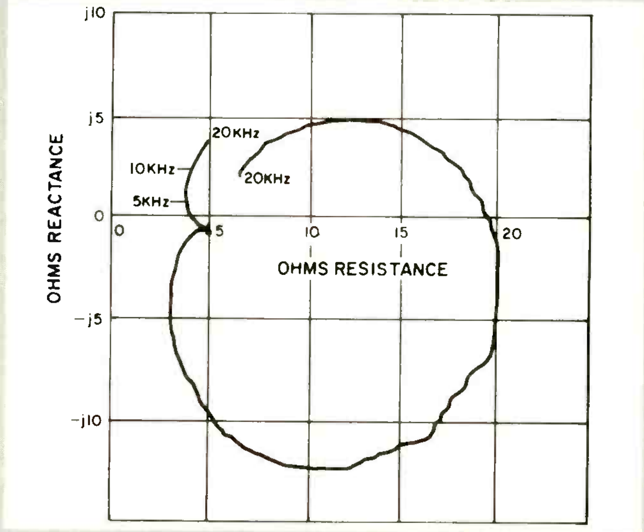


**Fig. 2 — Complex impedance plot.**

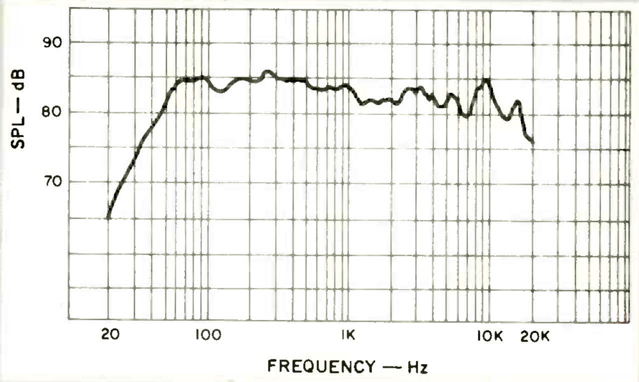


**Fig. 3 — Amplitude of one meter axial sound pressure level for constant voltage drive corresponding to one watt average into 4 ohms.**

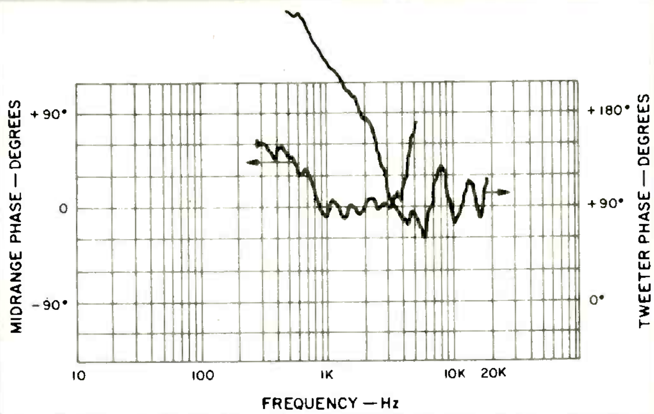


**Fig. 4— One meter-axial phase response. Note scale change for the tweeter.**

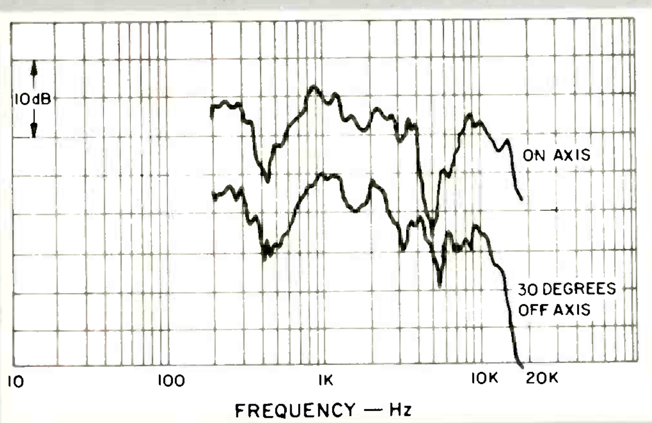


**Fig. 5— Three-meter room test.**

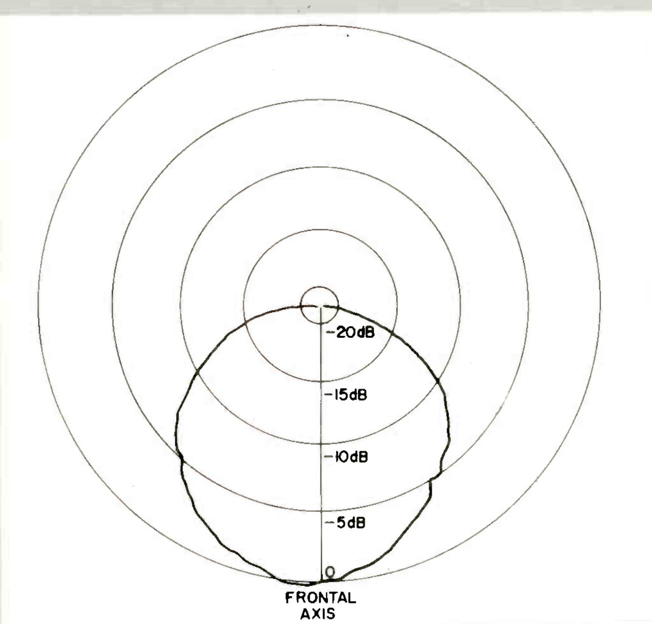


**Fig. 6— Horizontal polar-energy response.**

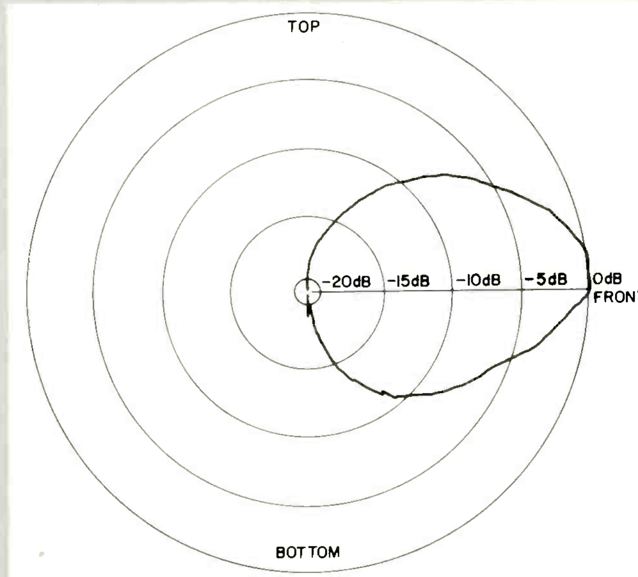


**Fig. 7— Vertical polar-energy response.**

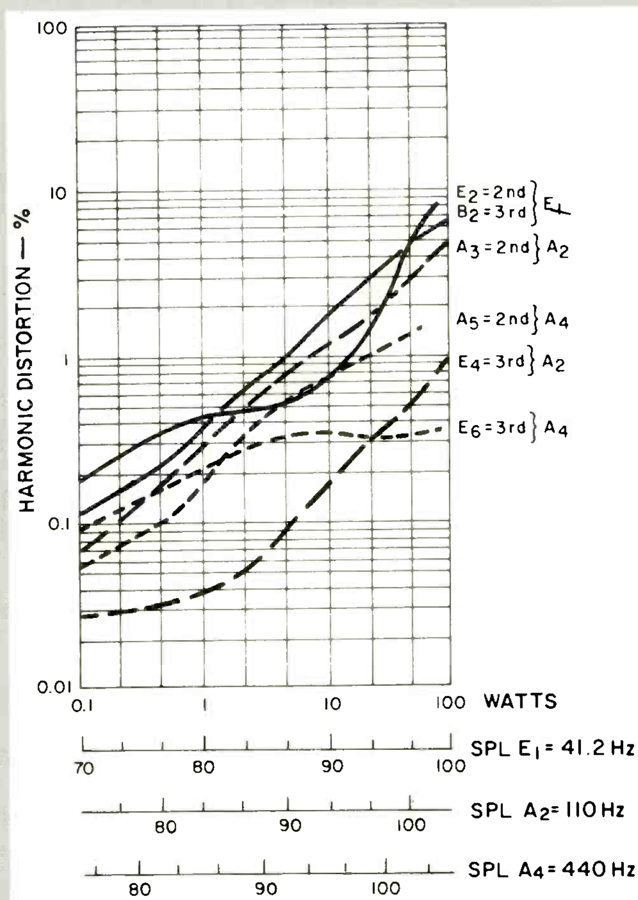


**Fig. 8— Harmonic distortion for tones $E_1$ (41.2 Hz), $A_2$ (110 Hz), and $A_4$ (440 Hz).**

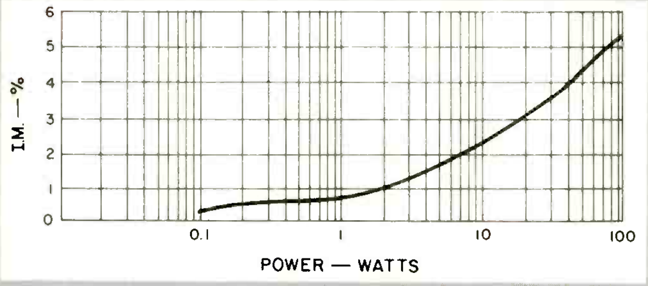


**Fig. 9 — IM distortion on $A_4$ (440 Hz) when $E_1$ (41.2 Hz) and $A_4$ are mixed one-to-one.**

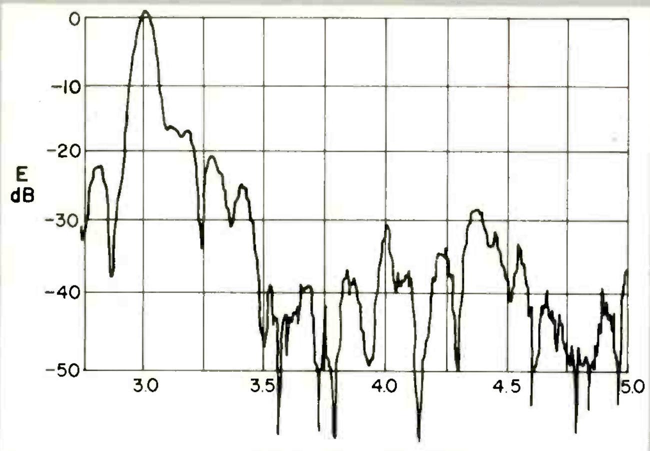


**Fig. 10 — Energy-time response without grille.**

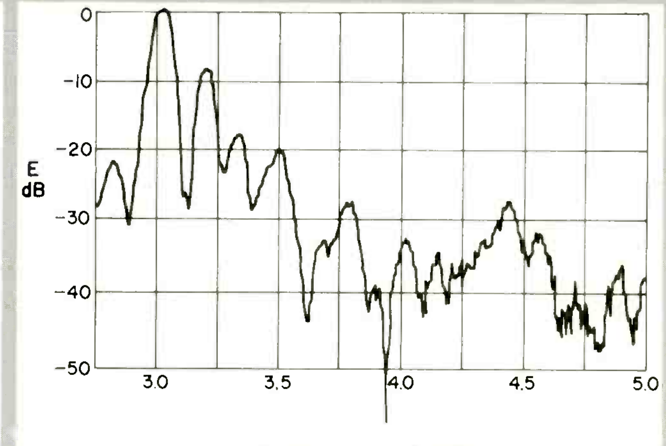


**Fig. 11 — Energy-time response with grille.**



one of the lowest distortions of this type which I have measured.

The M 70 also measures extremely well from the standpoint of linearity of response with coherent as well as incoherent signals. The acoustic transfer gain at 20 average watts was measured to be within 0.2 dB of its value at 10 milliwatts for sample tones at 110 Hz, 262 Hz, and 440 Hz. This means that musical timbre is not dependent upon intensity over that range. The crescendo test showed less than 0.1-dB change in level of inner musical voices when noise was added at a 20-dB higher average power level, even up to peak powers of 625 watts. This is extremely good for any loudspeaker regardless of price.

Figures 10 and 11 show the measured energy-time response with and without the grille; the reverberation caused by this grille is shown by the periodic components at 3.22, 3.36, 3.5, and 3.78 milliseconds. Some minor diffraction peaks, due to enclosure geometry, are visible in both measurements and contribute a minor peak near 4.35 milliseconds. The impulse response of the M 70 can be improved by the simple expedient of removing the grille.

**Listening Test**

My overall impression of the M70 in the listening tests performed before measurement is that there is good bass on some instruments such as kick drum, but no super-low bass as from the lowest organ pedal notes; there is a moderately good top end which needs a progressively larger boost above a rollover of about 1 kHz to fully balance the spectrum below that point.

The sound is large, clean, and generally pleasant, but I was somewhat disappointed in the illusion of reality presented, perhaps because my expectations were too high for a system which is deliberately designed to minimize time-delay problems. Stereo lateralization is good, but, in my opinion, that elusive sense of depth is lacking, as though the music was coming from a orchestra painted on a canvas strung between the speakers. I must stress that this is a highly subjective opiion which may well be different for other listeners. Other subjective impressions were that the bass response was a bit bumpy, giving some coloration to male vocals, and that there was some upper register shrillness which I guessed was in the 2- to 5-kHz range. *Richard C. Heyser*



(*Editor's Note:* Bang & Olufsen informs us that "The M-70s sent to Richard C. Heyser were from an early production period, and the later samples were improved. As far as the review is concerned [which was completely fair for the sample tested and supports our own conclusions] the following changes were made:

"The Masonite backing plate for the grill caused reflections due to comparatively small speaker holes necessary to support the grill cloth. When we changed to an elastic cloth with a more open weave, the openings in the Masonite were enlarged to cover almost the whole front area of the speaker. Treble transmission was appreciably improved, and the reflections virtually eliminated." —*E.P.*)


# Does it make sense to buy a new audio component you can't hear?

You bet it does. Especially if you care about absolutely accurate reproduction of recorded sound.

The new Crown DL-2 Distinction Series Controller is close to being the perfect pre-amplifier. It controls the signal level but changes nothing else unless you want it to.

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One of the reasons you can't hear the DL-2 is that it is three components.

The revolutionary phono preamp mounts next to the turntable. That eliminates most RFI problems. But it also includes wholly new circuit concepts for unmatched sonic performance, and new convenience in hook-up.

The separate power supply keeps AC line noise completely out of the signal path.

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**crown**

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*American innovation and technology...since 1951.*

# Kenwood KX-1030 Cassette Deck


**MANUFACTURER'S SPECIFICATIONS**

**Heads:** Three, ferrite type.
**Motor:** Electronically controlled d.c.
**Wow & Flutter:** 0.06 per cent W rms.
**Frequency Response:** Normal, 35 Hz to 15 kHz, ±3 dB; Ferrichrome, 35 Hz to 17 kHz, ±3 dB, and $CrO_2$, 35 Hz to 18 kHz, ±3 dB.
**S/N Ratio:** 67 dB with Dolby and 57 dB with Dolby out on $CrO_2$ tape.
**Headphone Output:** 48.9 mV @ 8 to 16 ohms.
**Dimensions:** 17 in. (43.2 cm) x 6½ in. (16.5 cm) x 12 in. (30.5 cm).
**Weight:** 16.5 lbs. (7.5 kg).
**Price:** $400.00.



Kenwood's KX-1030 is a typical example of the new generation of front-loading cassette decks introduced at the recent Japanese Audio Show (*Audio,* Feb., 1978, pg. 42) in Tokyo. Among the features of these decks are three heads with monitoring facilities, a built-in signal generator, separate bias and equalization controls, plus a servo-controlled d.c. motor. Styling is fairly conventional with the usual satin-silver panel and matching controls contrasting with the black metal cover. The six tape transport keys are located just under the cassette compartment, and while there is no *Eject* control as such, a light touch on the spring-loaded door pops the cassette out. To the left of the compartment is the *On/Off* switch and the headphone jack, while the two illuminated VU meters are to the right. The microphone and line input controls are underneath them, along with the *Tape Monitor* and *Dolby* switches. Next along the line come the dual *Line Output* control, *Oscillator,* and *Tape Equalizer* switches. A digital counter, *Memory* switch, and the *Dolby* and *Record* indicator lights are located just above the meters.

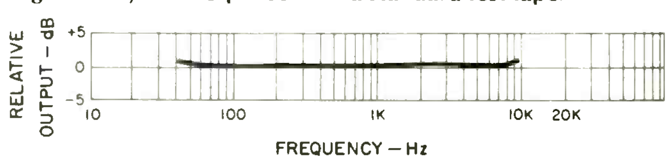
As most readers have probably guessed, the function of the built-in signal generator is to facilitate the adjustment of the bias controls (there is one for each channel, arranged concentrically). If the bias current is too high, then the treble response will tend to fall due to partial self-erasure; on the other hand, if it is too low, the high-frequency response will be greater, making the sound appear to be overly bright. One method of adjusting the bias is to record a frequency in the midrange and then juggle the bias until a signal in the 10- to 12-kHz range is at the same amplitude. Since the bias control will affect both frequencies, this procedure can become a bit tedious . . . so Kenwood has come up with an ingenious circuit using an automatic switch to apply both frequencies sequentially. All the user has to do is to insert the cassette, switch the deck to *Record,* and depress the *Oscillator* button. The VU meters will then show a fluctuating reading, and all you have to do is to adjust the bias controls to a level output—and that's it. Incidentally, the adjustment frequencies are at 400 Hz and 10 kHz. It should be mentioned that when the oscillators are functioning, the *Record* light flashes so there is little danger of spoiling a tape.

Inside the cassette deck, all the electronic components are dispersed among four printed circuit boards and the general quality of workmanship is excellent. The servo-control signals for the d.c. motor are obtained from a Hall-effect diode working in conjunction with a rotary ferrite magnet.

### Measurements

The first test performed was the measurement of the playback response using a standard test tape, and the results are shown in Fig. 1. Next a Maxell UDXL-I tape was inserted and the bias was checked, using the method described earlier. The Record/Replay response was then measured at 0 VU and at −20 dB and is shown in Fig. 2. The upper 3-dB point was just over 16 kHz with a low-frequency response only 2 dB down at 30 Hz. The Maxell cassette was then replaced by a TDK SA tape and the equalizer switch was turned to $CrO_2$ . . . again the bias was adjusted before making the measurements. The 3-dB point came out a little higher at 17 kHz (see Fig. 3) with a slightly greater roll-off at the low end. A Sony Ferrichrome was next tested, and the response was found to be quite similar to the TDK SA (see Fig. 4). Finally one of the new BASF Super Chrome cassettes was tested, and here the high frequency response extended out to 17.5 kHz. All four tapes had similar distortion characteristics at 1 kHz with the headroom between 5.5 and 7 dB (see Fig. 5). Figure 6 shows distortion versus frequency at 0 VU . . . a stringent test as we have mentioned before. It will be seen that the TDK SA has a slightly reduced headroom below 80 Hz, while the dif-

**Fig. 1—Playback response from a standard test tape.**



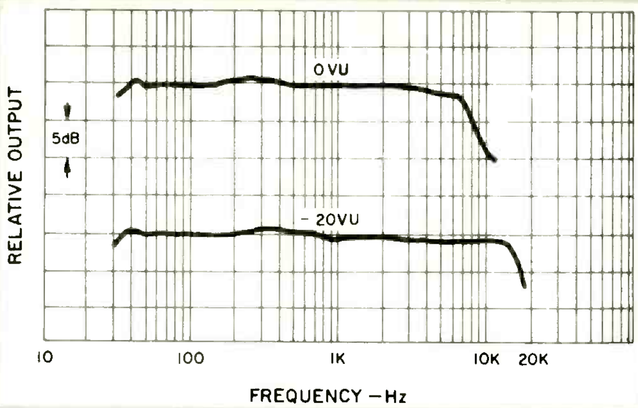



**Fig. 2—Record/Replay response with the Maxell UDXL-I tape.**

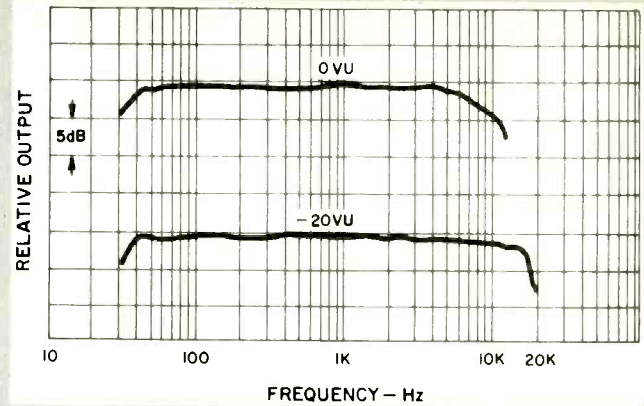



**Fig. 3—Record/Replay response with the TDK SA tape.**

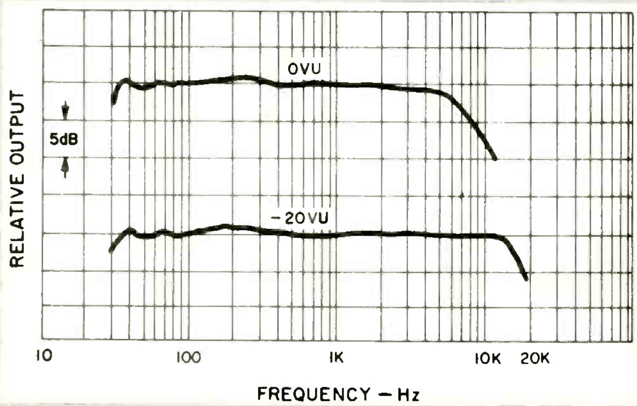



**Fig. 4—Record/Replay response with the Sony Ferrichrome tape.**

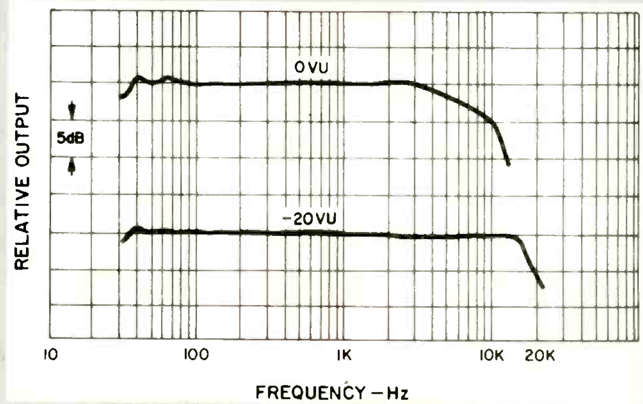



**Fig. 5—Record/Replay response with the BASF Super Chrome tape.**



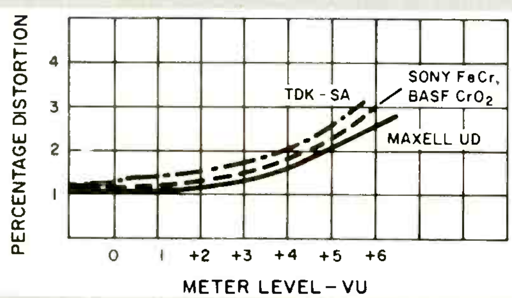



**Fig. 6—Distortion vs. level for a 1-kHz signal.**

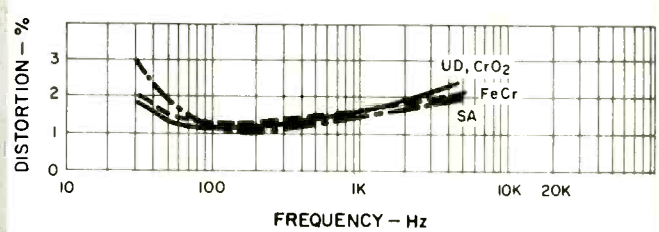



**Fig. 7—Distortion vs. frequency measured at 0 VU.**

ferences among the other three are small enough to be classified as insignificant. The signal-to-noise ratio measured 59 dB for the Maxell UDXL-I, 60 dB for the TDK SA, and 60.5 dB for the BASF Super Chrome (ref. 3 per cent THD, "A" weighting). Switching in the Dolby system would increase these figures by about 9 dB. At this point in the tests, the Dolby tracking was checked and found to be within 1.3 dB down to below −40 dB. Erase efficiency was better than 65 dB with all four tapes.

The input signal required for 0 VU was 85 mV line and 180 $\mu$V for microphone with the output then being between 650 and 800 mV, depending upon the kind of cassette tape used. Signal-to-noise ratio decreased by a maximum of 14 dB with the microphone input control in its fully-clockwise position. Wow and flutter measured a respectable 0.06 per cent, and the tape speed was found to be within two decimal places of absolute accuracy. Rewind time for a C-90 cassette was 115 seconds.

## Listening and Use Tests

As far as general performance is concerned, Kenwood's KX-1030 either meets or exceeds its specifications by a comfortable margin. There is no doubt that this unit must take its place among the very best in this particular price range. I suppose the most interesting feature is the ingenious bias adjustment system which not only takes care of all current tapes on the market, but will also get the best results from almost all future tape formulations. It must be remembered that not all cassette decks can use the $CrO_2$ tapes and only a few models have provisions for Ferrichrome. So the bias adjustment system is a definite plus feature that will appeal to many audiophiles, while the monitoring facility will be appreciated by the novice as well. At present, few cassette makers offer three-head decks, but I'm sure that many more manufacturers will offer this refinement in the not too distant future.

*George W. Tillett*

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# Onkyo's exclusive Quartz-Locked
## The closest thing to perfect tuning

Quartz-Locked, Onkyo's unique tuning circuit, provides near perfect FM tuning and stability. You need both for best FM reception, no matter how good the rest of your audio system may be.

Picture an electronic balance which detects and corrects off-frequency conditions as fast as they happen. So fast, in fact, you never even know it is happening. That's Quartz-Locked.


Quartz Crystal

It's done with a reference oscillator controlled by precisely ground quartz crystal which—by natural laws—vibrates at a fixed frequency. The reference frequency is compared with the desired frequency. No matter what can cause tuner drift, continual compensation prevents it. FM reception, clarity and separation are superb.

Quartz-Locked is controlled by the Sentry Circuit which reacts to your touch on the tuning knob, unlocking Quartz-Locked so you can tune it; locking it when you release the knob. Nothing is more foolproof.

Independent audio labs agree that it's practically impossible to mistune a Quartz-Locked system. We'll send you the reports to prove it. But you won't find a specification for Quartz-Locked or the Sentry Circuit.

That's the trouble with specs. Some things just can't be measured.

We suggest, then, you forget specifications and listen to Quartz-Locked FM at your Onkyo dealer. Onkyo has it in component tuners and receivers. After you hear Quartz-Locked, you won't care about specifications.

That's what Onkyo is all about. Listening. That's why only Onkyo has Quartz-Locked tuning. See your Onkyo dealer or write for information and test reports on the Quartz-Locked system.

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## The Metron Group PR-1 Preamplifier By Cerwin-Vega


**MANUFACTURER'S SPECIFICATIONS**
**Rated Output:** 2.0 V.
**Maximum Output:** 7.5 V.
**Input Sensitivity:** Phono, 2.0 mV, High Level, 220 mV.
**Phono Overload;** 230 mV.
**Frequency Response:** Phono, RIAA ± 0.1 dB; High Level, 5 Hz to 200 kHz, −3 dB, Microphone, 50 Hz to 20 kHz, −3 dB.
**Mike Input Sensitivity:** 1.8 mV.
**S/N Ratio:** Phono, 73 dB unweighted, 84 dB weighted; High Level, 92 dB unweighted; Mike, 70 dB unweighted, 77 dB weighted.
**THD:** Phono to Main Out, 0.01 per cent; High Level to Main Out, 0.005 per cent.
**IMD:** Phono to Main Out, 0.01 per cent; High Level to Main Out, 0.005 per cent.
**Tone Control Range:** ±10 dB @ 50 Hz and 10 kHz (controls defeated in center position).
**Subsonic Filter Response:** −9 dB @ 10 Hz.
**Mute:** −20 dB.
**Rated Headphone Output Level:** 3 V at 180 ohms.
**Dimensions:** 18.9 in. (48 cm) W x 2.75 in. (7 cm) H x 14.17 in. (36 cm) D.
**Weight:** 15 lbs. (6.8 kg).
**Price:** $500.00.

From the wonderful folks who taught us that "loud is beautiful . . . if it's clean," Cerwin-Vega, comes the PR-1 full-featured preamplifier via their Metron Group division. Preamps, by their very nature, are not "loud" —but this one certainly is clean! The design philosophy of this preamp falls midway between the "straight gain with no frills" camp and the "everything but the kitchen sink" approach. Some of the extras incorporated are not immediately apparent from the front panel (and are therefore incorporated strictly in quest of good performance), some are unusual even for a do-everything preamp, and a few commonly found on more elaborate control units are missing altogether.



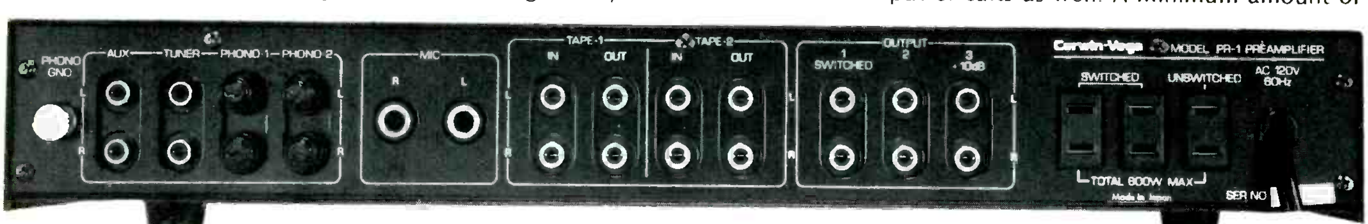
The front panel of the PR-1 is divided into a series of logically grouped control areas. At the left are the power *On/Off* switch and a phone jack. Bass and treble controls come next, followed by four toggle switches for *Mono/Stereo* selection, *Subsonic Filtering, Tape Dubbing,* and *Tape Monitoring*. Two tape decks can be accommodated by the PR-1. The input selector has two phono settings, microphone, *AUX,* and tuner. Volume and balance controls are concentrically mounted, and, to their right, is a muting switch which reduces the reproduced signal level by a fixed 20 dB.

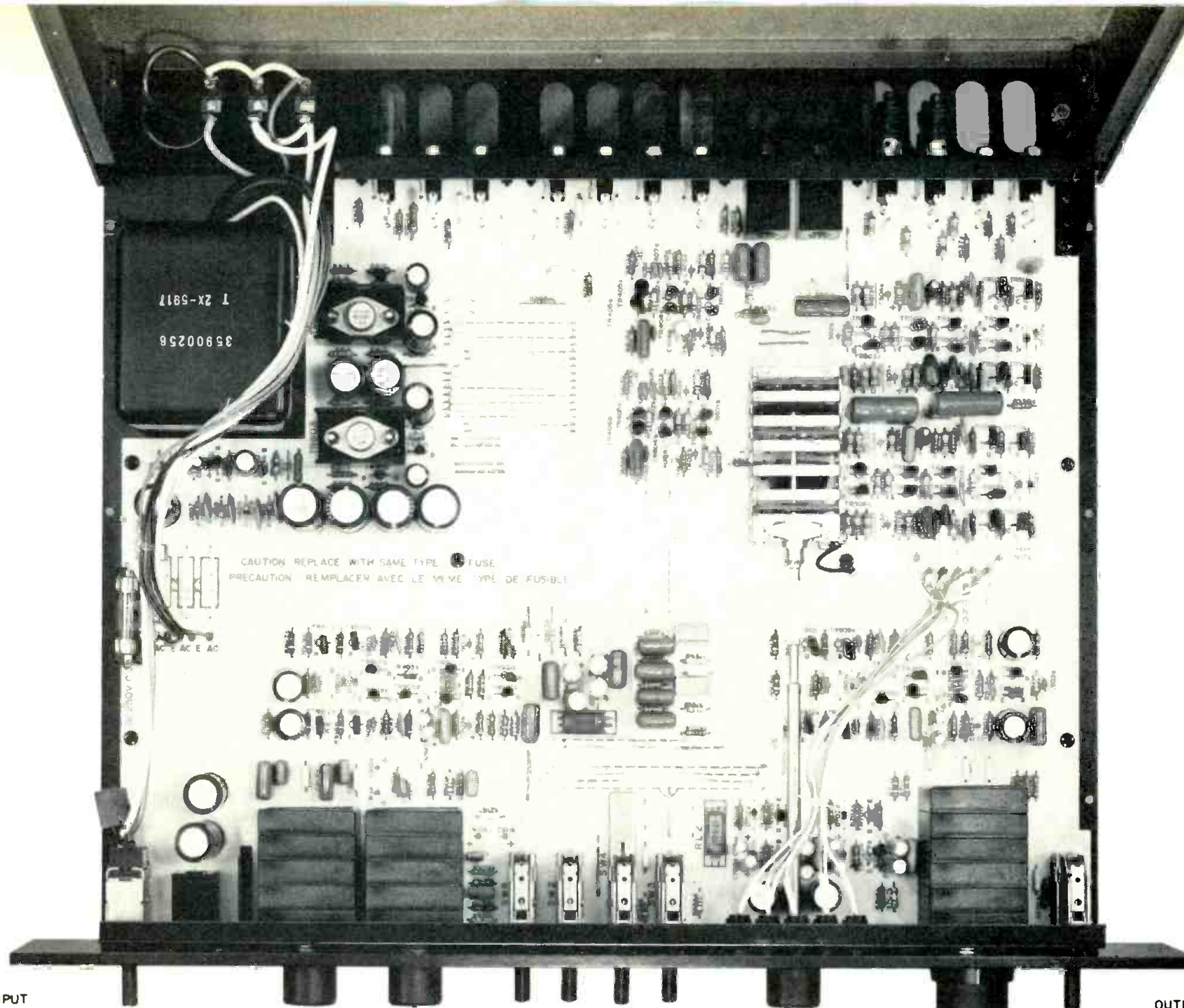
The rear panel contains the required input and tape output jacks, a pair of microphone input jacks (phone plug type), a chassis ground terminal, and a pair of switched plus one unswitched a.c. receptacles. There are three separate pairs of output jacks. Output 1 is a switched output pair and will not operate if stereo headphones are plugged into the headphone jack on the front panel. Output 3 is a 600-ohm drive output rated at +23 dBM and should be used when maximum power (or signal level) is needed, providing the total load impedance connected is 600 ohms or more. Output 2 provides a lower level of output (it has a 10-dB attenuator network in series with it) equal to that of Output 1 but without the headphone-related switching feature.

### Circuitry and Construction

Although a full schematic diagram was not provided in the owner's manual, we were given a block diagram by the manufacturer and it is reproduced in Fig. 1. Several interesting circuit refinements are evident from an examination of this diagram. For one thing, the microphone preamplifier circuitry is completely separate from the phono-equalizer stages. In many preamplifiers, which are equipped with microphone facilities, common circuitry is usually used for both functions. In view of the fact that Cerwin-Vega went to the trouble of providing separately optimized microphone preamplifier circuitry, it is surprising that they did not also provide a means whereby microphone signals might have been added to or mixed with other program sources. Noteworthy, too, are the two relay circuits, one of which delays turn-on of signal to the three sets of outputs, while the other delays turn-on of tape-out signals and serves to isolate the connected tape decks from the PR-1 when it is not turned on. Note, too, that the dubbing/tape monitor arrangement of this unit permits the user to accomplish tape dubbing (from Tape 1 to Tape 2 or vice versa) while either listening to or monitoring a completely different program source. The buffer amplifier associated with the tape-out circuits insures against loading of the regular signal path by the connected tape decks when one or more decks are connected. The five LEDs shown in the block diagram serve merely as selected program indicators. A separate transformer winding is used to develop the voltage necessary for driving the time-delay relays and indicator lights while signal circuits are powered from a dual-polarity supply section.

A look at the inside layout of the PR-1 discloses a highly professional circuit layout and top grade components. All potentiometers (tone controls, balance, and volume) are hermetically sealed units. The master volume control uses four sections, which suggests that attenuation is being applied at more than one point in the signal chain for best signal-to-noise performance at all listening levels. Note, too, that the function selector switch is positioned far back on the giant-sized PC board, close to the low-level (phono 1, phono 2, and microphone) amplification circuits. All power supply parts, including the rather large power transformer, are far removed from input circuits as well. A minimum amount of







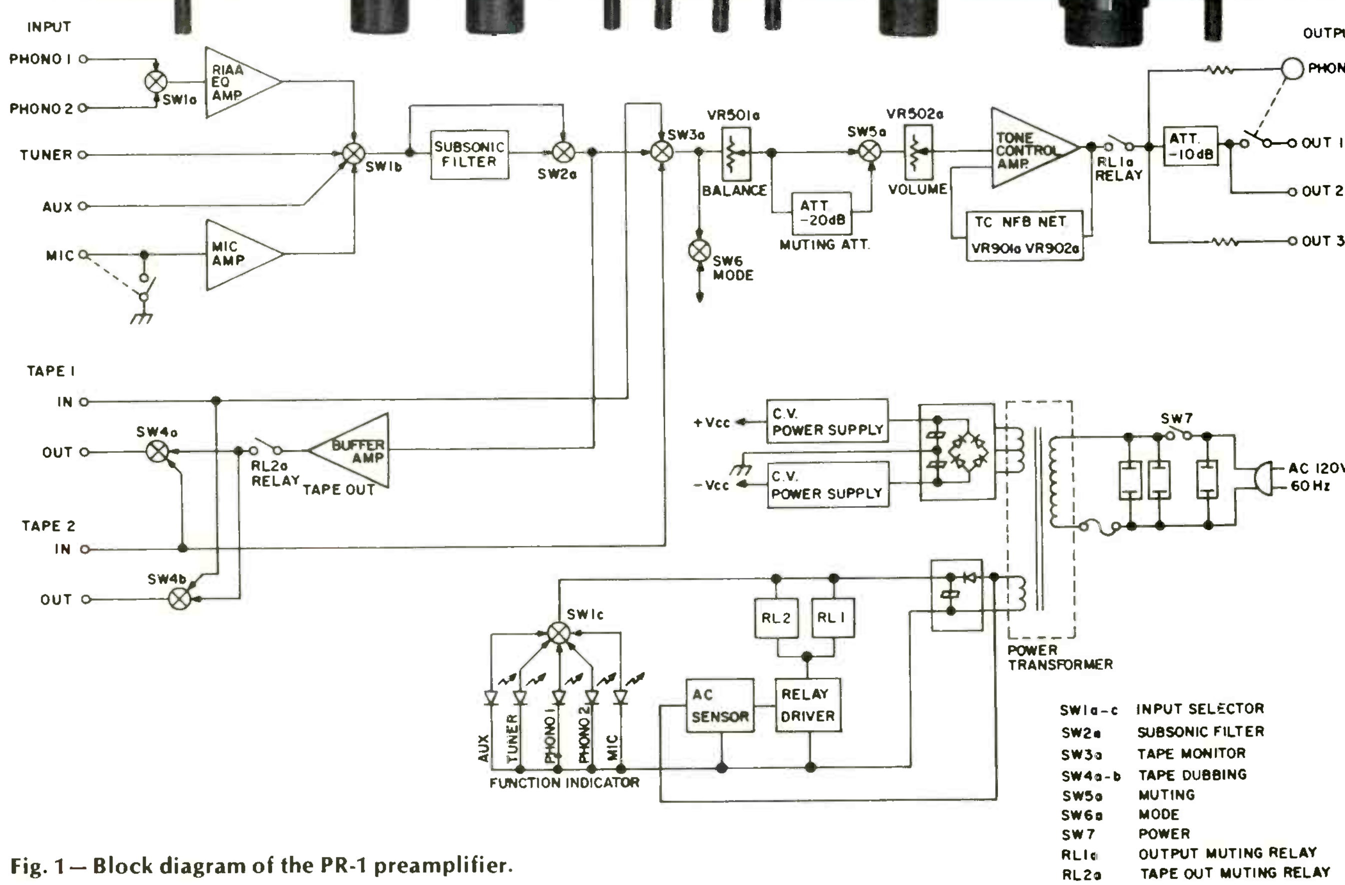



**Fig. 1 — Block diagram of the PR-1 preamplifier.**

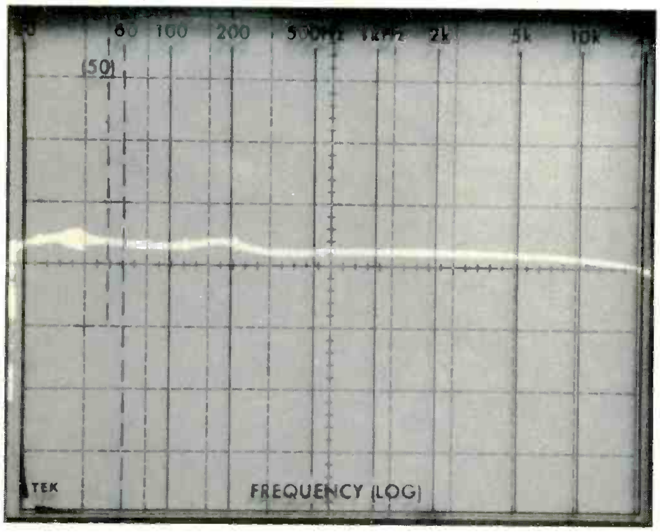



**Fig. 2— Normalized RIAA response of the PR-1 preamplifier. (Vertical gain is set at 2 dB per division.)**

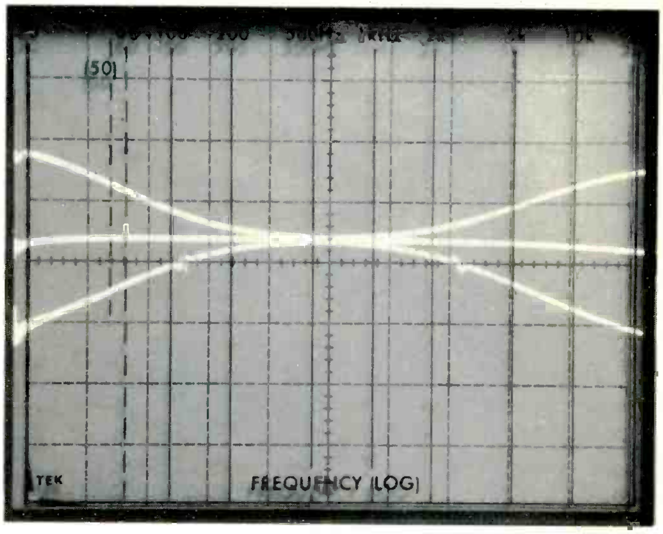



**Fig. 3— The tone control response range. (Vertical gain is set for 10 dB per division.)**

wiring is used in the PR-1, and what cabling there is, is carefully harnessed and routed for best and repeatable low-noise performance.

### Laboratory Measurements

Phono input sensitivity (for rated output of 2.0 volts via the Output 2 terminals) measured 2.6 millivolts, while phono overload was an impressive 230 millivolts at 1 kHz. Signal to noise in the phono setting was 73 dB below rated output for rated input, unweighted, increasing to 82 dB when an "A" weighting network was introduced. Distortion in phono was less than 0.01 per cent across the entire RIAA playback curve which was, incidentally, one of the most accurate playback response curves we have ever measured for any preamp. Deviation from true RIAA from 30 Hz to 15 kHz was actually better than the 0.1 dB claimed, as can be seen from the normalized sweep response shown in Fig. 2.

High-level input sensitivity measured 250 millivolts, while microphone input sensitivity was 2.3 mV, a bit higher than called out in the specs. Microphone overload occurred with an input signal of 210 millivolts. Maximum output level attainable from the main outputs was 8.5 volts. Distortion in the high-level circuits was 0.003 per cent at 1 kHz, 0.003 per cent at 20 Hz and 0.0043 per cent at 20 kHz, while the IMD measured 0.0047 per cent. Signal-to-noise ratio for the high level circuits measured 95 dB below rated output, and the frequency response extended from 10 Hz to 106 kHz, within ±1.0 dB. In the case of microphone inputs, response was flat from 50 Hz to 20 kHz, for −3 dB as claimed. Distortion in the microphone channel was 0.06 per cent at 1 kHz for rated output while signal-to-noise measured 73 dB below rated output (unweighted) and 77 dB (weighted).

Volume control tracking was exceptionally good, maintaining accuracy within 0.1 dB all the way down to 70 dB below maximum settings.

Tone control range is depicted in the sweep photos of Fig. 3. Note that turnover frequencies for the bass and treble control are somewhat removed from the usual 500 Hz or 1 KHz "pivot points" normally associated with bass and treble action. If a preamplifier is limited to only one set of turnover frequencies for these controls, we much prefer this choice of turnovers since the midrange is not affected as much when extensive use is made of the other type of controls. Of course, a preferred solution would have been to offer a choice of turnover frequencies, but as we said earlier, the Metron Group of Cerwin-Vega seems to have settled on providing *some* control and switching flexiblity without overdoing it.

It was not possible to illustrate the action of the subsonic filter in a spectrum-analyzer sweep since our analyzer sweeps the audio range only from 20 Hz to 20 kHz in its "log" mode. We did, however, measure response of this filter on a point-by-point basis and found its −3-dB cut-off point to be at 18 Hz, while at 10 Hz, attenuation was some 10 dB down from flat response.

### Listening Tests and Use Tests

We found the PR-1 to be a good performer during our listening tests and a unit which is both easy to use and easy to become accustomed to. Control action is positive, and one gets the feeling (with the discrete step action of both the tone and volume controls) that one can set things precisely for optimum listening preferences again and again. No audible coloration of any kind was introduced by the high-level section of the PR-1 when we played master tapes through the system and compared results with those heard when feeding the same program source through directly to our reference power amplifiers. Using a variety of disc material which contains sharp transients, we felt that the phono section handled such signals well. No bass response alteration occurred with the introduction of the subsonic filter, we indeed preferred using it during all of our listening tests because, if anything, it seemed to clean up some extraneous ultra-bass muddiness which we heard earlier and which was no doubt being introduced by speaker intermodulation effects caused by subsonic rumble from our less-than-perfect turntable system.

While the price of the PR-1 might, to some, seem a bit on the high side if one judges the product strictly by its features, one should not lose sight of the fact that first-grade, expensive parts and components are used throughout the unit, and this, to me at least, means increased longevity of the product and years of trouble-free performance. How many dollars one is willing to spend for those less obvious benefits depends upon the attitude of the prospective purchaser. I think it will seem like a good idea to many.

*Leonard Feldman*

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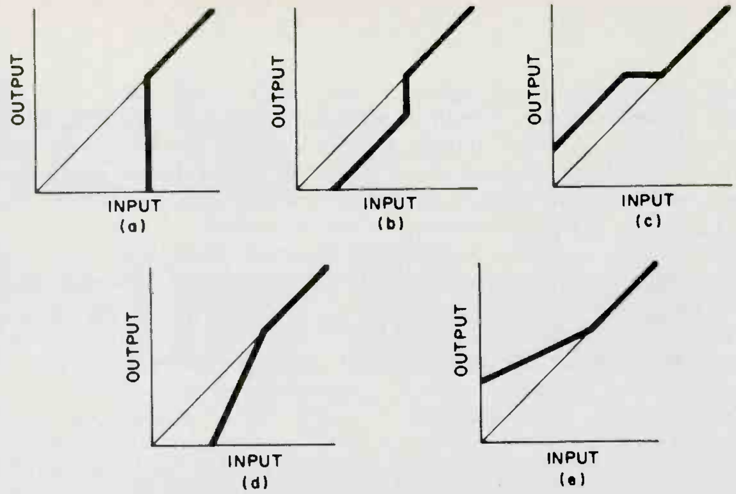


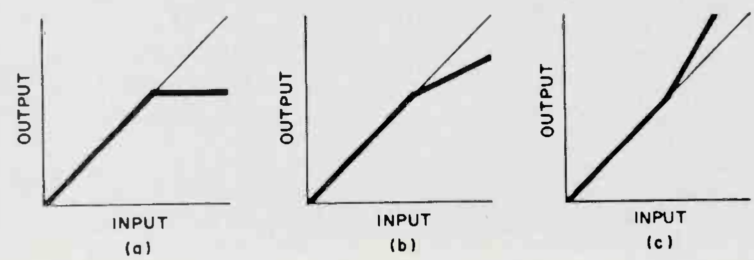


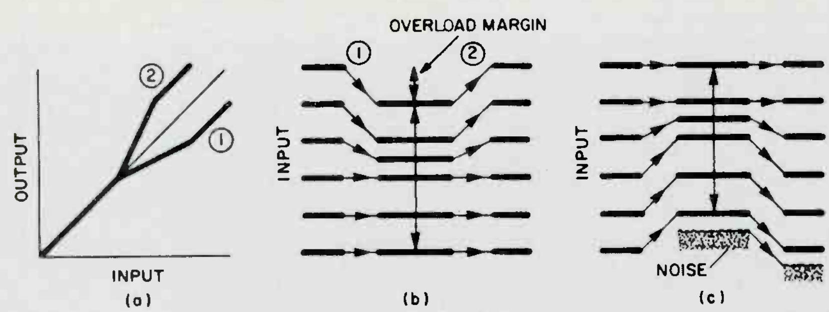


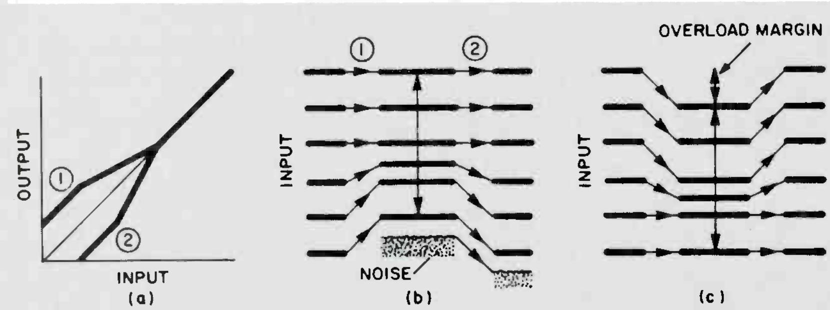


**Fig. 1 — Low level noise gate (a) simply loses both signal and noise below a certain threshold level. Finite attenuation of low-level signals is achieved with the expansion of the transfer characteristics of (b) and (d). Such "single- ended" expanders often reduce noise at the expense of distorting dynamic range. Compressors at the signal-source end can raise low-level signal above noise levels, but can similarly distort range (c) and (e).**

**Fig. 2 — High-level limiter and compressors (a) and (b) and expanders (c) suffer a possible disadvantage because of processing at a level where distortions would be more obvious.**

**Fig. 3 — Complementary high-level system (a) is able to reproduce original dynamic range while either reducing maximum level to give more overload margin (b), reducing noise (c), or giving a combination of both.**

**Fig. 4 — Low-level complementary system has advantage that any distortion products are at a low level where they are less likely to be audible.**

panders. Clearly, single-ended methods are difficult to adopt to normal high-quality reproducing systems.

**Complementary methods** One way of avoiding the difficulty of alteration to dynamic range is by the complementary method — the dynamic equivalent of static "equalization." In complementary systems, signal processing before transmission and recording, normally compression, is followed by an equal degree of complementary processing, normally expansion, prior to audition so that the original dynamic range is restored. Noise added by the medium after compression is reduced by the degree of expansion used. In the expander of Fig. 1(b) the complementary compressor characteristic would be (c) and the complement of (d) would be (e). Likewise, the transfer characteristics of Figs. 2(b) and (c) form another compander system.

Another kind of diagram makes it easier to visualize what happens so far as levels are concerned. Figure 3(a) is a typical high-level compander characteristic, showing both the compression and expansion curves. Its equivalent level diagram of Figure 3(b) shows the reduced dynamic range (indicated by arrows) where the maximum level to be handled by the interposing medium is assumed to be the same — the region marked "overload margin" giving an increased margin against overload and thus lower distortion. Figure 3(c) shows the same reduced dynamic range produced by the characteristic of Figure 3(a), but with the intermediate gain shifted so that the low signal levels can be increased in relation to the noise level.

Figure 4(a) shows low-level compander characteristics, with the level diagram of Fig. 4(b) illustrating the use of the compressed dynamic range to bring up the low-level signals relative to the noise. Figure 4(c) shows how, by reducing the levels by a constant amount, increased overload margin can be obtained. Notice the similarity between Figs. 3(b) and 4(c) and between Figs. 3(c) and 4(b), the difference being the locating of the region of "linear" operation at either a high level or a low level. Despite the immediate visual contrast between Figs. 3(a) and 4(a) there is clearly a close resemblance between curves.

In practice the characteristic curves do not have the discontinuities shown, corners being rounded to prevent objectionable noise modulation. The curves should be capable of easy realization, be readily reproducible, and the two complementary curves must be matched to within the required tolerance.

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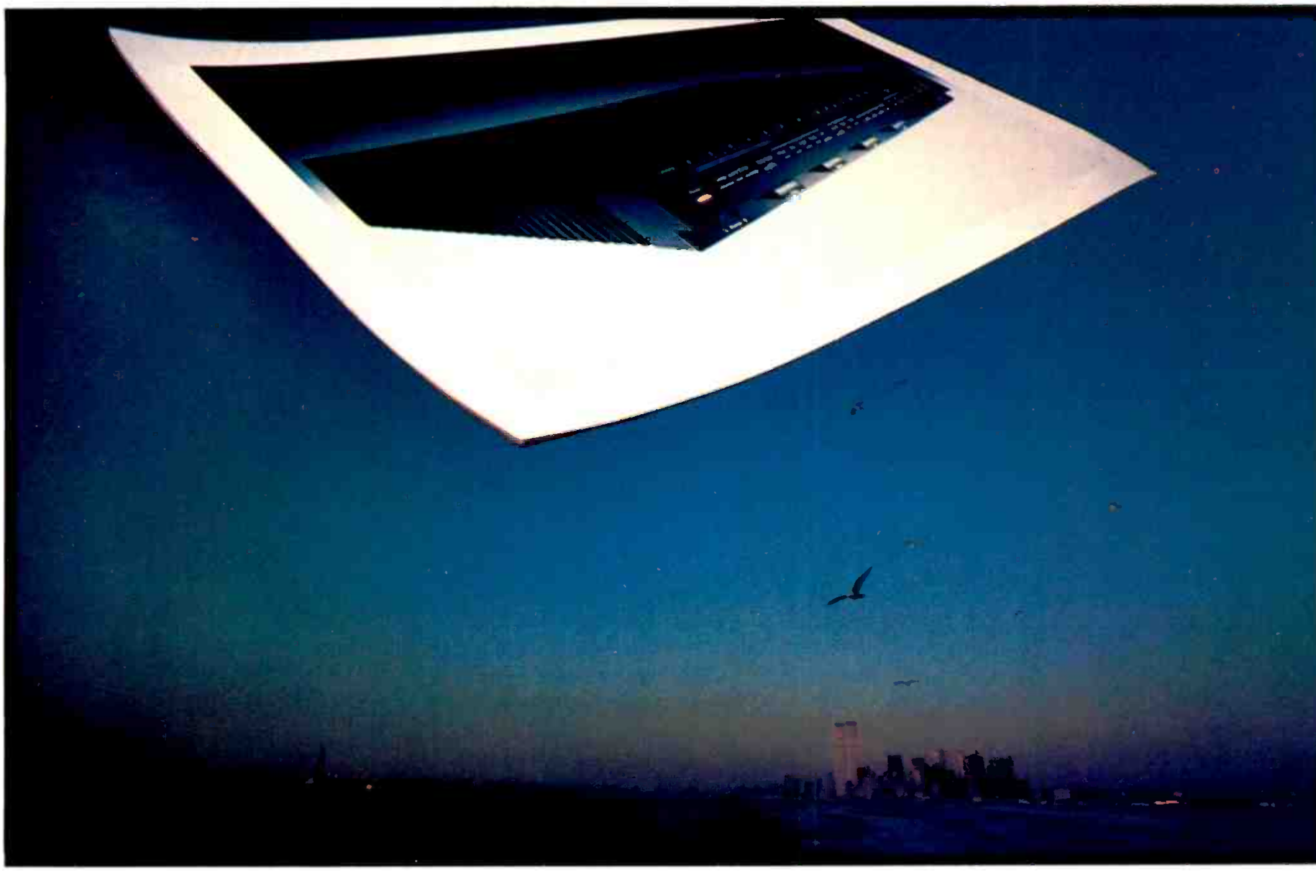



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quality link. High level companders can be very useful, however, in telephone circuits for example and the British Post Office's Lincompex scheme is an example of a compander in which dynamic range is reduced to zero. (Subsequent expansion would not be possible were it not for the fact that information on signal amplitudes is contained in separate pilot or control channel.)

The low-level method (Fig. 4) has a high tolerance of channel gain errors, produces modulation distortion at low signal levels rather than high levels, and there is less risk of overloading the medium. It seems a good idea anyway because one might expect the ear to be less sensitive to low-amplitude effects than to the same effects at high level. This then is the basic companding technique used in the Dolby system.

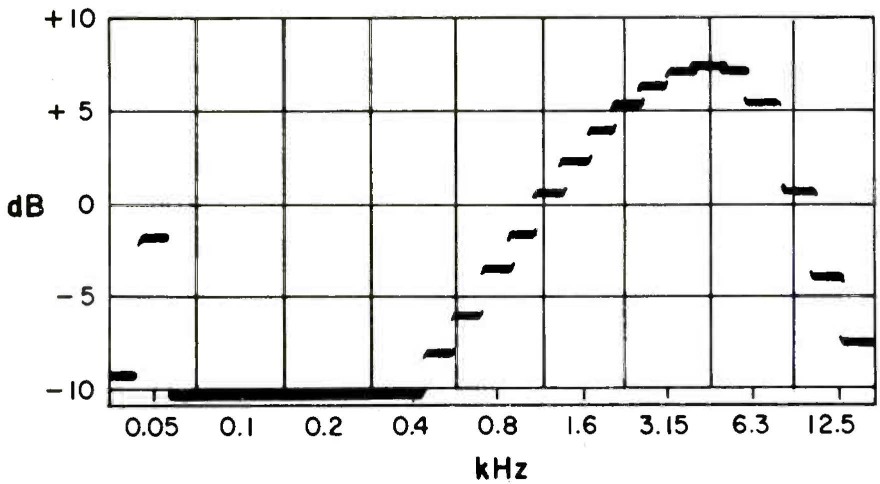



**Fig. 6—Noise spectrum of low-noise ferric-oxide tape shows the problem is a mid- to high-frequency one, rather than a broadband one for which the Dolby A system was developed.**

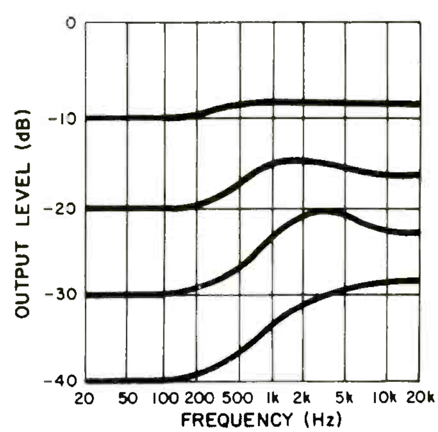



**Fig. 7—In the Dolby B system, low-level high-frequency signals are boosted during encoding by 10 dB at low levels, the amount of boost decreasing as input level increases. Characteristics shown are amplitude-frequency response curves, with input level as a parameter, for the encoding process.**

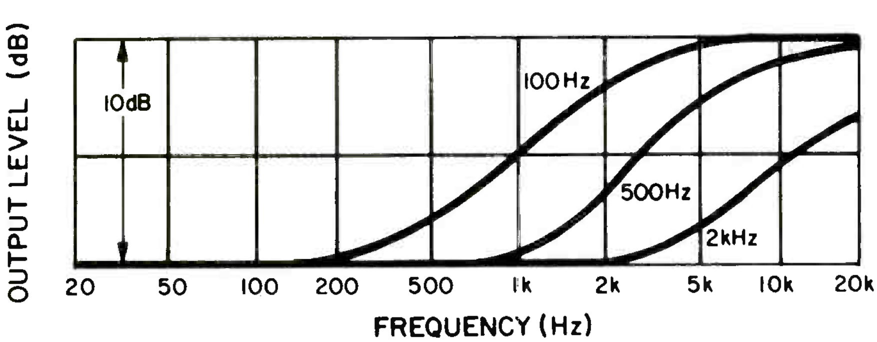



**Fig. 8—Because the compressor circuit is made frequency sensitive in B-type processors, frequency at which boost, and hence noise reduction, occurs rises with increasing input level. Thus noise reduction is preserved in the presence of mid-frequency signals at high amplitude, which would otherwise reduce or prevent noise reduction. Curves show response below threshold level in presence of 0-dB tones.**

## Dolby Low-level Compander

In conventional companding systems, there are two equivalent ways of achieving compression and expansion. One is to derive a control signal, after subjecting the input signal to a variable-gain element (compressor); expansion or "decoding" would then be achieved by the converse process—the control signal being derived prior to a variable-gain element (expander), Fig. 5(a). The equivalent, alternative way is to derive the control in the compressor part before the variable-gain element and to subsequently expand by using a control obtained after the variable-gain device, Fig. 5(b).

The Dolby technique makes use of a different approach—with an important difference; compression is achieved by deriving a special low-level signal that is added to the main signal, and expansion is obtained by subtracting a low-level signal from the main one, Fig. 5(c). (Within the low-level processor block, compression is achieved with method (a).)

Of course, the required compander characteristics could have been derived in the normal way, i.e. by direct action of a compressing circuit on the main signal path Figs. 5(a) and (b); but in the low-level approach the whole range need not be subjected to processing. It is obviously in the interests of quality that low-level signals be processed separately, leaving the main signal to a linear path whose quality is not restricted by that of the variable-gain path.

Tracking at high levels becomes easier using this low-level approach, and a tracking error due to channel gain variation would occur at an unobtrusively low level. Additionally with this technique, it is found that sufficiently accurate tracking can be maintained using a control derived from peak and average signal values. Thus, the elaboration of an rms-derived control, which would strictly be necessary for channels having a non-linear phase-frequency response, is avoided.

Notice that in the subtractive part of Fig. 5(c), a negative feedback loop is effectively formed in the low-level "contribution" to the main path. Advantage of this is taken in the Dolby system (and in the JVC a.n.r.s. system) in that an identical network to that used to produce the additive low-level signal at the encoder, can be used in forming the subtractive component at the decoder, merely by inserting the network in the negative feedback loop of a main path amplifier. Among other things, this means a single processor can be used for both encode and de-

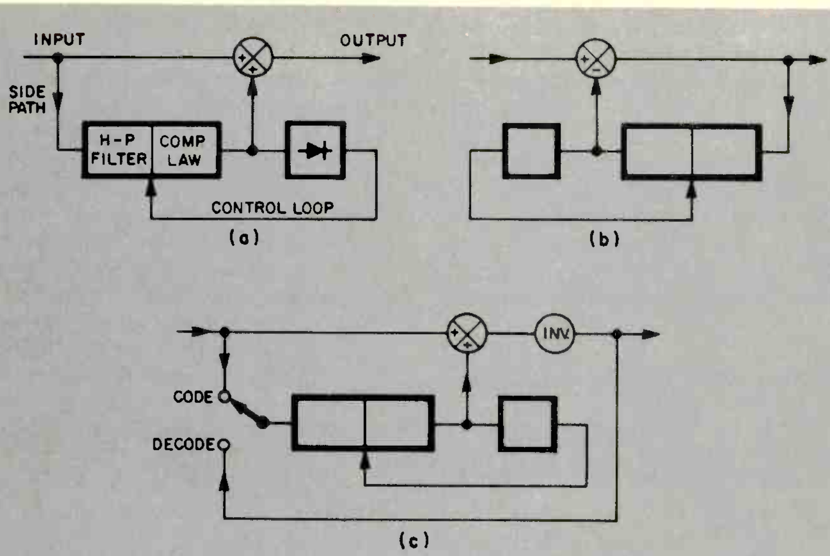



Fig. 9—Characteristics of Fig. 8 are realized by a voltage-controlled filter and compressor which adds up to 10 dB of subsidiary signal to the main path during encoding (a). In decoding, a similar network is used to subtract from the main path (b), the network forming part of a negative-feedback loop. This loop means that identical networks can be used for encoding and decoding. By placing the phase inversion in the main signal path, as shown (c), it can be left permanently in- circuit, simplifying encode/decode switching.

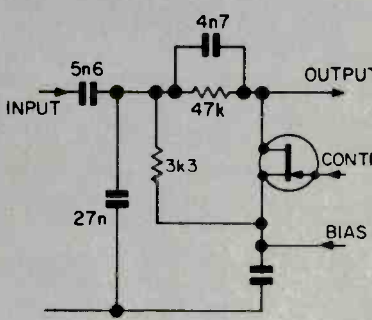



Fig. 10—Output of high-pass filter decreases after the compression threshold, set by gate bias, has been exceeded by the control signal. Response curve of combined fixed and variable filter sharpens when the two turnover frequencies coincide.

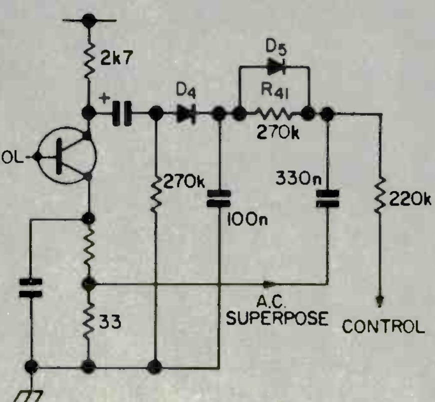



Fig. 11—Control-loop integrator has variable attack and decay times depending on speed and amplitude of signal changes. Large transients cause $D_5$ to conduct, shortening loop response time. Super-position of a.c. signal on control loop is to allow FET to operate symmetrically, thus keeping second harmonic distortion to a low level.



code functions by a suitable switching arrangement.

In a wideband compander of this kind having the kind of characteristic of Fig. 4, a low-amplitude signal below the operating threshold would result in the maximum amount of low-level boost being applied, and on decoding the noise level will be appropriately reduced; a high-amplitude signal would result in no noise reduction. Thus an intermittent high-amplitude signal could modulate the noise level, producing breathing (unless high-level signals were present in the same frequency band as the noise. This breathing can occur in any kind of wideband compander, of course).

In the Dolby A system, this effect is overcome by splitting the audio band into sections in the additive signal path, each section having its own compression and control circuitry. A high-amplitude signal in one band will not then prevent noise reduction being obtained in bands above and below. Within each band, the presence of a high-amplitude signal is relied on to mask, that is reduce the perceptibility of, noise components close to that signal. Studies of auditory masking show a shift in the hearing threshold in the presence of a (masking) tone, which effect can extend upward in frequency to a considerable extent; downward to a much lesser extent, the amount depending on the level of the masking tone.

When the economics of band splitting are judged against the extent of this masking effect, the amount of noise reduction required, and the value of threshold level in relation to the benefits of the additive technique, it turns out that four bands give a satisfactory compromise of cost versus performance. Splitting the band with 12 dB per octave filters in the ranges 80 Hz low pass, 80 Hz to 3 kHz band pass, 3 to 9 kHz band pass, and 9 kHz high pass would give a uniform 10 dB boost (and hence noise reduction) to low-level signals, as determined by setting compression threshold at 40 dB below peak operating level. By making the 3- to 9-kHz band-pass filter into a high-pass filter, an additional boost is obtained, gradually increasing from about 5 kHz to a maximum at 15 kHz. The lowest band provides reduction in the hum and rumble range, the second reduces mainly broad-band noise, tape print-through and cross-talk, while the upper bands reduce hiss.

## Dolby B-type System

The cost and complexity of the A system is not really appropriate to consumer products. Moreover, for slow-speed tape machines, in particular, the noise spectrum has a different distribution from that occurring in the studio situation, on account of the slower tape speed and thin oxide layers used in tape cassettes. Figure 6 gives a typical DIN-weighted noise spectrum taken from a low-noise ferric oxide tape cassette, showing the noise problem is mainly a mid- to high-frequency one. Noise reduction in the B-type system is therefore limited to this frequency range and Fig. 7 shows the amount of boost (hence noise reduction) applied at various input levels; a fixed high- pass filter in the subsidiary signal path, as is done with the Dolby system, would achieve this end. The Dolby system filter *also* has a variable frequency characteristic, but what about the noise modulation which in the A system is greatly reduced by the multiband feature?

In the B system, such a filter prevents high-level, low-frequency tones from activating the compression circuit, so there is no noise modulation by l.f. components. But there could still be modulation by high-level signals close in frequency to the filter cut-off. The trick used to avoid this in the Dolby B circuit is to move the filter pass band higher in frequency, so that the high-level signal would then be below the filter pass band. The curves of Fig. 8 show the effect of the variable-frequency filter under the influence of a high-level tone at three different frequencies; the lowest-frequency curve representing the lower limit of the combined filter's translation in frequency. As the figure shows, with a high-amplitude tone of 500 Hz applied, there is some 8 or 9 dB of noise reduction at 10 kHz; even with a tone at 2 kHz there is still some noise reduction obtained. Had the filter pass band remained fixed, these high-level tones would have caused the variable-gain element to operate, resulting in reduced or zero contribution from the subsidiary path, and hence little or no noise reduction.

Figure 9 shows a simplified block diagram of B-type processors, the encoder at (a), and the decoder at (b) with the same filter and compressor circuitry now in a negative feedback loop. In (b) a phase inversion is clearly required, which in (a) it is not. A simple dodge, that leads to a simplified encode/decode switching arrangement, is to relocate this phase inverter in the main signal path after the summing amplifier. The inverter can now remain in-circuit permanently, forming part of the feedback loop only during decode, Fig. 8(c).

**Circuit operation** The way in which the voltage-variable filter and compressor operates is interesting. A fixed high-pass filter, formed by the parallel combination of the 5.6- and 27-nF capacitors (fed from a low-impedance source, they are effectively in parallel) and the 3.3 kilohm resistor determines a turnover frequency of 1.5 kHz (Fig. 10). Imagine that a simple compressor then follows, i.e. a variable attenuator formed by a fixed resistor and the FET voltage-variable resistor (ignoring the 4.7-nF capacitor). The FET is to be controlled by a direct voltage obtained after rectification of the signal passed by the filter FET combination. Without any direct voltage applied to the FET gate, as would be the case for inputs of any level below the filter passband and for low-level inputs within the passband, the FET resistance is nominally infinite. The filter circuit would thus give minimum attenuation of h.f. signals and pass them to the main path, allowing h.f. noise reduction to be obtained. When an h.f. input is of sufficiently high level for the control signal to overcome the FET bias (this determining the compression threshold), the direct voltage to the gate would cause the FET resistance to fall, attenuating the signal, and reducing the amount passed to the main path. As the h.f. signal increased, a progressively smaller amount would be returned to the main path. Operation of this principle is shown by the curves in Fig. 7(a), which in fact apply to the Dolby B and a.n.r.s. circuits.

By replacing the fixed resistor with a capacitor (4.7 nF) in series with the FET resistance a second, variable, high-pass filter is formed. With increasing FET gate voltage, actioned by an increasing signal frequency and/or level, the filter characteristic rises in frequency, "overtaking" the fixed filter curve to largely determine a new, higher, pass band (after equilibrium between signal level control and filter is reached). Thus the frequency at which a significant signal is returned to the main path is raised, as depicted in Fig. 8, preserving some h.f. noise reduction in the presence of mid-frequency signals. In the region where the two filter curves are close, the combined filter shape is sharpened to around 10 dB/octave, so the effect of the filter action is heightened in this region, and the immunity of the circuit to noise modulation therefore improved.

## Dynamic Operation

To avoid modulation products being generated by rapid changes of gain in the compressor, which may or may not be canceled in the complementary expansion process, a long attack time is desirable in the rectifier circuit providing the FET control voltage. On the other hand, a short attack time is needed to minimize the effect of overshoots, which could have an amplitude equal to the amount of compression.

The elegant solution chosen is to use a time constant that depends on the rate of change of signal. Referring to Fig. 11, the 2.7-kilohm collector resistor and the 100-nF capacitor allow rapid following of a slowly changing input signal. But the time constant of the 270-kilohm ($R_{41}$) and 330-nF component gives an attack time for the control signal of 100 mS—long enough to prevent audible modulation products being formed. Diode $D_5$ is not brought into conduction because the voltage drop across it is never large enough (the discharge time of the 100-nF path being shorter than through the 330-nF capacitor). For large transient changes of input signal, the potential across the 100-nF rises faster than that at the 330-nF capacitor so $D_5$ conducts, reducing attack time to around 2 mS or less. Between these two extremes, charging of the 330-nF capacitor is shared by $D_5$ and $R_{41}$, as determined by the potential difference across them.

While the effects of transients are limited by the variable attack time, high amplitude transients require more rigorous treatment. Overshoots, as a result of the control loop not operating quickly enough, are limited to a maximum amplitude of 2 dB by two silicon clipper diodes. When added back to the main path the clipped subsidiary signal can result in a momentary distortion of between 2 and 4 per cent, lasting for around 1 or 2 mS. This distortion is momentary, occuring when the causal program transients mask the distortion and the ear is least susceptible to it.

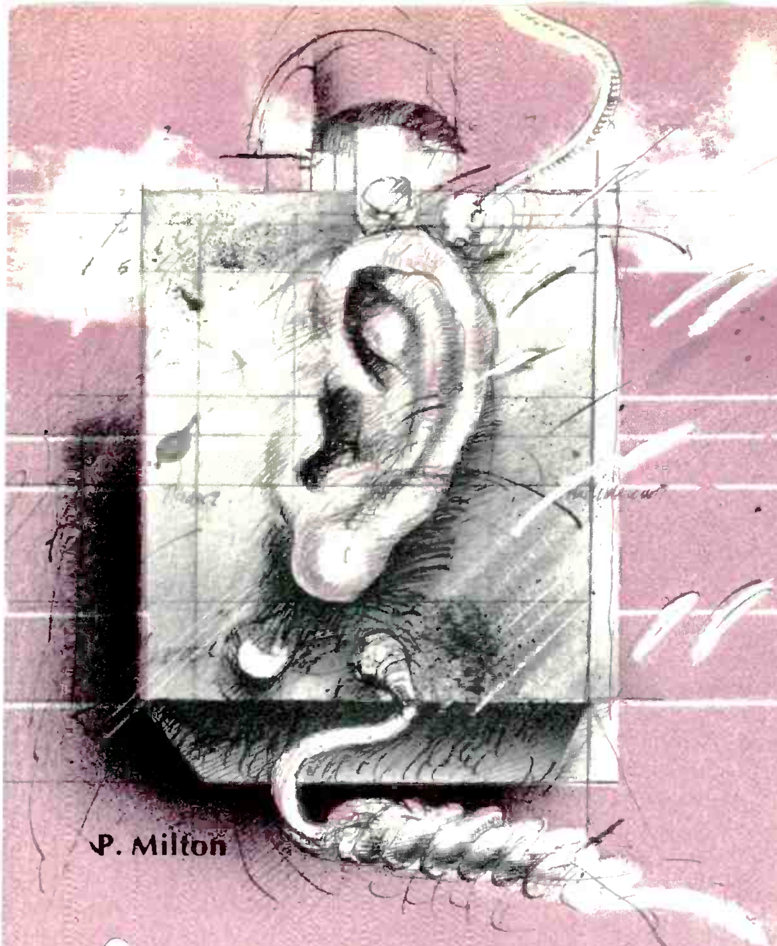
As with attack time, recovery time is as much a problem—it must be so short that noise reduction immediately following a high amplitude signal is restored within the time the ear takes to recover its normal hearing threshold, but not so short that low-frequency or modulation distortion results. The Dolby A system insures a 100 mS decay time normally, but for large sharp reductions in signal level this value is reduced. The variable decay time is not a feature of the Dolby B system.

In Fig. 11 there is a proportion of a.c. signal from the emitter resistors superimposed onto the direct control voltage. This is to maintain symmetry of operation in the FET and thus keep second harmonic distortion to a low level by ensuring that $v_{gd} = v_{gs}$. Therefore an a.c. signal is applied to the gate that is half the value of that at the drain. By this means, and by keeping the signal voltage at the FET low by the capacitance divider prior to the FET, distortion is reduced from a peak of 0.5 per cent to 0.05 per cent (at 1.5 kHz and −15 dB).

This simplified introduction to noise-reducing systems should help in understanding operation of the B-type circuit, for which kit building instructions will be given in next month's issue.

## Acknowledgement

We wish to thank Dolby Laboratories Inc. for their cooperation in developing this design and particularly Ian Hardcastle for his valuable assistance.



# HEADPHONES—
## HISTORY AND MEASUREMENT

P. Milton

Stereo and earphones have been with us for a considerable time. The earliest account of a binaural sound experiment I have found was by E. Hospitalier in *L'Electricien* in 1881, which described the sound system installed in the Paris Opera House. A pair of microphones was used, one at each side of the stage, supplying a number of pairs to telephone receivers. Apparently, the listeners received some degree of localization, even if the sound quality was not sensational.

It was a short step to providing the earpieces with a head band, but for the next 70 years or so, headphones were relegated to communications and were only required to provide a side-tone for CW reception, or at most, intelligible speech.

The situation might have remained as it was, but for an enterprising young man named John Koss, who saw the possibilities for private listening, thus founding an industry. He described the beginnings of stereophones like this:

"When I left the service in 1952, I opened a small business in Milwaukee, leasing television sets to hospitals. It was fairly successful, by the standards of being able to play golf and have dinner out with the family occasionally, but after four or five years I became involved with Martin Lange, a wizard in electronics who talked me into the tube checker business.

"Dealing with servicemen and distributors was not exciting enough for me, and at that time we saw that the stereo craze was getting under way, and the big names of the high fidelity business, like Harman-Kardon, Scott, and Fisher, were entering a new phase. We thought that there was something that we might get into. It gave us a good excuse to go out and buy some hi-fi equipment, and I appreciated that.

"We bought a changer, added some electronics, and put some side wing speakers on it. It was good, but I thought that we should have some sort of gimmick. We could see, even then, that other products would try to dominate the small amount of room available in the home, and we would be competing with television and the electronic organ, so I thought that we should provide some sort of private listening arrangement. Perhaps we could have a plug at the back for a set of headphones.

"The headphones at that time were all communications types, and when we tried a set, we found that the concept was good, but the sound was terrible. We kept listening and trying to figure out why we could not change the electronics to make the phones sound right. After many attempts, we finally realized that the problem was with the headset and not the electronics.

"A lot of developments are the result of happy accidents. In the corner of the room there happened to be a triangular box which had about 20 small speakers scattered all over the front to try to get the effect of a large woofer. My technical knowledge was limited to the fact that a woofer was big and a tweeter was small, but I could see that even those speakers were much bigger than the one-inch ones used in the headset. I pointed to the box and said that it was too bad we couldn't have something the size of those.

"About half an hour later, the intercom rang and Martin called 'I've something for you to hear.' He had removed a pair of speakers, attached them to a headband, ripped the cushions from an old army headset, and glued them to the front. He had pasted cone-shaped pieces of cardboard to the back of the speakers and put the new headphones on my head.

"The difference was amazing. There were plenty of lows, and although plenty of work was needed, we had beaten the major problem. We managed to develop a set of headphones in time for the show in Wisconsin in 1958, and I started to sell the idea of private listening.

"Everybody thought the idea was super and wanted to buy phones to put them on their units. I very patiently explained that they were only available as a complete package. So they said 'Right, now how do we buy *those* phones and put them on *our* amplifiers?' The decision was easy. We saw that the world was full of record player companies, so our place was to be a *stereophone* company."

### How 'Phones Work

Stereo headphones are sufficiently new to be in a state of rapid evolution. If we regard the actual drive system as a "black box," headphones can be divided into two main types, which have come to be called *circumaural* and *supra-aural*.

DYNAMIC TYPE STEREOPHONE

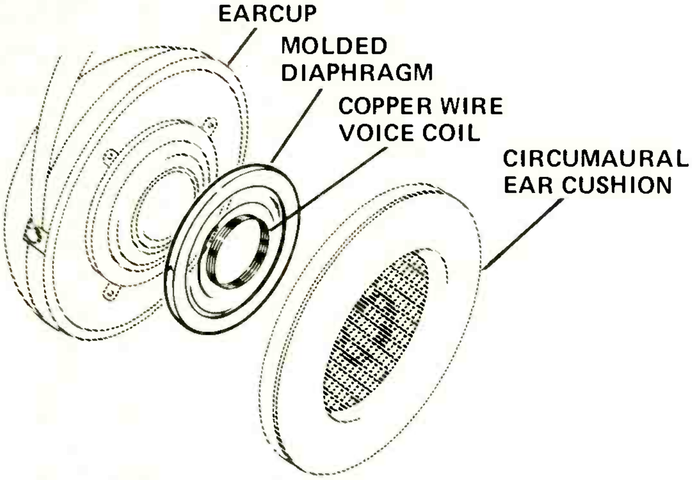



**Fig. 1—This telescoped view illustrates a conventional dynamic driver element using a voice coil and molded diaphragm.**

The circumaural types rely on a complete seal, in the form of a liquid- or foam-filled doughnut-shaped pad which surrounds the ear. The resonance of the moving system is placed fairly high, and at low frequencies the diaphragm produces pressure changes directly in the ear canal. The low-frequency performance can be extended to below 30 Hz, but it is very dependent on the efficiency of the seal. Long hair or spectacle frames can cause a drop in output below 200 Hz by between 10 and 20 dB. Completely sealed headphones isolate the listener and provide an acoustic environment in which all the sounds of reality, except those which are felt directly, are reproduced. The price to be paid is in extra weight and pressure around the ears, compared with the supra-aural or open-air types.

The present trend in design seems to be towards the lighter, open variety of headphones. The diaphragm is normally vented to the outside, via suitable acoutstic damping, and is spaced from the ear by urethane foam pads, which provide a more or less controlled resistive leak around the ears, or soft cushions which sit on the ear and perform almost the same function as the completely sealed types. The acoustic cavity is different, but they have the advantage of avoiding leaks caused by spectacle frames.

If a complete seal is difficult to achieve, then the philosophy of "If you can't beat them, join them!" applies to the open-air types. The response falls off rapidly in the bass and corresponds to a velocity characteristic. The art of design, in this case, is to select the right diaphragm resonance frequency and to adjust the acoustical and electrical circuit so that the output is reasonably level down to between 100 and 200 Hz. Slightly less bass than would be normally required with speakers seems to be acceptable with headphones, and this tends to be reinforced by current preferences for a tight and well controlled low end in speaker design, compared with the boom boxes which were popular just a few years ago.

The original stereo headphones used small loudspeakers as driving elements, and these are still used in the very cheapest units. The miniature speaker works well, particularly if it is properly sealed, to preserve the bass response, but for more accurate sound, a stiffer and more controllable diaphragm is necessary.

The Koss dynamic headphones use a molded-dome diaphragm, similar to a dome tweeter in shape, which is driven at its edge by a relatively large voice coil. The outer suspension is a single outward-going roll, molded integrally with the dome, which adds axial flexibility and some measure of extra radiating area. The diaphragm assembly is self-supporting and unlike a speaker, which is supported at the edge and at the center, is mounted at the edge only and allows the coil to move freely in the magnetic structure.

Good headphone design does not end at the driver. Comfort and weight also play their part in the acceptability of the product. It is little use having perfect reproduction, if it can only be heard for short periods. Figure 1 shows the basic construction of the dynamic driver from the latest example of the art, the Pro 4-AAA from Koss.

### ES-Type 'Phones

Electrostatic headphones have the attractive advantage that the mass of the diaphragm is comparable to that of the air next to it, and such a diaphragm presents a much better acoustic match than the relatively massive diaphragms of the dynamic types. The electrostatic charge is evenly distributed across the diaphragm, and the movement is essentially that of the electric charge and is essentially linear.

If a single-sided electrostatic transducer were used, the force acting on the diaphragm would be proportional to the spacing between the electrodes and second harmonic distortion would be produced. The problem is overcome by using a push-pull arrangement. A large, constant charge is placed on the diaphragm via a very long charging-time constant, and the audio signal is placed on perforated plates on either side of it. Under these conditions, the force acting on the diaphragm is determined only by the magnitude of the charge on it and the signal appearing across the plates. An exploded view of an electrostatic driver appears in Fig. 2.

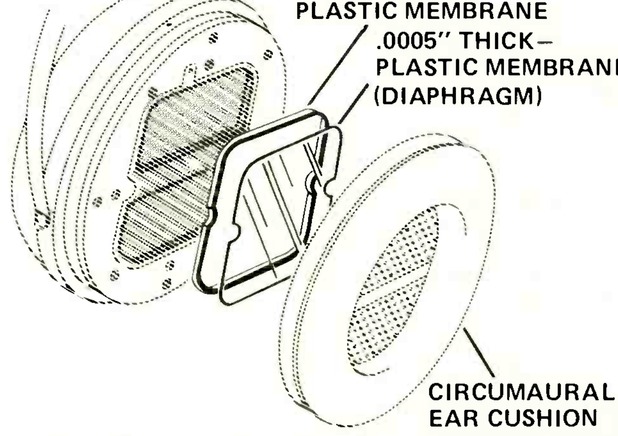
The uniform drive and superb transient response of electrostatic headphones make them a natural alternative to dynamic types, and nearly all of the best available headphones are electrostatics. They can be light, comfortable, and mercilessly accurate, but the necessity for an outboard power unit tends to make them substantially more expensive and not quite as easy to use as other types.

### Other Types

Yamaha has combined the advantage of the low impedance of a dynamic design with the even drive of an elec-

**Fig. 2—An ultra-thin membrane provides the diaphragm within the driver of an electrostatic 'phone.**

ELECTROSTATIC TYPE STEREOPHONE



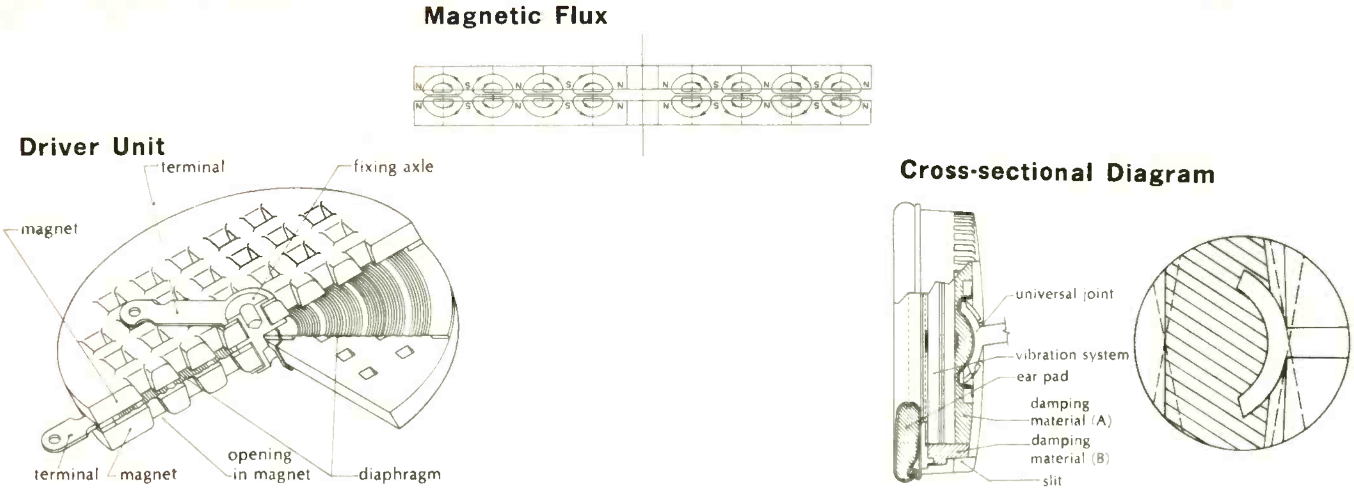



**Fig. 3—Construction of the Yamaha Orthodynamic headphone driver.**

trostatic diaphragm in their "Orthodynamic" driver. The heart of the arrangement is an extremely thin (12 micron, or 0.00047 inch) corrugated-polyester diaphragm, with an integral, spirally wound coil. The coil is divided into sections, each wound in alternate directions, and the assembly is mounted between two waffle-shaped, sintered magnets (Fig. 3). The magnets are pierced so that sound can pass and are magnetized in annular segments, corresponding to the sections of the coil. This forces the lines of flux in a radial direction along the surface of the diaphragm, thus ensuring an even drive. The headphone cup is vented around the edge to reduce the stiffness of the assembly, and isolation and damping are provided by pads of felt and urethane foam.

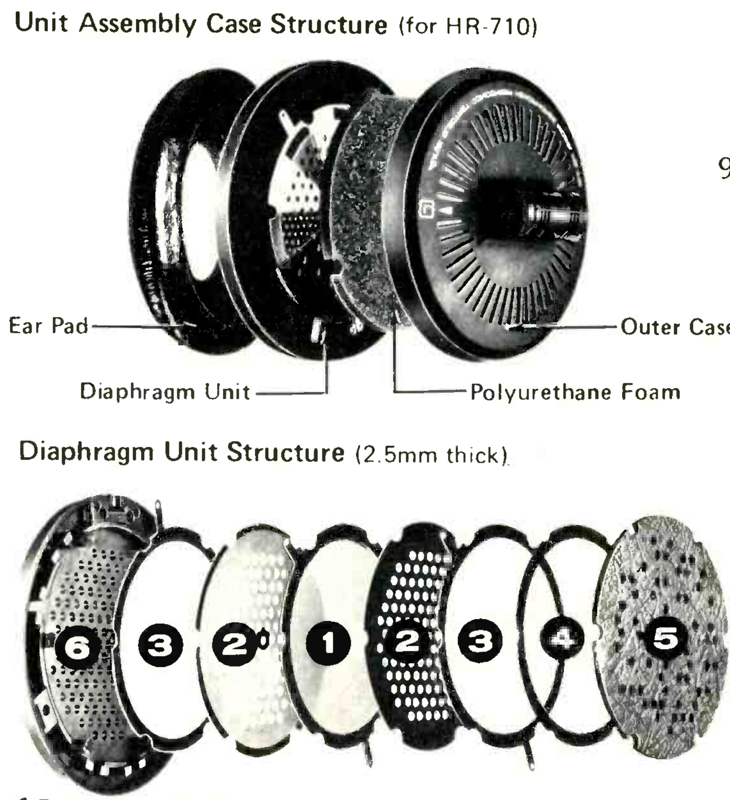
The British physicist Oliver Heaviside did not own a pair of electrostatic headphones, but he too was concerned about the impermanence of an electrostatic charge and the necessity to provide a continuous polarizing field. In 1885, he theorized that if a magnet produced a magnetic field, then an electrostatic field should be produced by an *electret*. Although Heaviside coined the word, it was not until 1919 that the first electret was made, more or less accidentally, by Mototaro Eguchi who was examining the electrical conductivity of cooling oils and waxes. He had poured a mixture of carnauba wax and a resin into a shallow, foil-lined dish and had hung a metal disc on silk cords just above it. A field of 10 kV/cm was applied while the wax was cooling, and a negative charge was measured on the surface connected to the positive electrode when the polarizing field was removed. After a few days, the charge disappeared and was replaced by a permanent charge in the opposite direction. Eguchi proved that this was a volume effect by slicing the wax into separate polarized layers and showed that this was similar to breaking a permanent magnet into sections.

The first U.S. patent for an electret microphone was granted in 1935, but the first practical electret microphones were made in Japan during World War II.

The chief enemies of the stability of an electret are humidity and high temperature, and until recently, the shelf life was limited to two or three years. The most promising of the new materials are the flourocarbons, and accelerated life tests at high temperatures indicate that under normal conditions, an electret can last about 500 years before the sensitivity will decrease by 1 dB.

Most electret microphones and headphones use a permanently polarized diaphragm, but the mechanical characteristics of the material and the amount of charge available do not always give optimum results. Toshiba's solution to the problem is a very low-mass, metallized polyester diaphragm, which is stretched between two perforated electret elements.

**Fig. 4—Construction of the Toshiba HR-710/810/910 series of electret headphones.**




**1** Diaphragm Membrane
(HR-710; 4 microns, HR-810/910; 2.5 microns thick)
The outer frame is the diaphragm membrane ring (0.6mm thick)

**2** Electrets (Back Electret Assembly)

**3** Anti-Condensation Membrane
(2.5 microns thick)
The outer frame is the anti-condensation membrane ring (0.3mm thick)

**4** Ring (0.3mm thick)

**5** Pressure Plate (ABS plastic 1mm thick)

**6** Unit Assembly Case

The system operates in push-pull mode, and by separating the functions of electret and diaphragm, Toshiba has been able to maximize the efficiency of the design and reduce the matching requirements to a small transformer incorporated in the plug (Fig. 4).

## Piezo Headphones

There is a whole range of substances which produce electricity when subjected to strain. The earliest known substance was quartz, which generated a voltage across the faces of the crystal when the crystal lattice was deformed. The reverse effect also holds, and a quartz crystal expands and contracts when a voltage is applied across certain faces of the crystal. The effect is called *piezo-electricity* and is not confined to crystalline substances. For the sake of those who are new to the word, *piezo* is pronounced with three syllables—*pi* as in apple pie, *ez* as in easy-pi.ezo.

Recently, a new piezo-electric substance was developed by Pioneer, and it has a natural application for headphones, microphones, and loudspeakers. The substance, vinyldene flouride, is a high-molecular-weight polymer which has 10 times the strain constant and a twentieth of the stiffness of quartz. The production of piezo-electric vinyldene chloride is similar to that of producing piezo-electric ceramics. The material is stretched to about four times its original length, and aluminum is vapor deposited on both sides. A high d.c. voltage is applied to the faces of the film, in a similar manner to charging a capacitor, and a residual piezo-electric property remains after the d.c. is removed. If two films are bonded together back to back, one will expand as the other contracts and the entire structure will bend. This arrangement is called a *bimorph element*.

The contraction of the film takes place at right angles to the direction of the voltage, so that if the signal is applied between the aluminized faces, the contraction will take place along its length in the case of a strip or along the radius of a disc.

In the case of the Pioneer headphones, the diaphragm is bowed slightly and clamped at the edges. When the material changes dimensions under the influence of the signal, the length of the arc changes, and the center is forced to move backwards and forwards. Figure 5 illustrates the movement of the diaphragm; the complete assembly consists of a perforated suspension board supporting the diaphragm and a urethane damping pad (Fig. 6).

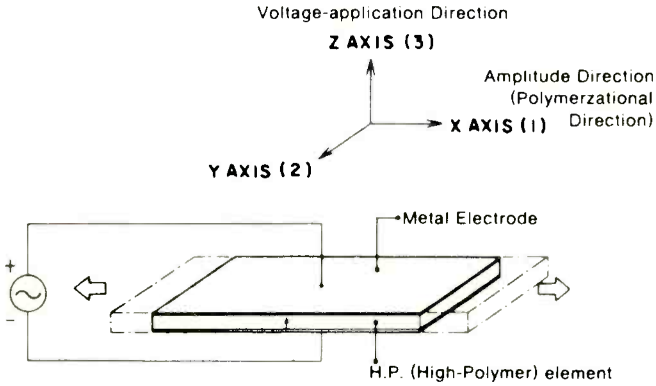
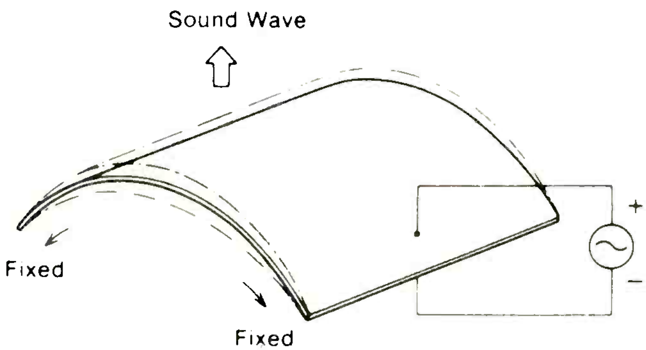



**Fig. 5—Above, when a voltage is applied across the plates (Z axis), the piezo-electric element moves along the direction of the X axis. Below, when an a.c. voltage is applied to the aluminized surfaces, the piezo-electric material expands and contracts. Since the edges are clamped, the element is forced to move.**




## Why They're Not "Flat"

The private world of headphones presents an entirely different acoustic environment from a normal listening room. We expect to see amplifiers with an absolutely flat response from d.c. to light and demand that our speakers produce straight lines across the graph with no phase deviations. We acknowledge the effects of the room and are doing something about it, yet although the direct coupling between the linear movement of the headphone driver and the ear canal should remove most of the problems associated with listening to speakers, when we hear a set of headphones with a flat response, they sound terrible.

Headphones present problems of their own, and to see why, let us look at the "hearing system" of Fig. 7. The loudspeaker is on one side of the room, and the sound produced takes an infinite number of routes to reach the ear. It travels directly, and it will reach the ear from almost any direction via multiple reflections from the surrounding walls, and is thus both delayed and changed in frequency response.

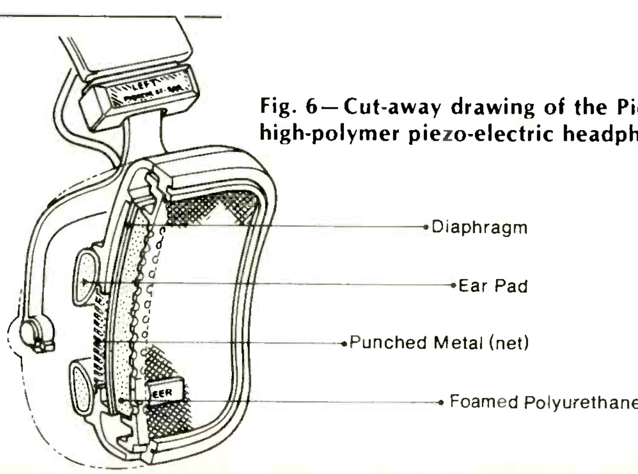



**Fig. 6—Cut-away drawing of the Pioneer SE-500 high-polymer piezo-electric headphone.**


**Fig. 7—Block diagram of the "hearing system" designed by Mother Nature.**

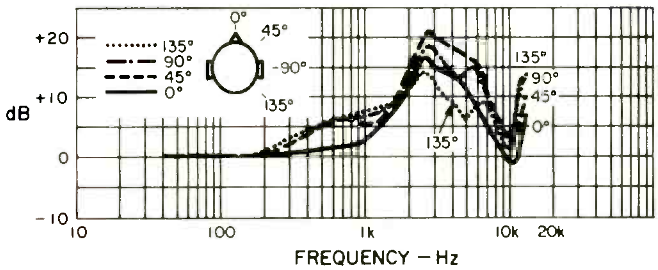



**Fig. 8—Transformation of sound pressure level from free field to eardrum (after Shaw).**

The external ear, or pinna, also has an effect on the sound. Those complicated flaps and folds have distinct resonances which are excited to a greater or lesser degree, depending on the direction of the sound and alter the frequency characteristic before the sound reaches the eardrum. Figure 8 shows the effect of the external ear on the sound pressure at the eardrum compared with the free field. The acoustic gain increases rapidly from about 1500 Hz and reaches a maximum of 17 dB when the sound is coming from the front. Sounds coming from 45° are increased by 21 dB and towards the rear the gain falls, but even sounds from directly behind you do not go below +6 dB.

This huge increase is due to the primary resonance of the pinna at 2600 Hz and is maintained up to about 5 kHz by the resonance of the concha, which is the funnel-shaped area just in front of the ear canal. The curve shows a dip in the response to sounds coming from the 135° direction at 4.5 kHz, caused by diffraction at the edge of the external ear. The lack of symmetry in the directional pattern plays an important part in sound localization, particularly in distinguishing between front and back.

Our ears are all different, and it is reasonable to expect wide variations between individuals. This being so, it would seem futile to have perfectly linear sound equipment, since we all hear differently. This, of course, is wrong. We listen with the same pair of ears all the time, and all our judgments regarding the accuracy of sound are done through them.

A loudspeaker is only required to produce an accurate sound field at the listener's ears. The rest of the "equipment" will be constant.

Figure 9 shows the situation when headphones are worn, and note that two important elements are missing—the room and the external ear. Suitable electronics could simulate the reflections caused by the room, but we are still left with the task of compensating for the response of the ear. The question is "What should the frequency response of the ideal headphone be like?"

There have been two ways to measure headphones. The simple approach for the circumaural types is to use a flat plate coupler. As its name suggests, the microphone is mounted flush with the surface of a board and the headphone is placed over it. No account is taken of the volume taken up by the ear or of the texture of the board. It is simply a method of comparison and superimposes its own series of resonances on the correct response.

The second method is a bit more scientific. There is in the audiometric branch of the art a standard 6-cc coupler. The microphone sits at the bottom of a cavity of this capacity and the earphones, usually supra-aural, sit over it. Audio-metric earphones are standardized, and an enormous amount of data has been collected regarding the complete performance at discrete frequencies. In spite of the dignity imparted by the work done by distinguished scientists, the 6-cc coupler is not a really good tool for measuring hi-fi phones. It gives repeatable measurements, but the best we can say is "These sound right to me, and this is the response obtained with the coupler. Other headphones with the same response should therefore sound the same."

The coupler itself does not confirm the accuracy of the headphones, all it does is to act as a transfer standard. What we require is a measuring system which has the same physical shape and acoustical performance of a real human ear. It would be sufficient to have a replica of a human ear which is essentially complete, except for the eardrum and ear canal.


**Fig. 9—Block diagram of the "hearing system" designed by John Koss, et al.**

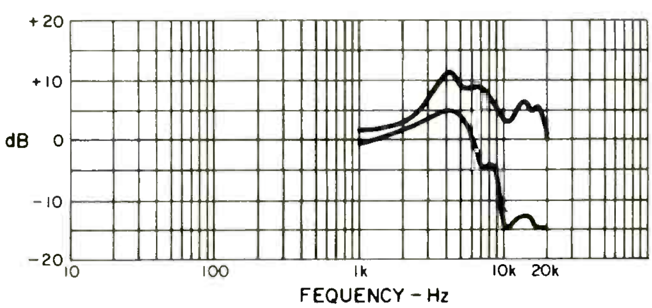



**Fig. 10—Envelope of transformation of sound pressure at entrance of blocked ear canal for various angles, average of 10 subjects (after Shaw).**

Dr. A.G. Shaw, of the National Research Council in Ottawa, Canada, has done extensive research on the performance of the external ear, and Fig. 10 shows the average response of 10 subjects to sounds from various directions when the ear canal is blocked by a specially fitted plug. Since we receive sounds coming from all directions, we could say that these curves would form an envelope for an "ideal" response taken with an artificial ear with a microphone placed at the entrance to the canal. There are still variations in performance which are due to differences in sealing and different positions, but at least we now have access to an "idealized" response envelope with which to compare the performance of real headphones under normal operating conditions. Now that we are on the threshold of producing the "perfect" headphone, what next?

Why not put a dummy head in the best seat in the house and place microphones where the ears should be? This is not exactly a new idea. It was first demonstrated by Alexander Graham Bell at the Columbia Exposition in 1892 in Chicago and has been resurrected every few years since then. There is an attractive simplicity about the whole concept. By using a model head, all the time delays and phase relationships between the ears would be preserved. Unfortunately, the practice falls down on several counts. The first is that no two ears are alike, so the directional clues which are associated with the world around us will not conform well with our own experience. The second is that if the ears on the dummy head were acoustically the same as real ears, then with "ideal" headphones, the modification of the frequency response would be doubled.

Either we should resort to probe-type headphones, or a relatively complicated network should be used for *kundstkopf* or dummy-head recordings. The *kundstkopf* technique does to a certain extent overcome the primary objection to headphone listening that the action is all in one's head. There is a side-to-side impression and things happen to the rear, but there is very little, if anything, happening in front. Even with the dummy head, circular space seems to be deformed into a bent figure eight, with very little front-to-back resolution. For this reason, the technique is better suited to plays, where verbal clues and more or less familiar surroundings augment the purely audible directional cues.

Work is going on to overcome the final obstacle to truly realistic sound when wearing headphones—getting the sound outside the head. Benjamin Bauer suggested his cross-feed circuit, which reduced the effects of absolute isolation between the ears and produced a delay effect at low frequencies.

Recently, workers at the Matsushita Electric Co. have proved that the ratio of direct-to-indirect sound is important when producing "out of the head" localization and have even produced the effect using mono recordings by creating delayed indirect signals electronically and mixing them with the original recording. They have produced a new system for listening to stereo, based on the idealized frequency characteristics of sounds reaching the ear from 30 degrees and using a bucket-brigade reflection generator, although this is not yet available in the United States. For those who wish to try the idea, a suitable circuit is described by Dr. M.V. Thomas in the July/August, 1977, *Jour. of the A.E.S.*

Headphones are getting better, lighter and more comfortable almost by the day. Soon, it seems, the last reasons for objecting to the sensation of listening to inner space will disappear, and we will be able to choose the aural perspective we desire.

Koss' Doc Severinson need no longer stand with his back to the orchestra!

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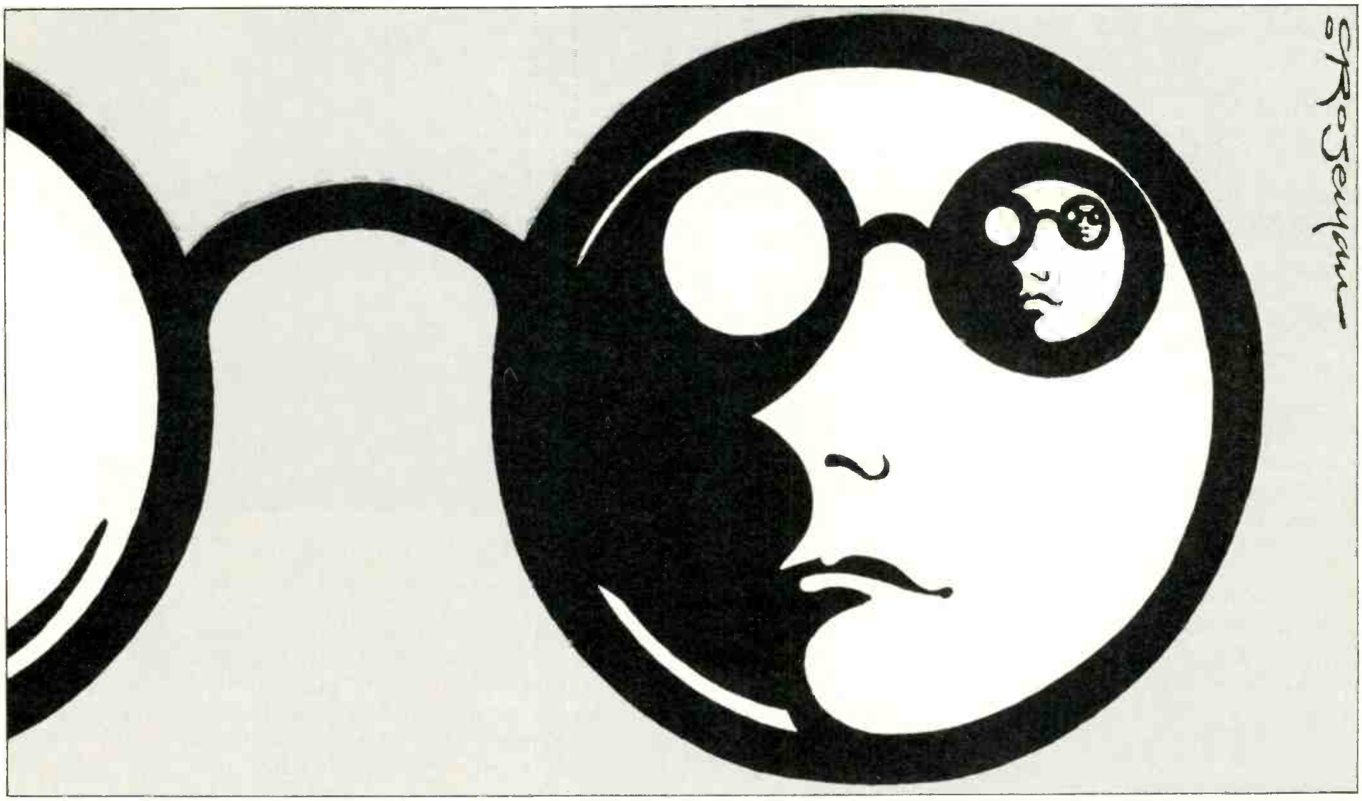
Michael Tearson

Jon Tiven

# The column






**Excitable Boy:** Warren Zevon
**Asylum 6E-118,** stereo, $7.98.

**Excitable Boy** is an exciting album, leagues better than Zevon's first Asylum album, released over a year and a half before. Jackson Browne again produced, this time with guitarist Waddy Wachtel, and their job is far more surehanded than on the first one. Zevon's songs are as bizarre and striking as ever, but more compact and commercial without sacrificing any guts. The single greatest improvement is in the sound. Greg Ladanyi, who also engineered Jackson's strong **Running on Empty,** has performed brilliantly. His use of the Aphex Aural Exciter on the voice brings Warren all the way into the room, not singing through gauze as he sounded on his debut. The bass is punchy, the drums are crisp, and Waddy's guitars are downright rude.

Zevon's done his job, too. He's singing fully a quantum better. And he's supplied some A-1 songs. *Werewolves of London* has HIT written all over it. *Johnny Strikes Up the Band* is an anthem to rock & roll. *Veracruz* is a beauty about an imaginary Mexican revolutionary who might as well be real. *Lawyers, Guns and Money* is an hilarious song about the ironic end of a dissolute. *Accidentally Like a Martyr* is a very pretty, sad love song. *Tenderness on the Block* is a coming-of-age song that also could be a hit— it's got that mysterious ingredient called "teen appeal," but I like it anyway. Throughout there are odd, often desperate people doing dangerous, often funny things.

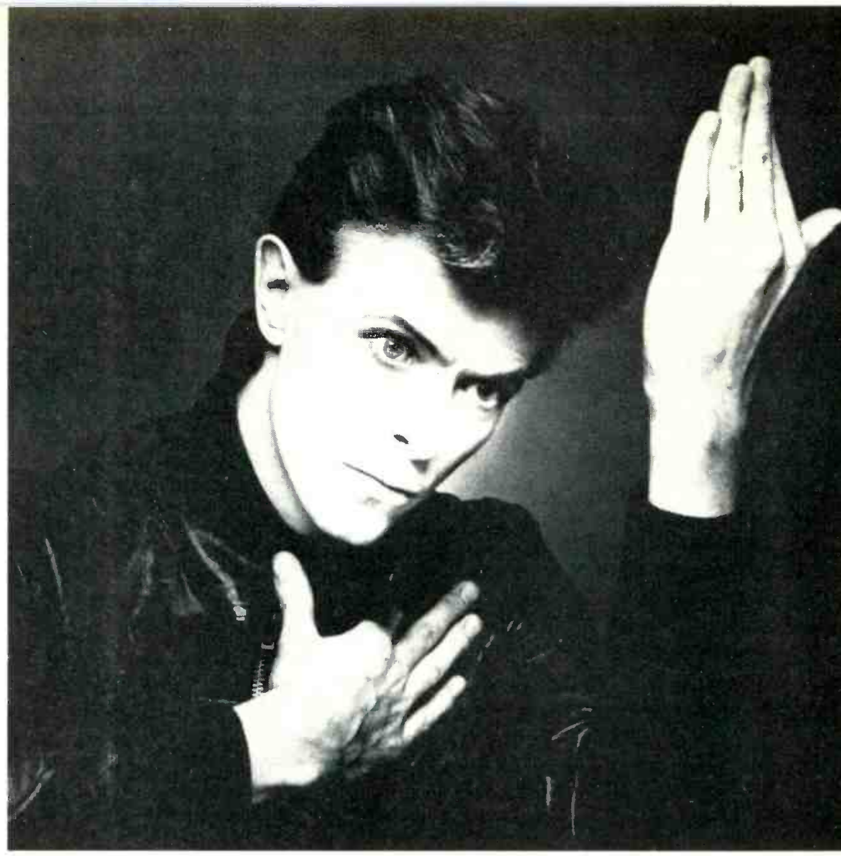
**Excitable Boy** has turned out much, much better than I expected it would. Everybody took their time to get it all absolutely right, but best of all, it doesn't sound contrived or stiff at all. Instead it's lively, fresh, and vital. With one notable exception. Through a mistake either in mastering or pressing the take-off grooves are a wash of noise that extends yea far into each side's final selection. Points off the sound rating for that. *M.T.*

Sound: C+ Performance: A−

**Heroes:** David Bowie
**RCA AFL1-2522,** stereo, $7.98.

David Bowie is a most peculiar artist, prone to periodic shifts in direction which make some of his albums seem like aural *non sequiturs.* His earliest days were steeped in the Anthony Newley tradition, followed by a hard rock binge and a touch of the poofter, with his last persona being the Duke of Disco. However, on his previous album, **Low,** we found this patron of the arts taking cult figure Brian Eno (formerly a synthesist with Roxy Music) under his tent for a blast at *avant garde* big beatism, and **Heroes** is for all purposes the sequel (from what I understand, it is actually the second part of a trilogy). Although **Low** was exceptionally innovative and fairly consistent composition-wise, **Heroes** is more of a hit-and-run effort. While *Heroes* is truly a viable rock anthem, *Sons of the Silent Age,* an entertaining throwback to Bowie's *Space Oddity* period, and a few of the rest hit their mark, there are quite a few minutes of wasted space here . . . not enough to prevent one from purchasing the record, but enough to warrant minor criticism.

There is a method to the apparent madness that dominates the record; David Bowie has gone for a method of recording/composition which seems to



have emerged only recently but often reaps great rewards . . . that being the writing of the lyrics and melodies to a song after the basic track (bass, drums, keyboards, and guitar) has already been recorded. In fact, these extended jams can turn into some fine songs a good part of the time—obviously Bowie really liked one of them, for he used parts of it on two tracks here . . . *Blackout* and *Beauty & the Beast!*

From what I am told, the sales on this record and the one before it were far below Bowie's disco meanderings, but I hope that he would have the courage to continue with this approach at least a little while longer. It is true that anything would be more lasting in its appeal than the **Young Americans** phase of his career (his best selling and least artistic record), this one in particular would be Bowie's best bet at making his dent in history. If slightly off-the-wall pop music appeals to you, this fellow has a lot to offer—he makes a far better eclectic than mainstream artist. *J.T.*

Sound: A Performance: B+

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**Rubicon**
**20th Century T-552,** stereo, $7.98.
**Striker**
**Arista AB 4165,** stereo, $7.98.
**The Godz**
**Millenium MNLP 8003,** stereo, $7.98.

The corporate rock syndrome strikes once again, as three new groups arise upon the scene, none of which containing any musicians who anyone has ever heard of before—but with three name producers there's a hit here as sure as a heart beats beneath the three-piece suit of every record exec. Rubicon, Striker, and The Godz have absolutely nothing new to say musically—in fact, you could easily take the "new" out of that sentence and still feel safe—while lyrically they are as adept as your nearest greeting card author. However, the rule of the game seems to be that breaking ground and/or going out on a limb are a sure way to bankruptcy so each and every one of these groups has at least a decent chance of making it to the top twenty; do not abandon hope. All they need is seven weeks in a row on "Midnight Special" or an act of Lee Abrams.

Let's take them apart one by one, as if you could actually do it without the record covers to be your guide. **Rubicon** is a creation of Richard Podolor (producer of Three Dog Night) and they seem to be lacking in direction to say the least. Every song is headed in a different direction, but they all end up in the same place . . . nowhere. To try to describe what their music sounds like would be a far more adventurous task than the making of this record must have been, so in all fairness to the group this writer will refrain from doing so and go on to **Striker.** Produced by Harry (Bay City Rollers) Maslin, this foursome seems to have been created in the image of the Babys, but if you can imagine a group with a greater gift for mediocrity, you'll have Striker. The physical resemblance is where the comparison ends—they put Michael Corby in the same league as Jimmy Page (from whom Corby was reputedly cloned) as an instrumentalist.

The **Godz** are by far the best of this lot, for they are merely lacking in taste and talent. Their producer is at the boards for his first time, but his name should be familiar to some of you as he was a musician when last seen, playing with Grand Funk Railroad . . . Ladies and Gentlemen, Mr. Don Brewer! He has found a group to take off where he and Mark Farner began, and thank heaven for that, as Kiss are getting a little too melodic these days.

If these be the last remnants of the Old Wave, I can't wait for the New Wave to get a firm grip on the record market. Creating groups out of air to fill a void left by the evaporation of dinosaurs has become a bad excuse to make records; there's got to be a better one, even if it's just to create new institutions which will soon become just as obsolescent. *J.T.*

Sound: B+ Performance: F

**Circles in the Stream:** Bruce Cockburn
**True North ILTA 9475,** stereo, $9.99.

As an artist Bruce Cockburn is a sensitive, caring man, and also a superb acoustic guitarist, absolutely in command of his instrument. This last aspect you can scrutinize on his instrumental pieces *Deer Dancing Round a Broken Mirror* and the riveting *Cader Idris*. Additionally Bruce is a writer of unusual power with a highly developed visual poetic sense.

His performance throughout **Circles in the Stream,** a two-record live album, is brilliant, no less. Aided by percussionist Bill Usher, Pat Godfrey on keyboards and sundries, and Robert Boucher's stunning upright and electric bass work, this is a captivating concert. The album has been purposely set up to simulate the concert setting as faithfully as possible. There is a beginning with a bagpipes fanfare, a middle, an intermission between discs, a second half, and an ending with encore. The program covers a primer of some of Cockburn's best songs: The oft-recorded *One Day I Walk*, the boozy feeling *Mama Just Wants to Barrelhouse All Night Long*, the very intense *Dialogue with the Devil*, the pristine beauty of *All the Diamonds in the World* and *God Bless the Children*, and the lilting *Love Song*. Bruce has also included some new songs, *Homme Brulant (The Burning Man)* in French, *Free to Be*, and *Red Brother, Red Sister*.

The production crew is composed of folks quite at home with Cockburn's personal music. Eugene Martynec has produced all of his albums, and mixing engineer Ken Friesen has worked on several. They have captured the live ambience very well with an airy, clearly concert hall sound a touch more distant than what they achieved on Bruce's last studio album **In the Falling Dark,** but impressive nonetheless.

If you're not aware of Bruce Cockburn, **Circles in the Stream** is the obvious place to start. Both it and the artist are most rewarding. *M.T.*

Sound: B+ Performance: A

**Heaven Help the Fool:** Bob Weir
**Arista AB 4155,** stereo, $7.98.

The Richard Avedon cover photo oozes pop star. And this cute Mr. Clean is a charter Grateful Dead member. **Heaven Help the Fool** is produced by Keith Olsen who also did the Dead's recent **Terrapin Station.** His song sense pervades the album as it did on **Terrapin.** The material is most melodic, often almost sing-songy with a light lilt of swing. However, in all fairness I should note that the previous Bob Weir solo, **Ace,** was also an extraordinarily tuneful album with the best version of *Playing in the Band* as well as such strong songs as *The Greatest Story Ever Told, Looks Like Rain, Black Throated Wind,* and *Mexicali Blues* on it.

**Heaven Help the Fool** is not quite up to **Ace** though it has some fine moments, especially on the stronger first side. As fine as *Bombs Away, Salt Lake City* (kind of a reworked *Kansas City*), and the cover of Little Feat's *Easy to Slip* are, the album misses the extra kick that an absolutely killer cut gives you. Still this is the song stuff that late 70's mainstream pop is made of. And **Heaven Help the Fool** is swimming right along with the current. As handsome and stylish as it is, it should do very well. *M.T.*

Sound: A− Performance: B−

**Safety in Numbers:** Crack the Sky
**Lifesong JZ 35041,** stereo, $7.98.

They emanate from Pittsburgh, these American exponents of what I call "clever rock" in the 10 cc tradition. They display an aggressive command of the studio which they mate to sardonically pointed, often funny material.

**Safety in Numbers** is the band's third album, and it finds them midway through a personnel change involving both a new singer and a new writing team. Though there is some unavoidable schizophrenia in the album, it doesn't untrack them. One of the holdover numbers from the prior lineup, *Nuclear Apathy,* opens the album with a big production number and a furious pace which does not let up. The ironic nature of their material almost demands the band's cool, distant stance, but it allows them to be ambitious while entertaining. Their ear-twitching use of stereo effects and clean recording adds a lot, too.

Few American bands have attempted this kind of music which relies on constant risk taking. **Safety in Numbers** is spotty, but its heights are high indeed. These guys are contenders. *M.T.*

Sound: A− Performance: B−

**Bat Out of Hell:** Meatloaf
**Epic PE 34974,** stereo, $6.98.

The opening song which lends the album its name is a real mother. Weighing in at 9:48 minutes duration, it is a massive, thundering behemoth. The neo-Spector wall of sound that characterizes Todd Rundgren's production, joined by a melody from right out of *Thunder Road,* makes for an insistent, unforgettable track.

From there the album loses its focus although it tries hard to maintain the furious pace it has set for itself. *You Took the Words Right Out of my Mouth* is a strong ballad plagued by a dumb spoken intro that utterly blows out the mood, which is never quite regained.

Jim Steinman writes the songs like a Harry Chapin possessed by demons. Sometimes he achieves great power best exemplified by the title song, but more often his writing is overblown, especially on the slower material.

Rundgren's production is ambitious. His band, Utopia, provides much of the support with the addition of Bruce Springsteen's pianist Roy Bittan whose presence is highly appreciated. But between the writing and the production, the album all but drowns in ambition.

Incidentally Meatloaf is the lead singer, not the name of the group, and his work is quite impressive. He has a big, big voice and a strong sense of drama. The Meatloaf-Steinman collaboration has great promise indicated most surely by the album's imperfections. This is an auspicious debut.

The amazing cover painting is by Richard Corben who renders "Den" for "Heavy Metal," the adult comic magazine published by the "National Lampoon" people. If only you could play the cover. *M.T.*

Sound: B    Performance: C+

**Rick Danko**
**Arista AB 4141,** stereo, $7.98.

Rick Danko, bass player and one of three lead singers in The Band, has released his first solo album in the wake of the Band's apparent long-term hiatus. In marked contrast to Levon Helm's album of New Orleans style rockin' rhythm & blues, **Rick Danko** is entirely composed of tunes either written or co-written by Rick. And this is a guy with maybe five writer credits throughout the Band's recording history.

It is a sparkling, bright album close in both spirit and sound to the Big Pink experience and, suitably, all of his former mates put in cameo appearances. In addition, the album is a virtual lead guitar salad with such lumenaries as Ronnie Wood, Eric Clapton, Sir Douglas Sahm, ex-Beach Boy Blondie Chaplin, and unknowns Michael DeTemple and Jim Atkinson, along with Danko all having shots. Though personnel varies, the album still has a real consistency that never lets go. And the really inspired moments laced with *deja vu* are frequent and glorious. The voice that sung *Stage Fright* rarely had a better vehicle than the scorcher *Brainwash,* or a more jovial one than *What a Town* and *Java Blues.* Garth Hudson's accordion intro to *New Mexicoe* echoes *When I Paint My Masterpiece. Sip the Wind* builds to a bright intensity. *Small Town Talk* has been recorded a few times before, but Danko's own version is delightful, maybe the best.

Danko produced the set with Rob Fraboni who earlier worked with the Band. A more sympathetic ear would have been hard to find, and the album benefits.

To be honest, I didn't think Rick Danko was capable of this fine a solo album. I didn't think he was prolific enough, and I doubted his leadership potential. The big trap is the obvious one, comparisons with the Band. He neatly avoids this trap by revitalizing and playing the hell out of the sound with full integrity. *M.T.*

Sound: A− Performance: A−

**Storm Force Ten,** Steeleye Span
**Chrysalis CHR 1151,** stereo, $7.98.

It's a new Steeleye Span stalking **Storm Force Ten.** For the first time in memory, Steeleye has no fiddler. Peter Knight's replacement is John Kirkpatrick whose concertina fills the void, and alters the band's balance. Effectively they have replaced a soaring lead voice with a lower pitched, sturdy foundation. The band becomes more compact sounding, more streamlined. They have also altered their recording approach from the boomy, bottomy, somewhat-forced commercial sound of **All Around My Hat** and **Rocket Cottage. Storm Force Ten** hearkens to the rich natural sound of **Parcel of Rogues.**

The other new member is Martin Carthy, himself a member on the early **Please to See the King** and **Ten Man Mop** albums. He has had an obvious effect on their material. His interest in Berthold Brecht has led to their impressive performances of *The Wife of the Soldier* and *The Black Freighter (Pirate Jenny).* Both of these, *Awake, Awake* and the grand tableau *The Victory,* which relates the story of Lord Nelson, use extreme dynamics to strong advantage. Full-tilt passages giving way to near silence emphasizes the excellent recording quality. The sustained presence of the album is a credit to engineer and co-producer Mike Thompson.

Among the remaining material *Some Rival* stands out as a handsome love song set in history. *Sweep, Chimney Sweep,* an *a capella* chorale done to perfection, emphasizes the rich vocal combination of Carthy, Maddy Prior, Tim Hart, Rick Kemp, and Kirkpatrick. Maddy deserves individual mention for her best singing on record in several albums.

The turnover in personnel thus has forced Steeleye Span to reconsider their sound and direction. This is what they have done with no shortage of wit and cunning. They have made some of the best Steeleye Span music ever. Add a most beautiful cover package, and **Storm Force Ten** emerges as a solid achievement, a musical coup and fine entertainment. *M.T.*

Sound: B+ Performance: A−

# VTR-ing

Les Davis

What true tape recording buff hasn't at some time had fantasies about his ideal home audio recorder? If your tastes are similar to mine, your dream is to own a tape recorder whose performance surpasses even the best conventional analog professional studio recorders. Our dream machine would possess a frequency response that would be perfectly linear from far below to well above the limits of human hearing. Wow and flutter and crosstalk would be so low that they could not even be measured and certainly not be heard. Of course, this recorder's dynamic range would rival that of live musical performances, shaking you in your seat and making your heartbeat quicken in time with the thundering crescendos. Yet this hypothetical engineering marvel, to totally fulfill all of our expectations, should also have the ability to play the quietest passage without adding any noise to the music as well as reproducing music at any volume level with extremely low distortion. Sound incredible?

As difficult as it may be to believe, such a machine is not the wishful fantasy of an overly imaginative audio enthusiast nor is it as a result of crystal ball gazing into the distant future. Employing an offshoot of computer technology—a form of processing called pulse code modulation (PCM), which holds the potential to completely revolutionize the audio industry—this remarkable recorder is a reality today!

The world's first home PCM recorder is made by Sony. Although there are other PCM or digital recorders which are equally noteworthy (including studio recorders by 3M, Mitsubishi, and Soundstream as well as a completely self-contained home cassette prototype by Mitsubishi), the Sony unit stands out since it is the only home unit, at this time, actually being sold to the public. The Sony device, currently being sold in Japan, is a universal PCM audio adapter that turns almost any U.S.-type video recorder (Sony's Betamax or any other American Standard, NTSC video recorder) into the best home audio recorder so far.

The Sony PCM adapter has performance that, prior to the advent of digital processing, was unattainable by even the best recording studio mastering recorders. The adapter has a frequency response of d.c. to 20 kHz, linear to ±0.25 dB or less, with a dynamic range which rivals that of a live performance (95 dB or more on playback and 85 dB and up on record). Add to these impressive figures unmeasurable wow and flutter, the total absence of hiss without using a noise reduction device, almost no dropout or crosstalk, and a harmonic distortion level of 0.03 per cent or less, and obviously you have a machine that represents a giant leap forward in recording technology. How is this possible?

## Digital Dynamics

The pulse code modulation system produces superior performance as a result of digitally processing audio signals and in so doing overcomes most of the inherent disadvantages of magnetic tape recording. PCM solves these problems because it places only digital information on the tape and replays only these digital impulses.

Here is how PCM works: In the pulse code modulation system, the input from the mike is frequently sampled and measured. Then each measurement is converted (encoded) into digital (binary) impulses of varying lengths (representing 0s and 1s) which are subsequently recorded on tape. If you plotted each of these measurements on paper and connected the dots, you would find that you would have a graph that closely approximated the original sound wave. The more frequently these measurements are taken, the more accurate the graph would be. In fact, PCM machines use a super-accurate quartz crystal clock to automatically monitor the input from the mike, doing so 40,000 (or more) times each second. At this speed, with other circuits to fill in the blank spaces, the reproduction is so good that a listener never realizes that the program had been separated into a string of impulses (representing a list of numbers), then decoded and finally reassembled into a recreation of the original sonic program. Unlike the analog recording system that records or replays the electrical impulses directly onto or from the tape, as well as the noise present in the system, PCM treats only the digital impulses (which are later converted to sound), never the noise. Hence, in PCM, tape hiss is never reproduced, quiet passages are virtually noise free, and the PCM method of recording makes possible virtually unlimited duplication of tapes. Each "copy" produced becomes an identical electronic twin of the original, so much so that the 100th generation "copy" sounds as good as the master. Distortion caused by extremely loud sounds—a major problem in analog recording—is averted in PCM since the digital system's dynamic range is not dependent upon the intensity of the magnetized signal. Instead it is only dependent upon the number of pulses the tape can store. The more bits of information, the greater the headroom, and more than 1.4 million bits of information per second are needed to produce a stereo signal with a dynamic range of 85 dB.

## Helical Scanning System

Both the Sony PCM adapter and Mitsubishi's PCM home audio recorder prototype use the same helical scanning system designed for video tape recording. However, the two PCM machines differ in that the Sony PCM adapter converts the audio signal into a video signal and uses an external video tape recorder, while the Mitsubishi will be totally self-contained and is intended for sound reproduction only. Due to the high-frequency band requirements of PCM audio (over 1 MHz), the helical scanning video tape recorder is an excellent medium to fulfill the requirements of PCM audio since the video tape recorder was designed to handle 100 times the information of a conventional audio recorder. In the helical scanning system, the tape moves at a speed similar to that of audio cassettes, but the greater frequency response needed for video recording (and PCM) is obtained by spinning two video heads (which are mounted on opposite sides of a drum) at a speed of 1800 rpm in the opposite direction to tape travel.

Editing with PCM recorders using video tape is purely electronic and does not involve either cutting or splicing. Much greater precision is obtained by this method, and the recording tape is completely reusable because it is never spliced.

Recording time is up to two hours per videotape in both systems. Although four-hour record/playback capability is available on some video cassette recorders, Sony does not recommend using their PCM adapter in the four-hour mode since this slower speed is likely to cause dropouts and deteriorate the sound quality. However, I have learned that there is a new longer playing video cassette tape that JVC is secretly working on which will extend the play/record time of the two-hour PCM audio machines to three hours without any loss of fidelity. This tape will also extend the ½-in. video cassette recorders' capability to 1½ times their normal playing time on a video program. For example, with the new JVC extended play tape, a video cassette recorder that has a four-hour capacity per tape could record and play back six continuous hours of TV programs.

Since the Sony PCM adapter does not alter the performance of the video recorder to which it is connected, many audio buffs who buy this PCM adapter and a home video cassette recorder solely for the audio advantages will soon learn to enjoy the convenience of video recording too. But for those people who are not interested in video recording, there will be another option in the near future, the self-contained Mitsubishi Home PCM Cassette Recorder. Although the initial specs of the Mitsubishi are not quite as good as those of Sony's PCM adapter, they are still quite impressive, and the expected $2000.00 list for a self-contained recorder that outperforms conventional studio units should prove very attractive to both dedicated audiophiles and semi-professional users.

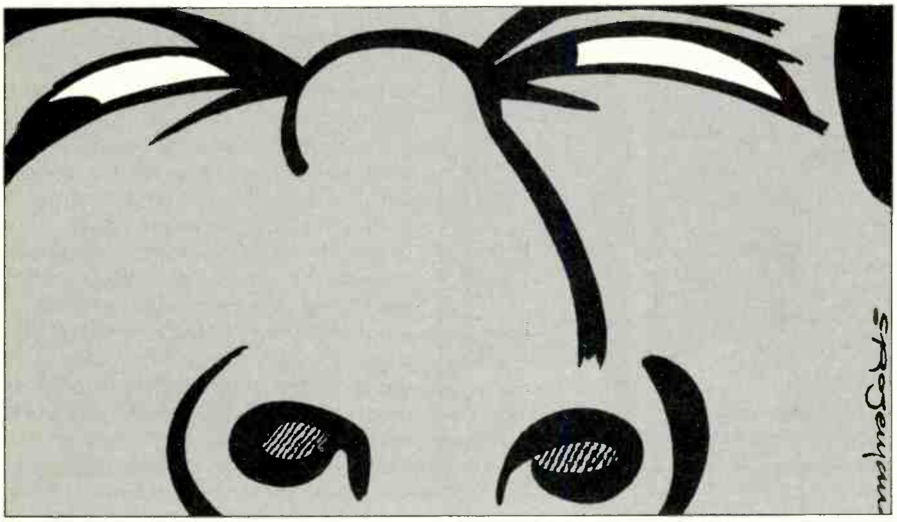
### Price Prognosis

Sony expects to market their PCM adapter in the United States either sometime late this year or by early 1979. The U.S. suggested retail price has not been determined at this time, but company executives inform me that, although Sony would like to price their unit as close to $1000.00 as they can, the changing relationship of the Japanese yen to the U.S. dollar could force the list price up to $3000.00. This, of course, would not include the cost of a video cassette recorder. Most home video recorders available today list around the $1000.00 mark (with actual retail discount prices going as low as $700.00). Therefore, the total price for the PCM adapter and video recorder will add up to between $2000.00 and $4000.00, depending upon the final price of Sony's PCM.

What impact will PCM recorders have on the audio industry? Sony's National Marketing Manager, Frank Leonardi predicts that "PCM units will totally replace conventional home (analog) recorders in the home in four to five years." He attributes this anticipated rapid consumer acceptance of PCM recorders to their amazing performance superiority over conventional machines and to the future availability of lower priced PCM recorders made possible by subsequent research and development. Leonardi tells us that "every major audio company is working on it now and trying to come up with some perfected, cost-effective version. PCM is definitely a trend of the future; all we have to do is to make it more affordable!"

PCM may well be the most significant development to hit the audio industry since Edison invented the phonograph over 100 years ago. It holds the potential to totally revolutionize the recording industry, not only with the superior PCM studio machines that will turn out better master tapes, but with commercially available PCM records and pre-recorded tapes that will virtually duplicate the excitement of the original performance. Prototypes of these studio recorders and PCM discs scanned by lasers are already today's reality, and the ultimate goal of the audiophile— perfection in sound—seems to be closer than ever. *A*

# Jazz & blues



**The Gene Ammons Story: Organ Combos**
**Prestige P 24971,** stereo, $7.98.

Jug's muscular, stomping sound is much in evidence on this reissue. Ammons can be heard at his visceral best on numbers like *Moten Swing* and *Twistin'* (sides one and two respectively). A powerful, big-toned player in the tradition of Coleman Hawkins and Eddie "Lockjaw" Davis, Ammons was also a master of the instrumental blues, as his *Stormy Monday Blue*s performance beautifully demonstrates. Heating up the Billy Eckstine classic, the tenor man's brawny tone takes on a sinuous cast, moving the blues line along with a graceful pulsation.

The popularity of the jazz tenor-organ combos reached its zenith in the early 60s when Prestige recorded these sessions. The organ's tonal resources were used, in lieu of a big band, by jazzmen who entertained on the "black lounge circuit." Personally, I find jazz organ harmonics generally sodden and heavy handed. Organist Brother Jack McDuff, however, rises above the limitations of his instrument, offering Ammons supple, lively support on the 1960 sessions covered by the first record of the double-set. Trumpeter Joe Newman and bassist Wendell Marshall also give a good account of themselves; Newman's solos are always attractive and often compelling. I could live without Ray Baretto's stilted conga drumming which tends to bog down the proceedings.

Record two focuses on a 1961 Ammons date with a group that featured organist Johnny "Hammond" Smith; Frank Wess, flute and second tenor; Doug Watkins, bass, and Art Taylor on drums—no congas, thank goodness. This is a loose, free-blowing session with both tenors cooking on a fast blues number called *Sid's Thing*. Rodgers and Hart's *Blue Room* swings along pleasantly with lovely work by Wess on flute and Ammons concise and crisp, hewing closely to the melody. On *Water Jug,* Ammons trots out what liner writer Bob Porter politely calls stock ideas (cliche and quotes). There's also a nine-minute version of *Angel Eyes* on which Jug manages to churn out some sinewy jazz despite the sugary overtones of the performance; flutist Wess and organist "Hammond" Smith blend deftly.

If you like Ammons and the tenor sax-organ format, you'll find this a very appealing collection. The Prestige sound is, as always, smoothly engineered, with Fantasy's David Turner doing the remastering on Rudy Van Gelder's original tapes.

*John Lissner*

Sound: A+ Performance: A−

**Hah!:** Milo Fine Free Jazz Ensemble
**Hat Hut E,** stereo, $5.50.

**Hah!** is the first album by the current line-up of the Milo Fine Free Jazz Ensemble. Actually, the designation "ensemble" is stretching things a bit, as the group has shrunk to a duo, consisting of drummer-pianist-clarinetist Fine and guitarist Steve Gnitka.

Gnitka is a thoroughly original abstract guitarist, whose self-developed approach owes virtually nothing to such more renowned guitar nihilists as Derek Bailey and Eugene Chadbourne. On pieces like *Numbers 8, 15,* and *21* (the numbers do not correspond to the bands of the record, but to the order in which the untitled textural-improvisations were recorded), he very briefly reveals a stylistic debt to Pat Martino and early (pre-Mahavishnu Orchestra) John McLaughlin. In a matter of seconds, though, he casts off these origins, advancing into an unexplored realm of uniquely unpredictable sounds and concepts. He expectorates spasms of unconnected notes and chord clusters, flings out agitated upward runs, and fabricates textures from all manner of dissonances, random knockings, eerie scratches, electronic hums, and extended silences. On *Number 9,* he sounds as if he's crunching a heavily bass-amplified rubber band between his teeth, until it becomes a cry of anguished frustration. Other peak moments occur on *Numbers 20* and *26,* where he constructs globular clumps from tiny tones packed tightly together.

Fine is a master at getting as much sound/music/noise (depending on your perspective) out of his instruments as possible without sounding excessive. On *Number 8,* he blends dancing cymbals, rumbling skins, and spastic rimclicks like a man possessed. On the last section of *Number 9,* he bows a cymbal to produce a grating machine-like whine; hear also the disjointed brushing on *Number 20.* Fine is equally at home inside a piano (building up overtones on *Number 9)* as he is on the keyboard itself. *Number 15* is a stunning display of power piano, with thundering chords yielding to fleet runs. His piano solo, *Number 25,* is a richly inventive tour de force, on the avant-classical side of McCoy Tyner; typically, the refreshingly melodic midsection gives way to immense dissonances. He has a clearer concept of how to accomplish his ends on the clarinet than before, as he shows on *Number 17,* with its two-note figures punctuated by harsh, raucous squeals and overblows which collapse into furious howls. On *Number 21,* though, he seems more repetitious and self-indulgent.

Though Fine's engineering is vastly improved over his earlier albums, the volume levels and tone quality are still less than optimum. The clarinet and piano come off well, but the drums are hollow and the guitar is somewhat distant. The last part of *Number 21* demonstrates an ingenious use of the recording medium, as Fine recedes far into the distance like a demented, clarinet-playing Pied Piper.

Hat Hut is a Swiss label available from a number of sources in the U.S., including Fine's own Shih Shih Wu Ai Records, 8120 Oakland Ave. S., Bloomington, MN 55420. *Tom Bingham*

Sound: C — Performance: A

**Pyramid:** Lee Konitz, Paul Bley & Bill Connors
**Improvising Artists IAI 37.38.45,** stereo, $7.98.

Paul Bley has been probing a very introspective course in recent years. After his initial barrage with the Bley/Coleman/Higgins/Cherry quartet of the 50s and 60s, and the electronic scribbles of the early 70s, he has settled into his own little corner of spacial airiness. It's a dome in which he sits self-sustaining, with no interruptions from outside. Bley surrounds his notes with space not only to create tension as Ornette so effectively does, but to bathe in the aura of his sound. "When I hear something I like," says Bley, "I like it to resonate and play itself out." And Bley has been hearing a lot of things he likes.

For **Pyramid** he has created a trio and duet setting for the arrid alto and soprano of Lee Konitz. Rounding out the trio is guitarist Bill Connors who seems to have found solace in Bley's world after the heavy metal fusion of Chick Corea's Return to Forever. **Pyramid,** while typical of Bley's recent work, also hearkens back to the Jimmy Giuffre Three of the early 60s. A trio with no rhythm section, the pulse is found in the melodies and the natural tension created in the improvisations. **Pyramid** is sparse and delicate but with an indefinable depth. Only on *Talk to Me* and *Play Blue* do they come down to earth. The first explores the unconventional sonics of their instruments to attain an exotic oriental flavor. Bley plays the inside of the piano, Konitz fingers without blowing, and Connors scrapes the guitar strings. *Play Blue* is a bluesy, balladic piece.

Music like this is very dependent upon the slightest nuances in shaping its sound. Paul Bley's Improvising Artists label is one of the few jazz labels to take the cue of ECM's Manfred Eicher. The sound is crystaline perfect and all the IAI records have clean pressings and colorful distinctive packaging. *John Diliberto*

Sound: A+ — Performance: A−

**Song For:** Joseph Jarman
**Delmark DS-410,** stereo, $6.98.

The Association for the Advancement of Creative Musicians (AACM) brought a new approach to jazz improvisation and composition that put free-playing in the context of precision ensemble playing. This new style blended tradition with anarchy. The conversational dialogue of New Orleans jazz was interpolated with the sonics of contemporary urban life. A finger-popping be-bop chart would be the conclusion of a frenetic blow-out. This Free Jazz was the result of having all music at your disposal and a consciousness of its roots in black history.

Joseph Jarman is a member of the AACM and its most flamboyant manifestation, the Art Ensemble of Chicago. **Song For,** recorded in the mid 60s and recently re-released by Delmark, shows a concept of sound and vision which is not worn away by time. *Little Fox Run* opens with clarion horn lines that reappear during the piece to underscore frantic solos by Fred Anderson and Jarman with William Brimfield's trumpet exclamations. It moves under the turbulent drums of Steve McCall. This intensity is contrasted against the solemn, languorous passage that leads *Adam's Rib* into its pensive mid-section of sustained sighs.

But the Art Ensemble is most renowned for its use of space, the ability to create tension and movement with very few notes. Like their masterful *People in Sorrow, Non-cognitive Aspects of the City* and the title track reveal a structural base around which the improvisations are formed that indicates low density playing with shallow rises and hollows. *Non-cognitive Aspects* couches an angry verbal abstraction by Jarman which has lost none of its intensity in the intervening decade. Charles Clark's bass scrapings, the percussive jangles, and Jarman's frustrated sax recitations heighten the darkness.

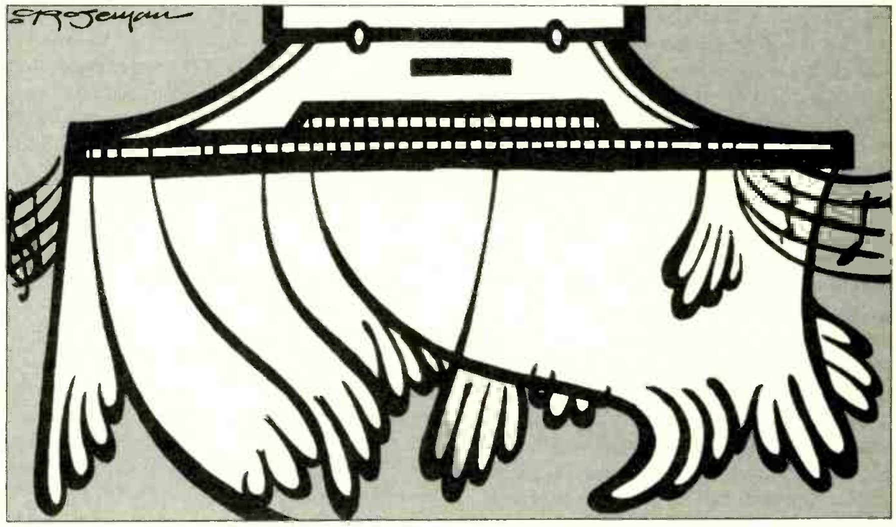
**Song For** is not a relic from the past, but a re-examination of a music that is not restricted to a specific time period. The recording is rough, not polished, with an edge that emphasizes the urgency of these musicians.

*John Diliberto*

Sound: B — Performance: A−

# Classical reviews

**Edward Tatnall Canby**



**Those Magnificent Music Machines.** From the collection of Doyle H. Lane, The Player Piano Museum, Vancouver, B.C., Canada. (Ensemble Productions), $7.95.

Here's a fascinating record, put out by a small outfit that isn't even a subsidiary label—exasperating for those searching for a copy. But, in any case, these are the big music machines. One of them I remember from my childhood, where it fascinated me in a nearby drugstore in Connecticut: the Mills Violano Virtuoso. It was a player piano with a violin attached, played by an incredible system of rollers, rosined, which rotated on the strings while "fingers" somehow managed to touch them for the right pitch. As recorded here, the piano is just fine (Chloe) but the violin, I'll hafta admit, sounds pretty crummy. There's also a 1915 dance organ from Belgium, a mechanical banjo that is actually plucked (c. 1900), a batch of early Seeburgs and Wurlitzers—before the days of the jukebox and the Mighty W., a German Polyphon, a music box run from a large metal disc with holes (my own brother liberated one of these, with austerity cardboard discs, from defeated Germany in 1945), a Tangley Calliope, run by steam (a *little* calliope, not the kind that used to carry for miles when the circus came to town), and, finest of all, a Chickering Ampico Grand, one of the aristocrats of the reproducing piano age. Funniest item for me was a pair of Brahms *Hungarian Dances* played on a real squawk box, with drum and cymbal. All in all, a disc to have around. Available from The Player Piano Museum, 3399 Dunbar St., Vancouver, B.C. V6S 2B9, Canada.

**Resurrexit, Gregorian Chant.** Benedictine Monks of St. Maurice and St. Maur, Clervaux. **Philips Universo 6580 105,** stereo, $7.95.

The age-old traditions of the Church's original chant were put aside long ago by the thrust of the developing "Western" type of multi-stranded instrumental and vocal music and until the later nineteenth century no one seemed at all interested in resurrecting them, restoring the official chant to a hypothetical authenticity. The Solemnes recreations did re-establish a "pure" style of unaccompanied declamation which grew to have an immense influence, no doubt chiefly because it is musical, and makes a useful and effective body of music for church use. Whether the Solemnes style is actually authentic is now a big question—but it still stands musically as a major advance in removing the accretions of later centuries. Inevitably, then, there are as many varieties of Gregorian presentation as there are dedicated choirs. If the radically revised Blackley Gregorian (Vanguard 71217) is technically the most advanced, there is all too much music still performed on the other side, conservatively out of earlier corruptions. This, alas, is of that sort.

The chant is done melodiously enough and it is in tune. But the entire music is accompanied by the organ—and the harmonies are the sort that simply force the older and beautiful modes into a false "modern" harmony. There are, again, ways and ways to do this falsifying—many a French church organ puts forth sleazy impressionistic chromatic harmonies to keep it's choir on the pitch—and this group is relatively chastely accompanied. But the damage is done, the sturdy modal scales are vitiated and the basic musical sense is thus missing.

**Aldrei Petrov: Songs of Our Days (Symphonic Cycle); Poem for Strings, Organ, Four Trumpets and Percussion.** Leningrad Philharmonic, Yansons. **Columbia/Melodiya M 34526,** stereo, $ 6.98.

Columbia has brought us some interesting minor Russian music on this prolific Soviet-based label, mostly, so far, of the prolific late-19th century sort and on into the Revolution. This is a departure, a young present-day composer, the new generation.

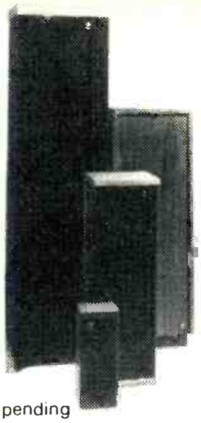
Phew! It is, shall I say, violently updated Shostakovitch with added acid and plenty of ground glass splinters along with a couple of carloads of TNT. I am sorry to report that I can only judge a bit of the fi because I could not go on. Excruciatingly harsh music, for the largest imaginable ensemble with the most incredibly grating, banging, shuddering sounds—you name them, they're here, and very expertly moulded and shaped and fired off at you, too.

The inspiration is not to be criticized, and probably needs this kind of sound—Leningrad during the terrible Nazi siege in WW II. But also about a variety of other things, from storms to holidays, Spring, war (in general), the Revolution, and a final item just called Conclusion. If you get through the (symphonic—no voice) songs, you'll come to the four trumpets and percussion. Might as well be 400 trumpets.

*Not* good surfaces, Columbia. Hissy but, worse, very ticky and scratchy at the beginnings of sides. Our little U.S. labels regularly do much better.

**Music from the American Academy in Rome. (Edwards: Exchange-Misère. Jones: Pièce mouvante. Hellermann: On the Edge of a Node. Bresnick: B's Garlands.)** Asst. soloists. **CRI SD 336,** stereo, $6.98.

Thanks for the handle—CRI. Otherwise these four works would not really hang together. All the composers have studied at the American Academy in Rome, founded 'way back when Rome was still the place for ART students, even music students, perhaps more







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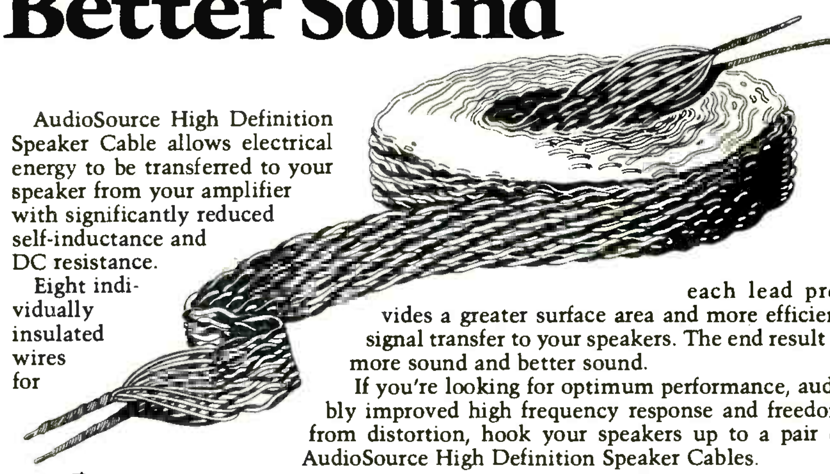

prestigiously, even, than Paris. But Roman academies usually have turned out moderately conservative results, like their French counterparts. Not any more!

The order of titles on the cover (above) is not that of the disc. Hellermann's *On the Edge of a Node* is a prepared music work, with paper clips fastened on violin, cello, and guitar; the guitar sounds like a vast, watery marimba and the violin scratches; the cello sounds cello-like. Maybe its paper clip wasn't big enough. Nodes. It's a nice piece of rhythm and tone color with a lot of Bach-like musical organization, a very classical (and Bach-like) registration, without change throughout. Martin Bresnick's *Garlands,* innocently composed for a cello teacher and her cello pupils and featuring eight of the instruments, are graded from easy to difficult—and an astonishing array of screetches and squeaks and wavery, watery noises such as you will not believe any cello teacher could approve of. She did. Not bad, once you get used to the acid.

Best piece, for my ear, is Edwards' *Exchange-Misère,* an odd French title but accurate. It is a very Schoenbergian work, though the composer doesn't say so, with that peculiarly disjointed and nostalgic effect, the last sad echo (yet heartening) of old times in Central Europe, that we hear in Schoenberg, Berg, and even Webern. Speaking of special-field jargon, if you think you can understand engineeringese, then see what *I* have to fathom, out of the musicians' world: This work, the composer says, is "a dense complex of linear, motivic, and harmonic associations and relationships embedded in a language which is both drastically simplified in its intervallic procedures and rich in means of elaborating a harmonic region or moving from one region to another. . . ." And so on for a paragraph. Yet I think I see what he means, and I like the music a lot. For my ear, it is a kind of passagaglia, going 'round and 'round with variations, and it is indeed full of fragmented bits of old-fashioned musical idiom, barely suggested for an instant, yet there, ever so nostalgically. I particularly liked the expressive use of a dropping half-step throughout. Lovely chamber music using solo strings and woodwinds, à la Schoenberg.

The final work, Jones, is a brief piano study which left me on first hearing moderately lukewarm; it obviously needs further attention (by me) and does not throw itself at you. So—OK. What's a recording for?

Yes—CRI does have good sound and excellent surfaces, well up to any of the vaunted European pressings. It's all done here, Windsor for pressing and, before that, Europa for plating (within 24 hours . . . ).

**Franck: Symphony in D Minor. Fauré: Pelléas et Mélisande.** New Philharmonia, Andrew Davis. **Columbia M 34506,** stereo, $6.98.

The originators of this disc, whoever they are, must be congratulated on an extraordinary recording of two war horse-type French works, often played and just as often given the routine treatment. Not here. (Is the recording EMI?) Andrew Davis—no, *not* Colin Davis—looks like an overgrown British schoolboy, and indeed he is of the new Romantic school of the youngest generation. But the man is a pro if there ever was one, schoolboy glasses and all. This is surely the most interesting, revealing, and purely honest interpretation of the Franck for many long years, as well as the most original. It is, of course, all-out Romantic, all stops wide open; and in this the conductor is assisted by his British musicians, a type who, I have often noticed, are always ready to play the supposed war horses of old-fashioned repertory as if they were brand new. British conservatism at its best?

But Andrew Davis brings out astonishing things in the old Franck symphony, which I "fell for" ardently at the age of 15 and have never forgotten. Inner parts I had never heard. New relationships between accompaniment and "big theme," continuities of phrasing and melody, that were to me a revelation. All *that* in the score? But yes! And such an intensity, from *piano* to *fortissimo* in great waves of feeling. Papa Franck would approve. The English always have had a peculiarly good feeling for French music.

Columbia pressed it. Why does Columbia make its center holes smaller than others? They stick on my AR table. And why are Columbia pressings so awful in the first couple of minutes, then not bad—aside from horrendous lumps and bumps that throw the stylus, once in awhile—not bad at all for the rest of the side?

**Vivaldi "L'Amoroso"—Concertos for Two Violins, Cello, Violin, Violin and Cello, with Strings and Continuo.** I Musici. **Philips 9500 301,** stereo, $7.95.

"I Musici"—the Musicians—has come a long way in musical breadth of vision since the group's earliest days, when it achieved fame through superb technique and Toscanini's endorsement. Then, they had little idea of older music such as this, played it solo without accompaniment when a small orchestra and harpsichord is so obviously required, etc. etc. Now—perfection! There is nobody better, with harpsichord, and with the right contrast between solos and string orchestra.

Astonishing how much *good* Vivaldi still is around to be sampled newly, along with the quantities of very nondescript material dug up after WW II and lamentably exploited by too many who didn't know the diff. I had never heard these four concerti, every one of which is a first-rate work in the composer's most patriarchal style, as pure as the driven snow, and as golden as the sun of Italy. The toughest is the first, a hard, brilliant piece for two violin solos; the following work for cello makes that instrument sound almost humble, but charmingly so. Then on side 2 is a strikingly "romantic" work, the title piece *L'Amoroso,* full of remarkable harmonies, very expressive; finally, a concerto for violin and cello with an excellent dialogue between the instruments of the first concerto and that of the second on the record. Really splendid Vivaldi for those who still think he's pretty good (though no longer quite the fad he was awhile back with young people of the 60's).

Sound? Philips' usual good surfaces and sharp, clean string sound, in an impressive but not blurring liveness.

**Schumann: The Four Symphonies; Manfred Overture.** Saint Louis Symphony Orch., Jerzy Semkow. **Vox SVBX 5146,** 3 discs, stereo, $11.95.

Vox continues its seemingly interminable series of "complete" recordings in Vox boxes at a bargain rate; they have been doing it since the 78 disc, and a very large portion of all the various Vox Boxes have been more than worth the money.

The Saint Louis has a new conductor from Poland (not New Jerszy) and he is good. I couldn't play all of this big box but I went through *Symphony No. 2,* and it was absolutely first rate, as communicative and natural as any Schumann I've heard for years—and that's saying a lot. Good recording, too, and plenty good enough surfaces. What you get in recordings like this is what a lot of us know all about—top-rate music from outside of the glamour-publicity music world. Not that Saint Louis wouldn't like to be right in there! Maybe their polish isn't quite up to the Philharmonia (but as good as the N.Y. Philharmonic any day) nor their prestige as potent as the Amsterdam Concertgebouw Orch. ("Amsterdam Concert-Building Orchestra") or the Vienna Philharmonic but, as the phrase goes, they are collectively no mean slouch—and they play *music.*

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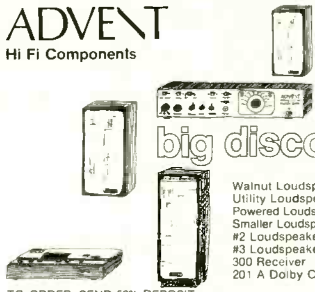

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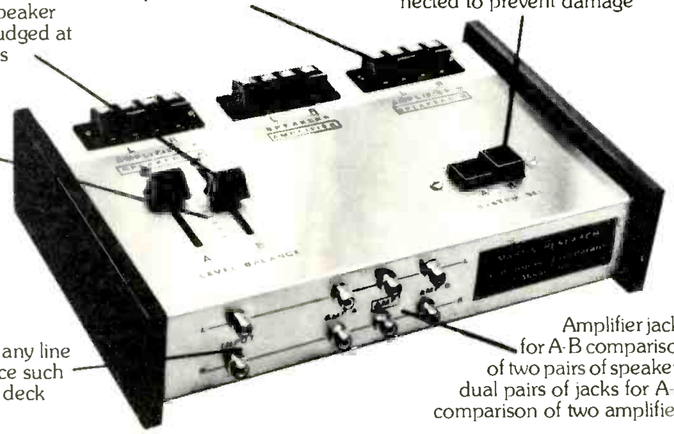


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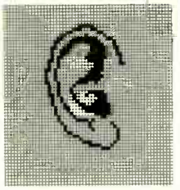

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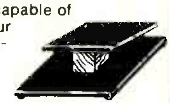

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# Ultimately

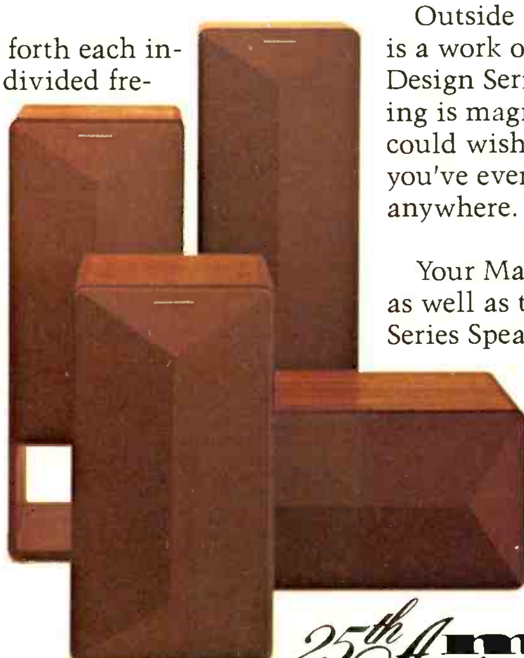
## Drums-Cellos-Trumpets instead of... DrumCselloTsrumpets.

Because what you're getting is the sharpest, cleanest instrument definition you've ever heard from any speaker system.

Through ordinary speakers, music is a sound of instruments jumbled together. Yet listen to the same music played through a Marantz 940 speaker system. The difference is amazing! The music comes out exactly the way it went in—instrument by instrument.

At the heart of the Marantz 940 is the most sophisticated crossover network ever developed. Most competitive systems have only two separate level controls in their crossover network, with no inductors. Marantz gives you three level controls with six inductors! So you get more circuitry for precise crossover points. The result: a flat frequency response with smooth transition of the frequency ranges between woofer, mid-range and high-frequency loudspeakers, combining all of those cleanly defined instruments into a brilliant, meticulous blend.

And, to do the job of bringing forth each individual instrument within the divided frequencies, Marantz designs and builds more expensive, more sophisticated transducers. Marantz woofers, for example. The big bass drum is heard in all its glory because Marantz builds woofers with a rigid new cone material—rigid enough to withstand ten times the force that can destroy a light airplane. This superior structural strength enables the cone to move in an ideal piston-like motion, instead of bending.



Which means a tight, low frequency response and uncolored sound quality.

The human voice—the most difficult sound to reproduce—takes on flesh and blood realism. Because the Marantz 5-inch mid-range cone transducer blends precisely with both woofer and tweeter elements. And it's completely sealed off in its own enclosure. Vibrations produced by the woofer (like the big bass drum) can't shake up mid-range reproduction.

Even crystal-shattering trumpets are a total reality thanks to the exclusive linear polyester film domes on the tweeters. The lighter weight film responds faster to high frequency vibrations: also, the small dome shape of the tweeters disperses high frequencies over a wide area. No matter where you are in the room you hear the same sound.

Is it possible to perfect the sound even further? Yes... with our exclusive Vari-Q* feature. It's a high density removable foam plug. Plug in, the system is "air suspension"—ideal for movie albums. Symphonies. Jazz. Folk. Pull the plug out and the system is "ported" to give the gutsiest low end for today's electronic rock.

Outside and inside the Marantz 940 is a work of art—the top of the Marantz Design Series. The elegant furniture styling is magnificent. The sound—all you could wish for. The truest musical sound you've ever heard from any speaker, anywhere.

Your Marantz dealer has the Model 940 as well as the full line of Marantz Design Series Speaker Systems, Marantz High Definition Speaker Systems and Marantz Mark II Speaker Systems. If you want the best—and are willing to spend a little more to get it—then go for it. Go for Marantz.

25th Anniversary marantz®

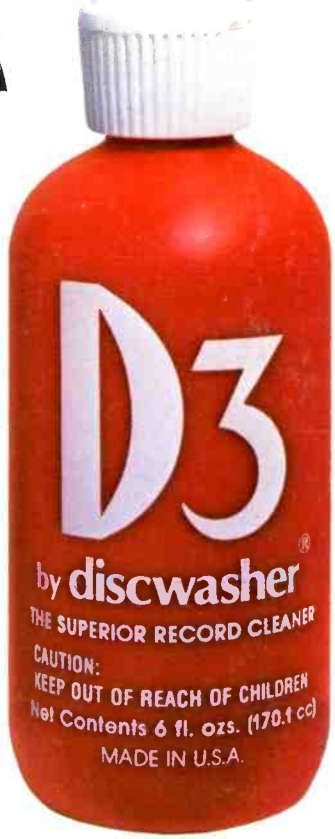
*Patent Pending  20525 Nordhoff St., Chatsworth, CA 91311. Prices and models subject to change without notice. Consult the Yellow Pages for your nearest Marantz dealer.

# It's Marantz.

# Go For It.

# If Your Records Are Valuable

# LOOK FOR THE RED BOTTLE




## Why?

**General Need:** Tests by the Discwasher Labs show that fingerprints are absolutely not totally removed by "dry cleaning" in any form, either brush or adhesive rollers. Long term record care requires the complex integration of micro-dust pick-up (not spreading around), with removal of chemical contamination such as fingerprints; plus an in-process reduction of static charge so that dust particles are not immediately sucked back onto the surface. And all of this must be done without leaving a residue.

D3 fluid, used with the Discwasher System for capillary removal of fluid/contamination achieves the results required for record survival. But the hidden requirements of a record cleaner are much more complex than integrated function alone.

**Chemical Integrity:** The trick is not to simply clean—but to clean with vinyl safety and extremely low "solute load" or fluid content. D3 is a solution that typically has half the dry weight residue of tap water and about one-fifth the median for other "record cleaners". D3 typically has the dry weight residue of distilled water sold in drug stores—and yet D3 has an activity in surface tension reduction/fingerprint removal that is greater than any fluid with twice the solute load of D3.

D3 fluid contains a complex blend of buffered surfactants conjugated in the labs of Discwasher, Inc. These provide cleaning "activity" against real-world record contamination, like fingerprints and airborne oils. But not against artificial "test conditions" of mineral oils and sheep wax (lanolin). Because if D3 removed waxes and oils of this nature, then D3 would also begin to soften critical vinyl stabilizers which are essential for record survival under the incredible heat and pressure of a tracking audio stylus. Alcohols and many cleaners pull stabilizers and age vinyl.

Some cleaning fluids contain large molecules of fatty acids to "float" dirt—but these "molecules" positively stick to vinyl and are literally a dust trap.

D3 fluid does not dramatically reduce static charge forever. The only liquid that can is one which leaves a coating. But D3 does reduce static charge during cleaning (using 3 drops on the Discwasher brush), and actual static voltage is reduced during playback to about one-half the normal levels.

**The Discwasher "Systems Approach":** Any cleaning fluid, when left on the record, only spreads out contamination. With three drops of D3 on the special directional micro-fibers of the Discwasher brush, dust is lifted out of the grooves, without "follow up" or adhesive oxide removal of the vinyl.

In addition, the Discwasher System wicks up D3 fluid plus suspended contamination. The fluid is drawn deep into the absorbent backing of the Discwasher brush. No liquid, dust or contamination "dries back" when the system is properly used. The "systems approach" of Discwasher includes a hand-rubbed, milled walnut handle. Something to outlast plastic wonders and out-perform everything else. Your records can't do better than the Red Bottle inside the "system".