

# Audio

The  
Authoritative  
Magazine  
About  
High Fidelity

JANUARY 1981 • \$1.50 • © 06030

**VIDEO SCENES  
GOES MONTHLY**



**Build A Wave  
Generator**

**Audio - Pair  
Or Pleasure**

**Construct An  
Indoor/Outdoor  
FM Antenna**



# Introducing Pioneer LaserDisc.

The biggest innovation  
in television  
since television.



Imagine you could sit down in front of your TV set and see virtually any movie or concert you wanted to see when you wanted to see it.

Imagine you could actually see and hear concerts on your TV in stereo. The best stereo you've ever heard. Or cut to your favorite scene in a movie at will. Or study sports in slow motion, even one frame at a time. Imagine a machine that could teach your children at their own rate.

You now have just an idea of Pioneer LaserDisc. A remarkable innovation that puts both picture and sound on a record. And plays them both by means of a laser beam onto your TV and through your hi-fi.

(The player hooks up to your TV with just one wire. And when it's not in use, your TV plays the way it normally plays.)

The laser picture quality is exceptional. As good as the best broadcast reception you've ever seen. And laser sound is better than the best conventional audio recordings you've ever heard. And since nothing touches the disc but a laser beam, the disc never wears out. The quality is forever.

For all it does, surprisingly, the suggested retail price of the player is only \$749\* (just \$50 more with remote control). And you can own a disc of a great

movie or concert forever for the cost of taking your family to the movies.

There are a few hundred different discs to choose from right now. And more and more are coming out every day. Someday, virtually anything that entertains anyone will be on the disc.

Nothing we say here will fully prepare you for the magic of Pioneer LaserDisc. You simply have to see it.

For a personal demonstration from the dealer nearest you call us at 800-621-5199 toll free. (In Illinois 800-972-5855.)



# LaserDisc

PIONEER



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# Audio

"Successor to **RADIO** Est. 1917"

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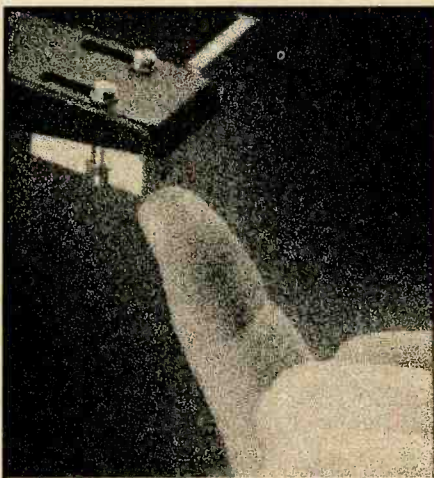
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**About the Cover:** Whether your New Year's celebration brings you agony or ecstasy, Martin Polon discusses some little-known relationships between high-level sound and our general health in his article, "Audio—Pain or Pleasure," beginning on page 48. Cover ice cube construction by James Wizard Wilson, photograph by Susanne Buckler.



## SC-2 gives your cartridge more than The Finger!

The famous SC-1 stylus brush (standard of the record and hifi industries) now has a synergistic fluid called SC-2.

SC-2 Fluid enhances and speeds cleaning and yet protects diamond adhesives, cartridge mounting polymers and fine-metal cantilevers against the corrosive effects of many other "cleaners."

The Discwasher SC-2 System. Stylus care you can finger as clearly superior.



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# The continuing story of TDK sound achievement.

## Parts Five and Six.



The guide roller and spindle pin are the turning point in a TDK cassette. It's there the tape takes on a sudden surge of tension. The winding angle changes sharply to 75°, causing great stress. The slightest imperfection, even a microscopic speck, will cause serious output fluctuations in sound.



TDK guide roller and spindle pin in cassette.

TDK engineers began by analyzing existing molding techniques. They knew many manufacturers used a low cost, inferior split-die process. This turned out rollers with seams, which disturb tape travel. Spindle pins were no better. Merely convenient mold extensions with pullout tapers which allowed rollers to slip up, wear out and wrench the tape off the track.

Part Five, the TDK guide roller, is flared and absolutely seamless. Made from a low-friction precision

molded plastic, it's created in one piece through an expensive forced-injection mold technique. Its flared edges provide perfect tape guidance while its six spokes maintain rigidity and perfect circularity. The tape flows through the mechanism and past the head gap in true vertical alignment. There's virtually no tracking variation or loss of high frequencies. Sixty checkpoints during the manufacturing process guarantee it.

For Part Six, the TDK spindle pin, our engineers chose stainless steel. Machined to size and aligned to a perfect 90°, it's designed without a taper. Micro-polishing and a silicone coating cut down friction. The TDK spindle pin is far more resistant to heat and cold than plastic. It won't bend out of shape

and wear down the spindle. Tape is assured safe passage with virtually no flutter or channel loss.

In a TDK cassette, the parts are much like the instruments of an orchestra. All equally important. Music is an outcome of the perfect interplay between them. In the end, that's what's so distinctive about TDK.

Music is the sum of its parts.



**TDK**  
The Amazing Music Machine.

**Our secret  
to tracking these  
fantastic grooves  
makes every  
record you own  
sound better!**

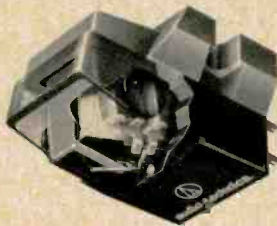
**New AT155LC  
Vector-Aligned™  
Stereo Cartridge**



There are perhaps a dozen reasons why the new AT155LC does so well tracking even the most explosive new digital records. An advanced new Line Contact stylus, our exclusive Vector-Aligned™ magnetic system, and new high-efficiency coil and core designs to mention just a few.

But it's our sound, not the construction that is important. And our capability to track even the tough records which benefits you every time you listen. Because even slight mis-tracking can quickly destroy any record, shortening both disc and stylus life dramatically.

Of course it's easy to claim "good tracking"... everybody says it. *Proving* it is something else. Well, we guarantee that every new AT155LC will pass an objective test which easily exceeds the limits of most commercial pressings. Specifically, at 1.2 grams the AT155LC cleanly tracks the 80-micron band of a standard



DIN 45 549 or AT6607 equivalent test record. And at 1.6 grams it even tracks the severe 90-micron band without visible distortion.

Of course tracking is not the only virtue of the new AT155LC. Response is uniform from 5 to 35,000 Hz, separation is great, and efficiency is uncommonly high\*. All claims we back up with specific tests any lab can duplicate.

But the most important test is a visit to your Audio-Technica dealer. Ask to hear the new AT155LC with your favorite records and with the new digital blockbusters. We promise a remarkable sonic experience. And audible proof that the new AT155LC can unlock the full potential of every other hifi component you own.

\*Performance specifications available on request.

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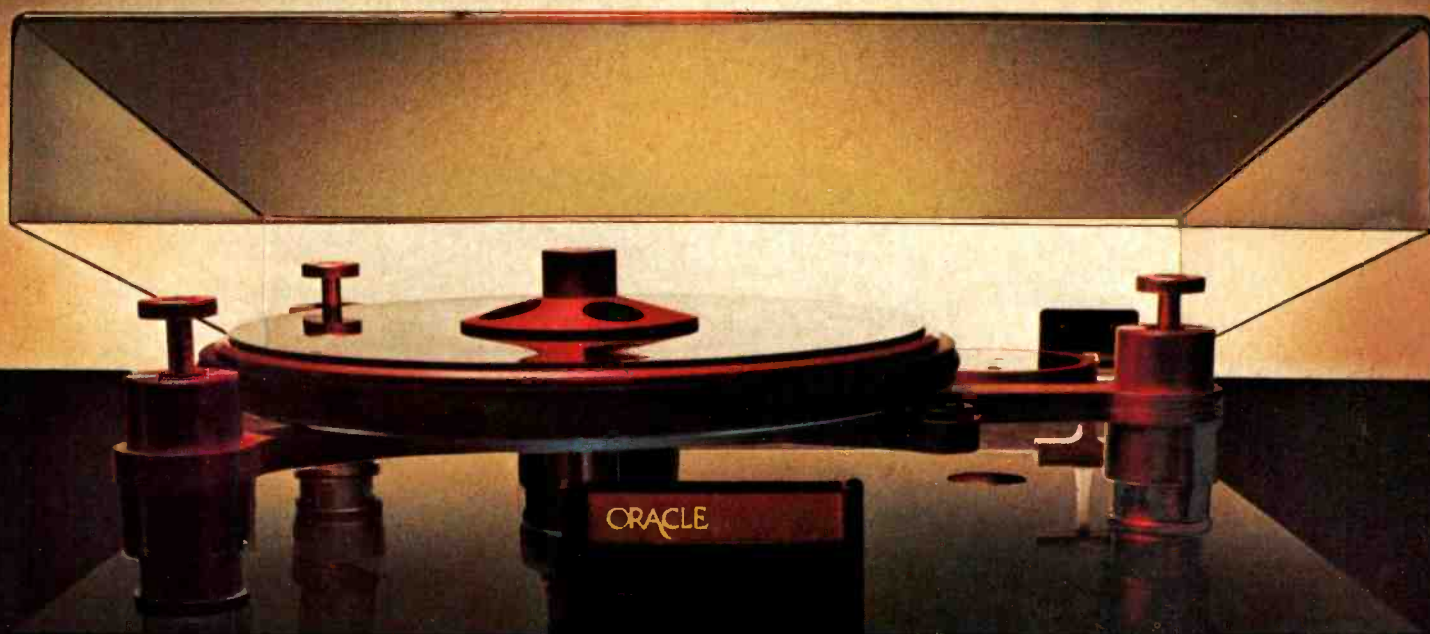
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*International Audio Review's* coveted "Class 1" Rating

"The ORACLE turntable earns a Class 1 rating because it is a totally and thoroughly engineered product. It represents, in our professional judgment, the best product that can be reasonably achieved, as measured against the objective, permanent yardstick of what is possible in turntable design. . ."

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# Audio etc.

Edward Tatnall Canby

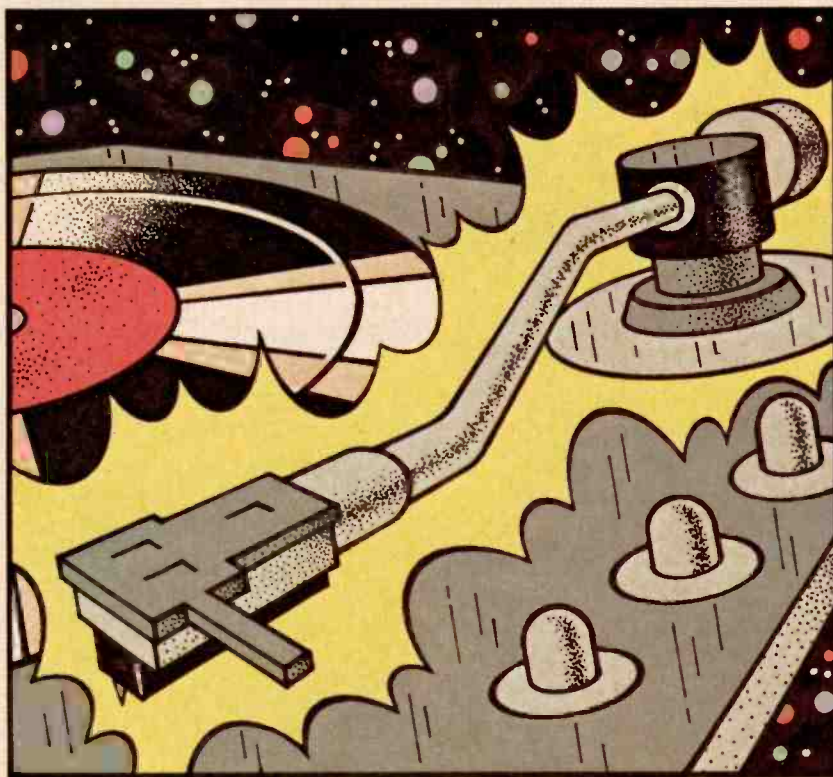
As the trends go, so go we, right down to the tiniest details of our everyday life. It's automation time! Pretty soon we'll be having electronically controlled shoelaces with Automated Tie and Untie. Micro-chip built into the shoe heel plus a couple of minibats between your toes. You push an ultra-button on your ring finger and — presto!

This bizarre thought comes to me as I turn to that august name, Sony, and Sony's new all-out turntable the PS-X75 with "biotracer" electronic tonearm, the arm that, so to speak, ties its own shoelaces. This Sony item represents a whole new generation of disc players such as I have not worked with before. Since well-made turntables tend to keep on turning year after year, perhaps you haven't either? If you think your old table is about ready to be turned in, then here's what's coming to you next. Something to really marvel at.

I am still in some obscurity (if not in the dark) as to how most of the automated functions of this table actually work and I may never figure them out. Things get complicated these days. The Sony has all sorts of sensors, magnetic, photoelectric, tied into electronic minibrains. To do the work of the arm, it has linear motors — that new kind that doesn't turn but just pushes gently. Three of these useful devices! Where have they been all my life? A brilliant idea — straight back to the horse and other similar means of linear action. A linear motor is very much like a muscle, which is an amazing thought. To heck with the wheel! Why didn't we think of this before?

To be sure, a few of the automated actions available in this PS-X75 seem to me *de trop*, too much. But then I

tend to be conservative in all this, trusting my 10 thumbs as the finest sensors anywhere around. I will admit that other new record players display an even more mandatory automation than Sony, for this is the game right now. And all, needless to say, for two good reasons, (a) it can now be done (i.e. where there's a way there's a will) and (b) because obviously *you* want it that way.



Ok, I'll go along. If my sound is OK. Sony gives me more than satisfaction on that score. Indeed, I've found to my surprise that even with the same old (excellent) cartridge and all else unchanged, a table of this generation may noticeably *improve* the overall quality of your sound. Better engineering at the cartridge/arm interface.

The Sony! We say this as we have said "the Fisher" for so many years, adding a sort of honorary title to a regular name. Curious. Did Sony get there firstest with the mostest? Maybe. But we have too much other excellent Japanese equipment to think that Sony has total superiority. Sheer hype? Not that either — ask the competing agencies. Just a carefully built-up mystique,

I guess, along with real quality and performance. My own Sony speculations don't go that far. I keep thinking of pasta . . . remember the pasta ad, *soni buoni*? In the plural. In a plate of spaghetti (pl.) each single strand is a spaghetti. Just as each item in the vast Sony line manages to be *the* Sony.

Sony's ample instruction booklet was written in Japan and in spite of the mostly excellent English I am not

clear as to what the term "biotracer" may mean. It sounds highly organic, like, say, biosphere, but I detect nothing organic (in *that* sense) in the arm's operations. Unless via the muscle analogy — could that be what they mean? Anyhow, in this player the arm is clearly the center of attention and the most automated feature. But I should say at once that it is still possible to move this arm by hand, though not with impunity. It doesn't rudely say "no"; it says, very gently, "please better not." The system is indeed designed to remove your sticky fingers, if tactfully, but you may override, if need be.

The PS-X75 comes with a large and astonishing diagram printed on transparent plastic attached to the dust cover. I studied it carefully before removing, then stuck it up on my wall for further study. Phew! If I add right, there are three linear motors, for horizontal arm motion, vertical arm motion, and arm lifting; each with a solid magnet, coil, and coil bobbin (none showing, of course, from the outside). In addition, two more similar arrays, magnet, coil and bobbin, for the horizontal velocity sensor, in the arm itself, and the vertical velocity sensor, down underneath. With two of these magnet-coil arrays actually inside the arm, one wonders how much mass is involved, but the weight, I

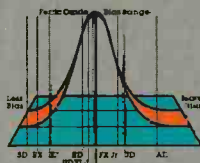
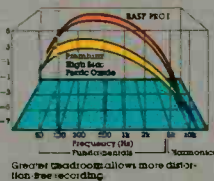


# The Tape Guide

**Professional·I.**  
The one tape  
that stands up when  
you crank it up.



Premium ferric oxide tapes have more headroom which allows higher maximum recording levels (MRL). Among all premium ferric oxides PRO I has the best MRL for loud recordings. Uniform magnetite particles provide increased headroom for very accurate and loud recordings with virtually no distortion. In the fundamental music range (20Hz-5kHz) PRO I can be



PRO I is designed to be compatible with the normal bias setting of more cassette decks than any other ferric tape.

recorded louder and driven harder than even high bias tapes. PRO I is the internationally accepted reference tape, whose bias point is specifically matched to the Type I/normal/ferric position on today's high quality cassette decks.

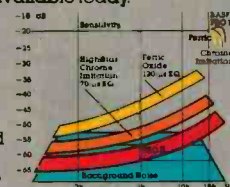
**Professional·II.**  
The world's quietest  
tape puts nothing  
between you  
and your music.



High bias tapes consistently provide wider frequency response and less tape noise (hiss or background noise) than any other tape type. Among premium high bias tapes PRO II is in a class by itself. It is the second generation chromium dioxide tape with superb frequency response and outstanding sensitivity in the critical (10kHz-20kHz) high frequency range. It also has the lowest background noise of any other competitive tape available today. PRO II will capture the many subtle harmonics of the most demanding recordings and play them back with the reality and presence of a live performance. PRO II is the tape for the Type II/chrome/high bias position that comes closest to Metal tape performance for half the price.



The pure chromium dioxide particles in the PRO II utilize ferric oxide particles are homogeneously shaped and uniformly sized to give this tape superior performance.

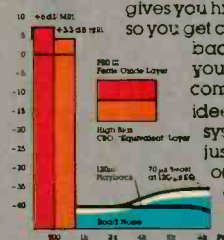


PRO II has the best high frequency sensitivity and the least background noise of any high bias tape.

**Professional·III.**  
The only car tape  
that eliminates  
the car.



Ferrichrome tapes combine the benefits of chromium dioxide and ferric oxide tapes for superior performance in car stereos. The top layer is pure chromium dioxide for unsurpassed highs and low background noise. The bottom layer is ferric oxide for superior lows and great middle frequencies. And it also gives you higher recording levels, so you get clearer, louder playback without cranking up your volume control to compensate. PRO III is the ideal tape for car stereo systems and performs just as well in the home on the Type III/ferrichrome position.



PRO III provides a higher maximum recording level (MRL) than high bias tapes and effectively boosts the highs to overcome road and car noise.

**GUARANTEE OF A LIFETIME**

"The guarantee of a lifetime." All BASF tape cassettes come with a lifetime guarantee that covers everything. Should any BASF cassette ever fail—for any reason—simply return it to BASF for a free replacement.



**Patented "Jam-Proof" Security Mechanism (SM).** All BASF tape cassettes come with our exclusive SM—Security Mechanism. Two precision arms actually "guide" the tape in a smooth, exact and consistent track, so that winding is always even, no matter how often the cassette is played. SM puts an end to tape jamming.



Crosby Drive, Bedford, Massachusetts 01730

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note, is placed over and behind the pivot, the front "S" of the arm being unencumbered. Surely, I figure, somebody had done all the calculating as to resonance and mass relationships between this and the cartridge/stylus up front. I have never had a better tracking arm. Suffice to say it's proof of the bio-pudding.

The direct drive motor is "BSL" — brushless and slotless — and comes up to speed in a half-turn, which is commendable for this type of drive. Some of the earlier direct drivers took an unconscionably long time to get going. Speed is crystal controlled, of course, and (naturally) there is a readout which says "locked" when we reach

fixed speed. Don't try to play your piano with this one. I can't find any optional speed adjustment. In fact, the locked-in speed is accurate within 0.003 percent, which is far less deviation than my rather keen musical ear could ever detect. No audible search-and-correct. And the signal to noise is -78 dB! That's almost digital-quiet. Shades of earlier tables — remember when the fanciest changers were set to run a half step sharp (speaking musically) in case the pile of discs got too heavy for the motor to manage? And as for noise, you could even feel it, a complex of vibrations from motor shaft, rubber idlers, eccentric dents and bumps, even, perhaps, a thump-

ing belt. (A belt often has a joint somewhere on its length.) I bless my luck in living long enough to outlive that sort of equipment.

### Techno-Trailblazing

You can't play a transparent LP automatically on this Sony because the record-size drop point is determined photoelectrically via holes in the table and, of all things, prisms mounted in the rubber mat. Light comes up and runs into a black wall — the disc — or it doesn't. Two light sensors determine the 7-inch and 12-inch drop and also — very important — they signal when there is no record on the table so that the arm will not drop. Nothing more disastrous than trying to play a rubber mat.

The biggest new convenience in recent all-automatic disc players is the bank of control buttons ranged outside the plastic dust cover, where you can do everything with the cover down. (For too long the manufacturers needlessly put the controls inside that cover, so you had to lift it to get any action.) And the biggest plus by far on the Sony PS-X75 is the extreme right-hand control, a small circular dial with a knob in the middle. Imagine it! Both stylus force and skating force, the two automatically locked together, can be set and reset by this knob *while the record is playing*. No tedious weights, no tiny grooves in which you try to lower the stylus, which never stays put while you clumsily adjust supposed pressure. Here, you just turn the knob. I couldn't believe it. Dial 0 and the arm gently elevates itself into the air (you have to balance to zero weight first, via the familiar counterweight principle). Turn to a half gram and it lowers and, maybe, if the record is flat, plays music. If the sound skips, turn it up to a gram or more and instantly things settle down. For a warped or eccentric disc, you can momentarily increase the point pressure, to taste — then turn it back, to standard. Really something.

Now that, to my mind, is a really profound improvement. I cannot tell you how many times I have hated that fussy job of setting up the right force ("weight" as we wrongly say) via balances and counterweights and overhang and so on, and I expect our normal readers will enthusiastically agree. It takes a freak, I say, to enjoy that kind of chore. But what can you do? All too often I've resorted to the thin dime or, more recently, a featherweight plastic stylus brush laid on top of the cartridge to bring the "weight" to the correct figure. I have a whole box of clutter measuring devices, from AR's little plastic weights to Shure's Very Best, but Sony has the

## the best value in hi-fi

### Three V15 Type IV Technological Breakthroughs

**Dynamic Stabilizer** Suspended from two viscous-damped bearings, acts like a shock absorber to maintain constant cartridge-to-record distance and uniform tracking force; eliminates record groove skipping caused by warp; cushions the stylus from accidental damage.

**Electrostatic Neutralizer** 10,000 conductive graphite fibers discharge static electricity from the record during play. Eliminates attraction of dust and tracking force variations caused by static charges.

**Telescoped Shank** Greatly improves trackability at the critical middle and high frequencies. Lowest effective mass, with no sacrifice of necessary stiffness or strength.

### Plus a Studio Cartridge Innovation

#### SIDE-GUARD Stylus Deflector

A unique lateral deflection assembly developed by Shure for its professional studio cartridge—prevents the most common cause of stylus damage by withdrawing the *entire* stylus shank and tip safely into the stylus housing before it can be bent by sideways thrusts.

### In 6 Models to Match Any

**Turntable, Any Budget** All these features are incorporated into six moderately-priced cartridges—with tracking forces ranging from  $\frac{3}{4}$  to 3 grams, and three different stylus configurations—including the revolutionary distortion-reducing Hyperelliptical stylus. Headlining the M97 Series is the M97HE-AH, featuring a precision aligned cartridge-headshell and adjustable overhang.

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Model M97HE-AH  
with adjustable integrated headshell

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# The Audio Critic announces a rather sensational change in its format.

Volume 2, Number 3 of The Audio Critic, which is expected to be off the press at approximately the same time as this ad, will be our ninth and last issue in the original magazine-like format. Starting in January 1981, the Audio Critic will be published biweekly—yes, every other week!—in the form of newsletter-size bulletins, featuring in-depth reviews of the very latest equipment as well as continuing updates of our top recommendations. With two issues skipped during the summer vacation, our frequency will be 24 bulletins a year.

Later in 1981, subscribers will also receive *The Audio Critic Handbook*, a book-length summary of everything the enlightened consumer of audio components ought to know (in our opinion) about rival design philosophies, engineering trade-offs, test methods, installation and alignment techniques, tape recording and disc-cutting problems, and just sound in general.

Together, the bulletins in their loose-leaf binder and the Handbook will read very much like a stack of The Audio Critic from 1977-80. Nothing will be different editorially. The celebrated writing style will be the same. As before, there will be no commercial advertising. Our reviews will still be based on a combination of sophisticated laboratory measurements and fine-tuned listening tests. The qualities that have raised The Audio Critic far above the "undergrounds" in the esteem of technically and musically educated audio practitioners will continue undiminished.

Only one thing will be different: the speed with which our readers will be informed about new developments. Instead of waiting for 35 or 40 reviews to accumulate before printing them, we will now publish our findings in a steady stream, as soon as they are firm. If we find out in March that a certain new phono cartridge is State of the Art, you will know about it early in April. What newsstand hi-fi magazine or underground journal can make that statement? Equipment reviewing will never be the same again.

*Present subscribers* to The Audio Critic will have their subscriptions fulfilled at the rate of six biweekly bulletins for each old-style issue due to them. The Handbook, when it comes out, will count as the equivalent of two old-style issues. *New subscribers* have the following two choices:

**Our \$30 package.** This includes the 24 biweekly bulletins to be published in 1981, starting in January, plus the Handbook when it is ready. If your subscription is postmarked no later than December 31, 1980, you will also get a handsome loose-leaf binder for your bulletins as a free bonus.

**Our \$50 package.** This includes the entire \$30 package, exactly as described above, plus the four magazine-size issues still in print: Vol. 1, No. 6 (cumulative reference issue with over 150 reviews) and Vols. 2, Nos. 1, 2 and 3, the last being the new issue with the much-awaited report of an important speaker development, among many other things. We strongly recommend that you get these issues in order to have a fuller understanding of what The Audio Critic is all about and a better foundation for reading the bulletins. Once the Handbook is out, all old-style issues will be allowed to go out of print. If you already own one or more of these, you may subtract \$5 from the package price for each one you do not wish to receive.

Send your check or money order in the correct amount (no Canadian dollars, \$6 extra for overseas delivery) to **The Audio Critic, Box 392, Bronxville, New York 10708.**

right idea. It must be that vertical motor. It just pushes, variably downwards. Now that's the kind of automation I like.

Some of the rest I don't. Sony makes a mild claim towards music cueing via that quick half-turn motor start. Yeah, but as an old radio man I know that there is only one simple way to get near-instantaneous music starts on cue and that is via the slip system, a table that turns at speed, a felt mat for smooth friction and a finger that holds the disc motionless. It'll start in a quarter of an inch, full speed. But this is mainly for specialists. More important and quite vital for a lot of us is to be able to start the music without squawks and fumbles at one of the inner LP bands. Through long practice I've got so I can hit the silent grooves by hand almost every time, given a good light. But nowadays you aren't supposed to because of those 10 thumbs. So — automation. Buttons to push.

OK, friends, just try. (And it's not only Sony that offers you this.) Push one button and the hanging arm moves leftward, push another and it goes right, push a third and the arm descends and plays whatever it finds. That is, after the muting circuit lets go. Like a cassette. Even more like a one-armed bandit, electronic style. Instead of trying to knock out an enemy space ship, you try to hit the beginning of the second movement of the Beethoven *Fifth*.

Aiwa, to name another maker, has really tied you into this device. If you acquire their home equipment rack, you cannot even open the dust cover and reach in — no room. Instead, the entire table rolls out so you can put the record on, then rolls back in and plays. So you *must* do your band-searching via the outside remote controls. No fingers at all.

Sony is more moderate. You can reach in (given space in your own cabinetry), and you can move the arm, though it does tend to remove itself from your grasp, gently but firmly. Occasionally, when you have found the exact right spot by hand, it simply turns the motor off on you. There's a button for *that*, too. Push and the motor starts again.

Well, just for kicks I tried to see the difference between what I could really do with automated buttons versus what I myself needed to do to hit the silent grooves between bands accurately. No use! After trying more than a dozen times to hit one quite wide separation band, I ended up each time with a blast of unwanted music and gave up. You try. Do not let minor eccentricities like this bother you too much. Sony has done nobly with the

real fundamentals, including much more, such as the ease with which all this complex machinery can be set up to accept widely differing cartridges for size, overhang, weight, height above the disc and so on. And there's that excellent tracking stability, aided by adjustable shock-absorbing feet. The once famous Canby Loose Floorboard, which has sent dozens of arms flying into the air, merely produced a slight hiccup in the Sony sound and no grooves jumped. For such an incredibly complicated table, that's good. If you can cough up the cash, if you are unintimidated, if you don't mind a big table (it wouldn't fit in the space I had), then maybe the Sony is for you. Linear motors and all. **A**

## Len Feldman and Edgar Villchur Honored



Len Feldman receiving award from  
Avery Fisher.

On October 4, 1980, Audio Contributing Editor Leonard Feldman and Edgar Villchur, founder of Acoustic Research, were inducted into the Audio Hall of Fame. Both men were recognized for their career achievements and contributions to the audio field.

Feldman, currently a writer and consultant, began his career as a television engineer, joined Fisher Radio, and later started his own manufacturing company. In 1957 this firm, Madison-Fielding, was one of the first to introduce an all-in-one stereo receiver. Feldman served as the IHF's technical director for a number of years, is now a technical consultant to the audio division of the EIA/CEG, and has written six books relating to FM and audio.

Villchur was an instructor of electronics and a freelance writer when he developed a loudspeaker based on his own invention, the acoustic suspension system, in 1953. He subsequently applied for a patent for the design and formed Acoustic Research to manufacture the speaker. Upon retiring from AR in 1967, Villchur established the Foundation for Hearing Aid Research and has continued to write general and technical articles. **A**

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BILLBOARD Magazine, each year, surveys U.S. recording studios to determine brands of equipment used. Year after year, the #1 power amplifier has been Crown, selected by more recording studios to drive monitor speakers than the next three brands combined.

MIX Magazine publishes equipment lists for U.S. recording studios. Again, the favorite brand of power amplifiers is Crown. Most interesting is the fact that as you consider studios with

more sophisticated capabilities (16 or 24 track and up), the proportion of studios selecting Crown as their *only* monitor amplifier increases. The more experienced the professional, the greater is his reliance on Crown.

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## Cutter Head Production

*Q. Why don't pickup manufacturers produce moderately priced cutter heads, inasmuch as the operation of each of these devices is similar?—A.S. Marroquin, Alice, Tex.*

A. I suspect that the greatest single reason for the small production of disc-cutting heads is simply the lack of sufficient demand for the product.

While it is true that the operating principles for both a phonograph pickup and a disc-cutting head are the reciprocal of one another, still you find that a cutting head has to do a considerable amount of work when cutting a groove, particularly at high frequencies. Just as is true for phonograph pickups, the mass must be kept low in a cutter head if good high-frequency cutting is to be achieved. I suppose you can argue that by employing mass production techniques, these problems can be minimized and prices lowered, but it still comes down to the fact that most recording studios do not cut their own discs; instead they rely on the few people who have found this technology interesting enough to pursue. Disc recording requires a considerable degree of mechanical ability if the equipment is to be maintained at moderate costs.

Because of the relatively light demand for cutter heads, those few which are produced sell at a very high price, often above \$10,000. Part of this price is to cover all of the research and development costs which made it possible to produce the head in the first place.

## Background Noise

*Q. I understand that phonograph record manufacturers use lamp black in the vinyl mix used to press discs. I have heard that this lamp black can cause an increase in the background noise level of a disc! Is it true? If so, why do they continue?—John Buford, Philadelphia, Pa.*

A. Properly mixed, lamp black adds only a very slight amount of additional noise. The lamp black is used because the public does not seem willing to accept a transparent record, but there are so many other reasons for noise on pressings that the lamp black problem

is not significant in comparison. To keep costs low, the pressing cycle is kept as short as possible. If the cycle is just a little too short, incomplete molding will result, and the background noise will be higher than would be true if more time was allowed for the pressing of each disc.

Still another source of noise results from a press in poor condition or perhaps a stamper being used for a longer time than it should be. Added problems are those which occur during the plating of the master disc; these can result if the plating cycle is rushed.

We could have quieter discs if the stampers are not chrome plated as most are. However, their working life would be considerably shortened by this lack. They also can strain readily during use, with increased background as a consequence.

## Take Your Cue

*Q. I have noticed some new (to me at least) terms being used, and I would like to know their definitions. The two of particular interest are back cueing and slip cueing as used with regard to playing phonograph records. I would like to know what they mean as far as the mechanics go, and what their effect is when used. In addition, if there are other well-defined "cueing" conditions, please explain them, too. —Richard Fink, Lyons, N.J.*

A. Back cueing refers to a means by which you can insure a precise start when playing a phonograph record. An example of this would be a DJ who announces the title of a selection, and just as his words trail off, we hear the first notes of the music.

What is done is to put the tonearm on the record and allow the turntable to spin until the music just starts. The DJ or engineer immediately does one of two things. He may simply grasp the edge of the disc and turn it backwards to perhaps a half turn before the start of the first note, and hold it that way,

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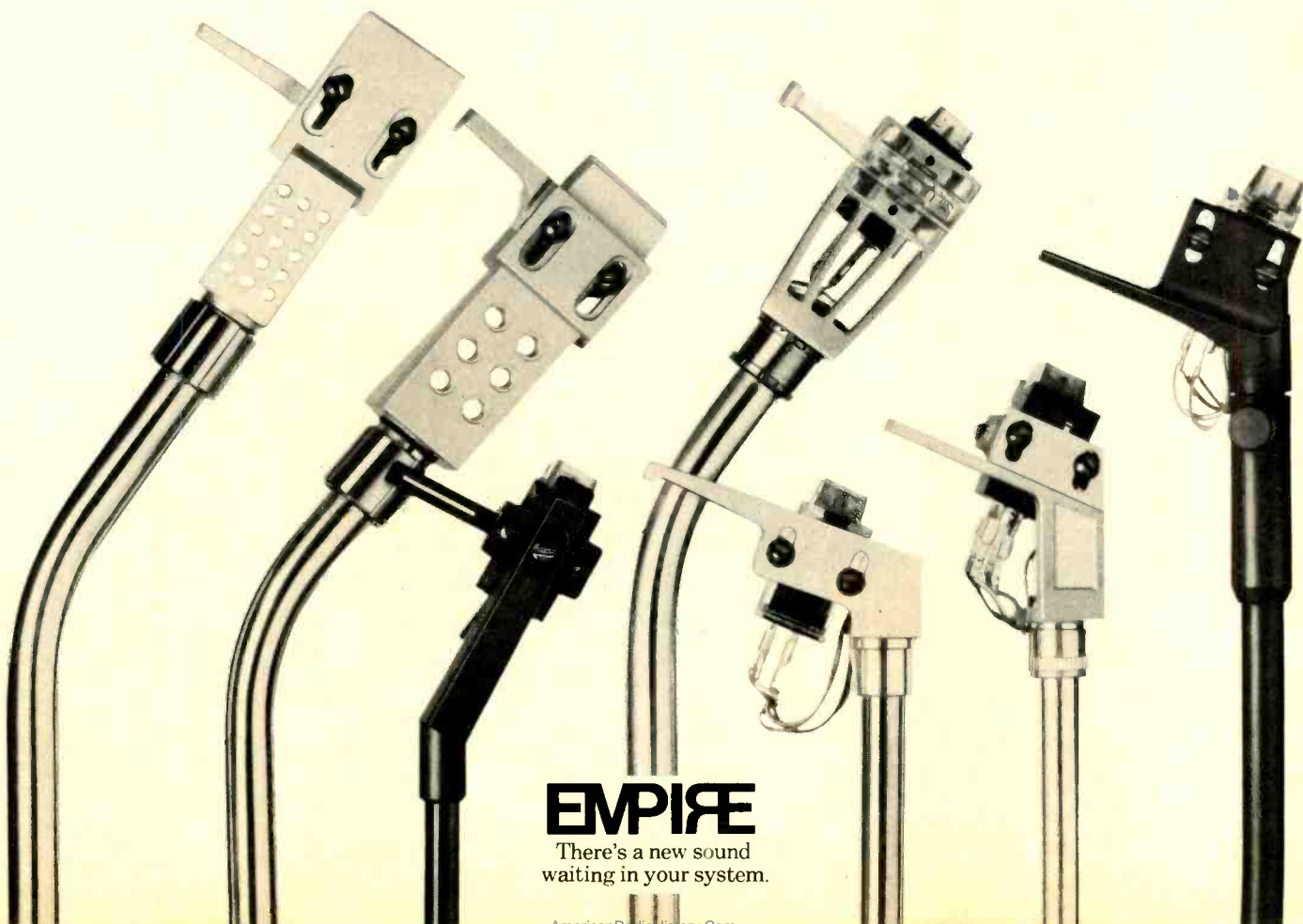
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with the turntable rotating, until the time the song is to start. At this time he releases the disc and fades up the volume control associated with that turntable. The music starts cleanly. (If the control was not faded up, but simply left up all the time, the sound of the table moving under the stationary disc would be heard under the announcer's voice.)

The second procedure is similar to the first: The engineer lets the music just begin; he stops the table and rotates the table manually back a half turn or perhaps somewhat more. Again, at the proper time, he starts the table. This latter procedure can be done only if the table is capable of coming up to speed very quickly. Many of the turntables used in home entertainment systems do not come up to speed that quickly. In fact, their motors have low torque, too little for them to come up to speed quickly or even to maintain their speed while an engineer grasps the edge of a disc with the table rotating. In the case of a broadcast turntable, the mat is made of felt and not rubber.

What I have described are two means of insuring the start of a phonograph record at a prescribed time. Each involves the rotation of the disc back-

ward from the start of the music; this process is known as *back cueing*.

*Slip cueing* is the first form of back cueing that I described, where the turntable is moving while the engineer holds the edge of the disc.

You will not be able to tell which technique is used when listening to a radio station or to a DJ cueing. The choice depends on the style of the operator, the equipment he is using, and what it will permit him to do.

For a number of reasons, most radio stations these days do not use either of the cueing techniques I have described. The songs are usually recorded onto a cartridge, similar to an eight-track cartridge. Such broadcast "carts" can be cued very accurately by means of special tones which automatically insure that when the engineer starts the "cart" machine, the song will commence instantly, with no "wowing in."

Up to this point our discussion has dealt with the proper start-up of phonograph records, but it is probably apparent that "cueing" refers to any situation where some given event must begin at a precise time. A motion picture projector in a TV station must start producing sound and pictures at a prescribed time. Because of the problems of such equipment coming

up to speed, the projector must often be started 10 seconds earlier than the desired starting time of the audio. If you have noticed the various combinations of live and taped commentary shown in TV news broadcasts, you will have an idea of the problems of a TV producer, and will realize how amazing it is that so few errors occur during this very highly complicated kind of programming!

Audio tapes are often used for programming, and again, they must start at a prescribed time. This is done by back-cueing them in a manner similar to what was done for discs. The reels are actually rocked by hand to the appropriate point ahead of the start of the tape. Here, however, the tape is not slip cued. That procedure would stretch the tape. Fortunately, professional-grade tape machines come up to a speed virtually instantly. There are some, however, which employ what are known as "inertia wheels" and these machines do not come up to speed quickly. (Inertia wheels are used to stabilize the tape and minimize wow and flutter.) In the case of these machines, a means must be found by which to start the tape early or to manually spin the wheel just prior to starting the tape. A

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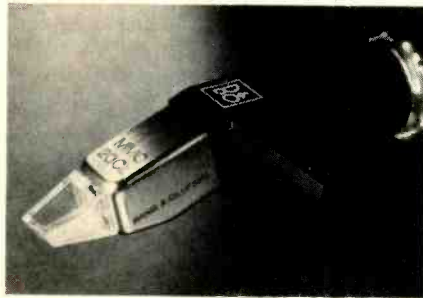
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Herman Burstein

# Tape guide

## Auto Audio

*Q. I am planning to buy an 8-track record and playback cartridge machine. This is to be used to record cartridges for playback on my car and home systems. I have read that as a rule, cartridge machines have a relatively high noise level. So I have been thinking of buying a Dolby noise reduction unit. This leads to two questions: Will this system give me a good tape system on both record and playback? Will cartridges recorded with this system be playable in my car system? — Name Withheld.*

A. Generally speaking, 8-track cartridge machines have not attained the quality of performance of the better cassette machines. Of course, adding a Dolby noise reduction unit will help, but I don't think that a cartridge machine with Dolby will give as good fidelity as a fine cassette unit without Dolby. There may well be exceptions to the foregoing statement, and the cartridge machine you plan to buy could be one of the exceptions.

You will have to query your audio dealer as to whether the cartridge unit you plan to buy will produce cartridges compatible with your car's cartridge system. My guess is that if you record with Dolby, you will get excessive treble when playing the cartridge in your car. On the other hand, the prevailing noise level and deficient treble response in your car's system might offset the excessive treble response of the cartridge.

## Weighing the Scales

*Q. I would like to know how to use the scales that are on cassette tapes. These scales are on both sides of the case and are numbered 0 to 100. Is there some meaning to them with regard to time, thickness, and speed of the tape? — John Johnson, Philadelphia, Pa.*

A. The scales to which you refer are sometimes known as logging scales. They have no absolute meaning in terms of time, number of feet of tape, etc. They are arbitrary reference points to enable you to locate specific portions of the recorded material. For ex-

ample, if you have a tape consisting of a number of musical selections, you can note at which point on the scale a particular selection occurs. The next time you play the tape you will be able to start it at the desired point on the scale.

## Splicing It Right

*Q. I am confused about tape splicing. On which side of the tape should I apply the splicing tape? — Craig Inouye, Dumont, N.J.*

A. Splicing tape should be applied to the side of the recording tape that is away from the heads. For most tapes this is the shiny side of the tape, the dull side being the one that contacts the heads. However, sometimes the tape sheen is reversed so that the magnetically coated side, which contacts the heads, is shinier than the base side. So make extra sure you know which side has the magnetic coating, and apply the splice to the other side.

## Foreign Fluctuations

*Q. I am contemplating a move to London and am concerned about the alterations I must make in my audio equipment. In particular, speed fluctuations in my tape recorders and turntables would be disastrous. I have heard a variety of reports about what could happen to my equipment and recordings while overseas and would appreciate any advice you can offer — Robert Miller, St. Louis, Mo.*

A. Some U.S. audio equipment is already designed to be used either in the U.S. or Europe, requiring only a flip of a switch in order to convert to the line frequencies and voltages commonly used in Europe. In the case of speakers, there is a problem only if they incorporate electronic equipment (such as an electrostatic speaker or one containing an amplifier). There may or may not be a problem with receivers, depending on what provision has

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

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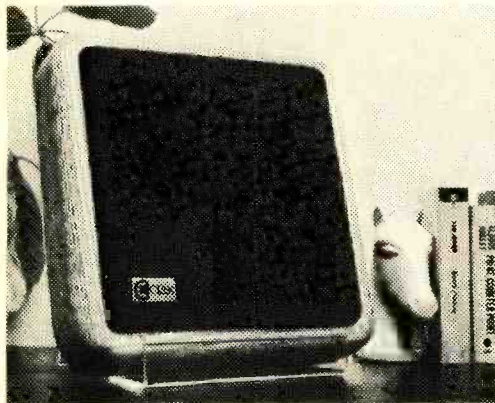
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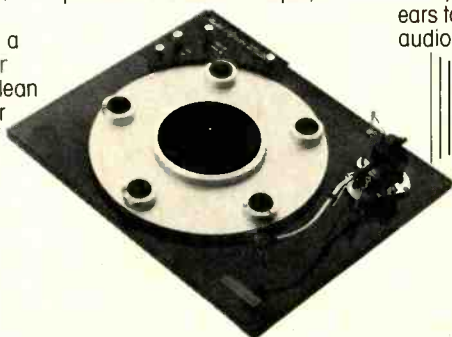
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been made for switching to a line voltage of 220 or 240 a.c. You have two problems with tape machines and turntables: Adapting to a line voltage much higher than in the U.S. (usually 220 or 240 volts a.c.) and adapting to a different line frequency (usually 50 Hz in Europe). The change in line frequency will change the speed of the turntable or tape transport unless special provision has been made, such as changing a pulley or capstan. (However, at least one manufacturer, ReVox, produces open-reel decks that maintain constant speed independently of line frequency; speed is crystal-regulated.)

Except perhaps for your speakers, you have to check the instruction manuals, and possibly with the manufacturers, about what adjustments are required for operation of the equipment in Europe. I doubt whether a line frequency of 50 Hz would hurt any of your equipment. But a line voltage of 220 could very well do damage.


### Don't Squeak to Me

*Q. Although my tape deck has not been used more than 30 hours, I hear a squeaky noise on playback and record. I have cleaned the moving parts, but still get a squeak — Raymond Greene, Richmond, Va.*

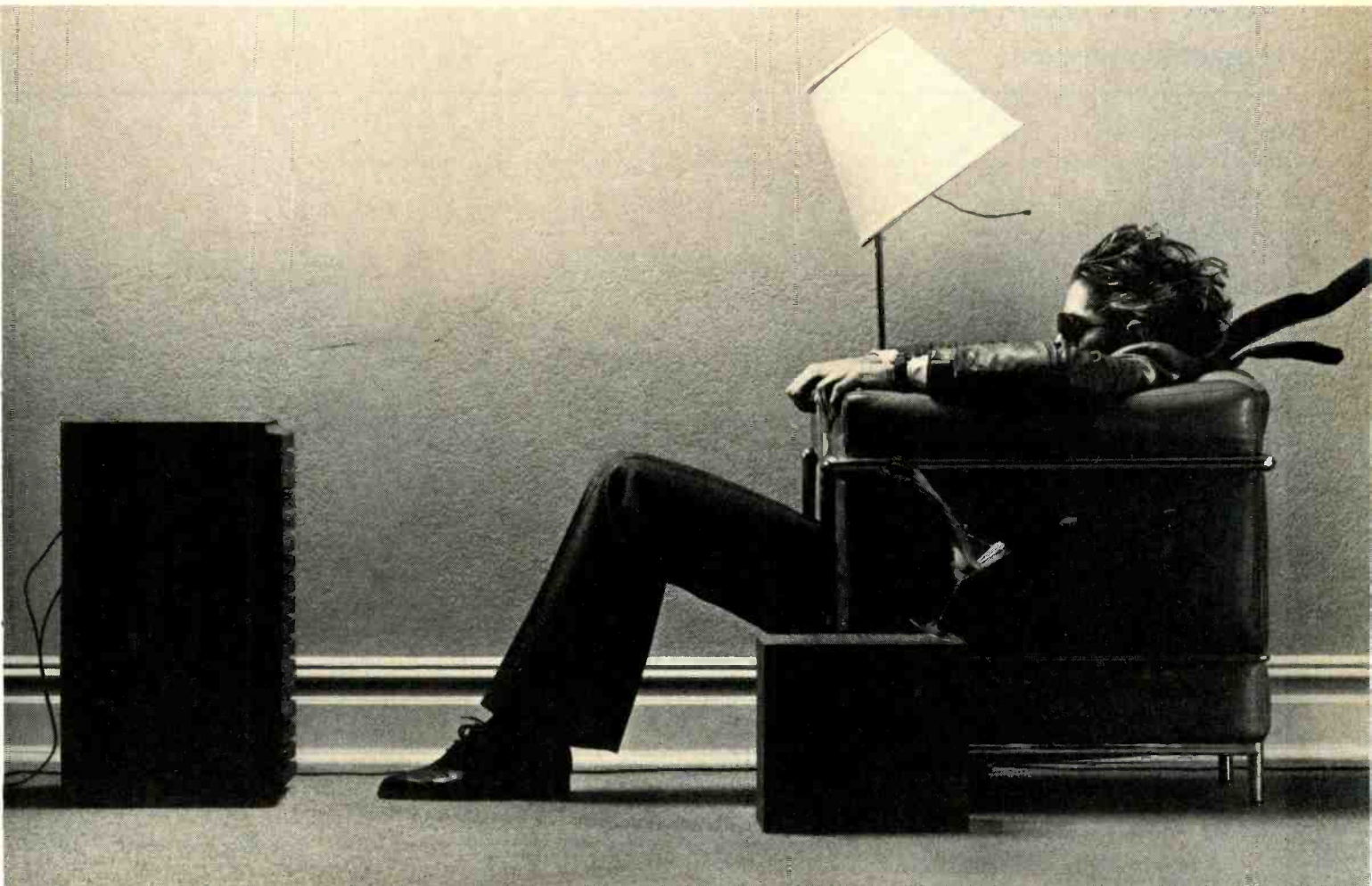
A. The most likely cause of the squeak is the particular tape you are using. Squeak, or squeal, is apt to occur with the thinner tapes. Squeal also varies with the particular combination of tape machine and brand of tape. For example, a tape may squeal with one machine but not with another, or a certain machine may squeal with one brand of tape of a given thinness but not with another brand of the same thinness. Make sure your machine is well cleaned, and try various brands of tape. If the squeal persists, you should consult an authorized service station.

### Let's Torque About It

*Q. I have a tape deck equipped with automatic reverse. My problem is that near the end of the reel the tape begins to slow down, at times coming nearly to a stop. Cleaning the heads and tape guides, plus a lube job, has not corrected this problem. Have you any ideas? — Steve Wells, Philadelphia, Pa.*

A. The motor driving the take-up reel may, for some reason, have insufficient torque. Possibly the brake may be contacting the supply reel or take-up reel. Additionally, your line voltage may be too low so that the transport motors cannot develop sufficient power. You should also check the reversing mechanism for faults. 

# AFTER 500 PLAYS OUR HIGH FIDELITY TAPE STILL DELIVERS HIGH FIDELITY.



If your old favorites don't sound as good as they used to, the problem could be your recording tape.

Some tapes show their age more than others. And when a tape ages prematurely, the music on it does too.

What can happen is, the oxide particles that are bound onto tape loosen and fall off, taking some of your music with them.

At Maxell, we've developed a binding process that helps to prevent this. When oxide particles are bound onto our tape, they stay put. And so does your music.

So even after a Maxell recording is 500 plays old, you'll swear it's not a play over five.



## IT'S WORTH IT.

# All That Data: Tape Deck Frequency Response And Headroom

Howard A. Roberson

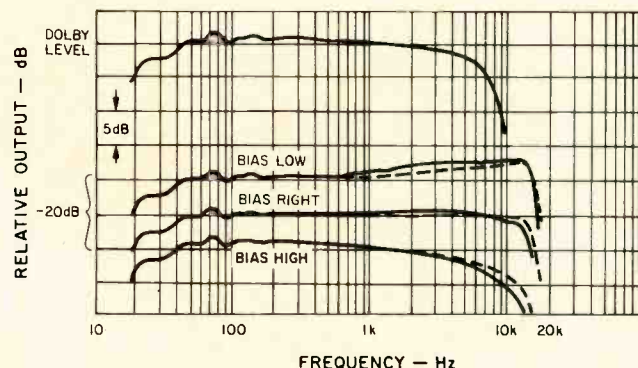
Whenever *Audio* reports on the results for testing a tape deck, we include a number of figures to help explain what the recorder's capabilities are. We usually have three graphs, or plots, that show the frequency response and headroom for three different tape types, usually a Type I (ferric), a Type II (CrO<sub>2</sub> type), and a Type IV (metal). Sometimes, a Type III (FeCr) is used in addition to, or in place of, one of the above.

Strictly speaking, what is commonly called "frequency response" would be more correctly labeled "amplitude response versus frequency." We are concerned with, and what our figures do show, is how the level, or amplitude, of the playback varies across the frequency band. Other high-fidelity components are rated by their frequency responses, of course, but a recorder's response is a long way from the extended, ruler-flat response of an amplifier. One of the goals of this article is to provide some guidelines for examining such graphs with greater perception.

It is best to compare the performance of one deck to another with the same signal or flux-level reference, and to use a reference easily identified by the user or reader. The Dolby standard flux level (200 nWb/m at 400 Hz) is used as the reference level of frequency response, as well as for other tests. Substantially all cassette decks have those little double-D symbols which pinpoint the record level that should gain Dolby flux levels. (It should be noted that because of equalization effects, the 200 nWb/m flux-level figure is correct for 400 Hz only.)

When frequency responses are run at the reference level, there will be a

**Fig. 1 — Typical frequency response curves of a cassette deck with and without (---) Dolby noise reduction, showing effects of three different bias settings.**



high-end dropping caused by any combination of several things: The tape itself, the design of the record head, the amount of equalization used in record — well, there's saturation and self-erasure mixed in here too. In any event, the plots at Dolby level are important since they show what the *high-level*, high-frequency limits are for the recorder/tape combination.

Responses are also shown at a level 20 dB lower, where frequency responses are usually specified by makers. This does not mean, of course, that with the record level 20 dB below Dolby level, we will be certain to get that ruler-flat line. There will be both lower and upper frequency limits, with electrical, mechanical and magnetic factors all involved. The results at this level are affected, perhaps greatly, by the closeness of match between the bias current provided by the machine

and the bias needs of the tape formulation. The performance in Dolby mode is affected by bias discrepancies, as well as any record sensitivity offsets. Because most users operate their decks in Dolby mode the majority of the time, the responses with NR are considered the normal ones. Responses without Dolby are usually also shown, particularly when there is a noticeable difference.

Examination of the figure with this article reveals that there is a plot at Dolby level and three plots at -20 dB, these last with three different bias conditions. The test signal was a sine wave which was swept from 20 Hz to 20 kHz. By this means, each and every point is a true data point. Discrete-point data are required if it is necessary to go beyond these limits in the usual frequency response curve.

Let's start with a critical look at the




Dolby-level response. Our reference frequency for plotting is 1 kHz, and the trace crosses the reference-level line there. There is a slight rise as we go down to 100 Hz, below which there are some bumps from head-contour effects. The response falls below 40 Hz, but it is not down 3 dB until just above 20 Hz. It would be ideal if there were no head-contour effects, and it is desirable that deviations from 40 Hz up be less than  $\pm 1.5$  dB. The significance of the lower limit is twofold: How low in frequency do your music sources go, and are the levels high in this region? Sometimes, but not in the case shown, recording at Dolby level causes a further dropping of the low end, relative to the -20 dB results. This is indicative of low-frequency overload or saturation and shows there is a definite level limit.

It's best if the response continues flat above 1 kHz, but at some point there will be a headroom limitation, and the response will roll off. In the figure, response is down 3 dB at about 6.3 kHz, which would be limiting in any attempt to record at high levels any music with considerable high-frequency content. The distortion also rises rapidly with level in the roll-off region, so it's not just a case of losing a little signal level. We would certainly like to see the response quite flat from 100 Hz to close to 10 kHz, which is possible with many decks. A general tilt, such as is evident from 70 Hz to say 4 kHz, might make the sound a little extra bassy.

Now let's take a look at the group of three sets of responses at -20 dB. The labels show what the deck's relative bias levels would be for a particular tape to get the results plotted. In each

case, the trace without Dolby NR is shown dashed. We can see that for each bias setting, the plot with NR is not quite as flat as without, and that when the bias matches the tape, the deviations are at a minimum. (The plot at Dolby level includes traces in both modes; the responses were exactly the same.)

At -20 dB the deck is not operating in a condition of high-frequency overload, so there cannot be a basis for excusing a general roll-off, such as shown in the high-bias case. At the same time, excessive high-end response can be much too bright, with a higher distortion level. So, tape formulations that match the deck are selected for testing. Immediately, we can say that we would like to see a response that is flat within a dB or so, from at least 100 Hz to 10 kHz, and extensions down to 40 Hz or so and up to 13 kHz or more would be nice to have. A very important region is from about 700 Hz to about 6 kHz where Dolby mistracking can cause either excessive presence, because of a boost in this region, or a dull, remote sound because of a saddle-like droop.

In summary, look at the responses at both Dolby level and at -20 dB over the range from about 40 Hz to 10 kHz or so. In both cases, flatness is the goal. Also give attention to head bumps at the low end, headroom limitations at the higher level, and Dolby-mode boost or saddle deviations at the lower level. See how far down in frequency the responses actually extend and whether there is additional roll-off at Dolby level. The extension of flat response above 13 kHz at -20 dB has some value, but this is not as significant as the other times, in most cases. 

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Hal Rodgers, Popular Electronics.

"The effect strains credibility—had I not experienced it, I probably would not believe it...the 'miracle' is that it uses only the two normal front speakers..."

Julian Hirsch, Hirsch-Tuck Labs.

"...it brings the listener substantially closer to that elusive sonic illusion of being in the presence of a live performance."

Larry Klein, Stereo Review.

"...seems to open a curtain and reveal a deployment of musical forces extending behind, between and beyond the speakers... terrific."

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# ADDENDA

# ANNUAL

# EQUIPMENT

# DIRECTORY

On the following pages, we present supplementary data to our Annual Equipment Directory and Car Stereo Directory (October and July issues respectively). In the main, this information is from firms whose material did not reach us in time or from companies we did not know about prior to our deadlines. As with all of our Directories, we suggest that the readers contact manufacturers directly for more specific explanations of the specs.

The Editors

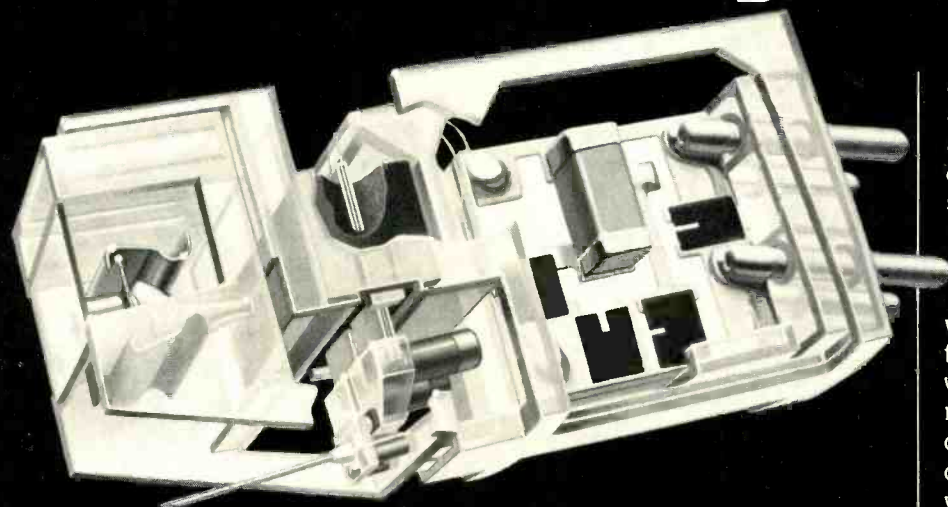
## DIRECTORY OF MANUFACTURERS

<p><b>A</b> <b>Acutex</b> P. O. Box 904 Fairfax, Va. 22030</p> <p><b>Amber Electronics</b> 500 Henry Ave. Charlottesville, Va. 22901</p> <p><b>Astatic Corp.</b> P.O. Box 120 Conneaut, Ohio 44030</p> <p><b>Axiom Engineering</b> 9601 Owensmouth Ave., #6 Chatsworth, Cal. 91311</p> <p><b>C</b> <b>Car-Fi International</b> 152 W. Cypress Ave. Burbank, Cal. 91502</p> <p><b>Cosmos Industries</b> 32-02 Queens Blvd. Long Island City, N.Y. 11101</p>	<p><b>D</b> <b>Denon America</b> P. O. Box 1139 West Caldwell, N.J. 07006</p> <p><b>Dex Research Mktg.</b> 60 Round Hill Rd. Dobbs Ferry, N.Y. 10522</p> <p><b>Dynavector</b> 7042 Owensmouth Ave. Canoga Park, Cal. 91303</p> <p><b>G</b> <b>Grafyx Audio Products</b> 310 Kirk Rd. St. Charles, Ill, 60174</p> <p><b>H</b> <b>Harman/Kardon</b> 240 Crossways Park West Woodbury, N.Y. 11797</p> <p><b>I</b> <b>Impulse Corp.</b> Route 2, Box 191 Dover, Ark. 72837</p>	<p><b>J</b> <b>Jamo Hi-Fi U.S.A.</b> 916 Ash St. Winnetka, Ill. 60093</p> <p><b>K</b> <b>KA/Kinetic Audio</b> 6624 W. Irving Park Rd. Chicago, Ill. 60634</p> <p><b>M</b> <b>Mission Electronics</b> Unit 9 89 Galaxy Blvd. Rexdale, Ontario Canada M9W 6A4</p> <p><b>P</b> <b>PDF</b> 2031 Main Kansas City, Mo. 64108</p> <p><b>Precision Fidelity</b> 1238 Green St. San Francisco, Cal. 94109</p> <p><b>PS Audio</b> 3130 Skyway Dr., #301 Santa Maria, Cal. 93455</p>	<p><b>S</b> <b>SAE</b> 701 East Macy St. Los Angeles, Cal. 90012</p> <p><b>Spectrum Loudspeakers</b> Box 2998 Toledo, Ohio 43606</p> <p><b>Z</b> <b>Zenith</b> Acoustics Dept. 1000 Milwaukee Ave. Glenview, Ill. 60025</p> <p><b>Addresses Update</b> <b>Bauman Research</b> Route 1, Box 52UA Rosenberg, Tex. 77471</p> <p><b>JVC</b> 41 Slater Dr. Elmwood Park, N.J. 07407</p> <p><b>Polydax/Sonosphere</b> c/o Nyco Sound Ltd. P.O. Box 169 Hanover, N.H. 03755</p>
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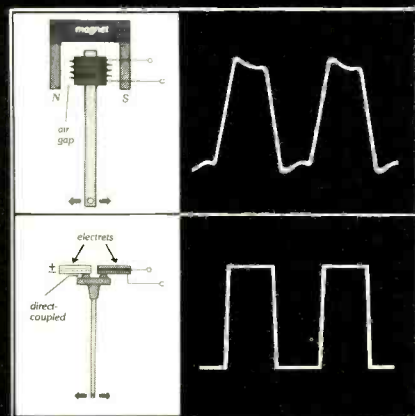
## OPEN/REEL TAPE DECKS

MANUFACTURER	Model	Letter Code	Speeds — See Letter Code	Maximum Reel Size, Inches	Number of Heads	Number of Tracks	Number of Channels	Number of Motors	Drive Motor Type	Drive to Capstan	Freq. Resp. — Hz-KHz, ±dB, with Beat Tape at Highest Machine Speed	Wow & Flutter, DIN 45-507, %	S/N, ±dB	Output Level at 0VU, mV	Dolby NR included?	Mike Mixing?	Mike Input Z, Ohms	Record Level Indicator(s) Type and Quantity	Dimensions, Inches	Weight, Lbs.	Price, \$	Notes
DENON	DH-510	F	10 1/2	3	2	2	3		A.C. Direct	30-30 ±3	0.025	66	755	No	Yes	50k	2 Mtrs. Peak /VU sw.	18 1/4 x 19 x 8 1/2	48 1/2	1350.00		

# Micro-Acoustics System II: The Stereo Cartridge. Reinvented.



Direct-to-disc. Digital. Dolby™  
While record-making has made quantum jumps over the last few years, one thing has remained essentially the same: the phono cartridge. Because, whatever their price, all are essentially the same—a coil and magnet interacting across an air gap. With built-in electromagnetic delays that degrade musical transients. And a



Transient ability of high-priced moving coil magnetic cartridge (top) vs. new MA System II. Note how magnetic cartridge air gap and hysteresis delay distort the square wave.

single damper that trades off tracking and transient ability.

Pushed to their limits by clever engineering, some still offer remarkable (if costly) performance.

But now there's something better. More than a new cartridge design... a new cartridge technology. Its name: Micro-Acoustics System II.

**Transient response up to 10X faster than magnetic cartridges.\*** Like the best amplifiers, System II is direct-coupled. Eliminating

the air gap delay by uniting a microscopic stylus and ultra-light-weight cantilever with a patented\* electret transducing system.

**The only cartridges with a brain.** Unlike magnetic cartridges, which require critical matching of tonearm cable capacitance and preamp inputs—something that's virtually impossible to achieve—MA System II cartridges are "intelligent." A built-in microcircuit automatically matches the cartridge to the rest of the system, eliminating the transient and high-frequency response problems of magnetic cartridge designs.

**Independent suspension and damping.** Instead of the single damper magnetic cartridges use to

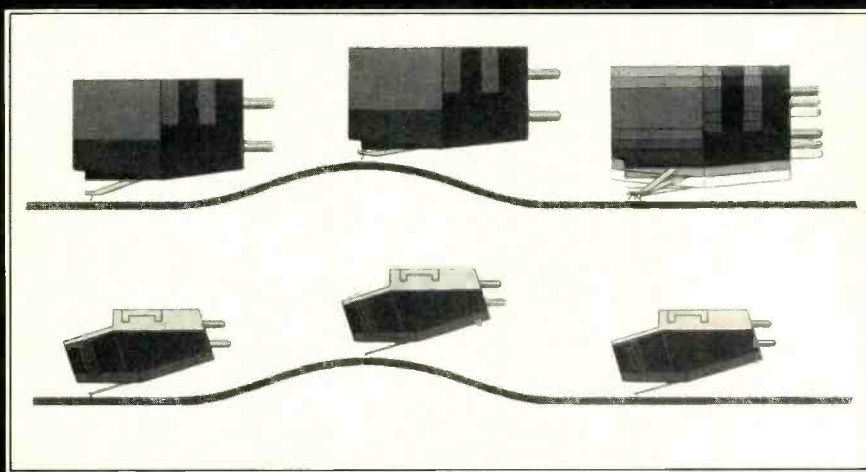
achieve compliance (for tracking ability) and damping (for transient ability), System II utilizes independent suspension and damping systems. The result is performance that's optimized—not compromised.

**The ultimate answer to record warp.** The laws of physics prove that the problems of playing warped records are best eliminated by dynamic damping in the cartridge. But only MA System II cartridges have a special internal warp damping system. Magnetic cartridges have no such provisions.

**Optimum performance in any tonearm.** With their carbon-fiber housings and lightweight transducers, MA System II cartridges are the lightest ever, for lowest cartridge/tonearm mass. And therefore, the best performance. System II's exclusive Vari-Balance™ system, with removable weights, allows a cartridge to be optimized for any tonearm.

All this, as the diagrams reveal, is just the beginning. But impressive as System II's technology is, it only hints at the audible difference it can make in your music.

To experience that, we invite you to visit your Micro-Acoustics dealer.



Record-warp tracking of magnetic cartridge (top) vs. MA System II. Note how magnetic cartridge's single-bearing design oscillates from record warp, producing distortion, while MA's warp-damping system prevents oscillation.

\*U.S. Pat. No. 3952171. Dolby is a registered trademark of Dolby Laboratories, Inc.

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# RECEIVERS

MANUFACTURER	Model	Unit Type: FM Only = FM; KT=K	Ave. Watts/Chan. @ Ohms	% THD	% IHF IM	Rated Power, Hz to kHz	Phono S/N, "A" Wtd., r.e. 5 mV dB, per IHF A-202	Phono Overload, mV per IHF A-202	Dynamic Headroom, dB	Mono IHF Sensitivity, $\mu$ V/dBf	Stereo IHF Sensitivity, $\mu$ V/dBf	Capture Ratio, dB	Mono Signal Strength for 50-dB Quieting, $\mu$ V/dBf	Stereo Signal Strength for 50-dB Quieting, $\mu$ V/dBf	% THD, 100% Modulation, 1 kHz, Mono/Stereo	Alt. Chan. Select., dB, Wide/Narrow I.F. Bandwidth	Max. S/N, dB, Mono/Stereo	Net Weight, Lbs.	Price, \$
DENON	DRA 600	60	0.03	0.03		86	200	1.8/					0.1/		74/	24.2	540.00		
HARMAN KARDON	HK350i HK460i HK570i HK680i	20 30 45 60	0.08 0.07 0.05 0.03	0.08 0.07 0.05 0.03	15-80 12-90 10-100 8-110	85 86 88 88	100 130 150 225	1.9 2.2 3 3	2.0/11 2.0/11 2.0/11 1.9/10.7	18/30.5 17/30 17/30 16/29.5	2 1.5 1.3 1.2	3.5/16 3.3/15.5 3.1/15 3/14.8	45/38 42/37.5 37/36.5 35/35.5	0.1/1.6 0.09/1.4 0.08/1.2 0.07/0.09	60 67 70 80	74/76 75/77 76/78 77/80	23 26 31 35	249.00 329.00 399.00 599.00	

# TURNTABLES

LETTER CODE FOR SPEEDS		Model		Speeds—See Code	Wow & Flutter, %, 33 1/3, DIN 45-507	Rumble, -dB, DIN 45-539-B	Motor Type	Drive System	Speed Inaccuracy, ±%	Speed Adjustment Range, ±%	Speed Accuracy Indicator Type	Overall Arm Length, Inches	Pivot Stylus Dist., Inches	Multi-Play? If Yes, # Discs	Auto. Cue = C; Auto. Off = O	Max. Tracking Error, Deg./In.	Anti-Skate Adjustment?	Tracking Force Range, Gms.	Total Cable Capacitance, pF	Damped Cueing?	Dimensions, Inches	Price, \$
DENON	DP 30LS	B	0.018	75	A.C. Servo	Direct	0.009	3	Strobe		9	No	C/O	3	Yes	0-2.5		Yes	18x16x5 1/2		290.00	
	DP 40F	B	0.015	75	A.C. Servo Quartz	Direct	0.002	0	No		9 1/4	No	C/O	2	Yes	0-2.5		Yes	19x17 1/2 x 5 1/4		535.00	
	DP 60L	B	0.015	75	A.C. Servo Quartz	Direct	0.002	0	Strobe	14 1/2	11 1/4	No	C/O	1.8	Yes	0-2.5		Yes	22 1/4 x 17 1/2 x 8		595.00	
	DP 1250	B	0.018	75	A.C. Servo Quartz	Direct	0.018	3	Strobe			No										340.00
PRECISION FIDELITY	Golden AB1	B	0.07	70		Belt																1500.00

# MICROPHONES

MANUFACTURER	Model	Directional Pattern	Operating Principle	Case Material	Most Common Use	Actual Impedance, 1 kHz, Ohms	Operating Range, Hz to kHz	Open-Circuit Sens., 1 kHz, dB re: 1 V/1 p bar	Mike Connector Type	Cable Length, Feet	Connector on Equipment End of Cable	Dimensions, Inches, Length x Diameter	Weight, Ounces	Mounting Method	Price, \$	Notes
ASTATIC	814HS	Card.	Dyn.	Zinc	Instr.	40k	40-15	74	A3F	18	Phone	8 1/2 x 1	9	1/4 x 27	142.50	
	814LS	Card.	Dyn.	Zinc	Instr.	250	40-15	74	A3F	18	A3M	8 1/2 x 1	9	1/4 x 27	137.50	
	815HS	Card.	Dyn.	Zinc	Vocal	40k	40-15	74	A3F	18	Phone	8 1/2 x 1	9	1/4 x 27	142.50	
	815LS	Card.	Dyn.	Zinc	Vocal	250	40-15	74	A3F	18	A3M	8 1/2 x 1	9	1/4 x 27	137.50	
	854HS	Card.	Dyn.	Zinc	Instr.	40k	40-15	74	A3F	18	Phone	8 1/2 x 2 1/2	9 1/2	1/4 x 27	162.50	
	854LS	Card.	Dyn.	Zinc	Instr.	250	40-15	74	A3F	18	A3M	8 1/2 x 2 1/2	9 1/2	1/4 x 27	157.50	
	855HS	Card.	Dyn.	Zinc	Vocal	40k	40-15	74	A3F	18	Phone	8 1/2 x 2 1/2	9 1/2	1/4 x 27	162.50	
	855LS	Card.	Dyn.	Zinc	Vocal	250	40-15	74	A3F	18	A3M	8 1/2 x 2 1/2	9 1/2	1/4 x 27	157.50	
	857HS	Card.	Dyn.	Zinc	Instr.	40k	50-15	57	A3F	18	Not Furn.	8 1/2 x 2 1/2	9 1/2	1/4 x 27	125.00	
	857LS	Card.	Dyn.	Zinc	Instr.	250	50-15	82	A3F	18	Not Furn.	8 1/2 x 2 1/2	9 1/2	1/4 x 27	125.00	
	950HS	Card.	Dyn.	Zinc	Vocal	40k	50-15	74	A3F	18	Phone	9 1/2 x 2 1/2	10 1/2	1/4 x 27	157.50	
	950LS	Card.	Dyn.	Zinc	Vocal	250	50-15	74	A3F	18	A3M	9 1/2 x 2 1/2	10 1/2	1/4 x 27	152.50	
	952HS	Card.	Dyn.	Zinc	Instr.	40k	50-15	74	A3F	18	Phone	9 1/2 x 2 1/2	10 1/2	1/4 x 27	162.50	
	952LS	Card.	Dyn.	Zinc	Instr.	250	50-15	74	A3F	18	A3M	9 1/2 x 2 1/2	10 1/2	1/4 x 27	152.50	



# FOR \$299,\* DBX TECHNOLOGY BRINGS YOUR HOME RECORDING SO CLOSE TO DIGITAL, IT'S ABSURD.

## INTRODUCING THE DBX RECORDING TECHNOLOGY SERIES MODEL 224. THE BEST PERFORMANCE YOU CAN BUY FOR UNDER \$50,000.

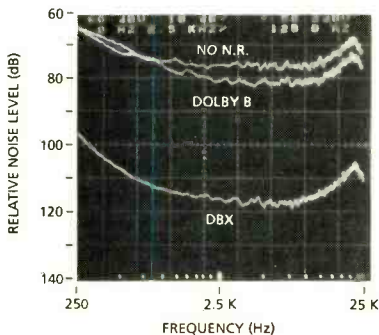
Digital recording means two things. No noise, and a full dynamic range of 90dB.

But until now, only recording engineers have been able to enjoy that incredible sound using studio recording systems costing \$50,000 or more.

Now, however, there's the new dbx Recording Technology Series Model 224, the state-of-the-art in home recording. It hooks right into your present tape system. And it lets you do almost everything you could do with a digital system, but for a whole lot less.

### THE QUIETEST SOUND ON TAPE.

As for noise reduction, nothing on the market comes close to the Model 224.



Dolby reduces noise by only 10dB at best, and only in the high frequency range. dbx virtually eliminates tape hiss, reducing it by more than 30dB across the entire frequency range. (Unretouched laboratory photograph. Data from "The Importance of Dynamic Range," Audio Magazine, January, 1980. For a copy of the article, write dbx.)

The Dolby<sup>®</sup> system you've been putting up with certainly doesn't. It only reduces tape noise by 10dB at the most, and only in the high frequency range.

Compare that with the dbx Model 224, which reduces tape noise by more than 30dB across the whole frequency range. It virtually eliminates tape noise, without adding any audible distortion or changing the tonal character of the sound.



Conventional tape recorders limit dynamic range. With the dbx Model 224, you can get the dynamic range approaching that of a live performance.

### DYNAMIC RANGE APPROACHING DIGITAL.

The Model 224 also gives you something else you've never heard before from a tape recorder: full dynamic range.

Dynamic range is the difference in volume between the loudest and quietest passages in a piece of music. It's just as important to the realism of music reproduction as flat frequency response, or accurate spatial perspective.

And although live performances—and digital master tapes—go up to 90dB of dynamic range, even the best home recordings have been limited to only about 50dB. So no matter how good your recorder is, you've been missing at least one third of your music's dynamic range.

Well, the Model 224 gives you the capability to record an unprecedented 85dB on open reel and 80dB on cassette.

So for the first time, you can make live recordings that capture virtually all the dynamic range of the original music.

In addition, the Model 224 is the only system that lets you tape fine audiophile records without losing any of their dynamic range.

And you can use the extra head room provided by the 224 to dramatically extend frequency response and minimize distortion during recording.

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The sound of digital recording really is here. Dynamic range approaching a live performance. Music heard against a background of virtual silence. And a purity of sound that's never been possible before in home tape recording.

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We think you'll agree with us. For \$299, you'd be crazy to pass it up. dbx, Incorporated, 71 Chapel Street, Newton, MA 02195.

\*Manufacturer's U.S. suggested retail price; actual price set by dealers.

\*\*Dolby is a registered trademark of Dolby Laboratories Inc.

**dbx**<sup>®</sup>  
MAKING GOOD SOUND BETTER

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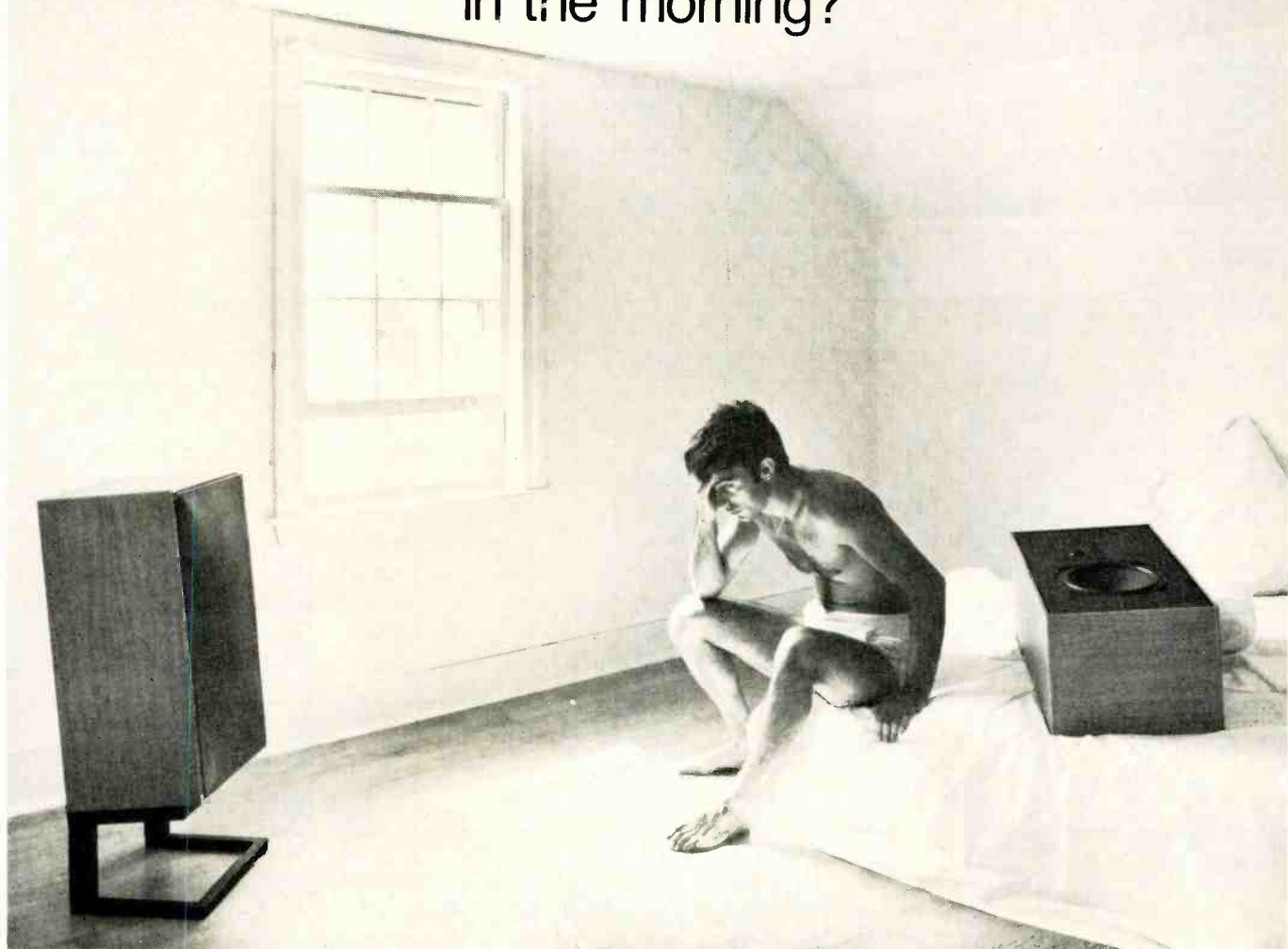
# PHONO CARTRIDGES

MANUFACTURER	Model	Frequency Response, Hz to kHz, ±dB	Principle Moving Element: Moving Magnet or Moving Coil; Acc. Induced Magn. or IM		W Individual Response Curve?	Channel Separation, 1 kHz, dB	Channel Separation, 10 kHz, dB	mV Output, 1 Hz, 5 Cm/Sec. rms Lateral Velocity Range, Gms.	Recommended Tracking Force, Dynes	Recommended Load Resistance, Ω	Stylus Type—See code	Stylus Radius (Radial), Mils	Stylus Replacement: User = U; Factory = F	Weight, Gms.	Price, \$	Replacement Stylus Price, \$	Notes
			IM	No													
ACUTEX	320 III STR	20-20 ±0.75	IM	No	33	29	3.5	0.8-1.8			†	0.3x1.6x0.5		5.45	195.00		†Symmetrical tri-radial.
	315 III STR	20-20 ±0.75	IM	No	32	28	3.5	0.9-1.9			†	0.3x1.6x0.6		5.45	145.00		
	312 III STR	20-20 ±1.0	IM	No	30	27	3.5	1.2-2.5			†	0.3x1.6x0.6		5.45	110.00		
	310 III E	20-20 ±1.0	IM	No	28	25	3.5	1.5-2.8			E	0.3x0.7		5.45	90.00		
	210 II E	20-20 ±1.5	IM	No	27	25	4.5	1.8-2.8			E	0.3x0.7		5.45	80.00		
	207 II E	20-20 ±1.5	IM	No	27	25	4.5	1.8-2.8			E	0.3x0.7		5.45	70.00		
	206 II	20-20 ±1.5	IM	No	27	25	4.5	2.0-3.0			C	0.65		5.45	50.00		
ASTATIC	MF-100	10-20 ±1	MF†	No	30	25	3.5	1-1½	47k	100	X††	Parabolic	U	5.5	267.50	133.75	†Moving flux; ††hyper-elliptical. In headshell.
	MF-100H	10-20 ±1	MF†	No	30	25	3.5	1-1½	47k	100	X††	Parabolic	U	5.5	290.00	133.75	
	MF-200	10-20 ±2	MF†	No	28	20	4.2	1½-2	47k	100	X††	Parabolic	U	5.5	160.00	80.00	
	MF-200H	10-20 ±2	MF†	No	28	20	4.2	1½-2	47k	100	X††	Parabolic	U	5.5	182.50	80.00	As above.
	MF-300	10-20 ±2½	MF†	No	25	18	4.2	1½-2	47k	100	E	0.3x0.7			100.00	50.00	
	MF-300H	10-20 ±2½	MF†	No	25	18	4.2	1½-2	47k	100	E	0.3x0.7	U	5.5	122.00	50.00	As above.
	MF-400	10-18 ±3	MF†	No	22	18	4.2	1½-2½	47k	100	S	0.5	U	5.5	80.00	40.00	
MF-400H	10-18 ±3	MF†	No	22	18	4.2	1½-2½	47k	100	S	0.5	U	5.5	102.50	40.00	As above.	
DENON	DL-103	20-45	MC	Yes	25			2.2-2.8	100		C	0.65	†	8.5	140.00		†Cartridge replacement program.
	DL-103S	20-60	MC	Yes	25			1.5-2.1	100		E	Special	†	7.8	186.00		
	DL-103D	20-65	MC	Yes	28			1.3-1.7	100		E	0.1	†	7.5	267.00		
	DL-301	20-60	MC	Yes	28			1.1-1.5	100		E	0.04x0.07	†	4.7	150.00		
	DL-303	20-70	MC	Yes	28			1.0-1.4	100		E	0.05x0.1	†	5.8	385.00		
	DL-305	20-75	MC	Yes	28			1.0-1.4	100		E	0.05x0.1	†	5.8	565.00		Amorphous boron cantilever.
DYNAVECTOR	DV-100D	20-70	MC	Yes	20		0.2	1.5	47k		X†	0.1x0.1	F	5.3	1000.00		†Line contact, diamond cantilever.
	DV-100R	20-50	MC	Yes	20		0.2	1.5	47k		X†	0.1x0.1	F	5.3	275.00	151.25	†Line contact, synthetic ruby cantilever.
	20B2	20-20	MC	Yes	20		3.6	1.8	47k		E	0.3x0.7	F	5.3	290.00	159.50	
	20A2	20-20	MC	Yes	20		3.6	1.8	47k		E	0.3x0.7	F	5.3	230.00	126.50	
	10X	20-20	MC	Yes	20		2.3	1.5	47k		E	0.3x0.7	F	9.5	120.00	66.00	

# HEADPHONES

MANUFACTURER	Model	Operating Principle	Frequency Range, Hz to kHz		Impedance, Ohms	Sensitivity, dB SPL for 1 mW input	Maximum Input, mV	Cord Length, Feet	% THD at 95 dB SPL	Cord Style: Flat—F; Coiled—C	Weight, Ounces	Circumference, C; Supra-aural=S	Price, \$	Notes
			75	115										
ACUTEX	HTS 1	Dyn.	35-22	75	115		10		F	7		49.50		
	HTS 3	Dyn.	20-27	75	105		10		F			89.00		
ZENITH	839-32	Dyn.	20-19	8	104 ±3	500	10		C	11		49.95		
	839-49	Dyn.	20-18	8	110 ±3	200				11		22.65		
	839-50	Dyn.	20-20	8	108 ±3	200				12		32.95		
	839-52	Dyn.	20-20	8	90 ±3	700	10		C	16		58.95		
	839-54	Dyn.	20-16	8	100 ±3	300	9		C	13		54.50		
	839-55	Dyn.	30-18	8	90 ±3	200	10		C	8		26.50		
	839-56	Dyn.	10-25	8	100 ±3	300				13		65.95		

## Will you still respect your speakers in the morning?



Sure, they sounded great last night.

But the real test of a speaker system is the morning after.

Will your speakers sweeten your morning coffee with Vivaldi, or will they make you wish you'd never turned your stereo on?

Do your speakers make you glad you're alive, or do they serve only to remind you of last night's excesses?

Some speakers are impressive when played loudly. But a truly great speaker is equally, if not more, impressive at low listening levels. "Loud" is desirable at times, but a speaker to be lived with must do much more.

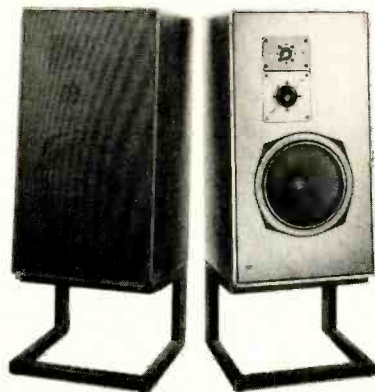
For years, and without fanfare, ADS has been building monitor speaker systems for some of the most demanding sound engineers in the music industry. ADS technology is uniquely able to accommodate their diverse and challenging re-

quirements. This same technology, not surprisingly, produces some of the finest speaker systems available for home use.

The new ADS L730, for example, is a direct outgrowth of ADS' continuing involvement in digital recording technology. An unusual combination of extended fre-

quency range, uncanny sonic accuracy, razor-sharp stereo imaging and true-to-life dynamic range, the L730 delivers untiring musical performance. Although the system is capable of shaking walls with clean, undistorted sound, you'll appreciate it most on those mornings when quality counts more than quantity.

The L730 is only one of many ADS speakers, all meticulously engineered and superbly crafted. Your ADS dealer will be happy to help you select the model which best suits your purposes. For more information and the name of the ADS dealer nearest you, please write ADS, Dept. AU22, or call 1-800-824-7888 (California 1-800-852-7777) toll free and ask for Operator 483.



Audio for the  
critically demanding

Analog & Digital Systems, Inc., One Progress Way, Wilmington, MA 01887 (617) 658-5100

# LOUDSPEAKERS

MANUFACTURER	Model	Enclosure Type	Woofer Dia., Inches		Midrange Dia., Inches		Tweeter Dia., Inches		Level Control? M=Wooder; M=Midrange; T=Tweeter; S=Super Tweeter		Anechoic Freq. Response Hz to kHz, ± dB		Recommended Min. Amp. Watt / Meter	Crossover Frequencies, Hz		Impedance Ohms; Nominal/Minimum	Dimensions, Inches	Finish	Grille Material, Color	Weight, Lbs. (Notes if per pair.)	Price, \$ (Notes if per pair.)
			Ac. Sus.	Ac. Sus.	1	1	1	1	83	12	2.5k	8		7 1/2 x 4 1/2 x 4 1/4	Alum. Wal.						
ACUTEX	MTS 1	Ac. Sus.	4				1	Dome		100-20	83	12	2.5k	8	7 1/2 x 4 1/2 x 4 1/4	Alum. Wal.	Metal Cloth, Blk.	5.5	99.00		
	MTS 1 W	Ac. Sus.	4				1	Dome		100-20	83	12	2.5k	8	7 1/2 x 4 1/2 x 4 1/4	Alum. Wal.	Metal Cloth, Blk.	5	129.00		
	MTS 2	Ac. Sus.	5				1 1/4	Dome		50-20		5	2.5k	8	10 1/4 x 6 1/2 x 5 1/4	Alum. Wal.	Metal Cloth, Blk.	8.8	139.50		
	MTS 3	Pas. Rad.	6 1/2				1 1/4	Dome		40-20		5	2.5k	8	13 1/4 x 9 x 6 1/4	Alum. Wal.	Metal Cloth, Blk.	11.5	149.50		
	3.1	Pas. Rad.	8				3	Cone		40-20				8	21 x 11 x 9	Rsnut.	Cloth	23	149.00		
	4.2	Pas. Rad.	10				3	Cone		35-20				8	23 x 13 x 11	Rsnut.	Cloth	28	199.00		
COSMOS INDUSTRIES	Cosmomatic Omnidirectional	Pas. Rad.	(4) 6	1 1/2, 682 Sq. in.	Dome, ES	682 Sq. in.	ES			31-20 ±3	92	50	1k	8/5	21 1/2 x 21 1/2 x 60	Oil. Wal.	Blk.	153	3600.00 Pair		
IMPULSE	Model One	Tuned Port	10				Rib.	T		30-18 ±2	84	100	200 Hz	4/3	Two Pieces	Wal.	Cloth, Opt.	200	2795.00 Pair		
JAMO HI-FI	K 20	Sealed	6				1	Dome	T	50-15			1.9k	8/4	12 x 8 x 4	Wood Ven.		5	139.95		
	Mini 80	Bass Ref.	6 1/2							38-20				8/4	12 x 7 x 9	Wood Ven.		18	139.95		
	J 73	Sealed	8				1	Dome	T	35-20			1.7k	8/4	17 x 9 x 8	Wood Ven.		13	136.95		
	J 103	Sealed	9	6			1	Dome	M,T	28-20			900, 4.5k	8/4	20 x 12 x 8	Wood Ven.		19	209.95		
	J 123	Sealed	11	6			1	Dome	M,T	25-20			800, 4k	8/4	20 x 13 x 9	Wood Ven.		26	267.95		
	J 153	Sealed	13	2	Dome	1	Dome	M,T	22-20				750, 4k	8/4	26 x 16 x 9	Wood Ven.		42	339.95		
	P 230 R	Bass Ref.	13	4 x 10 1/2	Horn	3 x 3	Horn	M,T	22-20				1.1k, 5k	8/4	26 x 16 x 9	Wood Ven.		43	399.95		
	P 260 R	Bass Ref.	(2) 11	4 x 10 1/2	Horn	(2) 3 x 3	Horns	M,T	22-20				1k, 5k	8/4	30 x 18 x 13	Wood Ven.		66	569.95		
	J 203	Bass Ref.	13	2	Dome	(2) 1	Domes	M, (2) T	22-20				600, 4.6k	8/4	28 x 17 x 13	Wood Ven.		55	539.95		
J 253	Bass Ref.	15 1/2	2	Dome	(2) 1	Domes	M, (2) T	22-40				650, 5k	8/4	30 x 18 x 13	Wood Ven.		66	697.95			
P 140 R	Bass Ref.	11			3 x 3	Horn	T	25-20				2.2k	8/4	22 x 13 x 9	Wood Ven.		26	249.95			
KA/KINETIC AUDIO	200 SW	TAL	12							32-3.5	93	10	65,100, 200 2k	8	24 x 14 1/2 x 9	Oil. Wal.	Knit, Blk.	55	199.00		
	Subwoofer	TAL	6 1/2				1 1/4	Dome	T	32-22 ±2.5	92	15		8	15 1/2 x 9 x 7	Oil. Wal.	Knit, Blk.	28	299.00		
	Micro Pulse Monitor Stat Nouveau	Dual TAL	(2) 6 1/2				1 1/4	Dome	T	34-22 ±2	93	5	1.8k	4	19 x 11 1/2 x 9	Oil. Wal.	Knit, Blk.	45	549.00		
MISSION ELECTRONICS	700	Bass Ref.	8				1/4	Dome		60-20 ±3	86	15		8/	18.1 x 10.2 x 9.8	Opt.	Foam, Blk.	14.4	347.00 Pair		
	710	Bass Ref.	8 1/4				1	Dome		55-20 ±3	87	15		8/	20.4 x 11.4 x 10.2	Wal.		21.1	497.00 Pair		
	720	Inf. Baf.	9 1/4	4	Cone	1	Dome			50-20 ±3	88	25		8/	26.3 x 12.5 x 12.5	Wal.		36.6	847.00 Pair		
	730	Bass Ref.	10	4 1/4	Cone	1	Dome			45-20 ±3	89	30		8/	35.4 x 12.6 x 12.6	Wal.		38.8	1197.00 Pair		
	770	Bass Ref.	8 1/2				1	Dome		40-20 ±2.5	85	30		8/	23.4 x 11.9 x 11.2	Opt.		27.7	997.00 Pair		
PDF	SMI	Sealed	(2) 5 1/4							50-16 ±3	101	10		16	12 1/2 x 6 x 6	Acryl.	Mesh, Blk.	12 1/2	130.00		
SPECTRUM LOUDSPEAKERS	108	Bass Ref.	8				1	Dome		35-20 ±4	92	10	2.5k	10/8	25 1/2 x 14 1/2 x 10 1/2	Wal. Vin.	Knit, Blk.	39	150.00		

# TONEARMS

MANUFACTURER	Model	Overall Length, Inches	Pivot-Stylus Distance, Inches		Cueing?	Damped Cueing?	Removable Headshell?	Maximum Tracking Error, Degrees/Inch	Anti-Skating Adjustment?	Tracking Force Range, Gms.	Total Cable Capacitance, pf	Cartridge Weight Range, Gms.	Vertical Bearing Type	Lateral Bearing Type	Price, \$	Notes
			Opt.	Opt.												
DYNAVECTOR	DV-505	13.19	9 1/2	Opt.	Opt.	Yes	Yes	0-3	37	0-23	Ball	Ball	700.00		Dynamic and electromagnetic damping syst.	

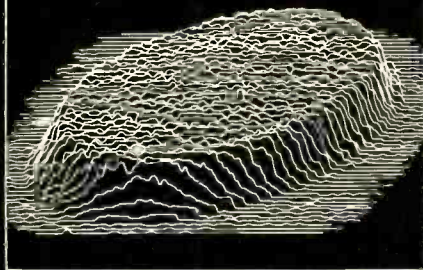


# PRESENTING THE FIRST SPEAKER WITH A LASER-PERFECT TWEETER.

It's something you've never seen before. Or heard. Perfection.

Perfect tweeter motion, frozen in time. Plotted by a new technique that captures what speaker designers only knew in theory. And were

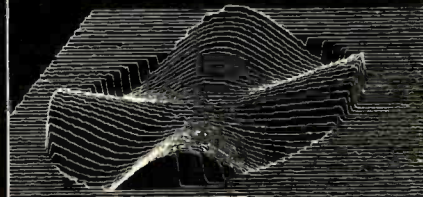
Perfect piston motion. The new ULTRA Tweeter vibrating at 3kHz.



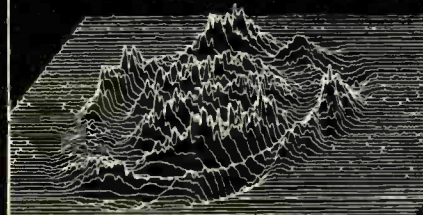
only able to correct by trial-and-error methods. Because no one had ever truly seen the dynamic behavior of an audio transducer. Until now.

It took a laser. Married to a special photosensitive detector and a computer capable of plotting 36,000 coordinates of microscopic motion with incredible precision.

ULTRA scan of bell mode cone behavior, long theorized but never before seen.

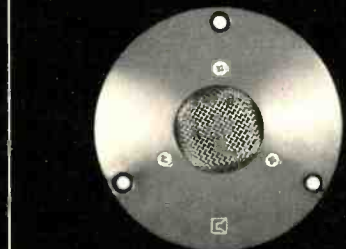


ULTRA scan of distortion-producing tweeter breakup.



ULTRA has changed all that. By making the invisible, visible. So we can see precisely how changes in critical dimensions, materials, mechanical and electrical characteristics—literally hundreds of different variables—affect the behavior

The new ULTRA Tweeter, perfected by Celestion's proprietary Ultra-accurate Laser Topographic Response Analysis.



and interaction of drivers, crossovers and enclosures. At different frequencies. And different levels. In different acoustic environments.

**Now, your ears will believe your eyes.**

The first results of this engineering breakthrough were recently revealed to the Audio Engineering Society in two major papers by our engineering staff. But a more exciting revelation awaits your ears, in our new Dittor 130, 150, 200 and 300 speakers.

New clarity, accuracy and detail. Improved stereo imaging. Combined with an almost unbelievable efficiency that extracts super performance from receivers and amplifiers of even modest output.

Visit your Celestion dealer and see what ULTRA laser accuracy can do for your ears.

Generating an accurate three-dimensional topographic map of vibration modes. To help us make speaker problems disappear, by first making them visible.

Its name is ULTRA™ Celestion's proprietary Ultra-accurate Laser Topographic Response Analysis. Made possible by unique equipment designed, built and programmed in our laboratories. And realized in our new ULTRA Tweeter.™

**See what you've been hearing.**

Speaker designers have long talked about speaker cone breakup and bell modes. Problems that signal a driver's operation at or near its mechanical or electrical limits, by producing distortion that the ear can hear, often before test equipment can detect or accurately measure it. Making speaker design a very subjective, hit-and-miss, finker-and-listen proposition.

# AMPLIFIERS

MANUFACTURER	Model	Unit Type: Integrated = I; Kit = K; Phono Stg. = P; Tube = T; Mono = M; Basic = B	Cont. Ave. Watts per Chan. into 8 Ohms	Power Bandwidth, Hz to kHz	Rated THD, Percent	Rated IHF IM, Percent	Rated SMPTE IM, Percent	Phono S/N, "A" Wtd., re: 5 mV, dB, per IHF A-202	Phono Sensitivity, mV, per IHF A-202	Maximum Phono Input, mV	Rated Slew Rate, V / $\mu$ S	High Level Sensitivity, V	Class of Output Operation	Dynamic Headroom, dB	Does Unit Invert Phase?	Weight, Lbs.	Price, \$	Notes
AMBER ELECTRONICS	Series 70	B	70	5-60	0.09	0.03			25		AB	2	No	29	499.00		Mono bridge, 200 W.	
DENON	PMA 530 POA 3000	I B	60 180	5-100 5-100	0.008 0.002	0.003 0.003	100	2.5	200	170 300		Dir. A A	No No	25 75	390.00 2300.00		No capacitors; MC input.	
HARMAN KARDON	HK750 HK770	I B	45 65	10-100 8-100	0.03 0.03	0.05 0.01	0.05 0.01	88	200	60 150		AB AB	3 3	No No	22 23	329.00 399.00	Toroidal power supply; discrete phono preamp. Sep. toroidal power supplies; gold relay contacts on speaker switches.	
PRECISION FIDELITY	M7	T	50													699.00		
PS AUDIO	II	B	40	2-100	0.09	0.1	0.1	100		80	0.7	AB		No	12	250.00		
SAE	X-25A X-15A X-10A	B B B	250 150 100	20-20 20-20 20-20	0.02 0.02 0.02	0.02 0.02 0.02				2.24 1.87 1.42	A A A	0.5 0.5 0.5	No No No	47 35 28	1500.00		Hypersonic Class A. As above. As above.	

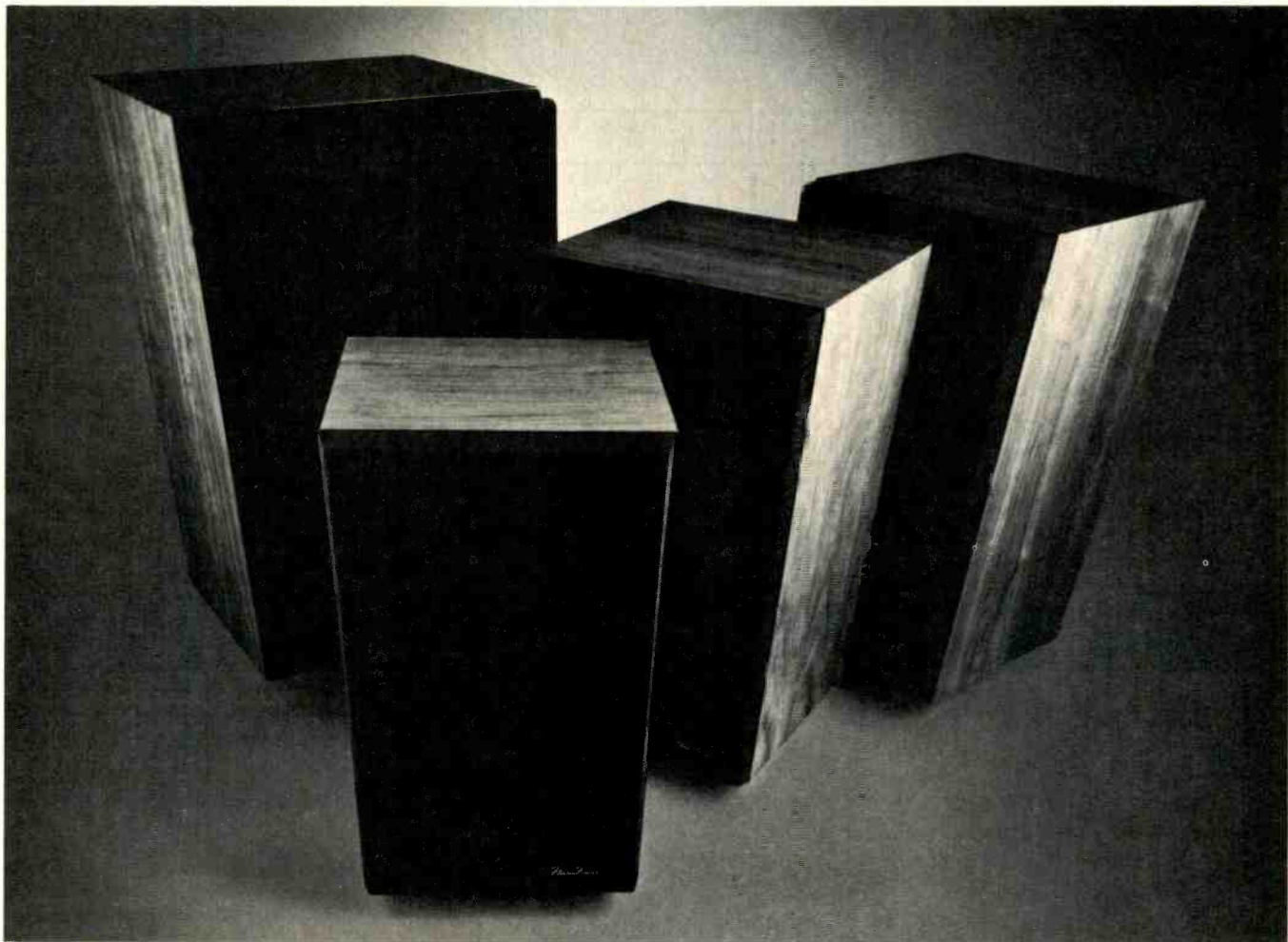
# PREAMPLIFIERS

MANUFACTURER	Model	Unit Type: Kit = K; Tube = T; Phono Stg. = P; Mono = M; Moving Coil = MC	Frequency Response, Hz to kHz, $\pm$ dB	Maximum Output, V	% THD	% IHF IM Distortion	Rated SMPTE IM, Percent	Phono Sensitivity, mV, per IHF A-202	Phono Overload, For 0.5 V Output at 1 kHz, mV	Phono S/N, "A" Wtd., re: 5 mV, dB, per IHF A-202	High Level Sensitivity, V	Tone Controls ?	Phono Input Impedance, $\Omega$	Phono Input Capacitance, Ohms	Moving Coil Input ?	Does Unit Invert Phase?	Weight, Lbs.	Price, \$	Notes
DENON	PRA 2000		20-100 $\pm$ 0.2	23	0.002	0.002	0.002	380	86	0.15	No		50k	Yes	No	24.2	1300.00		
DEX RESEARCH	GAIN BLOCK II	MC	6-120 $\pm$ 3		0.01	0.01		65	95†				Sel.			3			†At 10 mV.
HARMAN KARDON	HK725	P	1-150 +0,-1	6	0.005	0.009		2.3	250	90	0.145	Yes		No				279.00	D.C. coupled.
PRECISION FIDELITY	C7A JB1	T MC																549.95 199.00	
PS AUDIO	PSIII PSLCC	P	2-100 2-100	16 16	0.01 0.01	0.01 0.01	0.01 0.01	5 15	160	80	1.6	No	Sel.	42k, 22k	Yes	Varies No	2.2 3	237.00 255.00	

# TUNERS

MANUFACTURER	Model	Unit Type: FM Only = FM; Kit = K	Mono IHF Sensitivity, $\mu$ V / dB	Stereo IHF Sensitivity, $\mu$ V / dB	Capture Ratio, dB	Alt. Chan. Select., Wide/Narrow	Mono Signal Strength for 50 dB Quieting, $\mu$ V / dB	Stereo Signal Strength for 50 dB Quieting, $\mu$ V / dB	Separation, dB, 1 kHz	Separation, dB, 10 kHz	THD, Mono/Stereo, 1 kHz, 100% Modulation	THD, Mono/Stereo, 6 kHz, 100% Modulation	S/N, Max., dB, Mono/Stereo	Switchable De-emphasis?	Net Weight, Lbs.	Price, \$
DENON	TU 530		1.7/9.8		1.0	70			55		0.06/0.08	0.1/0.2 @10 kHz	82/79	No	13.2	260.00
HARMAN KARDON	HK710 HK715		1.9/10.5 1.7/10	18/30.5 16/29.5	1 1	70 70	3.5/16 3/14.8	37/36.5 34/35.3	46 50		0.08/0.1 0.07/0.09		75/77 77/79	9% 9%		229.00 369.00

# LOUDSPEAKERS ARE NOT PURESPEAKERS.



## INTRODUCING THE PHASE LINEAR P-500 SERIES PURESPEAKERS.

**Why Loudspeakers?** It's a fact: Most speakers that sound good at loud listening levels don't sound the same during a soft musical passage. And vice-versa. The drivers are simply not capable of reproducing such a wide dynamic range with clarity and accuracy. Until now.

**Purespeakers. Not loudspeakers.** If you love music as we do, you know that a hi-fi system is only as good as the "weakest" component. And for the most, it's the speakers. *Clearly, it was time we addressed the task of advancing the "state-of-the-art" in speaker and driver technology.* We began by identifying design objectives through a careful analysis of how we experience music. Then we got very serious, indeed, about meeting those objectives by:

- Applying every computer-aided technique available, including extensive laser-holographic analysis.
- Utilizing the lightest, strongest materials in the world.
- Pursuing "no-compromise" quality at every stage of design, prototype development, test and manufacturing.

The result was an exact discipline of speaker design that far exceeds anything ever produced. Or heard. In fact, anything less and the listener invariably experiences *the speakers*. Instead of *the music*. We urge you to contact your Phase Linear audio dealer and audition the Phase Linear P-500 Purespeakers.



### **P-580 System Specifications:**

Frequency Response: 28Hz-120,000Hz  $\pm$  2.5dB.  
Total Harmonic Distortion Content: 20Hz-20kHz, less than 0.3%  
Intermodulation Distortion: (SMPTE) less than 0.03%  
Sensitivity: 91dB, 1 watt at 1 meter.  
Driver Complement: 9mg. Ribbon Tweeter, 2 1/2" Beryllium Dome  
Midrange with Cantilever Suspension, 15" Concentric Rib Woofer.

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# CASSETTE DECKS

MANUFACTURER	Model	Frequency Response, Hz-kHz, ±dB	Top Load=1, Front Load=F	Number of Heads	% Wow & Flutter, W rms	S/N, dB, without Dolby NR	S/N, dB, with Dolby NR	Auto Off?	Fine Bias Adjust?	No. Preset Bias/EO Poles	No. Mike Mixing Inputs	Locking Pause Control?	Metal Tape Capable?	Limiter?	Memory Rewind?	Peak Level Indicator(s)?	Dimensions, Inches	Net Weight, Lbs.	Price, \$	Notes
DENON	DR-250 DR-230	30-16 30-16	F F	2 2	0.045 0.04	64 64	Yes Yes	Yes Yes	4 4	2 2	Yes Yes	Yes Yes	No No	Yes No	Yes Yes	17½x5½x10¼ 17¼x4½x12	16½ 17½	430.00 375.00	Timer start Rec./Play. As above.	
HARMAN KARDON	HK705 HK100M HK200XM HK300XM HK400XM	20-19 ±3 15-19 ±3 15-19 ±3 15-20 ±3 15-20 ±3	F F F F F	2 2 2 2 3	0.04 0.05 0.05 0.03 0.03	60 55 57 59 60	68 63 65 67 68	Yes Yes Yes Yes Yes	Yes Yes Yes Yes Yes	4 4 4 4 8	4 4 4 4 4	Yes Yes Yes Yes Yes	Yes Yes No Yes Yes	Yes Yes Yes Yes Yes	Yes Yes Yes Yes Yes	17¼x4½x13% 17¼x4½x13% 17¼x4½x13% 17¼x4½x13% 17¼x4½x13%	13% 16 16 17 18	449.00 269.00 349.00 449.00 649.00	Dolby HX. As above. As above. As above.	

# CAR STEREO DIRECTORY AMPS & EQUALIZERS

MANUFACTURER	Model	Price	Amp=Amp, EQ=Equalizer, Both=Both	Number of Bands of EQ	Separate Controls for Each Stereo Channel?	Boost/Cut Range, dB	Watts into 4 ohms	% THD at Rated Output	Dimensions, Inches
CAR-FI	EPA 7000 EPA 6100 EPA 3100 EQA 311 EQL 5500 EQL 5200	299.95 179.95 89.95 199.95 349.95 149.95	Amp Amp Amp Both EQ EQ	5 5 5 5	No No No No	12 12 12	50 30 15 21	0.05 0.1 0.1 0.1 0.02 0.02	3.5x6x9 3x5x9 3x5x6 1.6x4.2x6 2x6.3x4.8 1.3x5x1.7

# SPEAKERS

MANUFACTURER	Model	Price \$ (if Sold Individually)	Price \$ (if Sold in Pairs)	Recommended Max. Power, Watts	Woofer Size, Inches	Magnet Size, Oz.	Impedance, Ohms	Frequency Response, Hz to kHz, ±dB	Two-way (2) or Three-way (3)	Flush Mount (F) or Surface Mount (S)	Overall Dimensions	Notes
AXIOM ENGINEERING	MS-1	150.00	5	8		8/6	40-20 ±3	3			12x9	
CAR-FI	CS1 CS2 CS3 CS4	89.95 129.95 149.95 239.95	50 65 65 65	6x9 6x9 6x9 6x9	30 30 30 30	4 4 4 4	40-2.5 40-18 40-20 40-30	2 2 2 3	F/S F/S F/S F/S		6x9x3.5 6x9x3.5 6x9x3.5 6x9x3.5	
GRAFYX AUDIO PRODUCTS	SH-601	178.00	10	6	12	4	45-20 ±3	2				



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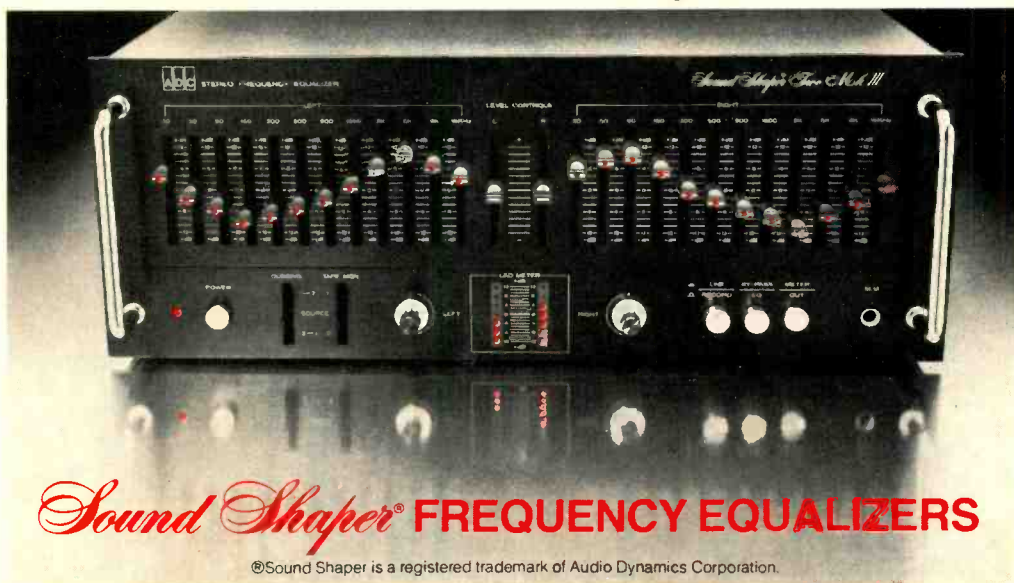
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# Construct An Indoor/ Outdoor FM Antenna

**Dr. Frank P. Maloney**

Assistant Professor, Dept. of  
Astronomy, Villanova Univ.,  
Villanova, Pa.

In light of the series of articles in *Audio* concerning FM antennas by M. J. Salvati [1-5] and R. Modafferi [6], it should be clear that the most significant single improvement which an audiophile can make to FM reception is the antenna.

The benefits of improved signal strength and directivity translate directly to a higher level of performance from any tuner or receiver, and studies at Villanova University indicate further benefits from the use of a quality antenna. Modern tuner front-ends are aligned and tested using signal generators with 75-ohm (or 300-ohm) internal impedances. So terminated, a tuner will exhibit its published performance specifications. Ideally, the antenna also should be 75 ohms, uniformly across the 88 to 108 MHz band. If it is not, several problems may occur. First, the sensitivi-

ty and the crossmodulation rejection of the tuner will be reduced somewhat. Second, baluns (devices used to convert a 300-ohm balanced transmission line to a 75-ohm unbalanced line) may exhibit significant losses if they are not terminated in 300 and 75 ohms. Lastly, antennas which are not nominally 75 ohms will produce standing waves on a 75-ohm transmission line. These standing waves adversely affect "stacking," the use of two or more identical antennas in order to increase gain and provide nulls to reject interfering stations. In this article, the design for an FM antenna which exhibits a good match to 75 ohms, as well as moderate gain and directivity, will be presented.

It is certainly true that the single most serious limitation to high-quality FM reception is the twin-lead dipole antenna. It is all too common to find a \$500 tuner or receiver using a 39¢ twin-lead antenna taped to the rear of a bookshelf. These antennas suffer greatly from impedance variations and lack of directivity. To test how closely a twin-lead dipole antenna matches a 75-ohm transmission line over the 88 to 108 MHz FM band, the antenna was taped midway up a large wall in a stone house, and its impedance measured. The data in Fig. 1 show the voltage standing wave ratio, VSWR, as a function of frequency. A VSWR of 1.0 indicates a perfect match to a 75-ohm transmission line, and a VSWR less than 2.0 is usually considered acceptable. Notice the extreme mismatch over the band. Similar but not identical results are obtained with different placement of the dipole. Further, the lack of directivity, or ability to discriminate against signals coming from various directions, can worsen multipath problems. (Multipath is the reception of a given FM station from two different directions, usually the direct path and a reflection from a large structure. The two signals, which have travelled different path lengths, combine to cause amplitude modulation distortion.) Clearly, the dipole antenna is not the best for use with a quality tuner.

By investigating the literature concerning antennas [7-11] and reviewing the commercial realizations of these designs, we have formulated a design

philosophy for an improved log-periodic dipole antenna (LPDA) for the FM band. Our philosophy is this:

a) We provide the details for the construction of an indoor as well as an outdoor antenna. The indoor model is simpler and cheaper to construct, and it is easily mounted and rotated in an attic. The outdoor model can be mounted high enough to provide superior reception. The raw materials for both are easily accessible.

b) The impedance must be nearly 75 ohms across the FM band. To accomplish this, we employ multiple feeders. Although this is slightly more expensive than using open-wire crossfeeding, as commercially available antennas use, the multiple feeders provide a substantially lower VSWR [10]. According to Bantin and Balmain [9], the

feeders should be terminated in their characteristic impedance. This further lowers the VSWR by eliminating reflections on the feeders.

c) We use an additional dipole element at the low-frequency end of the antenna, which will serve as an active reflector at the low-frequency part of the FM band, keeping the gain high and improving the front-to-back ratio. Many FM stations in this frequency region operate at greatly reduced effective radiated power, and their reception requires additional effort on the part of the antenna.

d) Most commercial antennas are designed to be shipped folded. The difficulty with such a design is that its success depends upon a friction fit between feeder and dipole for r.f. electrical continuity. In time, the contact oxi-

Fig. 1 — The voltage standing wave ratio, VSWR, of a twin-lead dipole antenna as a function of frequency in MHz over the FM band.

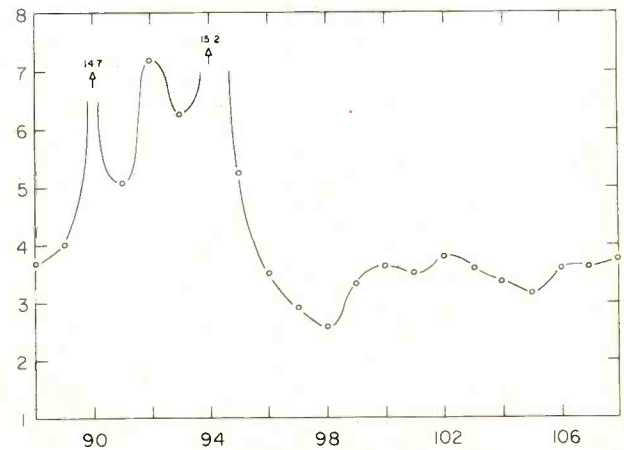


Fig. 2 — The geometric parameters of a log-periodic dipole antenna (LPDA).

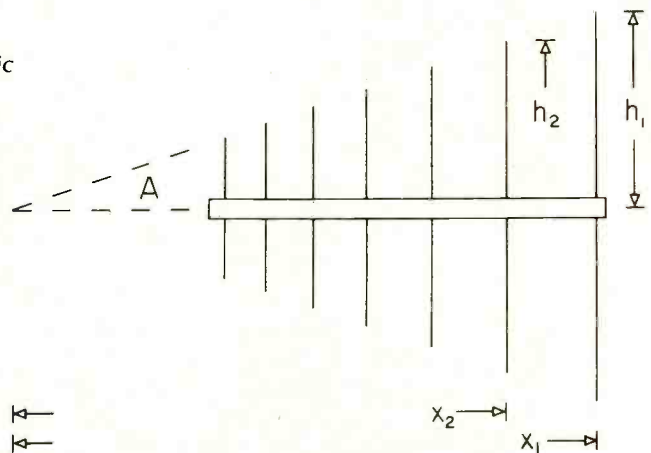


Fig. 3 — A perspective view of an LPDA showing the arrangement of the dipole elements.

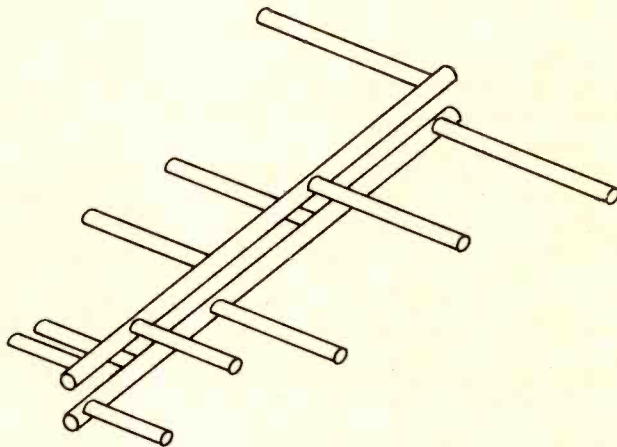


Fig. 4 — The  $h_n$  end of the LPDA showing the transmission line feed point construction.

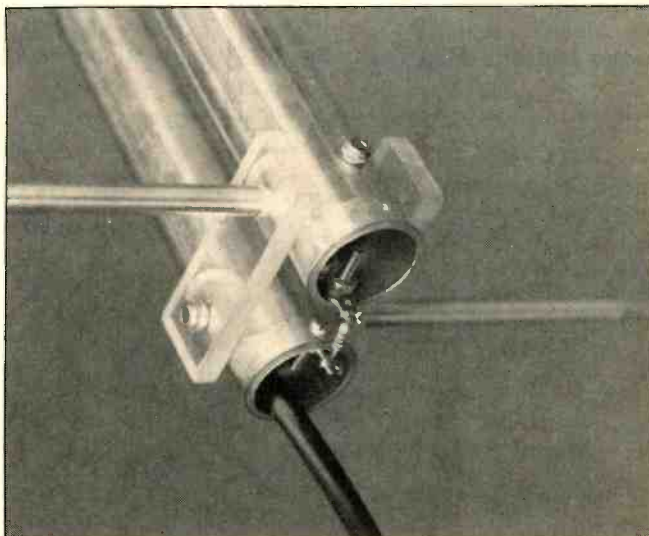
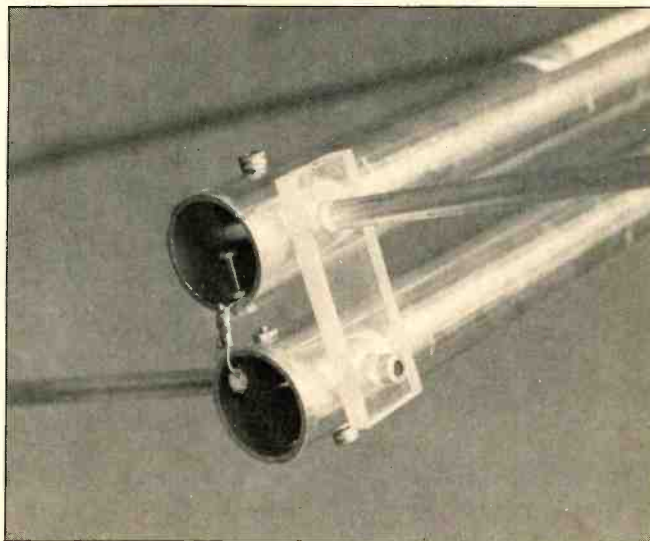


Fig. 5 — The  $h_1$  end of the LPDA showing the 100-ohm resistor.



dizes, yielding a rectifying junction. Our philosophy is that the metalworking required in the outdoor model provides for an antenna with superior weathering capabilities. This capability justifies the slightly increased cost and complexity.

e) The design must be amenable to duplication. That is, a second antenna, built within normal construction tolerances, must exhibit nearly identical characteristics (impedance, gain, position and depth of nulls). There are two reasons for this. First, if two antennas are to be stacked, they must be nearly identical in order for the advantages of stacking to be realized, and second,

TABLE I

n =	$h_n+2$ cm	Spacing
1	92.6 cm	36.2 cm
2	87.2	34.1
3	82.1	32.0
4	77.3	30.1
5	72.7	28.3
6	68.5	26.6
7	64.5	25.0
8	60.8	23.5
9	57.2	

you, the reader, must be confident that the antenna you construct is as capable a structure as the ones described in this article.

A typical LPDA, shown in Fig. 2, is fully characterized by these parameters:

$$H = \text{Height Ratio} = \frac{h_{n+1}}{h_n}$$

$W_{\text{max}}$  = Maximum Wavelength of Operation, and

$$S = \text{Spacing Factor} = \frac{x_1 - x_2}{W_{\text{max}}}$$

Often, the apex angle  $A$  is also used:

$$A = \tan^{-1} \frac{h_n}{x_n}$$

It is clear that  $H$  and  $A$  (or  $H$  and  $S$ ) set



the size, and therefore the gain and cost, of the antenna. Following DeVito and Stracca [10], we chose:

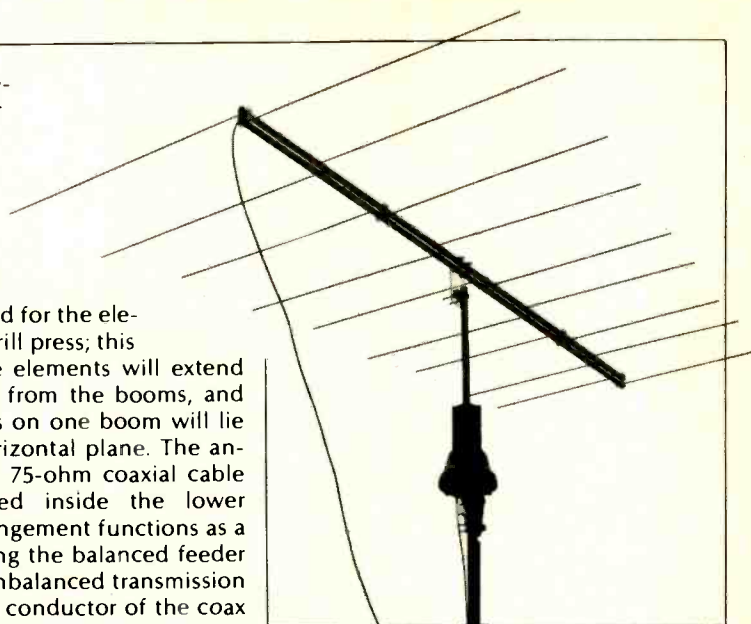
$S=0.10$ ,  $H=0.94$ , so  $A=8.5$  degrees, which will provide between 8 and 9 dBi of gain.

From Carrel [8], we find that the total number  $N$  of elements is 8. However, in order to increase the forward directivity of the antenna at the lowest frequency we will add an additional element, resonant at 82.73 MHz. This will make  $h_2$  resonant at 88 MHz. So we compute the element heights  $h$  and the spacings for  $N=9$  elements. These are shown in Table I. Additionally, 2 cm are added to each of the element lengths in order to extend the elements through the feeders.

**Outdoor Model Construction**

The feed boom arrangement is somewhat different from other antennas (such as Yagi types) and is shown in Fig. 3. Elements are staggered on the two booms in order to properly phase

Fig. 9 — The completed outdoor LPDA.



the dipoles. The booms are drilled for the elements using a drill press; this insures that the elements will extend perpendicularly from the booms, and all the elements on one boom will lie in the same horizontal plane. The antenna is fed by 75-ohm coaxial cable which is routed inside the lower boom. This arrangement functions as a balun, converting the balanced feeder booms to the unbalanced transmission line. The center conductor of the coax is connected to the upper boom at the  $h_9$  end (Fig. 4). The shield is connected to the lower boom at the  $h_9$  end. The coax exits the boom at the  $h_1$  end and is not electrically connected there, although it would be wise to provide some manner of strain relief. At the  $h_1$  end, the two booms are connected together by a 100-ohm, 1/4-watt carbon resistor (Fig. 5). This resistor properly terminates the feeder booms, which act as a 100-ohm transmission line for the dipole elements. It is best to sur-

round all electrical connections to the antenna with noncorrosive RTV sealant to prevent weathering. The electrical connections to the antenna are made with #4-40 stainless or brass hardware.

The elements are held in place in the booms by drilling and tapping the elements to accept a #6-32 screw. The booms are drilled to accept the 1/4-inch diameter elements and the screws at right angles to these elements; see diagram (Fig. 6).

To properly space the booms at 3.4 cm center-to-center, eight plexiglass spacers (Fig. 7) are placed against both sides of the feeder booms, over the  $h_1$ ,  $h_3$ ,  $h_7$  and  $h_9$  elements. The booms are spaced and connected to the mast by the phenolic structure shown in Fig. 8. The mast, if metallic, must not contact the lower boom. In extremely windy areas, you may wish to use two such structures, on either side of the booms. The booms are drilled to accept the 1/4-inch brass bolts. The completed antenna is shown in Fig. 9.

**Indoor Model Construction**

If you wish to construct the model for attic placement, you will need three lengths of 0.75 x 0.125 x 96 inch aluminum bar stock, available at most hardware dealers, for the feeders. The middle bar serves as a ground reference. The three feeders are spaced by 0.125-inch thick by 1-inch square plexiglass spacers. The dipole elements are formed from aluminum foil or, better, aluminum foil duct tape. The adhesive side of the foil tape adheres to the plexiglass spacers, not the feeders. This sandwich of aluminum and plexiglass is shown in Figs. 10 and 11, and is held together either with nylon screws

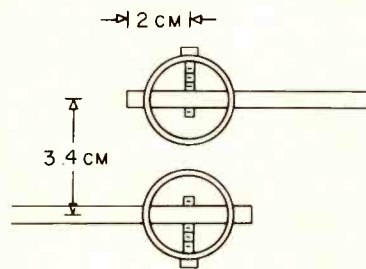


Fig. 6 — Detail of the boom-element construction.

Fig. 7 — Detail of the plexiglass spacers.

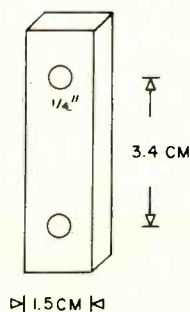
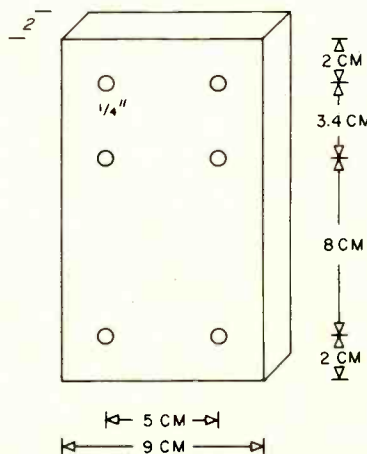


Fig. 8 — Detail of the phenolic block used to attach the booms (upper four 1/4-inch holes) to the mast (lower two 1/4-inch holes).



# INDOOR/OUTDOOR FM ANTENNA

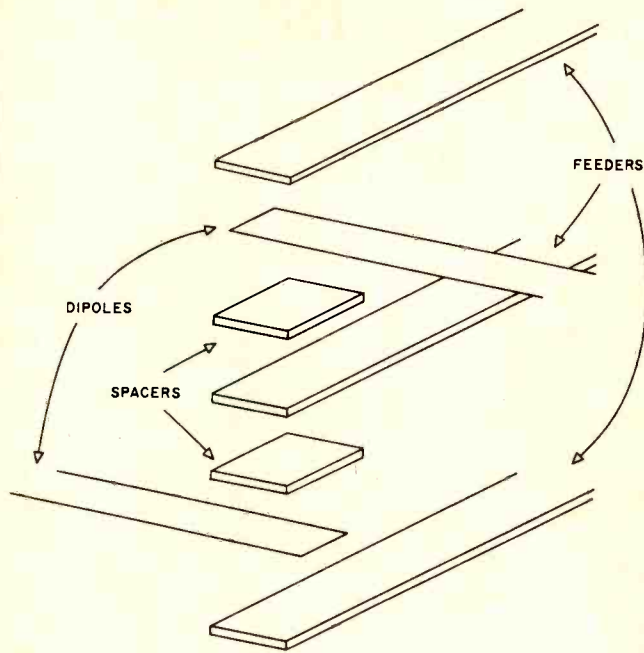


Fig. 10 — The feeder-dipole-spacer sandwich.

through the sandwich or with nylon cable ties around the sandwich. The use of the center aluminum feeder bar as ground reference reduces its terminal impedance from 75-ohm balanced to 37-ohm unbalanced. To match this 37-ohm impedance to the 75-ohm transmission line, we use a one-quarter wavelength section of 50-ohm cable, RG 58 (not foam dielectric), shown in Fig. 12. The  $h_1$  end of the feeder assembly is terminated by a pair of 50-ohm, 1/4-watt carbon resistors.

The ends of the feeder bars and the free ends of the dipole elements are attached to lengths of 1 x 2 inch furring strips, two of 96-inch length, one of 72-inch length, and one of 44½-inch length. The angle brackets shown in Fig. 11 attach the feeder bars to the frame, and the free end of the dipole elements may be tacked to the frame. The entire structure may be perched, suspended, or rotated in the attic by any means which you may find convenient.

## Measurements

We subjected the antennas to a number of tests in order to verify their performance. It should be stated that neither antenna was tuned or otherwise adjusted to achieve these specifications. First, we measured their impedance and converted the impedance to VSWR; the results are shown in Fig. 13. Notice the much improved performance over that shown in Fig. 1. Second, we measured the gain at three frequencies — 88, 98, and 108 MHz — by using a standard gain dipole. The results were 8.5, 9.5, and 9.0 dBi for the outdoor model, and 8.5, 9.0, and 9.0 for the indoor model at the respective three frequencies. The accuracy of those measurements is  $\pm 1$  dB. Clearly, the antennas are achieving the design target for gain. Lastly, we measured their azimuthal power pattern at 88 and 103 MHz under conditions similar to actual home use, and not inside an anechoic chamber. The results, again with an accuracy of  $\pm 1$  dB, are shown in Fig. 14; the data for the two models were nearly identical. Notice the depth of the nulls at about  $\pm 90$  degrees. These positions can be used to null out interfering stations. Further, the front-to-back ratio is about -20 dB.

Fig. 11 — Detail of the end construction of the feeder bars. The offset hole in the center feeder for the #4-40 screw is for the connection of the resistors, at the  $h_1$  end, and for the RG 58 cable, at the  $h_2$  end.

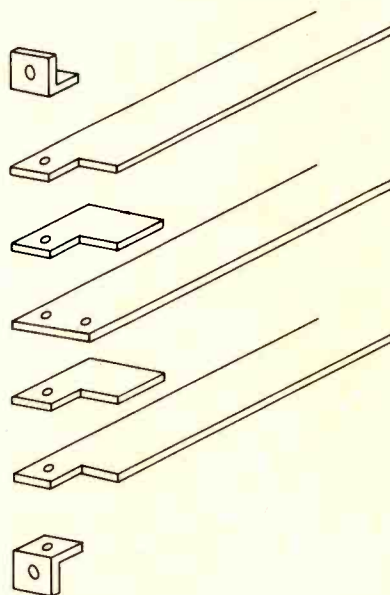
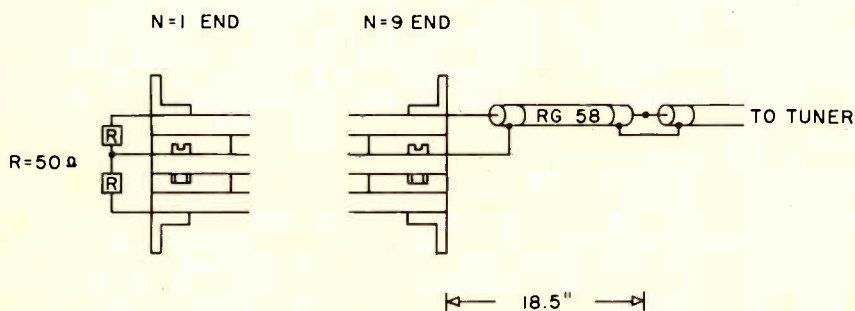


Fig. 12 — Electrical connections to the feeders.



These antennas have been in use for about a year and have provided a vast improvement in the FM performance of our audio system. In tests, the combination of an inexpensive tuner and the LPDA consistently outperformed a very expensive tuner and the twin-lead dipole. With local stations, multipath distortion was measurably lower and crossmodulation interference was nonexistent with the LPDA. With distant stations, the LPDA provided superior signal-to-noise ratios and a complete absence of alternate channel interference. The combination of a more expensive tuner and the LPDA was quite superb. Further, three other LPDAs have been constructed, all exhibiting characteristics nearly identical with the first. We would certainly enjoy hearing from readers who build the antenna or who have questions regarding this article. A

### Acknowledgements

I wish to acknowledge the efforts of Messrs. R.J. Maloney, M.K. Hart, R.S. Flagg, and H.H. Bradley for their efforts directed toward the development of these antennas.

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Fig. 13 — The VSWR of the LPDA as a function of frequency in MHz over the FM band. The circles denote the outdoor model, the triangles denote the indoor model.

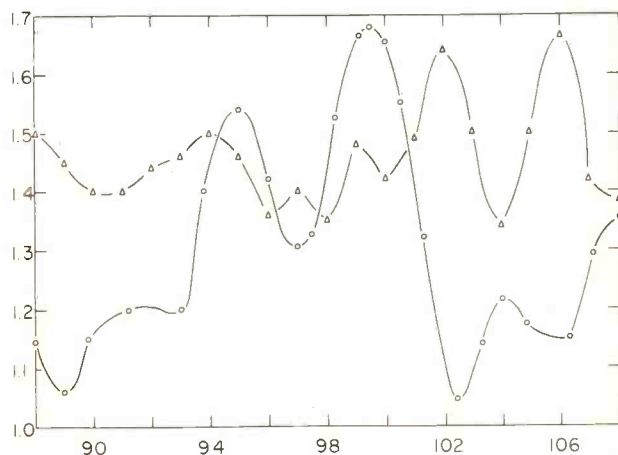
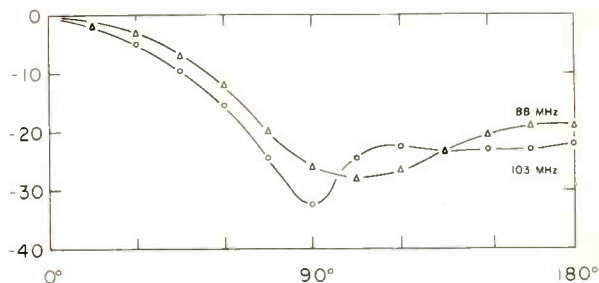


Fig. 14 — The azimuthal power pattern, in dB below the maximum, as a function of azimuthal angle in degrees.



## PARTS LIST

Item	Indoor Model	Outdoor Model
Feeders	0.75 in. W—0.125 in. T—96 in. L aluminum bar stock, 3 each.	8 ft.—1 in. od aluminum tubing, 2 each.
Dipole Elements	Aluminum foil duct tape, Sears #88346.	43.5 ft.—0.25 in. od aluminum tubing or rod.
Spacers	1 in. sq.—0.125 in. T Plexiglas, Lucite or Lexan, 22 each.	2.125 in.—0.625 in.—0.125 in. (5.5—1.5—0.5 cm) Plexiglas, Lucite or Lexan, 8 each.
Support	1 in.—2 in.—96 in. L furring strips, 2 each. 1 in.—2 in.—72 in. L strip. 1 in.—2 in.—44.5 in. L strip.	3.5 in.—6 in.—0.75 in. (9—15.5—2 cm) phenolic or Bakelite.
	Nylon cable ties (Radio Shack #278-1632) or nylon #6-32 screws and nuts, 11 sets.	Steel mast clamp. #6-32—0.75 in. stainless steel or brass screws, 18 each.
	Small angle brackets with wood screws, 4 sets.	#4-40—0.25 in. stainless or brass screws, 4 each.
	Wood screws for frame.	0.25 in.—20, 2 in. L. stainless steel or brass bolts, lockwashers and nuts, 4 sets.
Termination	#4-40 screws and nuts, 2 each.	
Coaxial Cable	50-ohm, 1/4-watt carbon resistors, 2 each.* 18.5 in. length of RG 58 solid dielectric 50-ohm cable.*	100-ohm, 1/4-watt carbon resistor.
	Any low-loss 75-ohm coaxial cable (Belden 8228 used).	

\*Should you experience difficulty obtaining such a small quantity of the RG 58 cable, send \$1 to: Communications Electronics, 672 Sproul Rd., Bryn Mawr, Pa. 19010. They will send, via first-class mail, the cable and the two resistors.

# BUILD A SQUARE WAVE GENERATOR

M.J. Salvati

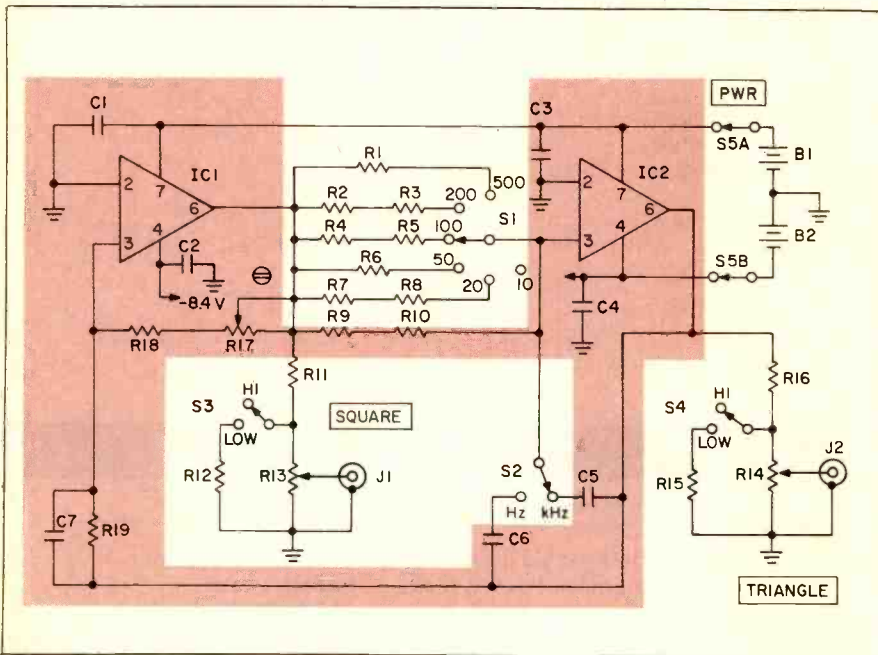


Fig. 1 — Schematic diagram; shaded area indicates parts on circuit board.

This article describes the construction and operation of a battery-powered signal source that provides very clean square-wave and highly linear triangle-wave outputs. The quality of the output signals compares very favorably with commercial function generators selling in the \$100.00 to \$150.00 price range. Full specifications are given in Table I.

This little generator is designed for use in repair and adjustment of amplifiers and performance testing of hi-fi components and systems. The square-wave output is useful for checking the frequency response of power amplifiers and preamplifiers, as well as for checking the transient response of these items and speakers. The triangle waveform is superior to a sine-wave test signal for observing clipping and overload.

## Theory of Operation

Op-amp IC1 generates a square wave by positive feedback through resistors R17/R18 to its noninverting

## Table I — Specifications.

**Frequencies:** 10, 20, 50, 100, 200, 500 Hz, and 1, 2, 5, 10, 20, 50 kHz.

**Frequency Response:**  $\pm 0.3$  dB.

**Output Level (HI):** 0-3 V p-p into 10 kilohms or higher.

**Output Level (LO):** 0-300 mV p-p into 10 kilohms or higher.

**Square Rise Time:** 600 nanoseconds.

**Square Fall Time:** 600 nanoseconds.

**Power Requirements:** Two 8.4-volt batteries.

input (pin 3). This square wave is integrated by op-amp IC2 to produce the triangle wave. Op-amp IC2 also controls the switching point of IC1 by feedback through resistor R19. The integration frequency (hence that of the triangle and square waves) is determined by resistors R1-R10 and capacitors C5 and C6.

Variations in the resistance of R17/

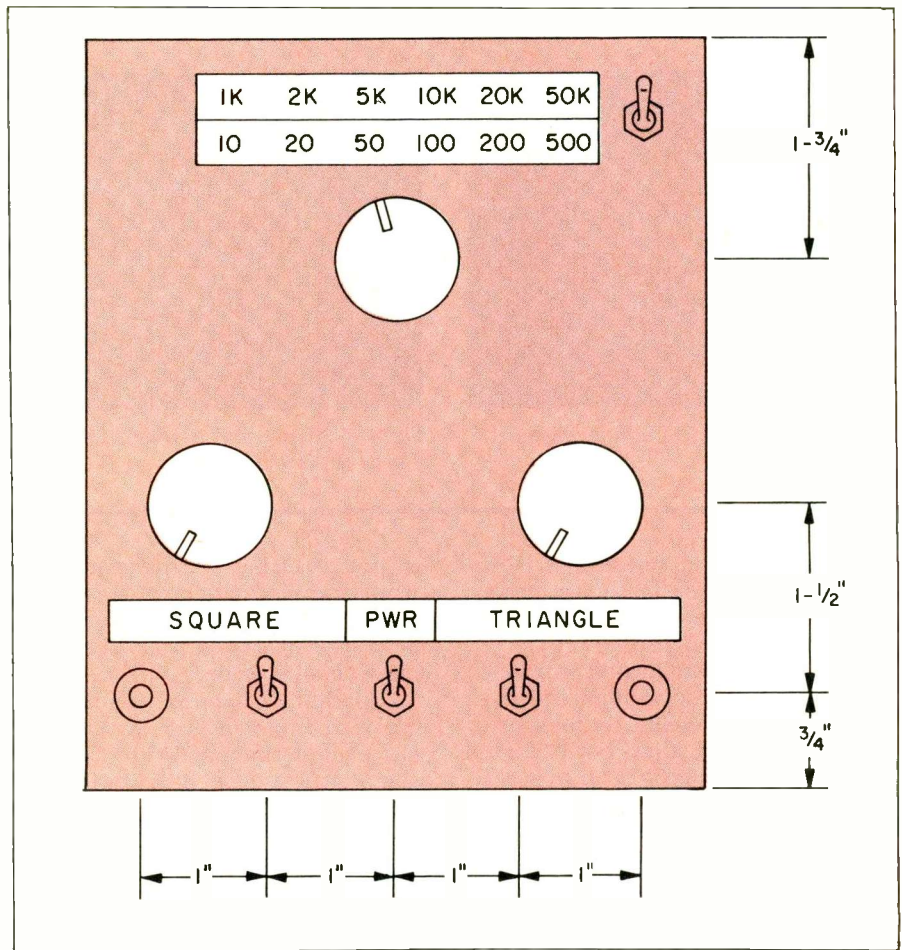
R18 affect both frequency and triangle output amplitude in this design, and this effect is used to advantage in this present circuit. Here, the frequency can be adjusted so that readily available values of R and C yield the desired spot frequencies. The value selected for R16 yields the desired triangle output level from the resulting circuit constants.

Switches S3 and S4 connect low-value resistors across the output pots (R13 and R14) to reduce the available output voltages by 20 dB.

The ICs have FET inputs, so the bias current of IC2 cannot upset the circuit operation when high-value integrating resistors are used. This allows using resistors as high as 400 kilohms (R9 and R10) and as low as 8 kilohms (R1 in parallel with R9/R10), which in turn allows using the same capacitors to cover many frequencies. Just two integrating capacitors (C5 and C6) cover nearly four decades of frequency. The resulting system with six spot frequencies per range also has a practical ad-

# TOR AND TRIANGLE

Fig. 2 — Suggested layout for front panel.



vantage in that it allows using readily available switches.

Simplicity and practical accommodations were stressed throughout the design of this generator. If the output of IC1 were zener clamped, the output amplitudes could be stabilized against supply-voltage changes. However, with suitable zeners, this occurs only at higher supply voltages (ruling out battery operation), and then the supply-voltage variations affect frequency (not the case with the chosen design). Furthermore, for 50-percent duty cycle (inherent in this design), the zeners must be closely matched. Therefore, I opted for this simple design, using mercury batteries (which have a very flat discharge characteristic) to take care of the supply-variation problem.

### Construction Notes

As far as layout is concerned, nothing is especially critical. Even packaging is easy; to accommodate the switches, connectors, and frequency scales, a cabinet much larger than

needed for the "innards" is used. Thus, you will have no problems fitting the batteries and circuit board inside. The frequency scales and other front-panel nomenclature are Dymo-type labels. See Fig. 2 for suggested layout.

The components covered in tone on the schematic diagram are mounted on the circuit board. Use No. 22 solid wire and resistors R11 and R16 to make the connections from the circuit board to the cabinet-mounted parts. The stiffness of the connections will support the tiny and lightweight circuit board. Perforated board or printed-circuit techniques can be used for the circuit board, but I recommend Vero-board by Vero Electronics. The metalized 0.1-inch grid pattern accepts DIP ICs directly and it also permits dense packaging.

The frequency accuracy depends on component quality. For most applications 5-percent tolerance resistors and 10-percent capacitors will do nicely. However, for best performance, use 1-

percent metal-film or deposited-carbon resistors and temperature-stable capacitors for C5 and C6.

Switch S1 should have shorting contacts for transient-free frequency selection. However, because resistors R9 and R10 are hard wired in this design, the worst that can happen if you use a switch with nonshorting contacts (such as the Radio Shack 275-1386) is a few cycles of 10-Hz signal while switching. This is one of the many design accommodations made for constructors who do not have access to large industrial parts-supply houses.

Consumer-oriented mail-order houses can supply most, if not all, of the parts. I obtained the FET op-amps and ceramic capacitors from Digi-Key and the switches and connectors from the local Radio Shack. Digi-Key's address, for those who don't have it, is P.O. Box 677, Hiway 32 South, Thief River Falls, Minn. 56701.

### Adjustments

The circuit will oscillate without ad-

# The output from this square and triangle wave generator compares with \$150.00 units.

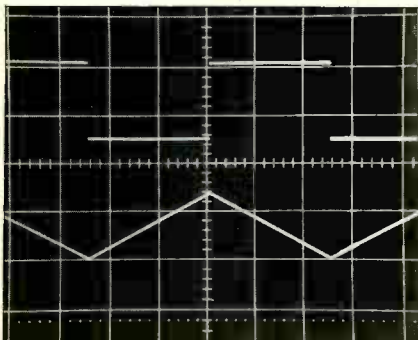


Fig. 3 — Square and triangle waves at 10 Hz, 20 mS/div.

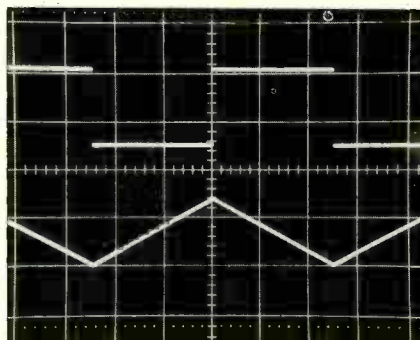


Fig. 4 — Square and triangle waves at 1 kHz, 0.2 mS/div.

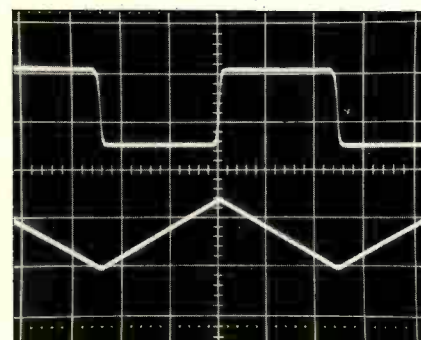


Fig. 5 — Square and triangle waves at 50 kHz, 4 μS/div.

justment or start-up procedures. However, there are optimization procedures in regard to frequency accuracy and frequency response.

Trim pot R17 permits precise adjustment of average operating frequency. If a counter is available, set the generator to 1 kHz and adjust pot R17 until the counter indicates 1000. If a counter


is not available, a triggered-sweep scope with accurate timebase will do. Adjust R17 for a 1-millisecond period of the generator's square wave as displayed on the scope.

Capacitor C7 improves the high-frequency performance of the circuit. It has greatest effect at 50 kHz and progressively less effect at lower frequen-

cies. Below 2 kHz, it has negligible effect. Increasing the value of C7 increases the frequency of oscillation and lowers the triangle output amplitude. Conversely, decreasing the value of C7 lowers the frequency and increases the triangle output amplitude. The exact value that yields maximum high-end frequency accuracy and flattest frequency response depends to some extent on the construction technique employed. The indicated value (180 pF) is fine for most applications, as evidenced by the Table of Specifications. However, if super-flat frequency response and high-end frequency accuracy are important, connect a wide-band voltmeter to the triangle output and a frequency counter to the square-wave output. Then change C7 as directed above until the 50-kHz frequency accuracy and triangle amplitude are the same as at 1 kHz.

## Use

Applications of this generator were mentioned earlier. However, there are certain points of usage you should note. Since the output level controls are linear pots, it is important to use the HI-LOW switches to attenuate the signal when driving preamps, integrated amplifiers, and receivers. The HI position is intended only for driving power amplifiers.

Both triangle and square wave are simultaneously available, and their levels are set independently. When using one of the outputs to drive an amplifier under test, use the other output to trigger the scope. This gives a stable scope display regardless of how much you vary the test signal level. 

## Table II—Parts list with some suggested commercial parts.

- IC1—National Semiconductor LF357.
- IC2—National Semiconductor LF356.
- B1, B2—8.4-volt mercury battery, Eveready E146.
- J1, J2—RCA-type phono jack, Radio Shack 274-346.
- S1—6-position, 1-pole rotary switch with shorting contacts (see text), Centralab 1400.
- S2-S4—SPDT miniature toggle switches, Radio Shack 275-613.
- S5—DPST miniature toggle switch, Radio Shack 275-614.
- C1-C4—0.1-μF, 25-V disc ceramic capacitors, Panasonic DE104.
- C5—1000-pF ±2% mica capacitor (see text).
- C6—0.1-μF ±5% polystyrene or polycarbonate capacitor (see text).
- C7—180-pF mica or ceramic capacitor (see text).
- R1—8.2-kilohm, ¼-W film resistor.
- R2—20-kilohm, ¼-W film resistor.
- R3—1-kilohm, ¼-W film resistor.
- R4, R5—22-kilohm, ¼-W film resistors.
- R6—100-kilohm, ¼-W film resistor.
- R7-R10—200-kilohm, ¼-W film resistors.
- R11—3.3-kilohm, ¼-W carbon resistor.
- R12—91-ohm, ¼-W carbon resistor.
- R13, R14—1-kilohm potentiometers, Centralab B-5.
- R15—82-ohm, ¼-W carbon resistor.
- R16—2.2-kilohm, ¼-W carbon resistor.
- R17—5-kilohm trimmer potentiometer.
- R18—13-kilohm, ¼-W carbon resistor.
- R19—10-kilohm, ¼-W carbon resistor.
- 6 x 5 x 4 inch aluminum case, Bud CU-3007A.
- Knobs with index mark, three required.
- 9-V battery connectors, two required.

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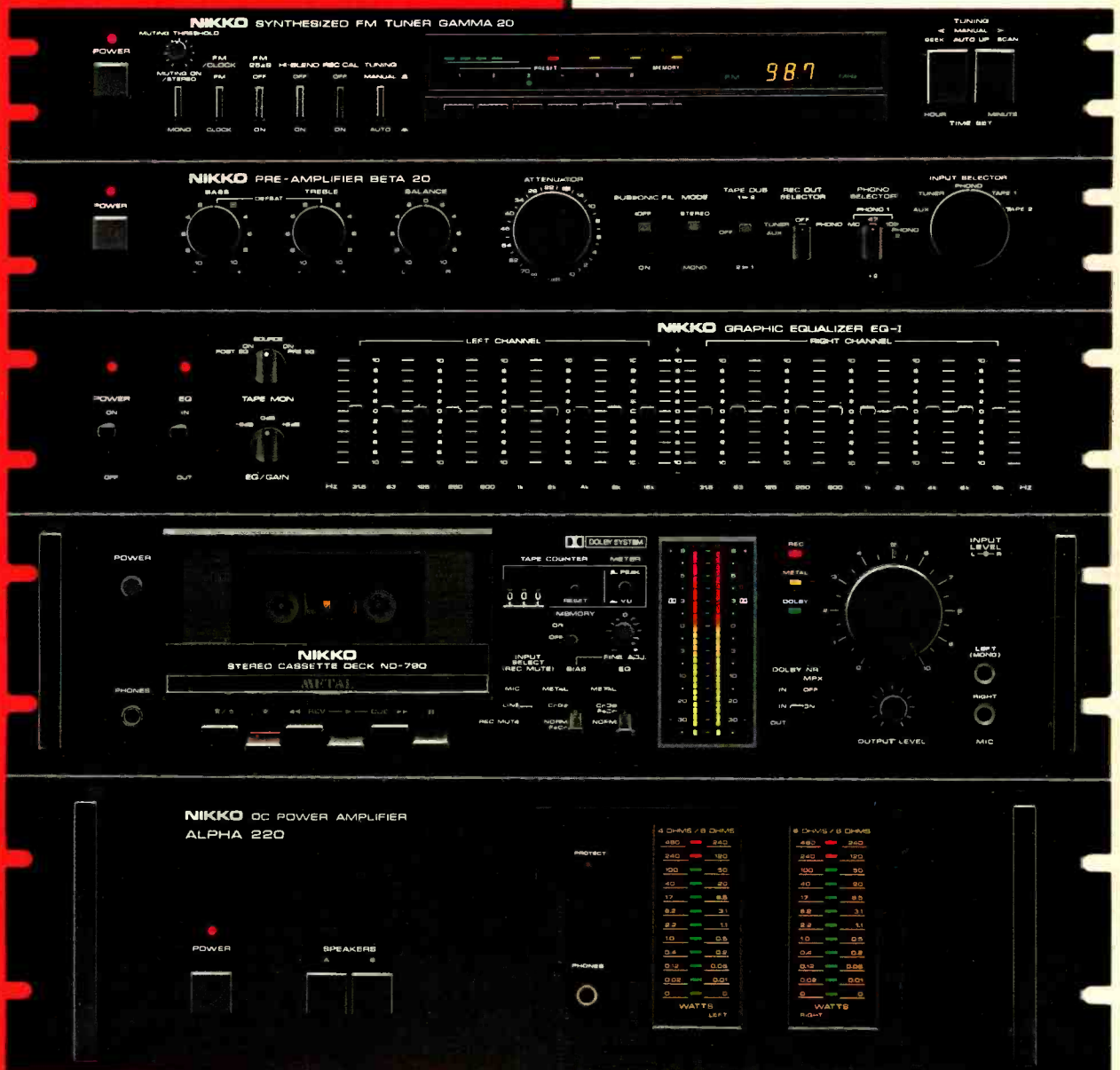
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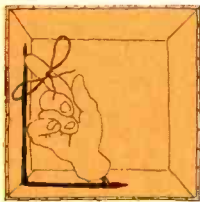
# AUDIO

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## PAIN OR PLEASURE

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### Martin Polon



Man has received many blessings from the technology that propelled the 19th century towards the 21st—a lengthened life span with added material pleasures are ones to which urban man has become accustomed. Many of his electronic entertainments use audio—from graphic-equalized car stereos to multichannel sound systems for disco. The good life now encompasses high-level audio in such diverse entertainments as indoor and outdoor concerts, multimedia displays, discotheques, etc. Quality high-level sound entertains around the world. Home entertainment has evolved from the table radio of 40 years ago to today's high-power home stereo system.

The difficulty with all this remarkable technology is that it bears a hidden and complex set of negatives. There is just no such thing as a free lunch. The human body is a complete biological system that reached its current state of refinement by a process that did not include audio at high levels. The human life support mechanisms developed to keep the wolf from the door—literally! Man's physical and mental responses to various external stimuli evolved from the real threats and dangers of the primordial past. Today's threats and dangers are much more subtle than a pack of hungry wolves, yet pose dangers far greater to human life. Many stimuli from the technologies and life style of modern man act as analogs of basic threats,

regularly triggering body reactions that would normally occur infrequently. Worse still, electronically amplified music can easily exceed high sound levels found in manufacturing plants, subways, and at airports.

Man is by conception, terminal. The factors for each individual's life span are determined to some large extent by personal habits, including ingestion (food, beverages, alcohol, drugs, and tobacco), exercise and exertion or the lack thereof, and exposure to various polluting influences in the environment. While certain pollutants may be deadly, they also are so obviously toxic that avoidance is reflexive. Not many of us would breathe pure automobile exhaust or handle a beaker of corrosive fuming nitric acid. Less obvious and far more dangerous are polluting substances or energies that are quite attractive. High-level sound is in this category. "One person's treat is another person's poison," or so the old saying goes. Energy pollution effects do vary in susceptibility from individual to individual. The dosage and duration of exposure determines the ultimate effect of any pollutant. But there is one sobering fact to remember: The human body is an unforgiving storage medium with a permanent memory. Anything that is carcinogenic, mutagenic or toxic, be it a substance or an energy form, can change the physical condition of those exposed. The only question is how much damage is done, and when the consequences of the damage become irreversible.

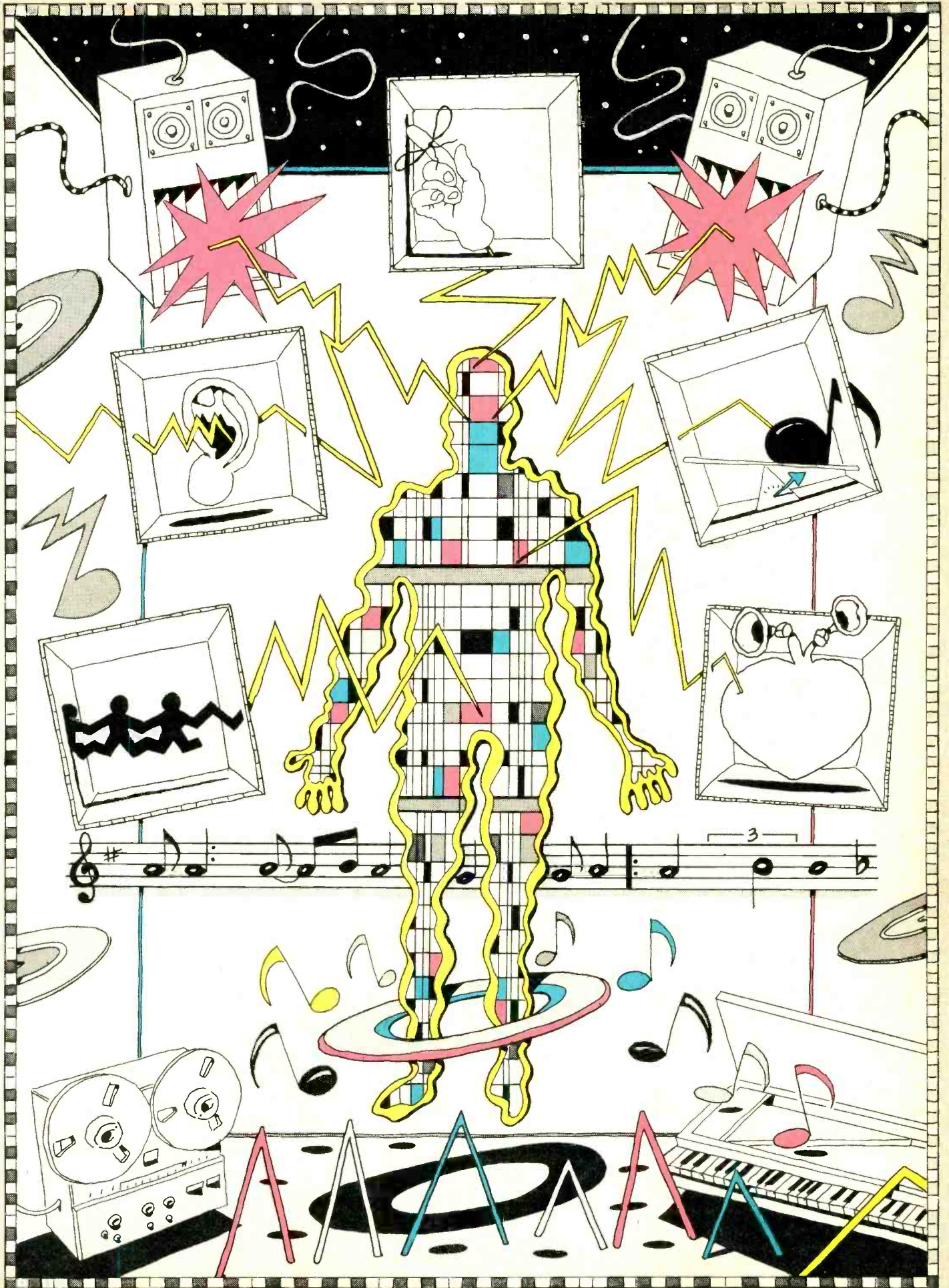
After World War II, medical technology was able to measure and treat disease caused by pollution. At the same time, pollutants became so com-

plex as to defy the prediction of long-term medical consequences. One example from the benzene family is the polychlorinated biphenyls (PCBs) used in the manufacture of utility power transformers. These chemicals, utilized for the past 30 years, have been identified with serious disorders in people who live in proximity to the use or discard of these materials. This is "invisible pollution," because it cannot be seen or sensed, except by the toxic effect on human beings over a long time span. Another example of near invisible pollution is cigarette smoking. The introduction of commercial cigarettes for the male population was followed by a period of relative calm before a storm of lung cancer erupted. Similarly, the wide acceptance of cigarettes by women in the 1940s was followed 20 years later by a dramatic upward swing in the lung cancer rates for women.

What has all this invisible pollution to do with audio? The answer to that depends on what audio is. The science of epidemiology is literally translated as "the study of epidemics," in other words, the study of negative results to large segments of the population from causative agents. The dictionary describes *audio* as "audible sound" and *noise* as "unwanted sound." Audio is sound, and sound when unwanted is noise. Sound can cause extensive problems in terms of hearing and whole body damage. Sound is energy, and the effects of energy on the body are defined by dosage and duration, regardless if the energy is from solar, nuclear or electroacoustic sources.

Music changes to noise in a medical sense when the level exceeds 90 dB





"A" SPL. Sound energy above 90 dB triggers systemic stress which can lead to body damage. Direct damage to the inner ear can take place with exposure in excess of 95 dB and, in the United States, OSHA says that daily exposure must be less than four hours. In the United Kingdom, medical experts recommend that exposure to 128 dB not exceed 28 seconds. The International Organization for Standardization (ISO) calls for a maximum exposure of 10 minutes a week to a level of 114 dB or greater. Musical content has no value if the energy present is in excess of what the body can tolerate. If established safe levels of exposure restrict a sound level of 120 dB to 28 seconds during a day, the content of the sound is not significant. The state of the art in audio has made levels of 90 to 120 dB very common in performance, recording, and playback. Higher levels are frequently encountered. Paradoxically, the medical arguments on the threshold of hearing damage do not center on 90 dB. There is a consensus of opinion on damage at 90 dB. The current recommendations in the medical literature range between 65 and 85 dB for susceptible populations.

The environment that man inhabits has never been totally silent, but the gradual rise in technology of the 20th century has markedly increased the daily noise dose. The advancements in recording and reproduction of sound give audio systems underestimated potential for generating high levels of sound in the working environment. This "audio inflation" can also be heard in the home. Systems are equipped with efficient loudspeakers using large, heat-resistant voice-coils capable of handling 50 to 250 watts of power per channel. How many would expect that car stereos could produce sound pressure levels easily exceeding 90 dB? The car is a small, highly reflective area in which to deliver 10 to 100 watts rms per channel to multiple speakers. The headphone is one of the most "invisible" elements of sound pollution because it couples directly to the ear and can generate considerable energy. Concert entertainments regularly use large sound systems driven by 5,000 to 25,000 watts of power amplification, capable of constant levels in excess of 110 dB at several meters.

Level and exposure are the keys to susceptibility in sound-induced damage. The body has evolved through time, and many aspects of hearing are

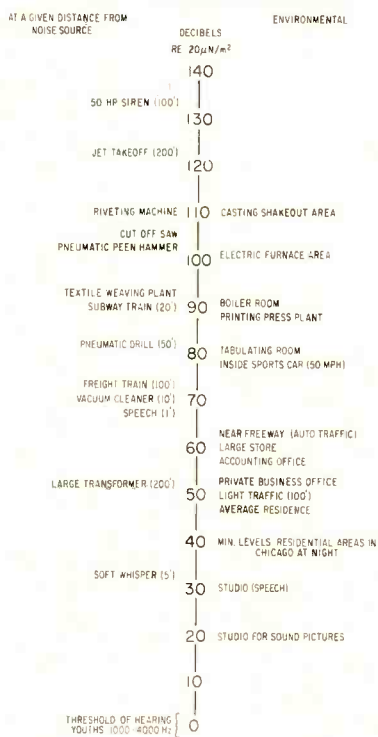
functions of survival mechanisms. Our high-technology life style may have rendered these mechanisms obsolete. The apparatus of human hearing features acute midrange sensitivity and selective accuracy. Through man's distant past, it was necessary to hear the approach of, say, a pack of wolves. To survive was to hear distant sound, allowing for escape or defensive action. The perception of threatening sounds would begin a series of physiological responses, involuntary functions which prepared man for reaction to the perceived threat. This complex defense mechanism, triggered by sound, allows man to have maximum levels of

posure to sound levels which mimic threats.

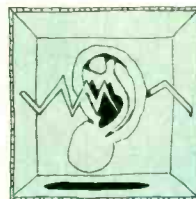
Living man is a complex biosystem which can defy precise explanation. However, medical information on the negative effects of high-level sound can be obtained in a number of ways. Rats, gerbils, chinchillas, and certain monkeys are quite similar to man. Detailed examination after exposure has yielded significant confirmations of sound-related damage. Further information has come from human autopsy analysis and the medical histories of large populations known to have been exposed to high-level sound.

High-level sound exposure can produce negative effects in two major areas, auditory and nonauditory. Auditory damage from sound has been well documented, but there are some relationships between auditory and nonauditory damage that should be explored. Briefly stated, continued exposure to high-level sound of variable threshold and duration will produce significant and permanent damage to the hearing mechanism in the inner ear. The damage is variable since each human being has a unique vulnerability to auditory and nonauditory damage, based on a variety of individual characteristics.

TYPICAL A-WEIGHTED SOUND LEVELS



output from various body functions; when man is in the stressed mode, physical strength is enhanced and endurance for exertion is maximized. This defense mechanism functions as well today as it did 50,000 years ago. A noise outside our living space at night will produce the same response as that of our ancestors, alerting for fight or flight. None of these physiological mechanisms evolved to trigger regularly as part of a life style. The changes in the body are to defend from infrequent threat, rather than frequent ex-



In the human hearing apparatus, the outer and middle ear exist principally to collect and transmit sound to the inner ear for sensory reception.

In the inner ear, the sensory mechanism consists of the cochlea, which is a coiled-up canal. It contains the basilar membrane which supports four rows of hair cells. These hair cells will bend with incoming sound impulses, sending bioelectrical signals towards the brain (via nerve fibers which are grouped to form the spiral ganglion and become the auditory branch of the cranial nerve).

Sound injury to the inner ear is based on the following mechanisms of damage:

1. Exposure to high-intensity noise produces a physical detachment of a portion of the hair cells from the basilar membrane. This injury is a consequence of mechanical stress which can develop during high level exposure.

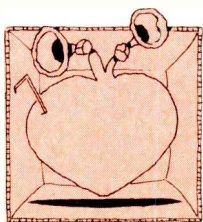
2. The outer hair cells are damaged initially by sound exposure, while the

inner hair cells die from a reduction in blood flow. Subsequent exposure increases the extent of the damage.

3. The membrane structure changes, causing further damage during high-level exposure. Nerve cells are damaged as well as the hair cells.

4. The destruction of a number of cells at the same time during an exposure episode can leak a minute amount of ear fluid. Possessing excessive potassium ions, this fluid causes swelling and rupturing of the uninjured sensory cells and nerve fibers which may continue long after exposure ceases.

There are definite, well-documented patterns of exposure and measured damage in auditory injury. The use of audiological tests is empirical and they produce irrefutable information. Formulas exist which predict the physiological deteriorations. Approximately 96 percent of the working population can be protected from sound damage by limiting exposure to sounds at 90 dB and above. What of those who are not limited by the nature of their work or by recreational choice or both? There is a predictable pattern of damage in the frequency range of 1,000 to 6,000 Hz, with peak damage at 4,000 Hz. The degree of loss can increase with subsequent exposure and can prove very severe in some individuals, assuming the natural loss with aging (presbycusis). The relationship to non-auditory damage is that the individual afflicted with a notching of hearing sensitivity will attempt to compensate by increasing sound levels to achieve perception. This will cause further hearing damage, especially at levels in excess of 100 dB, and accelerate the nonauditory damage.



At the cardiovascular system level, the effects of high-level sound are most prominent. At the onset of a high-level episode, the body goes from an alert state, known as the orienting response, to a sustained reaction called the defense response. Characteristically, these two responses cause an involuntary change in the body that begins with a tensing of the muscles (by the main motor nerves). This is followed by the nervous system causing changes in heart activity, breathing, blood pressure, etc. Dis-

eases of the heart and associated blockages of the veins and arteries can be complicated by the involvement of high-level sound, contrary to the optimum functioning of the cardiovascular system. A most apparent phenomenon is the change in size of the blood vessels (called vasoconstriction), which occurs at the onset of high-level sound. It may begin to disappear in some individuals when the sound ceases; in others it may persist for up to 25 minutes afterwards. Other heart-related changes include blood pressure (especially diastolic), heart rate, cardiac output, and pulse volume. All of these components are interrelated, and the changes may create further effects. For example, sound does not seriously affect long-term blood pressure of a normal population group, but for those suffering from high blood pressure (hypertension), the effect of high-level sound is to cause a small but definite further increase in pressure. High sound levels also can increase the agents of blockage in arteries, that is elevated blood levels of triglycerides and cholesterol.

One interesting auditory and non-auditory correlation involves peripheral vasoconstriction. This changing in size of the blood vessels tends to restrict the supply of blood to the head. The effect on the brain must be gauged in conjunction with the psychological and hormonal changes which also occur during high-level exposure. The ear, the very sensory organ which receives all of the high-level sound, is very much affected. The restriction of supply causes the ear to suffer cochlear anemia (ischemia), and this lack of blood flow occurs at the very time when the ear is under attack. The sensory cells need an increased supply of blood to provide energy sources and remove metabolic products resulting from the high sound level and related auditory metabolic activity. The ear does not get the needed blood in sufficient volume to save all of the threatened cells.

Sound also acts on the digestive system as a stress agent. A number of changes take place in the gastrointestinal system such as increased movement (motility), with waves of contractions passing along the intestines causing the contents to increase speed. The result is diarrhea and/or frequent episodes of irregularity. Abnormal contractions of the stomach can take place along with the more

usual outpouring of hydrochloric acid into the stomach; the two result in an unstable condition which can lead to peptic ulceration in susceptible individuals. There is an interesting note here. Those individuals who are able to control the level and duration of the sound source suffer greater motility problems than those who have no control on the sound at all. This is a complex reaction to sound and might be explained in terms of interaction between the brain and the psychological impact through the central nervous system.

The respiratory system of the body is a vital part of the metabolic process, and it is assumed that high-level sound has very little effect on the respiratory function. The only involvement is the inducement of slow, deep breathing, producing optimal ventilation of the lungs and high oxygenation of the blood. One fact of concern, however, is that sound can and does kill many laboratory animals under certain conditions. This is known as audiogenic seizure, and the cause of death is most usually respiratory failure (brought on by contractions of the respiratory muscles). Fortunately, man does not appear to be involved with this phenomenon at sound levels below 160 dB SPL "A."

The central nervous system is intimately involved with high-level sound inputs. We see the specific neurological involvements as the nonauditory response of the body. The central nervous system controls the voluntary nervous system, the autonomic nervous system, and the endocrine system through the hypothalamus in the brain. All of these are involved in a chain reaction. The management aspect of the central nervous system follows through the various systems. The second involvement of the central nervous system is with the psychological impact of high-level sound. Of greatest interest are the arousal and distraction effects. The effect of arousal is difficult to identify here since it is related to surprise, and the presence of high-level sound in a listening environment is an expected quantity. The distraction effect is pronounced, and it manifests itself as follows in terms of human performance:

1. Sound can increase or decrease efficiency, but the effect will occur later rather than sooner.

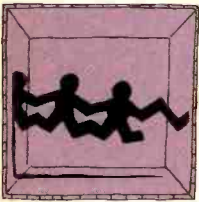
2. Negative effect is normally associated with complex tasks that have

multiple components or high information loads.

3. Tasks involving cognitive skills, such as memory, can be interfered with at levels as low as 70 or 80 dB.

4. Conversation may be rendered incomprehensible via distractive processes at levels far below those which physically mask conversation. In other words, the ability to perform certain tasks is alterable by high-level sound.

Other psychopathological changes come with sound exposure. Studies of individuals working within a high sound level environment indicate a trend towards depression and neurotic behavior among susceptible subjects, especially single women. The interrelations of body functions come into play, and the increased output of various hormones may well account for this impact, especially given the hormonal change found during menstruation.



Both the female reproductive system and the immunologic system can be significantly influenced by the hormonal output triggered by sound.

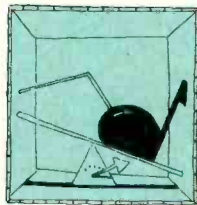
Immunological agents such as the eosinophils (white blood cells involved in allergic reactions) and gamma globulin (plasma protein which protects against certain diseases), among others, appear to be depressed in availability during the periods of high sound levels. The presence of certain hormones in the body of the human female during pregnancy can affect the rate and form of fetal development and the effect of sound produces stimulation of the breasts and uterus, yielding additional hormone activity. The fetus of any mammal is very susceptible to any kind of change from a stabilized condition, so the presence of sound-induced hormones cannot be viewed positively in any context. There is even some research to suggest that the fetus itself will undergo physiological changes as growth brings it to the point where it can physically sense either the sound or the mother's reaction to the sound.

The major source of chemicals in the brain is from the hormonal output triggered by the initial response to sound (in the hypothalamus to the pituitary gland), and then to other hor-

none-involved glands. This stimulated production of hormones (such as primary steroids like 17-hydroxycorticosterone), involves virtually all body functions not previously discussed. During a high-level sound episode, for example, male sexual drive seems to be increased while sexual potency is decreased because the gonads are signaled with a hormone. The basis of much of the tensing during the orienting and defense reactions involves the release of adrenaline which causes the increase in neuromuscular tension, nervousness, irritability, and anxiety. Other hormones affect the function of the kidneys and the amounts of substances in the blood. The trigger hormones, the corticosteroids, can retain their high bloodstream level over a long time frame after episodes of high sound levels have concluded.

It is important to note that all of these radical hormonal changes occur when sound levels above body tolerance are perceived. The effects tend to be extended due to the time required for the various chemicals to be dissipated in the body.

The effect of high-level sound on the mental state is documented in terms of the presence in the brain of chemicals also found in those with schizophrenia and psychosis. High-level sound stimulates these chemicals, such as norepinephrine, in susceptible individuals. There is even some suggestion of specific involvement between high-level sound and a rare form of epileptic seizure.



The special senses of vision and balance are influenced by the presence of high sound levels, but without any apparent health negatives past temporary dysfunctions. One change is a tendency in susceptible individuals for dizziness and vertigo via acoustic stimulation of the vestibular labyrinth or canal link in the ears. Sound also can cause susceptible individuals several alterations from normal vision. These include a narrowing of the angle of the visual field, impaired acuity and color vision, and interference with the critical flicker-fusion frequency. The brain's ability to use relevant visual information can also be disturbed. Perhaps the most interesting fact associated with high sound

levels and vision is that the pupil of the eye dilates with high sound levels (dilation increases with the increase of the stimulus).

All of the changes that the body undergoes during episodes of high-level sound exposure suggest that the total effect is less than positive. In fact, it would seem that for a certain percentage of the population, such exposure to levels in excess of 90 dB could pose a substantial hazard to long-term health. The real focal point of the problem with high-level sound is the invisibility of the effects. There are very few members of a susceptible population group who are going to realize that damage is taking place, and that in various ways, the ability to perform all life-related tasks is deteriorating. The bottom line in exposure to high levels is the total lack of identification of those most susceptible.

Certainly, the amount of exposure time tends to shift the possibility of severe health and hearing damage to those audio professionals who are involved on a daily basis or those enthusiasts who use their systems daily and have the very large sound systems necessary to reach levels in excess of 110 dB. (There may be benefit to the urban dilemma in housing, in that the presence of neighbors tends to limit the levels.)

Alternatives are many, but few will work practically because those who already have impaired hearing cannot tolerate attenuation without seriously compromising their perceptions. For undamaged individuals, two solutions seem reasonable. Those using audio at levels in excess of 90 or 100 dB can use some kind of hearing protectors. There is some frequency response alteration, but it may be acceptable as an alternative to health damage. Secondly, the use of small, inexpensive sound level meters can provide a constant means for keeping levels at or below 90 dB. Doing nothing is unacceptable because it ends with negative changes in the body. No one can know how susceptible they might really be to the physiological impacts of high-level sound, and the question demands thoughtful answers. Lastly, it is foolish to assume that the well-established (and restrictive) governmental safety standards for sound will never reach the audio profession. The recording and reproduction of audio will suffer from start to finish if solutions are imposed as regulations. A

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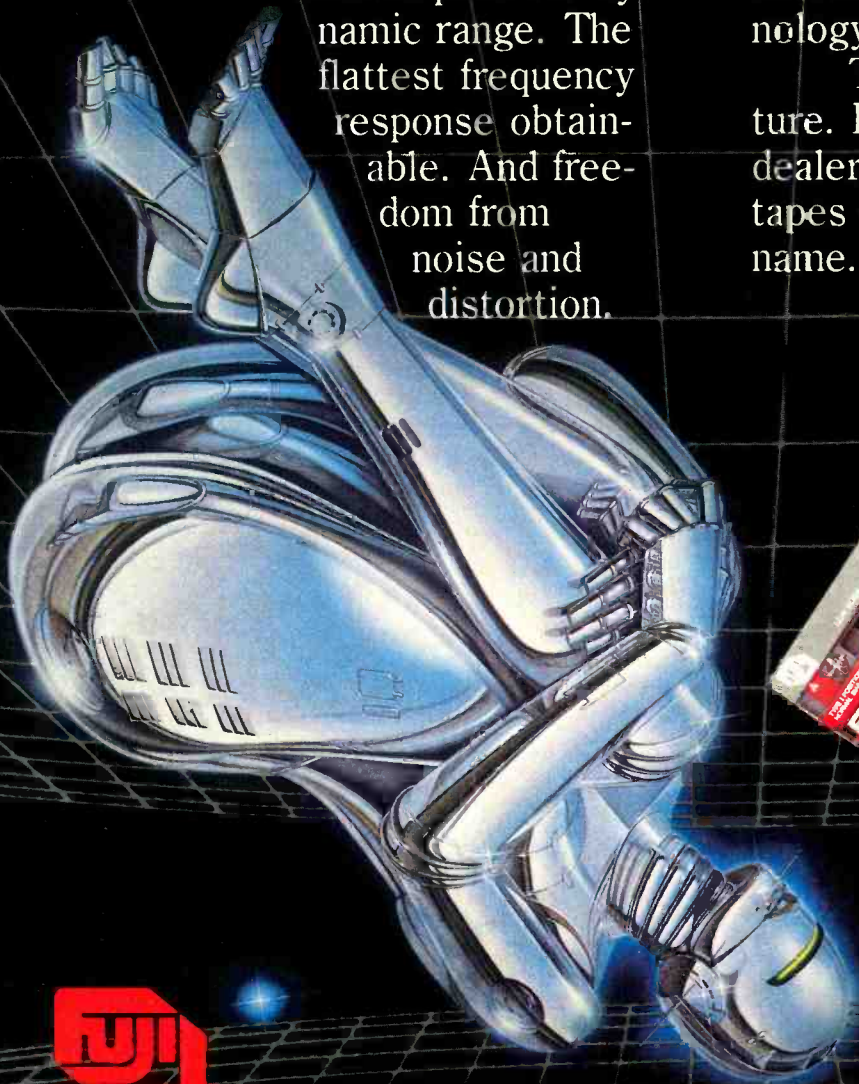
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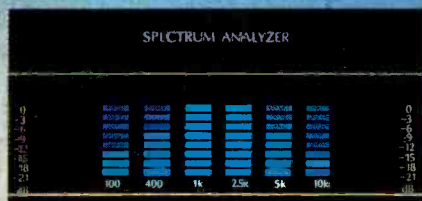
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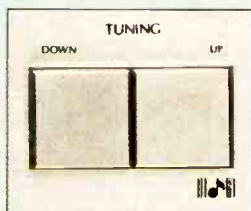
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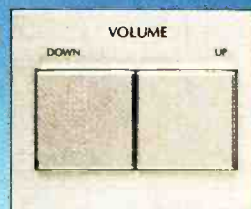


The digital circuitry ensures that every station received is automatically locked in for lowest possible distortion, with its frequency indicated both on a digital readout and by a LED indicator along an analog type dial.

**12 PRESET STATIONS.** To make FM and AM tuning still easier, up to 12 user-selected stations may be "stored" in all "Z" Receiver memory circuits for instant recall. The last station received will be remembered when the tuner is turned on again; and memories are kept "live" even during a power outage.

**TOUCH VOLUME CONTROL & LED PEAK POWER LEVEL INDICATOR.** The Sansui "Z" Receivers use a pair of touch-buttons to adjust the listening level. Relative volume control setting is indicated on a fluorescent display. On most models actual peak power amplifier output is shown by 14- or 18-segment LED indicators.

And there's more. Instead of up/down tuning buttons, both the 9900Z and the 8900ZDB have tun-



ing knobs linked to a rotary "encoder" disc. As you turn the knob, the encoded disc works with

an LED and a photo transistor to generate electronic pulses to raise or lower the tuned frequency. In addition, the 9900Z, 8900ZDB, and 7900Z have ceramic buzzers which signal unobtrusively while you tune in a station. There are three speaker select switches on the 9900Z for driving any two of three connected speaker pairs and two switches on all the other "Z" receivers. Included are LED's for every important function. Two Muting Modes. Two tape deck connections with dubbing. And much more.

The full line of Sansui "Z" Receivers are at your Sansui dealer now. Visit him for a complete demonstration soon. He has just the right model for your pocketbook and power requirements.





### SANSUI "Z" RECEIVERS

#### 9900Z

160 watts/chan., min. RMS, both channels into 8 ohms, from 20-20kHz with no more than 0.015% THD.

#### 8900ZDB

125 watts/chan., min. RMS, both channels into 8 ohms, from 20-20kHz with no more than 0.02% THD.

#### 7900Z

100 watts/chan., min. RMS, both channels into 8 ohms, from 20-20kHz with no more than 0.02% THD.

#### 5900Z

75 watts/chan., min. RMS, both channels into 8 ohms, from 20-20kHz with no more than 0.03% THD.

#### 4900Z

55 watts/chan., min. RMS, both channels into 8 ohms, from 20-20kHz with no more than 0.03% THD.

#### 3900Z

40 watts/chan., min. RMS, both channels into 8 ohms, from 20-20kHz with no more than 0.03% THD.

Cabinet of simulated wood grain.



### SANSUI ELECTRONICS CORP.

Lyndhurst, New Jersey 07071 • Gardena, Ca. 90247  
 SANSUI ELECTRIC CO., LTD., Tokyo, Japan  
 In Canada: Electronic Distributors

# Equipment profiles

## JVC Model R-S77 Stereophonic FM/AM Receiver



### Manufacturer's Specifications

#### FM Tuner Section

**Mono Usable Sensitivity:** 10.3 dBf (1.8  $\mu$ V/300 ohms).  
**50-dB Quieting Sensitivity:** Mono, 14.8 dBf (3.0  $\mu$ V); stereo, 37.2 dBf (40  $\mu$ V).  
**S/N Ratio:** Mono, 80 dB; stereo, 70 dB.  
**THD at 1 kHz:** Mono, 0.15 percent; stereo, 0.3 percent.  
**Frequency Response:** 30 Hz to 15 kHz, +0.5, -0.8 dB.  
**Capture Ratio:** 1.0 dB.  
**Selectivity:** 80 dB.  
**Image Rejection:** 78 dB.  
**I. f. Rejection:** 100 dB.  
**Stereo FM Separation:** 45 dB at 1 kHz.  
**Subcarrier Rejection:** 72 dB.

#### AM Tuner Section

**Sensitivity:** 250  $\mu$ V/m.  
**S/N Ratio:** 50 dB.  
**Selectivity:** 63 dB.  
**Image Rejection:** 55 dB.  
**I. f. Rejection:** 40 dB.  
**THD:** 0.5 percent at 10 mV/m.

#### Amplifier Section

**Power Output:** 60 W/channel, 8 ohms, 20 Hz to 20 kHz.  
**Rated THD:** 0.005 percent.  
**Output Power at 1 kHz:** 65 W/channel, 0.001 percent THD.  
**Rated SMPTE-IMD:** 0.004 percent.  
**Damping Factor:** 55 at 8 ohms.  
**Input Sensitivity:** Phono, 2.5 mV; high level, 180 mV.

**Phono Overload:** 180 mV at 1 kHz.

**Frequency Response:** Phono, RIAA,  $\pm$ 0.5 dB; high level, 15 Hz to 50 kHz,  $\pm$ 1.0 dB.

**Graphic Equalizer S. E. A. Control Range:**  $\pm$ 12 dB at 40 Hz, 250 Hz, 1 kHz, 5 kHz, and 15 kHz.

**High Filter Range:** -3 dB at 6 kHz.

**S/N Ratios (Per New IHF):** Phono, 75 dB; high level, 75 dB.

#### General Specifications

**Dimensions:** 18-29/32 in. (48.02 cm) W x 4-23/32 in. (11.99 cm) H x 15-1/16 in. (38.26 cm) D.

**Net Weight:** 23.8 lb. (10.8 kg).

**Price:** \$529.95.

JVC has completely restyled their top receivers for 1980-81. The rather unusual cosmetic features introduced by the company three years ago have yielded to a more traditional looking faceplate having only one surface (the older receivers had controls mounted in two planes, both horizontally and vertically). There are still no rotary knobs on this receiver, and all control functions and switching functions are handled by slider-type potentiometers or touch-button switches.

Since the new R-S77 receiver features synthesized frequency tuning, there is no longer any need for a space-consuming, long dial scale. Instead, a small cutout area near the center of the panel is devoted to a digital display of frequency (for both AM and FM stations) at the right of the cutout, while at the left there are banks of LEDs which serve as power output indicators calibrated in watts referred to an 8-ohm

load. Additional indicator lights below the digital-readout and power-indicating sections include a standby light (on so long as the unit is plugged into a live outlet, to indicate that station memories are retained), program source indicator lights for AUX, Phono, AM, and FM, and a series of LEDs which tell the user relative signal strength for both AM and FM received signals. A stereo indicator and an indicator which tells you when stations have been tuned in and "locked" are also present in this area of the panel.

Below the cutout area are five tiny rocker switches and a large pair of touch-switches for tuning "up" or "down" in frequency, either in a scanning mode (where tuning stops when usable signals are encountered) or manually in 200-kHz increments for FM and 10-kHz (or 9-kHz) increments for AM. The smaller switches in this area include an S.E.A. record



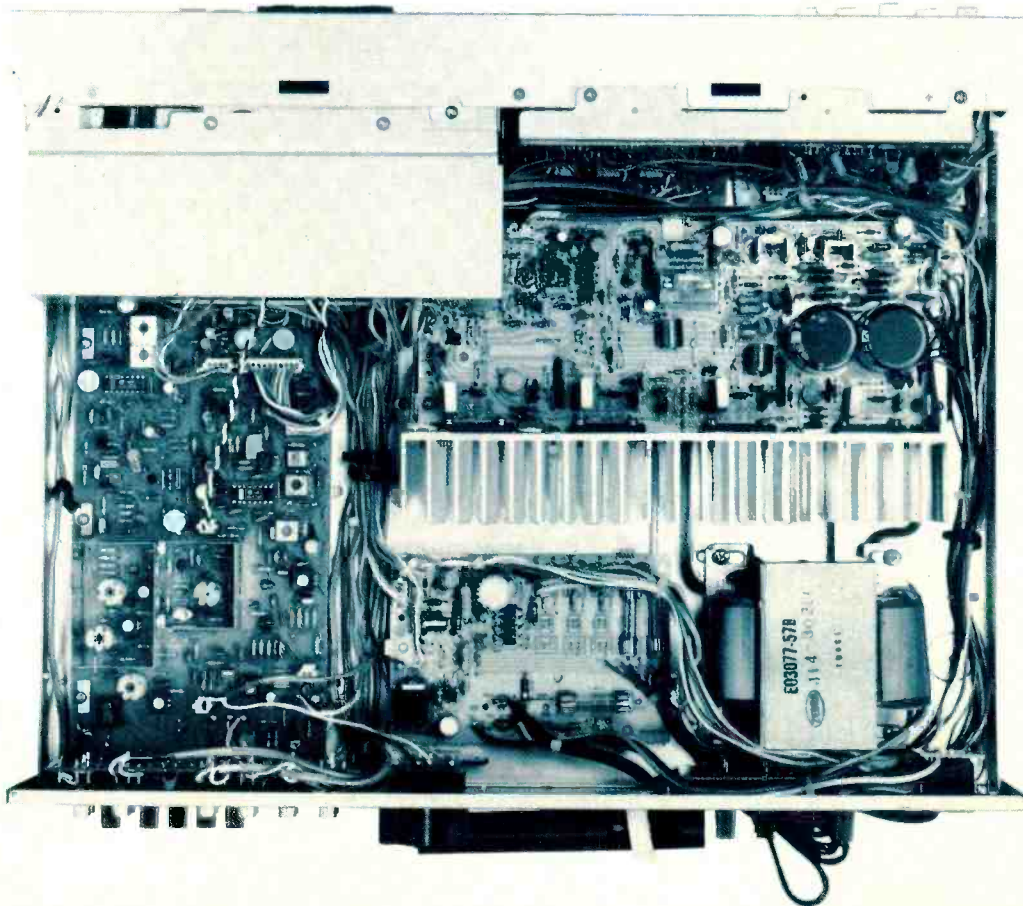
switch (enabling the user to add graphic equalization to the signal prior to its emergence at the tape-out jacks), two tape monitor switches, a mono/stereo switch which also defeats muting on FM when in the mono position, and a loudness compensation switch.

At the left end of the front panel are five slider controls which constitute a graphic equalizer system that JVC continues to call their S.E.A. system. Center frequencies are about two octaves apart so that, in effect, the user has separate control of low bass, upper bass, mid-frequencies, lower treble and upper treble — a far more flexible system than could be had with ordinary bass and treble controls found on most receivers. The power switch, two separate speaker selector switches, and the usual headphone jack are also located in this area of the panel.

At the right end of the panel we find the program source selectors, a high-cut filter switch, slider controls for volume and balance (the latter with a detent-stop at its center point), six numbered buttons for storing or recalling that many AM plus that many FM frequencies, a "memory" switch (used when entering a frequency into one of the memory posi-

tions), a dimmer switch which dims display lighting, a scanning indicator to tell you when the tuner is scanning, a manual/auto switch that determines the manner in which the "up" and "down" tuning switches are to operate, and a local/DX switch that determines the signal strengths at which automatic scanning will "lock" onto received signals. In general, the layout of this panel is well thought out, and if you review the features just discussed you cannot help but admire the way in which JVC's design engineers have been able to cram this many features and controls onto a panel that is not much more than four inches in height. The only repositioning of a control that we might have favored would be the movement of the auto-manual tuning switch closer to the "up" and "down" tuning buttons to which it is related.

The rear panel includes the usual 75-ohm coaxial, 300-ohm and external AM screw-type antenna terminals, a pivotable ferrite AM bar antenna, the necessary input and tape output jacks (plus a multi-pin DIN connector for tape deck connection of those decks which utilize such DIN cables), and two sets of color-coded speaker terminals of the screw/clamp type. An unusual feature also found on the rear panel (and



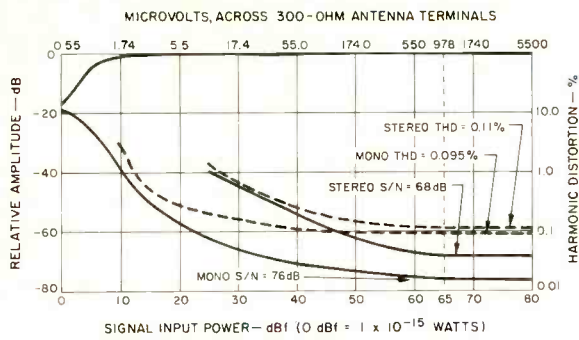


Fig. 1—Mono and stereo quieting and distortion characteristics, FM section.

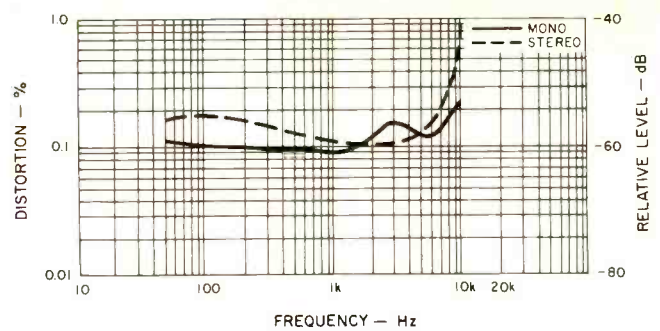


Fig. 2—Distortion vs. frequency, FM section.

the first time we have seen it on either a tuner or receiver) is a 9-kHz/10-kHz switch. Many areas of the world employ 9-kHz spacing between adjacent AM channels. Only the region consisting of North, Central and South America continues to employ 10-kHz spacing, and this may change in the near future to conform with the rest of the world. If that should occur, the purchaser of this JVC receiver will be able to simply flick a switch to obtain the new 9-kHz increments of tuning with frequency synthesis.

### Circuit Innovations

As far as we know, this is the first time that JVC has employed their "Super A" amplifier circuitry in a receiver. For readers unfamiliar with this circuit approach, we should mention that Super A is a two-part solution to problems which JVC considers to be of importance in amplifiers. One circuit refinement takes care of nonlinearities which frequently occur in driver- and voltage-amplifier stages of a power amplifier, while the second circuit is concerned with the output stages of the amplifier and the prevention of "notch" or switching distortion. As explained by JVC, ordinary Class AB output stages actually operate in Class A over a limited range of low-output levels. When that range is exceeded, one of the complementary pair of output transistors is cut off because bias voltage in Class AB or Class B circuits is fixed. With each transistor of the pair cut off for part if not half of a cycle of the waveform being amplified, switching distortion can and often does result. Measured as a distortion percentage on a conventional distortion meter, such switching distortion seems almost insignificant, but in fact it is readily audible, particularly at lower listening levels where the amplitude of the distortion remains fixed while overall reference signal levels decrease. The relatively low readings are simply a result of the short duty cycle (and higher order harmonics) of the switching distortion.

JVC's solution to the problem, as exemplified in this receiver, is called a logarithmic compression bias circuit. The output stage uses a pair of complementary output transistors, as

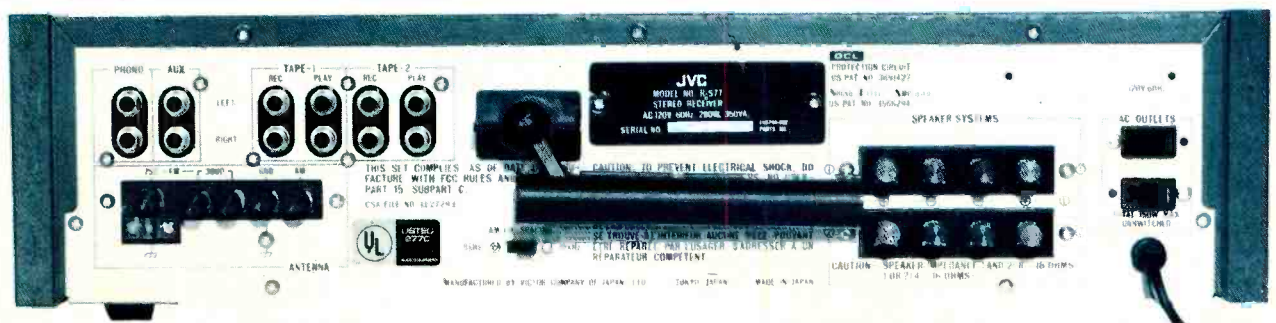
in a Class AB amplifier, but the bias voltage is made to vary so that the minimum bias voltage needed to maintain Class A operation is present even when the power transistors approach cutoff. With this approach, high efficiency of Class B is retained, while excellent linearity is not sacrificed at any power level. As we were soon to learn during our measurements of the amplifier section, the Super A circuitry results in unmeasurable distortion levels even when these are measured using conventional static or continuous test signals.

### FM Performance Measurements

In the past, frequency-synthesized tuner designs have tended to be excellent insofar as tuning accuracy and low distortion are concerned but have suffered somewhat from poor selectivity and signal-to-noise ratios compared with conventionally tuned circuits. Those trade-offs seem to be disappearing, as evidenced by the excellent sensitivity (9.8 dBf), selectivity (80 dB as claimed), and signal-to-noise ratio (76 dB in mono) measured for the tuner section of this receiver. Quieting and distortion (for 1-kHz modulating signals in mono and stereo) characteristics for mono and stereo are shown graphically in Fig. 1. The 50-dB quieting point in mono was attained with signal strengths of only 13.5 dBf (2.6  $\mu$ V/300 ohms), while for stereo 50-dB quieting sensitivity measured 36.1 dBf, or 35  $\mu$ V across 300 ohms.

Distortion was 0.09 percent in mono and 0.11 percent in stereo for a 1-kHz signal at a signal strength of 65 dBf. In fact, with somewhat stronger signals, THD in stereo actually decreased somewhat further. Figure 2 shows harmonic distortion levels for both mono and stereo plotted against frequency of the modulating signal, and aside from the rather high reading observed at 10 kHz in stereo, which was caused more by slight "beats" than by actual harmonic distortion, we see that THD levels remain consistently low for all musical fundamental frequencies of broadcast program material.

Figure 3 is a spectrum analyzer plot of frequency response of the tuner section in the stereo receiving mode (upper trace) as well as stereo separation (lower trace). Frequency





# Single-play vs. multiplay: the argument is over.

BSR is proud to put an end to the seemingly endless debate over what style of turntable is the "correct" turntable—single-play or multiplay.

## **Introducing the BSR Pro III Series— the third generation of turntables.**

The BSR Pro III Series combines the precision and accuracy of the finest single-play and the ease and versatility of a multiplay. At a price well within the range of both.

### **The tonearm—a story in itself.**

This may be the finest tonearm ever offered on a multiplay turntable. It has an extremely low mass carbon fiber head shell, designed to be used with today's finest low-mass cartridges and measures an impressive 237mm from pivot to stylus. And, its sleek, rapier-straight line will give you unerring tracking performance.

### **Two motors are better than one.**

The BSR Pro III Series 300 and 200 models feature a direct response FG Belt Drive turntable with a quartz-locked control system that references the speed of the motor to that of the turntable. Additionally, there is an independent servomotor that drives the tonearm only during cycle changes. This unique two-motor design eliminates complicated cams, trip switches, etc.—all of which can interfere with optimum turntable performance.

### **Independent tonearm and turntable suspension.**

BSR Pro III Series turntables utilize a floating suspension system to isolate both the turntable and the tonearm. Mounted together on a separate subplate, independent of base, cover and controls, this eliminates most causes of vibration and acoustic feedback.

### **Three-record umbrella spindle— short and sweet.**

Unlike traditional six-record multiplays, the BSR

Pro III Series turntables are designed to play up to three records. The decreased height and weight of the record stack allows for a much more precise vertical tracking angle and overall turntable performance.

### **Digital readouts.**

BSR Pro III Series turntables have a multifunction digital display, allowing you to determine both quartz-locked and variable turntable speed, elapsed time, stylus time and exact turntable leveling.

### **Lateral cueing.**

The BSR Pro III Series has the only lateral cue control on a multiplay turntable. It provides fast and slow cueing in both directions, allowing for precise location of any portion of a record.

### **Remote control.**

For total convenience, the BSR Pro III Series 300 has infrared remote control, which handles all major turntable functions, including volume control, from as far away as 40 feet.

### **Look at the look.**

The BSR Pro III Series has a handsome low-profile design, with all electronic pushbutton controls conveniently placed outside the closed dustcover.

### **Add it up—both sides win.**

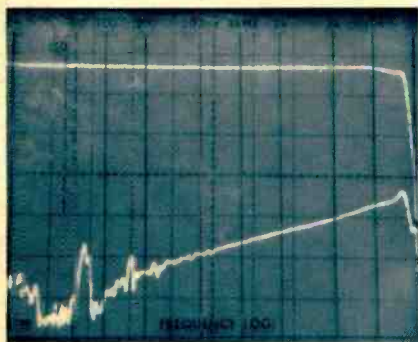
Whether you're a believer in single-play or multiplay turntables, we believe that the BSR Pro III Series offers exactly what you demand. We invite you to examine it at your audio dealer.

**BSR Pro III Series.**  
The Third Generation of Turntables.

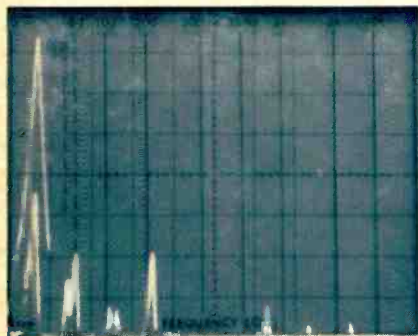
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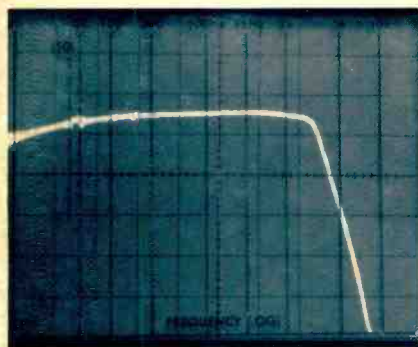
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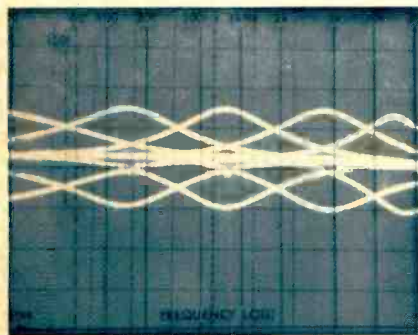
**Fig. 3—Frequency response and stereo FM separation.**



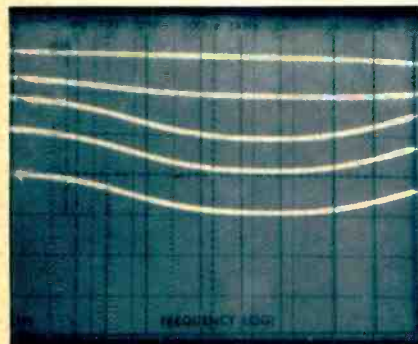
**Fig. 4—Crosstalk and distortion products at 5 kHz, FM section.**



**Fig. 5—Frequency response, AM section.**



**Fig. 7—Range of adjustment in the 5-band S.E.A. equalizer.**

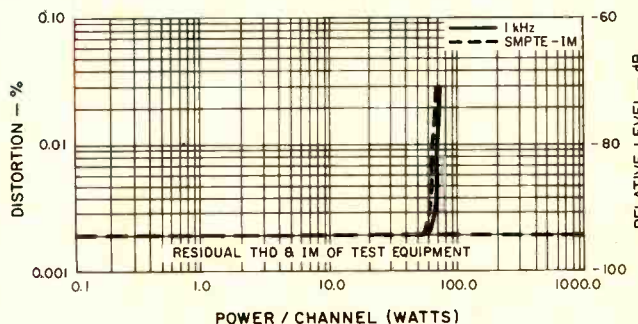


**Fig. 8—Action of the loudness control.**

sweep is from 20 Hz to 20 kHz and vertical sensitivity of the display is 10 dB per division. At the specific test frequencies of 100 Hz, 1 kHz and 10 kHz, we measured separation figures of 53 dB, 51 dB and 33 dB. To separate crosstalk from distortion products in an unmodulated channel's output, we used our spectrum analyzer to display a reference 5-kHz signal in Fig. 4 (tall spike at left). Sweep range is now linear, from 0 kHz to 50 kHz, or 5 kHz per division. The shorter spike contained within the reference spike shows that separation at 5 kHz was actually close to 40 dB, while to the right we see some harmonic distortion components at 10 and 15 kHz as well as the expected 19-kHz and 38-kHz residual output products and sidebands which are above and below the 38-kHz carrier by a spacing of 5 kHz.

Capture ratio measured 1.0 dB as claimed, while selectivity was actually a bit higher than the 80 dB claimed, with readings of 82 dB at one end of the band and 81 dB at the other. I.f. rejection measured in excess of 100 dB, while image rejection measured 80 dB. Spurious suppression measured 93 dB.

The frequency response of the AM tuner section of this receiver was better than most, as can be seen in Fig. 5. The -6



**Fig. 6—At all but overload levels, THD and IM is lower than the residual distortion of the test equipment.**

dB points occurred at 4 kHz and all the way down at 25 Hz, and while these numbers may not impress the high-fidelity oriented audio enthusiast, they are considerably better than those observed for most stereo receivers.

### Amplifier Measurements

The power amplifier section of the JVC R-S77 receiver produced 72 watts of power per channel at 1 kHz into 8-ohm loads and 69 watts per channel at the frequency extremes of 20 Hz and 20 kHz. While power output into 4-ohm loads was considerably higher than the 60-watt rating (as high as 85 watts per channel at mid-frequencies), JVC would not be able to rate the amplifier any higher than 65 watts for the 4-ohm rating because of FTC preconditioning requirements. In fact, JVC provides no 4-ohm rating for this receiver.

As for distortion levels below rated power output, there is little we can discuss. As you can gather from Fig. 6, both harmonic and distortion readings are limited by the residual distortion of our test signals (around 0.002 percent) so we can only report that at all levels below overload, THD and IM for the Super-A designed amplifier are "less than 0.002 percent." Dynamic headroom, or the ability of the amplifier to deliver higher power levels on a short-term basis before clipping, was 1.6 dB, and damping factor, measured at 50 Hz and referenced to 8-ohm loads, was 50. Power bandwidth extended from 15 Hz to 30 kHz for full power at rated THD.

### Preamplifier and Control Section Measurements

Since JVC has not elected to report input sensitivities in accordance with the new IHF/EIA Measurement Standards



0.00% switching distortion. 0.00% FM drift.  
 Two reasons Technics has a lot to say about nothing.

Technics SU-V8 amplifier with New Class A circuitry eliminates switching distortion. The ST-S7 quartz synthesizer eliminates FM drift. And as you'll discover, the more we eliminate, the more we add.

Take the SU-V8. You won't hear any switching distortion because, unlike most of today's amplifiers, its output transistors don't switch on and off as the input waveform goes from positive to negative. The reason: Technics synchro-bias circuitry. What it does is employ high-speed diodes that constantly send minute amounts of current to the transistor not in use. And since the transistors are always on, switching distortion is eliminated.

And there's nothing minute about the SU-V8's power

output: 110 watts per channel from 20 Hz to 20 kHz into 8 ohms with no more than 0.005% THD. The results: Music that's rich, crisp and bursting with dynamic range.

In concert with the SU-V8 is the ST-S7. With its quartz-crystal oscillator, only the broadcast frequencies you select can be received. And since both frequencies are quartz-synthesized, the tuner can't drift. That means any station you tune is perfectly in tune.

And the ST-S7's microprocessor allows you to preset eight AM and eight FM stations and even turn the power on and tune three stations all by itself.

Discover Technics new amps and tuners. When it comes to New Class A and quartz, Technics gets an A plus.

**Technics**  
 The science of sound

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# THE FIRST \$500 SPEAKER THAT LEGITIMATELY QUESTIONS THE AUDIBLE ADVANTAGES OF A \$1400 SPEAKER.

If you want to listen to Apollo moon launchings, or organ music with pedal notes below what the human ear can hear, and you own a concert hall, then without question the \$1400 speaker has its merits. In fact, for those purposes we'd recommend something even more impressive: the \$8000 Sony APM-8.

But, if you want to listen to Beethoven, who wrote notes as low as 32 Hz, or "rock" which usually ranges from 55 Hz on up, and you don't own a concert hall, then what you want is the first affordable speaker that dares to challenge the audible advantages of the \$1400 speaker: the \$500 Sony SS-U80.

## NASTRAN STRUCTURAL ANALYSIS AND OTHER MIRACLES OF ENGINEERING.

If technology alone made a speaker great, then the U80 would be the unchallenged leader.

While other manufacturers are still using guesswork, Sony designed its low-frequency driver with the aid of a highly sophisticated NASA computer program called NASTRAN. With NASTRAN, Sony engineers could rapidly identify potential causes of distortion on literally hundreds of woofer configurations and evolve the optimum woofer. A woofer distinguished by tight, accurate sound; deep, authoritative bass response; and new lows in distortion.

On the direct-drive ribbon tweeter the engineering was no less impressive. We did away with the transmission system between the source of motion, the voice coil, and the object to be moved, the diaphragm. In fact, we did away with the separation of coil and diaphragm altogether.

So unlike cone or dome tweeters, the entire radiating surface moves as a unit for remarkably low distortion.

While the U80 is endowed with a whole host of other technological virtues, one not to be overlooked is a special "Sound Source Alignment" of the woofer, tweeter and midrange drivers. This ensures that when the sound reaches you its imaging is solid, stable and credible.

## INNOVATIONS FROM BORROWED EARS.

Truly superb loudspeakers cannot be designed by technology alone. Even the most sophisticated computer program cannot evaluate a speaker's sound quality. Even the most elaborate design theory cannot embrace all the nuances of music reproduction.

It is for these reasons that Sony subjected the U80 to hundreds of hours of listening tests throughout the United States with musicians and audio professionals. People who make their living with music.

What they helped us come up with were subtle refinements in the drivers, the baffle board and the crossover network. This is the kind of fine tuning that heretofore was only found in esoteric speakers produced by inspired audiophiles working out of their garages.

As a result, we at Sony are confident that the U80 offers the kind of clean, accurate, high-quality sound that will not only earn the respect of the most demanding music lover, but dare question the audible advantages of the \$1400 speaker as well.

**SONY**  
High Fidelity

U80 FEATURES AND SPECIFICATIONS: 4-way floor standing acoustic suspension system/12" NASTRAN-Plus woofer/Direct-drive ribbon tweeter/Sound Source Alignment of the drivers/Level controls for low-mid, high-mid and high-frequency drivers/Recommended amplifier power 50 to 200 watts.

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(we wonder why, inasmuch as they have switched over to reporting S/N ratios per the new IHF input and output reference levels), readers wishing to compare our measured input sensitivity results with those claimed by JVC will have to multiply our results by a factor of 17.78 dB, or by 7.75. We measured a phono sensitivity of 0.29 millivolt for 1-watt output, while in the high-level inputs, sensitivity was 21 mV for the same 1 watt of output. Signal-to-noise ratio in phono, referred to 1-watt output and using an input level of 5 mV, was 78 dB as against JVC's claim of only 75 dB and, for high-level inputs (referenced again to 1-watt output but with an input level of 0.5 volt), we measured 80 dB, A weighted, again better than claimed by JVC.

Overall frequency response was flat within 1 dB from 10 Hz to 50 kHz via the high-level inputs, and RIAA equalization accuracy was virtually perfect from 100 Hz upward to 20 kHz but had a positive rising characteristic reaching +1.0 dB at 30 Hz. Phono overload was 220 millivolts as against 180 mV claimed by the manufacturer.

The flexibility and versatility of the five graphic equalizer controls are best understood by examining the composite sweep 'scope photo of Fig. 7, in which you can see the maximum range of boost and cut offered by each of the five slider controls. Clearly, this sort of five-control arrangement provides a great deal more in the way of tone control flexibility than either two- or three-way tone controls.

Loudness compensation characteristics at various settings of the master volume control (approximately 10 dB apart) are plotted in the spectrum analyzer 'scope photo of Fig. 8 and are typical of what one usually finds in these simple loudness control switching arrangements.

## Use and Listening Tests

The JVC Model R-S77 receiver delivered sound quality that can only be described as well balanced and uncolored. Controls were easy to use and did exactly what they were intended to do. We would have been more pleased with the control layout if JVC had supplied a subsonic filter instead of the high-cut filter. The action of the latter could be easily duplicated by the top control of the graphic equalizer, while the ultra-low frequency response capability of the amplifier section makes a subsonic filter an often-used and often-needed circuit, especially if warped records and less-than-perfect turntable systems are used in conjunction with the receiver.

Sound quality was good, too, using the radio facilities of the receiver, and we were especially conscious of the low-distortion reception obtainable with this frequency-synthesized tuner despite its excellent and relatively high alternate channel selectivity. The station memory feature is a nice addition (up to six AM stations *plus* six FM stations can be "memorized"), providing you remember (or write down) where you have placed which station (is it in memory number 3 or number 5?).

Sixty watts per channel seems to be an optimum value for most of the medium to higher efficiency speaker systems being offered these days and should not restrict listeners to "less than lifelike" sound levels in most medium-sized listening rooms. Abandonment of the "power race" by leading manufacturers such as JVC in favor of more audibly beneficial features and circuits was a wise course, in our opinion, and has made possible such cost-efficient products as this new receiver.

Leonard Feldman

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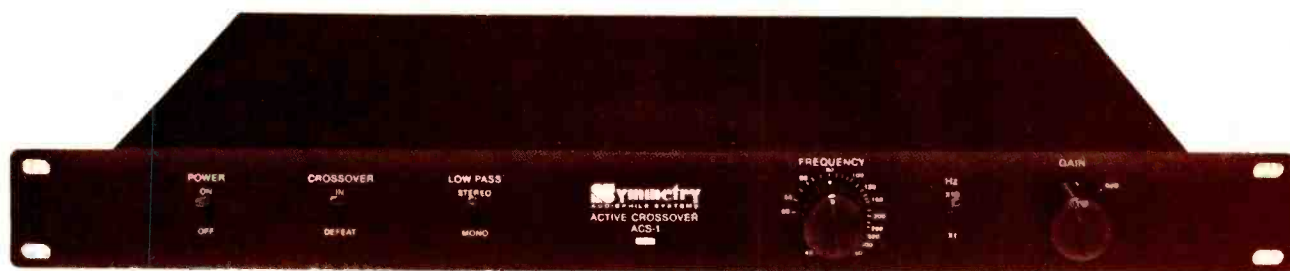
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## Symmetry ACS-1 Stereo Crossover



### Manufacturer's Specifications

**Crossover Point:** Continuously variable, in two ranges, from 45 to 4500 Hz.

**Filter Slopes:** Low pass, 12 dB/octave; high pass, 6 dB/octave.

**Input Impedance:** 100 kilohms.

**Noise:** -100 dB, re 3 V output.

**Slew Rate:** 200 V/ $\mu$ S.

**THD and IM Distortion:** Less than 0.01 percent at 3 V.

**Dimensions:** 1 $\frac{3}{4}$  in. (45 mm) H (plus removable feet) x 19 in. (480 mm) W x 9 in. (230 mm) D.

**Weight:** 4.7 lbs. (2.1 kg).

**Price:** \$750.00.

With the growing use of biamplication in audiophile sound systems, there is an increased interest in the electronic crossovers associated with such configurations. There are a number of crossovers, widely distributed, but they are primarily made and marketed for sound reinforcement. The Symmetry ACS-1 crossover can easily be installed in a professional system with its 1 $\frac{3}{4}$ -inch-high rack-mount construction. Beyond that, however, the unit delivers performance that should be of interest to anyone considering biamplication. Symmetry claims the ACS-1 to be a "transient perfect crossover," which one might hope for at its fairly high price. This claim will be examined more critically later.

The front panel is a flat black with legible white lettering. Long-handled toggle switches control power and select crossover *In* or *Defeat*, low-pass *Stereo* or *Mono* and frequency range *X1* or *X10*. In the *Defeat* position, the high-pass output is made full range, and the low-pass outputs are turned off. The *Mono* mode for low-pass is for use with a single subwoofer, and the two low-pass signals are mixed before the output. With the *X1* position, the crossover frequency can be adjusted from 45 to 450 Hz; with *X10*, the range is from 450 to 4500 Hz. A pot, with a good-sized knob, allows setting the high-pass gain, and there is an index mark for the 0-dB position. There are dual phono jacks for stereo inputs and low-pass and high-pass outputs on the back panel. There are also a fuseholder and a ground post.

Removal of the top cover revealed a single, large high-quality p.c.b. with superior quality components. Precision capacitors and resistors, and the multi-section frequency and gain pots, were an impressive sight. The ICs were soldered directly into the board, which would eliminate possible pin/socket contact problems, but would make replacement more difficult. All IC designations were rubbed off, apparently to slow up the circuit stealers. The switches referred to earlier were soldered quite solidly into the p.c.b., but were not supported at the front panel. With careful use of the switches, there should be absolutely no problem, but continual, rough operation could crack a solder joint.

### Performance

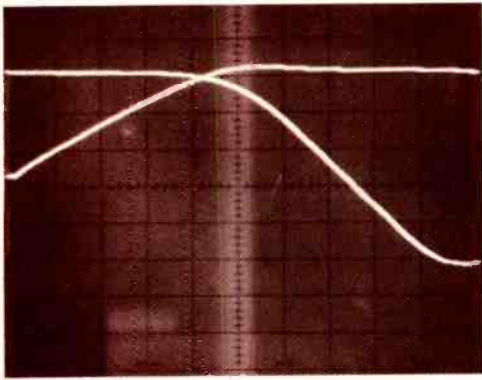
With the crossover function defeated, the response was flat from d.c. to 59 kHz at -1 dB and 131 kHz at -3 dB. With

the crossover frequency set to 700 Hz per dial, the high-pass outputs had the same high-end roll-off as above. There was about a 1.4-dB rise around 1250 Hz, and the low-end -3 dB point was at 397 Hz, with 700-Hz level close to reference level. The low-pass output was flat from d.c. and was 3 dB down at 680 Hz. These results may not be quite what the reader would expect, but they are quite correct for the ACS-1, which is a derived filter network design.

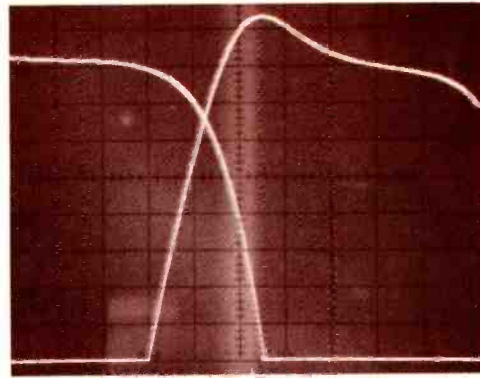
Figure 1 shows the results of plotting the two outputs on the spectrum analyzer, using its tracking oscillator. Noting the fact that the vertical scale is 10 dB/div., we can see the expected filter slopes, 12 dB/octave low pass and 6 dB/octave high pass. Figure 2 is a repeat of the plots except that the vertical scale is just 1 dB/div., showing greater amplitude detail in the crossover region. A plot of the voltage summation of these two outputs was flat within 0.2 dB for the entire band. The phase response was also close to "flat" over the same range.

With a -2 dB reference used to check the frequency dial, and high-pass gain at 0 dB, the designations were accurate from 45 to 4500 Hz. Output phases were compared to the input with the 400-Hz setting. The low-pass outputs were in phase at the lowest frequencies, but shifting more negative with increasing frequency, being -70 degrees at 400 Hz. On the high-pass output, the phase was +50 degrees at 400 Hz, and the discrepancy decreased with increasing frequency, down to less than +5 degrees at 2000 Hz. As noted above, summing low pass and high pass produced flat amplitude and phase outputs.

The measured input impedance was over 80 kilohms out to about 5 kHz, and it fell slowly above that point to 41 kilohms at 20 kHz. These excellent values were obtained whether the crossover was in *Defeat* or in normal operation, for any crossover frequency. The low-pass output impedance was a constant 1000 ohms across the band. The high-pass output Z was about 100 ohms across the band. At the high-pass output, there was no gain change between *In* and *Defeat*, whatever the setting of the gain pot — a good design. At the low-pass output, there was no change in gain between *Stereo* and *Mono* (with the same signal at both input jacks). The high-pass gain could be adjusted up to +14 dB (20 dB specification), and all the way down to zero. One good feature of the



**Fig. 1 — Frequency response of both outputs with a 700-Hz setting. (Scales: Vertical is 10 dB/div.;**



**horizontal is 20 Hz to 43 kHz log sweep.)  
Fig. 2 — Frequency responses with 1 dB/div. vertical scale.**

pot is that the majority of its rotation covers from just -20 to +14 dB, which facilitates more accurate setting. Pot sections tracked within a dB over the range of the pot, important in this application. The maximum output from low pass was 27 V p-p from 15 Hz up, 25 V p-p with the standard IHF load. The maximum high-pass output was 28 V p-p across the band for IHF and other higher-Z loads.

The input overload was at 9 V across the band, plenty high enough. With the high-pass gain at maximum and with a 100-kHz square wave of 6 V p-p in, the output was just shy of clipping. There is obvious rounding (Fig. 3) of the output waveform, and we may very well try to pick a slew rate value from the first part of the rise and fall portions — but we would be wrong to do so. This point was covered by Walt Jung in his series of articles (*Audio*, June-August, 1979); we are observing the roll-off in the small-signal bandwidth, and actually proving that the ACS-1 will not slew limit under any normal operating condition. In fact, all combinations of input drive and gain produced the same waveform, as long as there was not clipping. John Curl, designer of the unit, stated that the specified 200 V/ $\mu$ S slew rate might be better designated as “intrinsic slew rate,” as the internal circuitry has that capability. It could not be measured with external connections, however, as the purposely included high-frequency filtering — to prevent slew limiting — causes the rise-time limiting appearing in Fig. 3.

Harmonic distortion was measured with a 1-V signal, 0-dB gain, and a crossover frequency of 400 Hz. The great majority of the readings from both outputs were 0.0016 percent or

less. Attention was also given to the distortion levels from low pass above the crossover frequency, and from high pass below that point. In all cases, distortion levels remained very low. Checks on other crossovers had shown very high distortion levels in the regions of filter attenuation. With the ACS-1, twin-tone IM distortion was less than 0.03 percent out to 50 kHz, and THD was less than 0.01 percent out to 110 kHz with 2 V drive. SMPTE IM distortion was 0.008 percent with 3 V input.

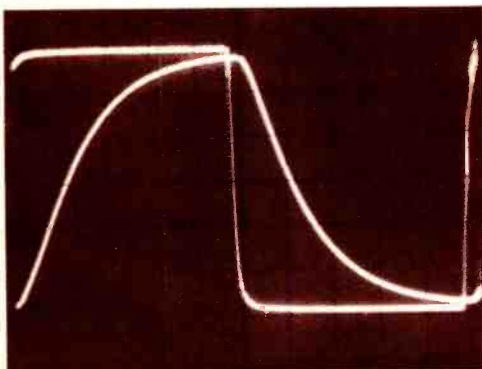
The manufacturer refers to the ACS-1 as a “transient perfect crossover,” which actually generated a bit of skepticism in these quarters. A variety of tone bursts was fed into the unit with various crossover frequencies. Figure 4 shows the input and the high-pass output with a 700-Hz burst and crossover frequency. We can really say that what we see is a perfect replica of the input, and compared to the results obtained with other crossover units, the waveform is a beauty.

Noise on the output measured -94 dBA re: 1 V output, 4 dBA better than the manufacturer's -100 dBA re: 3 V. On a CCIR/ARM basis, noise was -95.5 dB re: 1 V. In a 20 Hz to 20 kHz band, the noise was -90 dB re: 1 V. All of these figures are excellent, providing a bit of challenge in making the measurements.

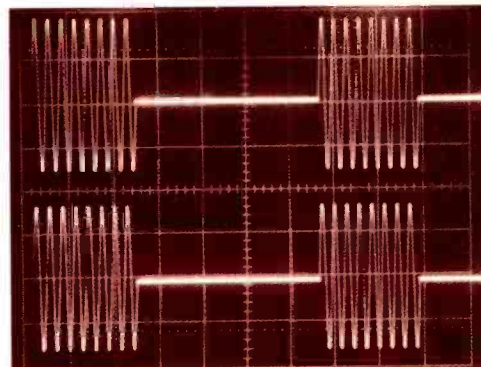
#### In-Use Tests

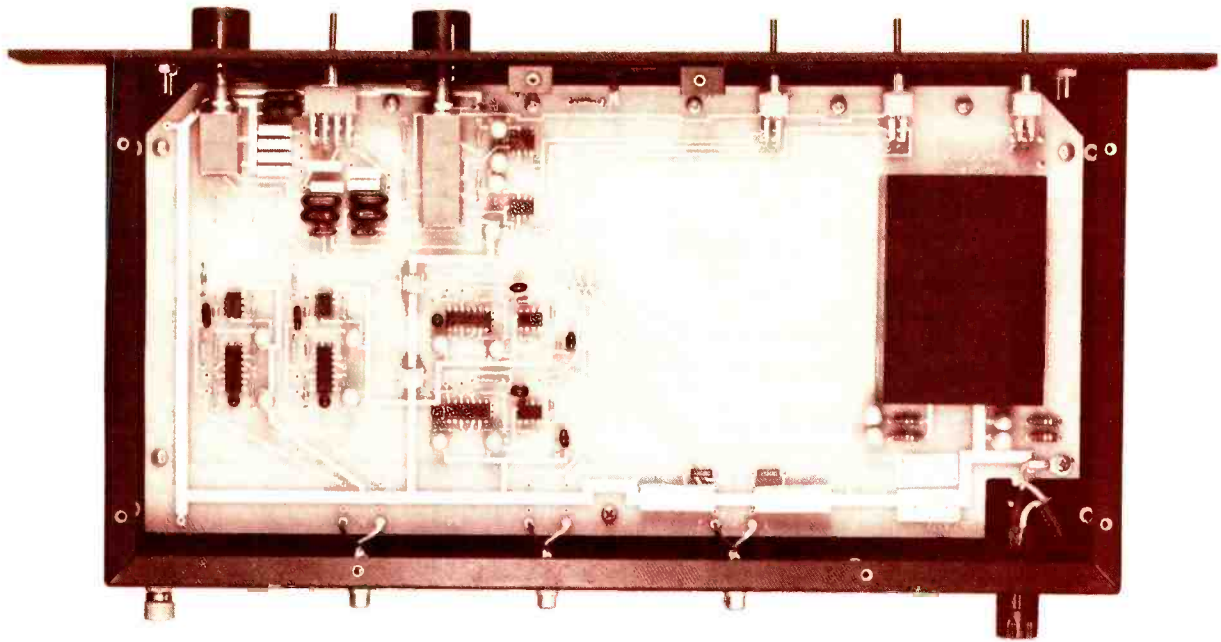
The instruction book is nicely printed and covered, but there is relatively little text and no illustrations. The instructions on setting a system up with listening tests, however, are quite good. All controls worked very well without any mal-

**fig. 3 — Input and output with 6 V p-p, 100-kHz square wave signal and maximum gain. (Scales: Vertical input is 1 V/div., output is 5 V/div.; horizontal is 1  $\mu$ S/div.)**



**Fig. 4 — Input (top) and combined outputs (bottom) with tone burst at 700-Hz crossover frequency. (Scales: Vertical is 0.5 V/div.; horizontal is 5 mS/div.)**





functions. Listening tests were performed with a Dynaco amplifier driving a single Altec two-way system. Two other crossovers were put through the same listening evaluation. Earlier, without the crossover, there had been evidence of electronic differences: What would the ears have to report? It is no exaggeration to state that the improvement in sound quality with the ACS-1 was so great that the first conclusion was that a mistake had been made when changing some of the connections. Repeated tests showed, however, that al-

though one of the other two crossovers was a "little better" than the other, the Symmetry unit was emphatically better than both of them. As the ACS-1 has just phono jack inputs and outputs, it would not fit in with balanced professional systems, but maybe there will be another model. In any event, whether it be for a high-level audiophile system, or a professional system operating single ended, it is an excellent performer, giving a good return for its money.

Howard A. Roberson

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## Crossovers and Sound Fields

The accompanying review of the Symmetry ACS-1 crossover commented favorably on the results of the listening tests performed, particularly in comparison with two other units tried. Immediately, it might seem that this was sufficient proof of the superiority of the constant-voltage-output, derived-filter-network design for all uses. Before expressing a personal opinion, it is worth noting that a number of experts in this area have expressed some doubts, pointed out limitations, or stated preferences for other configurations. The Symmetry unit showed that its voltage summation of low- and high-pass outputs had constant amplitude and phase. That's quite appealing to anyone who has seen the results from voltage summing the outputs of other crossover designs.

If we have two identical loudspeaker drivers delivering equal energy into a room, there are two ways that this energy may be added. If we consider how the direct pressure waves would add at an ear (or microphone), we can see that with acoustic distances to the drivers the same (time aligned) and with individual pressures the same, the total pressure would be doubled, or 6 dB higher. If, however, we are in a reverberant field and want to add the contributions from pressure waves from all directions, we are after the result from adding the two equal powers, which is an increase of 3 dB. Do notice that I keep saying "if" before stating what a result might be. I will not take the space here to cover many other possible variations such as the effects of the separation of drivers, of different types such as woofer and tweeter, of poor responses

above or below the crossover, etc. I would like to make this somewhat-loose distinction: Crossovers with flat voltage output if summed are best with systems with good time alignment and where a flat direct-field response is desired; crossovers with flat power output if summed may be best for listening in a reverberant field with little direct energy.

The word "may" is used with flat-power-output crossovers because we are all still learning the significance of the direct pressure wave, even in a field that is primarily reverberant. TDS (time-delay spectrometry) as invented by Dick Heyser and applied by Don Davis and others has shown many facets of loudspeaker radiation and generation of sound fields within a room unrevealed in the past. The conclusions of those supporting the application of TDS on what is desirable for good system design are basically supportive of the design approach used by Symmetry. I tend to lean that way myself from what I have heard, and from what I believe I understand, but there is much listening and questioning for us all remaining in the future.

H.A.R.

## References

1. Small, Richard H., "Constant-Voltage Crossover Network Design," *Jour. of the Audio Engineering Soc.*, Vol. 19, No. 1, Jan., 1971.
2. Thiele, Neville, "Another Look at Crossover Networks," *Audio*, Aug., 1978.
3. Augspurger, G. L., "Electrical Versus Acoustical Parameters in the Design of Loudspeaker Crossover Networks," *Jour. of the Audio Engineering Soc.*, Vol. 19, No. 6, June, 1971.
4. Murphy, John and Jim Ford, "An Overview of Crossovers, Part 2," *Modern Recording & Music*, Sept., 1980.

# Cassette Retest:

## Tape 5

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New samples of this formulation have shown a performance level superior to that reported in the September, 1980 issue. There was a very worthwhile improvement in MRLs, as shown in the figure. The signal/noise ratio measures 57.1 dBA — the best figure for all Type I (ferric) tapes tested to date (10/80). The modulation noise is a few dB higher, however, -45.0 dB from -49.0 dB. There was a significant improvement in tape skew, which had been a definite problem with the earlier samples. There were three C-90 and two C-60 samples available for this retest; with the exception of the flip side of one C-90, there was very little skew. In addition, sensitivity and bias needs were quite consistent. The output level stability was very good, usually within 0.3 dB. Infrequent dropouts just approached the audibility threshold, while flutter was typical for cassettes.

These latest samples give a level of performance right among the best Type I tapes, with the exception of the modulation noise. With its low purchase price, the Tape 5 Wide Latitude formulation represents good value overall, though some advertising claims still appear to be overly strong.

Howard A. Roberson

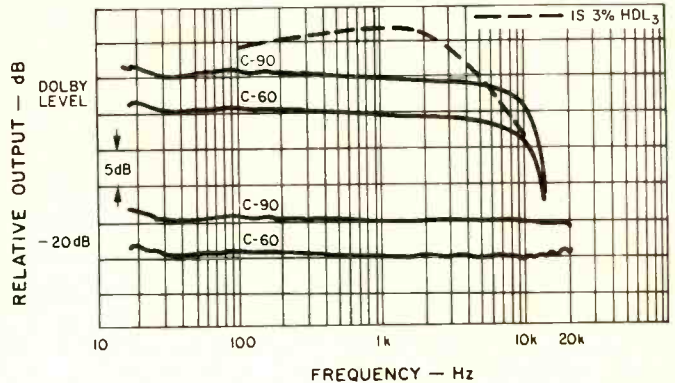


Fig. 1 — Frequency responses and MRL (---), Tape 5 C-90 only.

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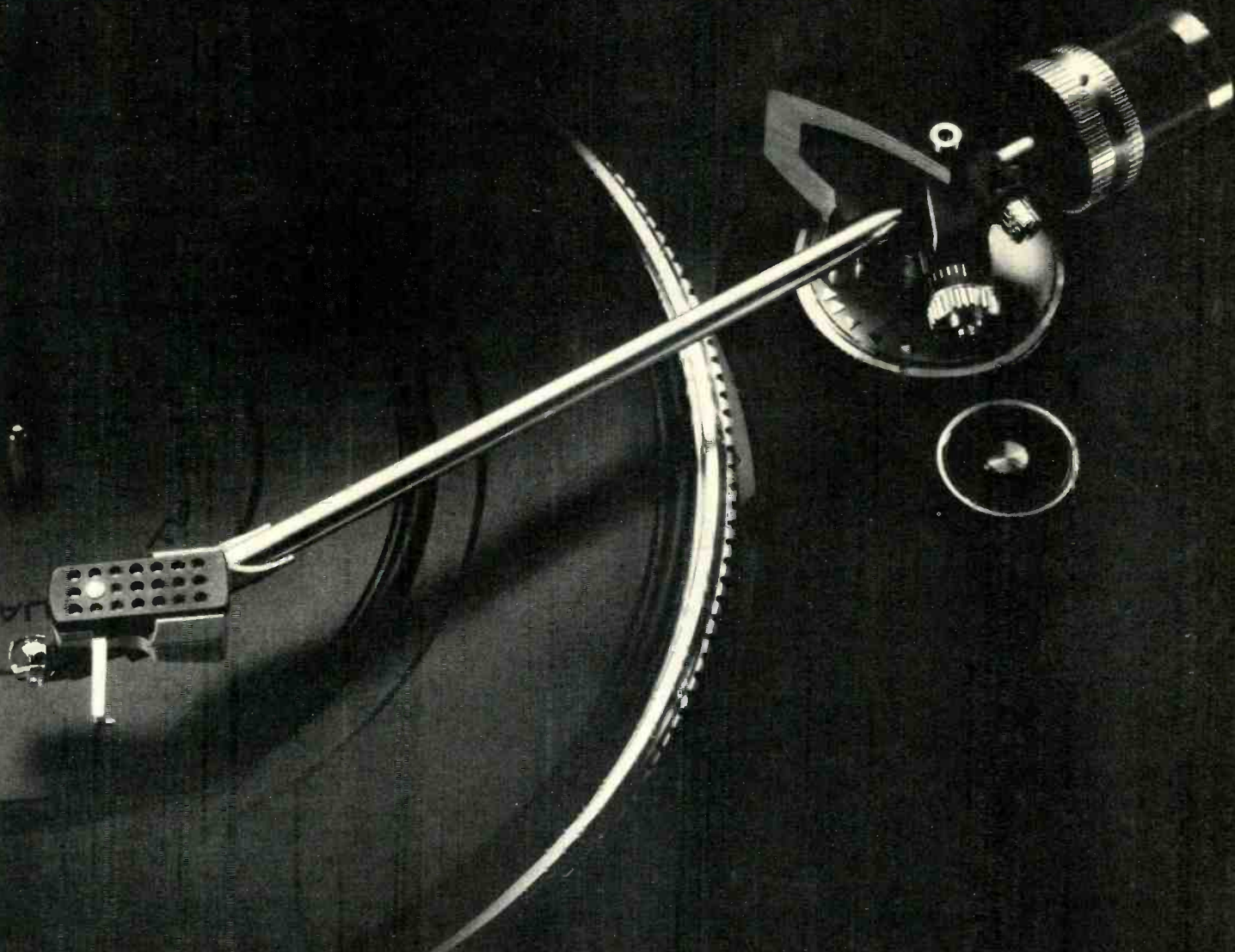
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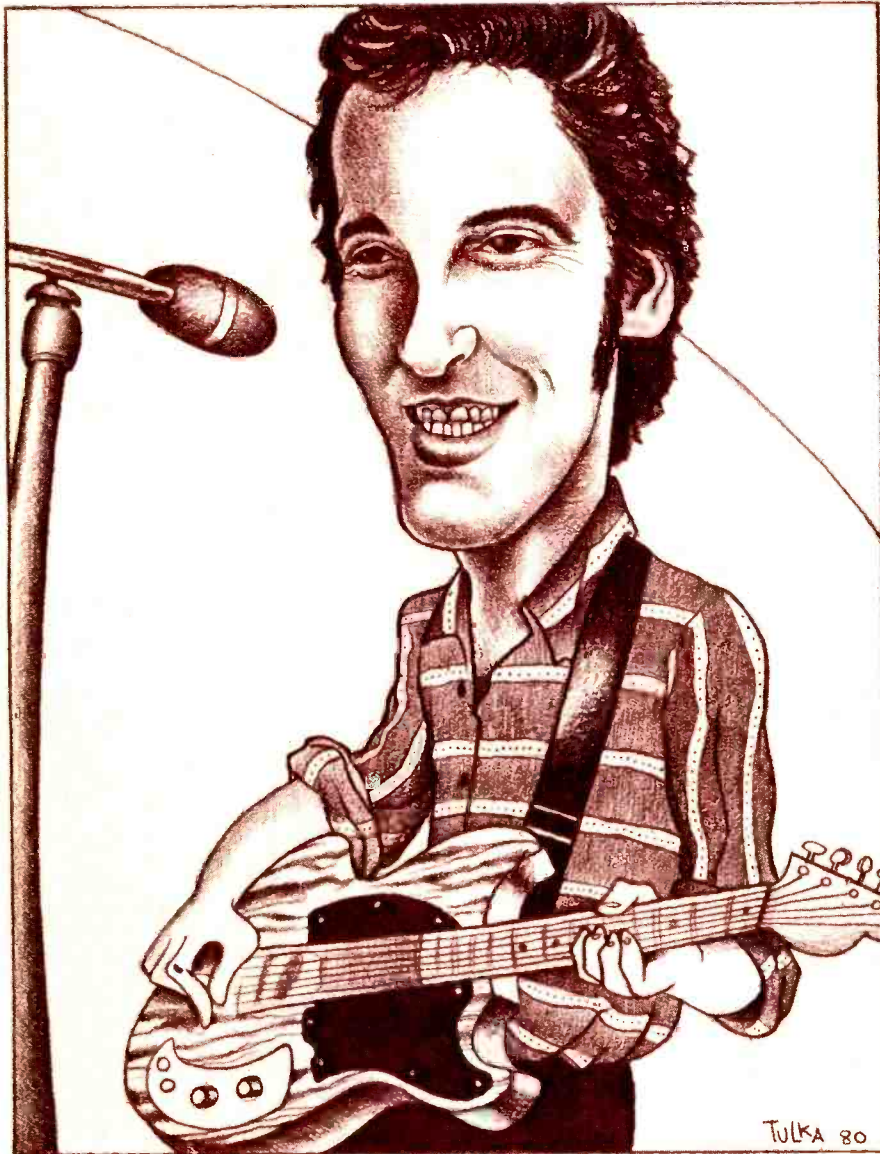
For the complete ULM story, please write directly to United Audio, 120 So. Columbus Ave., Dept. Q, Mt. Vernon, New York 10553.



Michael Tearson

Jon Tiven

# The column



**The River:** Bruce Springsteen  
Columbia PCII-36854, two discs, stereo, \$15.98.

Perhaps the single most influential musician in the latter half of the '70s was Bruce Springsteen, who declared that music can be meaningful and danceable at the same time. Combining a range of influences which reached from the earliest rock recordings through the late '60s, Springsteen's style has always sounded more like everything put together than one artist in particular — sort of a Doc Pomus-written opus produced by Phil

Spector sung by Van Morrison with lyrics by Bob Dylan and theatrical lighting by Andrew Oldham, kitchen sink available upon request. Although his recording career has been spotty, to say the least, Springsteen set the stage for Southside Johnny, Meatloaf, Graham Parker, and Billy Joel, not to mention blatant imitations such as D. L. Byron, Carolyn Mas, and Bill Falcon.

**The River** shows Bruce Springsteen at both his best and worst, as it took over two years and close to a million dollars to record. It also drew in various producers, co-producers, mixers,

and musicians to either mire Springsteen's music in a wall of mush or display it in sharp focus. These alternate approaches to Springsteen recording are showcased side by side, and all one has to do is read the credits to decide which Springsteen is the superior one. Granted, for some instances the use of reverb is an aesthetic rather than objective decision, but the way it's been consistently utilized (post-**Wild, Innocent & E-Street**) to make Bruce's high, tremulous vocal register sound like a trademark of pretentiousness is a blatant example of misproduction. This unsympathetic treatment of his voice is present on a large portion of the album, but fortunately there are a few tracks, most notably the single *Hungry Heart*, which at last reveal that Bruce can sing in a voice that suits his tunes (credit that hurdled obstacle to Bob Clearmountain, who mixed that and one other tune). One small step for rock 'n' roll, one giant leap for Brooosie!

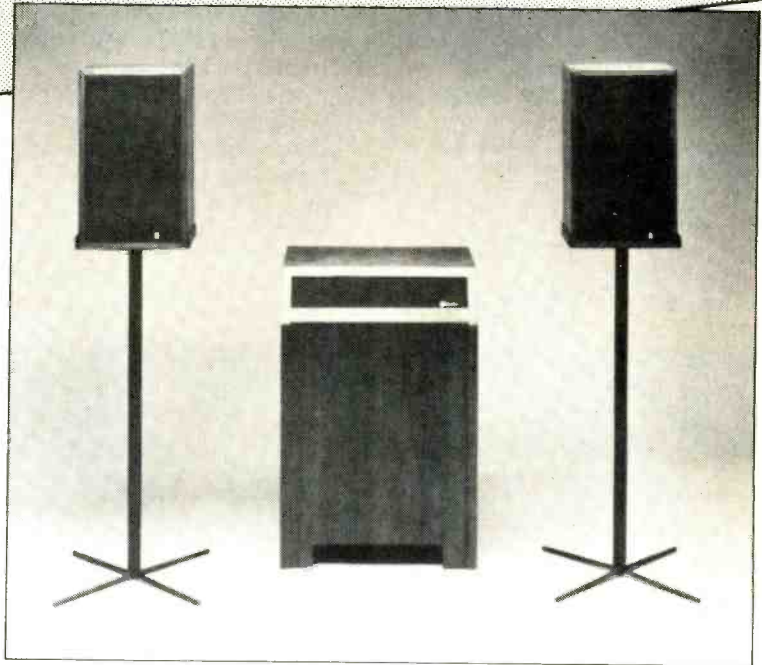
One of the other striking things about **The River** is that Springsteen must have achieved some sort of epiphany at the No Nukes Concert, as on some of the tunes here he actually sounds just like Jackson Browne (and likewise, Browne sounds much like Springsteen on *Hold On Holdout* from his most recent album), although the album does not contain the antinuke tune Springsteen wrote prior to the show. It would seem that he brought his Eddie Cochran records out of the closet before he wrote *I'm A Rocker* (a cross between *C'mon Everybody* and *Summertime Blues*, and, in general, there are a lot of songs here that were written to emulate the style featured on the Mitch Ryder medley (from the **No Nukes** soundtrack album). In the past, many of his cover tunes have stuck out like sore thumbs when jammed in between *Jungleland* and *Rosalita*; in the context of the songs found on **The River**, they fit in much more comfortably.

The question that arises, is: Just how good/great is Bruce Springsteen? Is he as great as John Lennon, John Fogerty, Smokey Robinson, Keith Richards, and/or Bob Dylan? On the basis of what he's released to date, I'd have to say no — strictly on the grounds that his innovations tend more toward cu-

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mulative synthesis than introspective catharsis. However, with **The River** (which smacks of being a concept album even though it probably isn't—hope), Bruce Springsteen has given us at least some flashes of how good he can be, and that, indeed, greatness is not that far away for him.

Jon & Sally Tiven

Sound: C+

Performance: A-

**Shandi**

**Dreamland DL-1-5001, stereo, \$7.98.**

Shandi's album is pure sex. Aggressive raw sex. If you take it tongue-in-

cheek it is one very funny album, however unintentional.

Shandi's band members are all L.A. pros; her producer is the hot Mike Chapman of Blondie/Knack fame. Dreamland Records is Chapman's latest toy and Shandi one of his first signings to the label.

Shandi sings her trashy, raunchy songs as if everything, but everything, depended on her. The album has no redeeming social value whatsoever, and that makes it my kind of toy. Worthless but fun. M.T.

Sound: C+

Performance: C+



**Solo in Soho: Philip Lynott**

**Warner Bros. BSK 3405, stereo, \$7.98.**

The main complaint about the last few Thin Lizzy albums has been their sameness, as if having every song sound almost exactly like *The Boys Are Back In Town* was a cardinal sin. The group's attitude was "why mess with success?" but unfortunately their attempts at duplicating the commercial viability of their first (and only) hit single didn't bring them any additional fans. So when making a radical departure, leader Phil Lynott is playing a safe bet by putting it under his own name rather than the group's, even though the musicians on the album are mostly current and former members of Thin Lizzy.

Of course, Thin Lizzy is primarily a vehicle for Lynott anyway; it's not as if he was the frustrated member of a group who had thousands of songs saved up and was suddenly out on his own. However, **Solo in Soho** embraces many different styles of music that Lizzy has steered clear of since their second LP, and for the most part the songs are of a quality above that on Lizzy LPs. There's the funky *Tattoo* (*Giving It All Up for Love*) which is extremely infectious and should by all rights be a big hit, *Yellow Pearl* co-written by and featuring the synthesizers of Mr. Midge Ure (ex-Rich Kids) exploring the Kraftwerk/Gary Numan territories, the heavily arranged ballad entitled *A Child's Lullaby*, the more than slightly reggaefied title track featuring Snowy White, the newest member of Thin Lizzy, and of course a host of rockers featuring the likes of Dire Straits supplying musical backing. All in all **Solo in Soho** is a very satisfying album from Thin Lizzy and friends, and we hope they'll be able to recreate many of these tunes live next time they tour.

Jon & Sally Tiven

Sound: A

Performance: A

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## AUDIO MAGAZINE QUOTES

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"performance level superior to (earlier test) ... worthwhile improvement in MRLs ... the best signal/noise ratio of all Type I tapes... significant improvement in tape skew... sensitivity and bias needs quite consistent... output level stability very good... a level of performance right among the best... the Tape 5 Wide-Latitude formulation represents good value overall."

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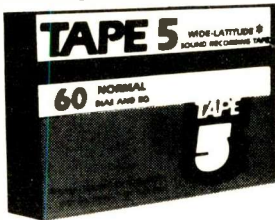
Sure the "establishment" tapes are good products, but why put up with dropouts, jams, and tangles? And why ruin a tape with fuzzy, rasping distortion during loud music? And why not be able to make a tape that sounds good in your car?

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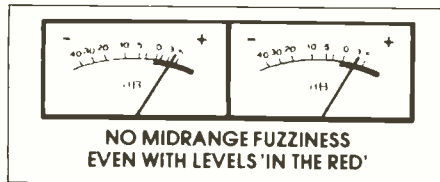


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## MUSICIANS, TAKE NOTE

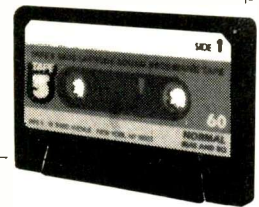
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**Sports Car: Judie Tzuke**  
MCA/Rocket PIG 3249, stereo, \$7.98.

The second Judie Tzuke (pronounced to rhyme with kook) shows promise similar to her first, *Stay With Me Till Dawn* (Rocket PIG 27001). Her songs written with Mike Paxman use textures not unlike those Elton John was using around *Madman Across the Water* time — those rounded, full sounds. *Sports Car* has diversity like the debut did.

Good as it is, the songs on the new album are just half a notch below those of *Stay With Me*. But I haven't let *Sports Car* get out of my slim pleasure music pile since it arrived. M.T.

Sound: B-      Performance: B-

**Deface the Music: Utopia**  
Bearsville BRK 3487, stereo, \$8.98.

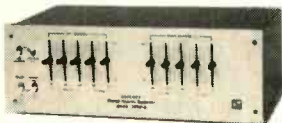
Todd Rundgren's productions have always had somewhat of a cartoonish ring to them, and the concept of defacing music is not foreign to him. On one of his own albums he featured a side of cover tunes that were only distinguishable from the originals by Todd's vocals and surreal production; with Meatloaf, Todd took the Phil Spector Sound and then Spruced (Brooced?) it up with even more overstatement, and on recent Utopia albums he's taken to a deliberate bastardization of the Boston sound. Still, *Deface the Music* is a surprise, as

74

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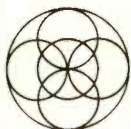
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Todd's famous for going forward while this album is a deliberate attempt at low fidelity to capture the sound and spirit of The Beatles in an unabashed and flattering way.

Todd's certainly got guts — he's letting himself in for all sorts of criticism with a project like this, as ostensibly it's guilty of the same crimes as Beatlemania or any of the groups that play around doing Fab Four covers. But the only danger that really exists in Todd & Co. doing a project so heavily in debt to another artist is that somehow it could diminish Utopia in the eyes of the public.

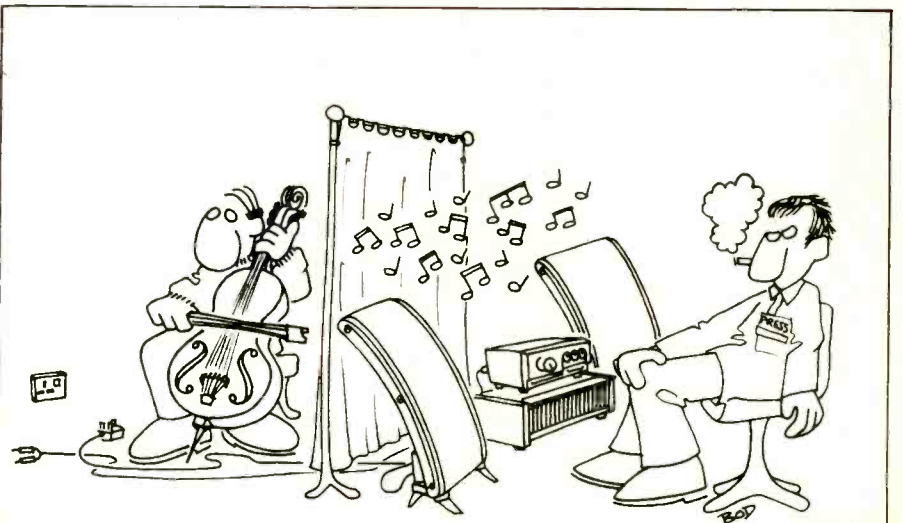
Utopia really hasn't found a strong enough aesthetic identity to allow this album (many other of their LPs) to type them. At first they were just a vehicle for Todd's songs, mutating into something approximating an American Yes. With the addition of bassist/ace songwriter Kasim Sultan they once again returned to more of a pop music framework, reaching astronomical aesthetic success with *Ra* and sort of treading water ever since.

Surprisingly enough, **Deface the Music** has allowed some of the group's best material to emerge in this somewhat strange presentation. The ballads are a bit hokey, but as Kasim always wanted to be Paul McCartney and Todd's had a strange love/hate relationship with John Lennon (they had a fight but later made up), the group's basic structure falls into place more comfortably than on any of their recent albums (Roger becomes George and Willie apes Ringo with no hesitations whatsoever). Side one of the record is primarily early Beatles rips (*She Loves You* and *Can't Buy Me Love*). Side two sends up the later recordings (*Eleanor Rigby* to *Getting Better*), and the treatments work. Utopia might well have hit single off this record, which I'm sure they wouldn't mind at all.

Recording a project like this doesn't surprise us given that Todd does have a studio at his disposal 24 hours a day, but releasing it under your own name gives us a little bit of the willies. If they put it out under the Prefab Four or The Liverpuds they might stand a chance of tickling the public's imagination — some might even buy it thinking it was a Beatle or two. Then again, Utopia's just perverse enough to go out and perform this stuff in Beatle wigs, so we'll just humor them for the moment and be happy that they picked a group as worthwhile as The Beatles to ape. Imagine if they'd done an album of Bee Gees productions. . . .

Jon & Sally Tiven

Sound: B (A-for 1968) Performance: B+



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original n: that from which a copy, reproduction or translation is made. (Webster's Collegiate Dictionary)



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# Jazz & blues



**We Insist — Freedom Now Suite: Max Roach**

**Columbia JC 36390, mono, \$7.98.**

**Pictures In a Frame: Max Roach**

**Soul Note 1003, stereo, \$9.98 (import).**

Few works have withstood the test of time and adversity as well as Max Roach's epic **We Insist! — Freedom Now Suite**. It has done this while being out of print for over a decade. Recorded in 1960, it has not aged either in philosophical/political content or musical intensity. **We Insist!** was a direct response to the growing black consciousness both in the United

States and Africa. Its urgency is derived from the first demonstrations by black students in February of 1960.

Collaborating with lyricist Oscar Brown, Jr., Roach created a conceptual piece that even today is as stark and vivid as it is hauntingly beautiful. From the opening tune, *Driva' Man* with its slashing whip and chain percussion, Roach takes you into a different reality. Abbey Lincoln's defiant vocal tells of life under slavery while Coleman Hawkins delivers a poignant tenor solo that is a classic of irrevocable anguish. *Freedom Day* provides a respite with

its driving rhythms, Lincoln's jubilant voice, and a sparkling solo from Booker Little's trumpet. But *Tryptich: Prayer/Protest/Peace* rips the glow away as Roach and Lincoln engage in a duet that ranges from the solemn gospel intro into an agonized and violent scream and finally resting.

As clear and sensual as Roach's arrangements are, his selection of musicians was extraordinary. On *All Africa* he uses the conga drums and percussion of Olatunji, Ray Mantilla and Tomas Vall, who along with Roach sound like an entire percussion ensemble. James Schenk's bass pulses with a primal earthiness that laces together the sustained horn section of Little, Watler Benton on tenor, and Julian Priester on trombone. The same personnel appear on the closing, *Tears for Johannesburg*, with all the horns taking crisp, probing solos that float across the vibrant polyrhythmic dervish created by the percussionists. Through it all, Lincoln's throaty horn-like voice brings added content and urgency without ever getting mired in cliched polemics.

It is probably unfair to review any record next to *We Insist!*, arguably one of the finest jazz albums ever recorded. While any record would pale against its visceral impact and lasting effects, *Pictures in a Frame*, one of a handful of Roach discs in the last decade, is especially inconsequential. With a fine group of young players, Roach coasts through several uninspired compositions with perfunctory performances. Saxophonist Odeon Pope has played better almost everywhere else, including with Roach. His solos remain within the limited dynamic confines of the composition with no attempts to stretch those boundaries. Cecil Bridgewater opens up some nice angles with his trumpet on the self-penned *Magic* but seems similarly constrained elsewhere.

Roach's drums are as sharp and multi-edged as ever, but his many solos on this disc show a distinct lack of context; he just places them in at will, as if they were pieces unto themselves.

*Pictures . . .* is not a bad record, but next to the standard of *We Insist!* it comes off as just another session.

*John Diliberto*

**We Insist!**

Sound: B Performance: A+

**Pictures in a Frame**

Sound: B Performance: C+

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**Undiscovered Masters: Red Garland**  
**Prestige P 24078, two discs, mono,**  
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This Garland collection from Prestige consists of previously unreleased sessions led by the Dallas-based pianist on June 27, 1958; August 12, 1959, and March 16, 1961. Sides one and two are with bassist Paul Chambers, drummer Art Taylor, and Latin percussionist Ray Barretto on congas. Side three contains trio selections with Doug Watkins, bass, and Specs Wright, drums. Side four is with a quintet that includes Richard Wil-

liams, trumpet; Oliver Nelson on tenor and alto; Peck Morrison, bass, and Charlie Persip, drums.

This doublet showcases the uniqueness of Garland's lilting, fluent style with its locked chords; fleet, single-note lines; rhapsodic, out-of-tempo introduction, and isolated, bell-like notes. He plays standards such as *Avalon* and *Soft Winds* and pop tunes like *A Tisket a Tasket* and *Mr. Wonderful* with imagination, taste, and an impeccable sense of Swing. His deft solos always have a graceful, melodic flow that fall easily and delightfully on the ears.



Rudy Van Gelder's superior engineering on the original dates produced vivid stereo sound that was recaptured in the remastering by David Turner in the Fantasy studios. *John Lissner*

Sound: A

Performance: A

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**Live at Eddie Condon's**  
**Chiaroscuro 167, mono, \$7.98.**

Record producer Hank O'Neal, a traditional jazz lover who owns the Chiaroscuro label, obtained these mono tapes from the late guitarist, who had them laying around his Greenwich Village apartment. While the sound is somewhat low-fi by today's standard, the playing is tremendous.

The music, recorded in 1960 at Condon's second New York City club on East 56th Street, focuses on vintage jazz standards. Tunes like *I Found a New Baby*, Fats Waller's *Stealin' Apples* and *Alligator Crawl*, *Up a Lazy River*, and *Runnin' Wild* are performed with the straight-from-the-shoulder, full-speed-ahead drive of a typical Condon ensemble. Personnel is made up of Condon; Peanuts Hucko, tenor sax and clarinet; Ralph Sutton, piano; Dante Montucci, bass and George Wettling, drums.

*I Found a New Baby*, *Stealin' Apples* and *Runnin' Wild* are steaming, propulsive swingers that will heat up your turntable. *Up a Lazy River* spotlights Hucko's exhilarating Goodman-like clarinet and Ralph Sutton's exuberant piano; Sutton's solo on *Alligator Crawl* is a jubilant excursion into the stride idiom, and Hucko switches to tenor for a warm, compelling solo on *Love's Got Me in a Lazy Mood*. **Live at Eddie Condon's** offers vibrant, timeless music; a very appealing album.

*John Lissner*

Sound: B

Performance: A+

**Zulu:** Randy Weston

**Milestone M-47045**, two discs, stereo, \$8.98.

Randy Weston is an important and innovative modern jazz pianist and one strongly influenced by Thelonious Monk. As intensely original as Monk, Weston is more of a swinger, and this remarkable collection of 20 tunes, packaged in a Milestone two-fer, consists of sessions recorded between 1954 and 1956. These were Weston's first recordings and reveal a strong, well-developed style. Sides one and two contain solos, duets and trios; sides three and four feature a quartet with Cecil Payne on baritone sax, Ahmed Abdul-Malik on bass, and Wilbert Hogan on drums.

The duets, with Sam Gill on bass, are interpretations (one might say reinterpretations) of Cole Porter tunes. I do not know if the late composer would appreciate Weston's reworking of *What is This Thing Called Love* but I found it quirky and fascinating. The five solo cuts of Weston originals are moody and melodramatic with the pianist juxtaposing stark dissonances and rich harmonies, alternating rhythmic with rubato passages, elegiac lyricism with thundering chordal bursts. On the trio cuts, Weston plays almost straight-ahead modern jazz piano in the lithe, looping post-bop Bud Powell groove. On the quartet sides, Weston's work is full of unexpected twists and turns. *The Man I Love* is exuberant, his interpretation of the Glenn Miller hit, *Serenade in Blue*, is evocative, and

*These Foolish Things* flowing and relaxed. An extra bonus is a recording of one of his best originals, *Little Niles*, a spirited and charming waltz. The excellent mono sound is an added plus.

John Lissner

Sound: A

Performance: A

**Skyscraper:** Scott Hamilton and Warren Vache

**Concord CJ-111**, stereo, \$7.98.

Tenor-man Scott Hamilton was brought up on his father's 78 rpm recordings of Coleman Hawkins, Choo Berry, and Lester Young. As a swing revivalist, Hamilton has attracted much attention with a style that attempts to combine the gutty sound of the Hawkins-Berry-Ben Webster school with Lester Young's light-colored tones and soft, dry textures.

On this Concord recording, and particularly on selections like Nat Pierce's *Do It In Blue*, the eight-piece ensemble plays with the mobile, springy rhythms reminiscent of '30s swing groups. Unfortunately, Hamilton's soloing often lacks the personal, robust

quality associated with the swing giants he idolizes. (He almost achieves the feeling on *Do It In Blue*, a crisp, catchy riff piece.)

More impressive is the aggressive, biting work of the neo-swing cornetist-flugelhornist Warren Vache, a player who improves with every recording. Pianist Pierce, in his buoyant Basie bag, is excellent, offering the elasticity and simplicity of the Count's keyboard approach, romping through numbers like *Nancy's Fancy* and *Lightly and Politely*. Trombonist George Masso has some good barrelhouse

breaks, and guitarist Chris Flory swings hard, offering rhythmic variety and contrast. Ellington tenor veteran Harold Ashby is also aboard, and, although he takes no solos, he contributes an authentic voice to the ensemble expressiveness that is heard throughout a pleasant album aimed at those who relish the sound of the Swing Era.

I like Concord's stereo sonics which are exceptionally clean and beautifully balanced.

John Lissner

Sound: A+

Performance: B

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In this series we are discussing the various aspects of preamplifier performance which vitally affect the overall sound of your high-fidelity music system.

The fifth of these is volume-control circuit dynamic range. Previous designs have customarily used a volume-control attenuator ahead of a line amplifier. In this arrangement, the preamp's output noise is fixed at the level of the shorted-input noise of the amplifier plus the noise contribution which occurs due to the impedance of the volume control at various settings in its' range (even a resistor just sitting at room temperature exhibits noise: this is called Johnson noise and is related to Brownian motion). One previous attempt to solve this problem has been to include extra sections of the control right at the output of the preamp, but this leads to changes in output impedance as the output level is varied.

The Apt/Holman Preamplifier, on the other hand, uses the volume control in a unique circuit configuration, so as the control is turned down, the actual *gain* of the high-level stage is lowered. The result is that while the noise is the same as the best other designs with the volume control all the way up, the noise is less at the settings where the control is usually used. This occurs because the noise is reduced along with the signal as the gain is turned down, and the dynamic range is enhanced over other designs for the typical condition.

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# Classical reviews

Edward Tatnall  
Canby



**Mozart: Don Giovanni.** Price, Sass, Popp, Burrows, Weikl et al.; London Philharmonic Orch., Opera Chorus, Solti; **Eleven Concert Arias for Bass and Orch.** Various performers. **Time-Life Records**, Vol. 4, five discs, stereo, \$24.95. (Mail order: 541 North Fairbanks Court, Chicago, Ill. 60611.)

**Mozart: The Middle Piano Concertos.** Various performers, orchestras. **Time-Life Records**, Vol. 5 (same as above).

This is the most recent manifestation of a phenomenon in the record biz that goes back and back, as you will have noted over the years in a thou-

sand and one ads. The idea is first cousin to the record club in more ways than one, and, however portentous the promotion, is good for just one thing — to bring you a lot of music at a low price, relatively. Once in a blue moon, these offerings are new recordings; more often, as here, they are proprietary reissues from a major label, in this case London (i.e. English Decca), reassembled, relabelled, possibly recut and certainly repressed on presumably newer, more up-to-date equipment. In other words, if all is done well, they could be an improve-



ment over the originals, at a lower price. There could even be minor differences in the actual musical material, from different takes, etc. — I will not go into that. Also perhaps in the cutting of new masters and/or use of different generations of master tape, and/or stampers.

The original London *Don Giovanni*, for instance, is still listed in current Schwann (along with nine or ten other available versions); it will cost you, list, around \$36, four records, minus the fifth disc, of arias for bass and orchestra that comes from Time-Life. Since more than half of these are by the excellent Dietrich Fischer-Dieskau, it is a good bonus. Make your own comparisons at your record store — but don't forget the Time-Life shipping and handling charge. These babies are heavy.

At least, *Don Giovanni* is a single performance, by one cast and orchestra and conductor! The Mozart concerti are played by a bewildering array of different pianists, orchestras, conductors, too many even to list, let alone review. This type of collection is not designed for critical connoisseurs who

pick and choose. I tried the first few sides of *Don Giovanni* before I had to stop to write — I was definitely pleased. Under Sir Georg Solti, this cast of notables gets into the opera's immensely sophisticated portrayals of the amoral Don and his partner, versus variously high-minded ladies and their swains who are his victims, and the music moves along with lively drama and style. It isn't always that way, even with top celebrity casts.

As for the ten "middle" concerti, starting with very early works (since the first of the list were arrangements of other music), I got as far as the first two, same performers, and was delighted: A noticeably fresh and limber small orchestra playing youthfully spirited music in just the right way and a piano more or less to match. Not a single word on the outside about performers. But they are all famous or reasonably celebrated, which guarantees you at least an authoritative sound throughout, as of the big time. That's the idea.

Sound: B Recording: B+ Surfaces: B-



**Tomita — Bolero. (Ravel: Bolero; Mother Goose Suite; Daphnis and Chloe Suite No. 2, Pavan.) RCA ARL 1 3412, stereo; also CRD13412 CD-4, quadrasonic, \$8.98.**

There are two versions of this, stereo and CD-4. Take your choice, but be warned that whereas the stereo version has annotations in English, the CD-4 disc came all-Japanese — two pages of characters.

Tomita, the great synthesizer man, is "back" — from incursions into various space sounds back to his original love — the Impressionist music of French composers Debussy and Ravel. His transcriptions are now even more elaborate (by far!) and much more opulent. Shades of Leopold Stokowski in his palmy days!

Such a tasteless, gloppy mess I've never heard. It'll sell, as all Tomita

does, so don't believe me if you do not wish to. Tomita (for my ear) just piles it on, via an enormous array of synthesizing machinery including seven tape recorders on two to 16 tracks; three families of synthesizers, Moog, Roland and Yamaha; a Vocoder, 9 mixers and more (see list on record jacket). The man is a mixing genius, no question about it, but the emerging stuff — I've been trying to think of an adequate analogy to give you the flavor. OK, take two fried eggs and pour on a cupful of honey, add six oysters, two cherries, a jigger of gin, and sprinkle with Ajax cleanser. That ought to do it.

Some of the sonic effects, of course, are lovely and even arresting. Grant you that. But many others are merely crude, stultifying. And the hideous bath of reverb that engulfs everything

# 5

Series 2, Number 5

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is enough to make any Ravel lover groan. Of all recent Western composers, Ravel was the most fastidious and delicate in his music, even including *Bolero* and *La Valse*. In *Bolero*, that incredible slow buildup of orchestral tension, the hypnotic repetition, ever more insistent and pounding, than the fantastic sudden change of key at the end which has made the skin crawl on millions of listeners — Tomita doesn't even bother with it! His ending just tape-spirals upwards faster and faster, by now a tired old effect, and then fades out, another killer-diller for boredom.

As for that masterpiece of disciplined understatement, *Mother Goose*, it simply wallows in glutinous gloppitude via Tomita — made me sick. Go ahead — you'll probably love it if the charts are right.

Didn't try the CD-4 version but pause only to note with some astonishment how CD-4 keeps plugging along, though the source is in Japan now, where it all started. If you have a CD-4 demodulator, here's something new for it.

**Beethoven: Symphony No. 4.** Berlin Philharmonic, Jochum (1961). **Quintessence PMC-7139**, stereo, \$5.98.

The Quintessence label is a new one dealing with an old need: Reissues at reasonable cost of available past recordings not now on the market. All the advantages of remastering and newer pressing are inherent and, unless somebody is getting away with murder, very worthwhile for the musical record collector. Things are OK here. The 1961 Berlin sound is in good German fashion very acceptable, if a bit on the tubby side (at least in this product). The performance of the ever-elusive *Fourth* is excellent, one of the best.

Curiously, the notes speak much of the sly humor of the work; that may be true of the *Second*, but I have never found this one other than a marvelously lyric piece, almost gentle for Beethoven in spite of typical outbursts here and there — and Eugen Jochum must have felt the same. It is that sort of performance.

The side-filling dividend is a good one, not the usual *3rd* but the prototype *2nd Leonora Overture* — same music in a first draft, full of genius but weightier, less intense, more cumbersome. If you know the *3rd* and have never heard the *2nd*, you should find it quite astonishing. (The "first" of the *Leonora* overtures is an entirely different piece.)

Sound: B- Recording: B Surfaces: A-

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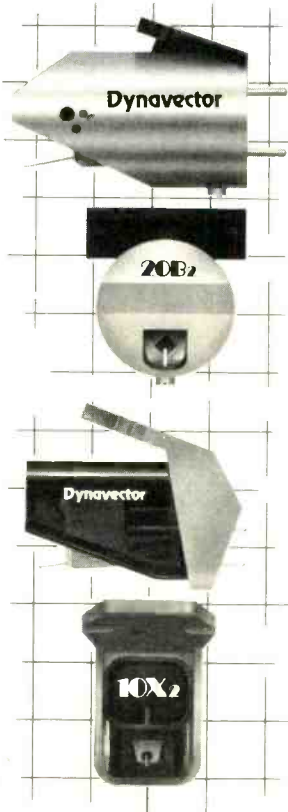
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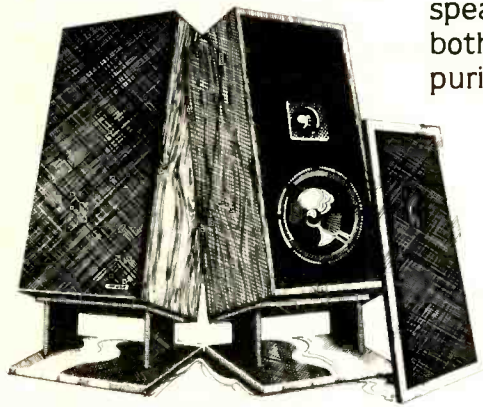
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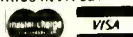
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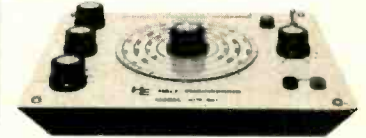
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**THE ABSOLUTE SOUND**, in its December issue, ventures a look at the \$20,000 Infinity IRS system, at the \$2,000 straight-line tracking Goldmund arm from France, at a tube/transistor hybrid amp from Audioics (the BA-150), at the brouhaha over speaker cables (with some specific recommendations) in a massive cable report, at the amp-less and rather different Acoustat II, at the new version of the Conrad-Johnson preamp, and a good deal more. Doug Sax, who cuts 20 percent of America's master discs, gives you the technical low-down on digital, namely, some of the things its promoters aren't telling you. The debate over Dr. John Diamond's controversial assertions (that digital recordings induce stress) flares anew. You will also be able to read reviews of the latest Telarc discs (a Rite of Spring and a Bolero), some of the newest audiophile recordings, and about some dubious values in re-mastered super discs. We now publish four issues annually at \$20, a last-time price (by the way). You may, if you have VISA or Master Charge, call us Monday-Friday at 516-671-6342 (10-5 ET) or send a check to The Absolute Sound, Box L, Drawer A, Sea Cliff, New York, 11579.

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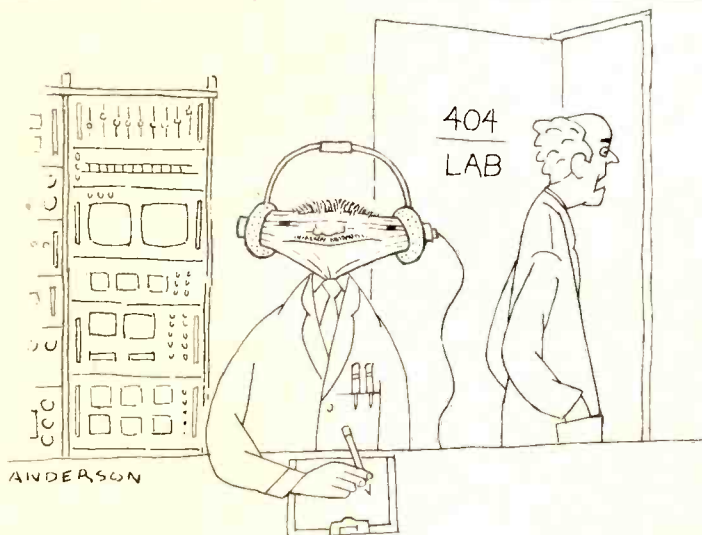
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"BYRNES! GEIGER! I THINK WE'RE GETTING  
SOME DATA ON LISTENER FATIGUE!"

# Video Scenes

Bert Whyte

It is hardly news that the laser/optical videodisc of Philips, the groove/capacitance disc of RCA, and the grooveless/capacitance disc of JVC are not compatible with each other. Nor does there seem to be even the most remote possibility at present that any sort of truce between the competing companies is likely to result in a standard videodisc format. Each of the companies has committed millions of dollars, and each confidently predicts that the superior virtues of its system will prove itself in the marketplace and become the videodisc standard. I have noted these facts previously, and as we head into 1981, this situation remains unchanged.

The first quarter of 1981 is the stated target date for the introduction of the RCA SelectaVision videodisc, and the JVC UHD videodisc may appear in the fall of 1981. Thus, 1981 would appear to be the year in which the battle lines for the competing systems will be drawn.

If the old adage "firstest with the mostest" continues to be a prime factor in marketing, then clearly the laser videodisc has made significant progress in the drive to become the standard format. Magnavision, from Magnavox, was first on the market in 1978, followed by the Pioneer LaserDisc in 1979. Both of these systems, compatible with each other and produced under the Philips laser/optical videodisc license, were test-marketed in a limited group of cities. As of January, 1981, both systems will approach national distribution. While merchandising giants like Sears and J.C. Penney have opted for the RCA SelectaVision system, the fact remains that the only videodiscs John Q. Public could view — and buy — were of the laser/optical variety. Even when the

RCA and JVC videodiscs arrive on the market, there is no doubt that many people will still be fascinated by the idea of a device that uses a laser beam. It is probably equated in their minds with some sort of glamorous futuristic outer-space high technology.

While the laser/optical videodisc obviously won the race to the marketplace, no new technology is without its teething troubles. As I have ex-

plained in previous columns, all Philips licensees have their videodiscs manufactured by DiscoVision Associates. Rumors have persisted for some time that the reject-rate on the laser discs for the Magnavision players was very high. Understandably not wanting to acknowledge problems with this new technology, the stories were denied. Apparently there was indeed trouble with the laser discs and possibly with the playback unit as well. Finally admitting to this, the Magnavision folks announced a "reorganization" and updating of DiscoVision's replicating technology would be undertaken, and some modification to the player might be forthcoming.

I am currently testing a Pioneer laser

videodisc system and will be giving you a full report on my findings. In the meanwhile, since the Pioneer unit is compatible with the Magnavision player, I have checked some of the videodiscs supplied for the Magnavision system. (This is merely a question of marketing — the discs all come from DiscoVision and Magnavision was first on the market.)

The results I obtained from playback of these laser discs was disconcerting, to say the least. Frequent glitches occurred in the form of momentary loss of part of the signal information. This manifests itself in a "twisting" distortion of the image on the TV screen, a color picture that turns to black and white, and a complete absence of sound! The worst part is that these glitches can appear in brief repetitive sequences, a sort of "stuttering," with dozens of them visible and lasting anywhere from two or three seconds up to 15 or 20 seconds. I have checked with several friends who have laser/optical players, and they confirmed they had

found the same sort of problems I had, and had also encountered other picture anomalies — such as wavy horizontal lines across the TV screen.

The infuriating thing about these glitches is that they might appear in profusion on one side of a laser disc, while the other side would have just an occasional one or none at all! Obviously, this sort of problem must be corrected if the laser disc is going to be a thoroughly viable product. I have no idea what revisions in replicating techniques will be undertaken by DVA, but perhaps a new development will be helpful.

The 3M Company has vast experience in the manufacture of such high-quality products as recording tape. It

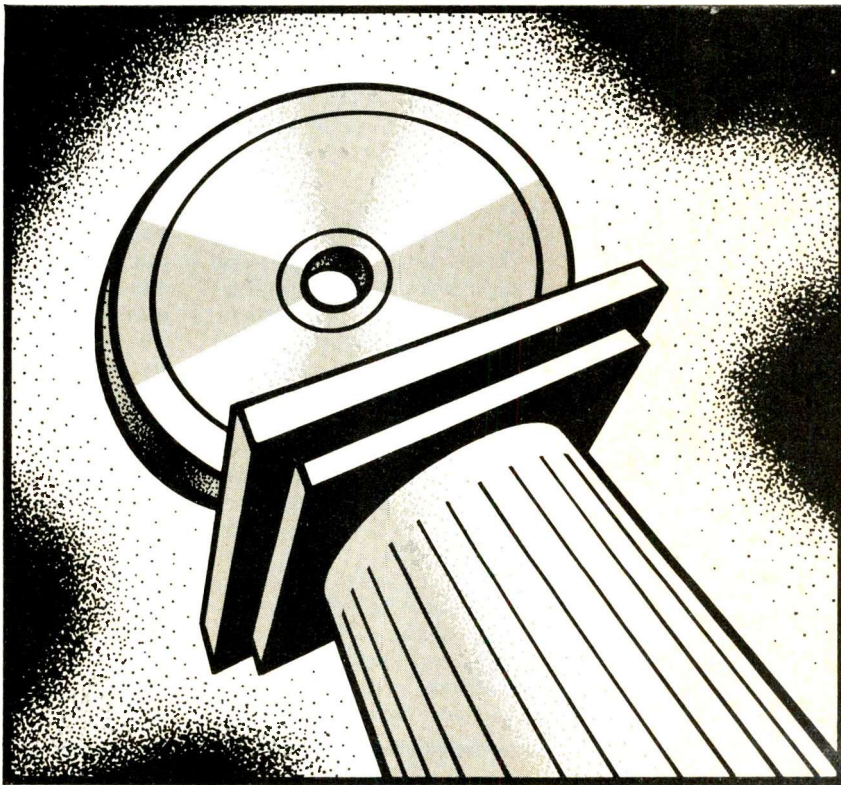


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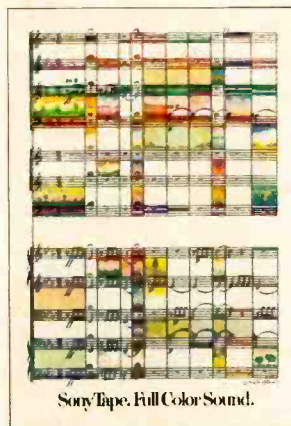
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Pioneer's VP-1000 LaserDisc player.

seems 3M was also involved in an early effort in producing a videodisc back in 1961. With their expertise in coating technology, a photographic storage technique for videodiscs was envisioned. In September 1980, 3M signed a nonexclusive agreement with North American Philips to set up a mastering and replication plant for the laser/optical videodiscs in the St. Paul/Minneapolis area. Perhaps forewarned by DiscoVision's experience, it is expected that the entire plant will operate under "clean room" conditions. This plant is to manufacture the reflective type of laser disc for Magnavox/Pioneer, and under a separate agreement with Thomson/CSF will also produce transmissive video discs. These latter discs, slated for industrial use only, should be available now, while reflective laser discs for the consumer market are expected to come on-stream by the third quarter of 1981. This new 3M facility should go a long way toward

making the laser videodisc a high-quality and reliable product.

After my disappointing experience with the Magnavision discs, I subsequently obtained four movie productions from DiscoVision, but this time through the auspices of Pioneer. I was not able to substantiate a report that, although these videodiscs were replicated by DiscoVision, the masters for the productions were laser cut in Japan. In any case, my experience with these DiscoVision/Pioneer laser discs was completely opposite to that with the Magnavision discs. Throughout the playback of all four movies, not a single glitch was encountered. In a word, they were flawless! I don't know whether the purportedly Japanese mastering had anything to do with this, if DiscoVision cleaned up its act, or if it was a combination of these factors. But the quality was extremely good, and one can only hope that this will become the norm. **A**

## Flash—Flash—Flash

Matsushita Electric Industrial Co., Victor Company of Japan, Thorn EMI, and General Electric have formally announced the establishment of three jointly owned companies to launch the VHD (video high density) videodisc system in the U.S. by the end of this year. The three firms will specialize; VHD Programs for program distribution and artistic production, VHD Electronics for player manufacture, and VHD Disc Manufacture for production of the grooveless, capacitance-type discs.

System features will include fast and slow motion, fast forward and reverse, stop mode, and random access, using a 10.2-inch disc with one-hour playing

time on each side. The initial VHD library is expected to include some 160 current, all-time favorite, and future theatrical motion pictures, and negotiations are underway with Twentieth-Century Fox, Warner Home Video, Columbia, MGM/CBS, Walt Disney Productions, Filmways, and Time-Life Films. In addition, some 40 special-interest subjects are planned, with a heavy emphasis on music, fully utilizing the system's capability for stereo playback.

Thorn EMI will have responsibility for the management of the businesses, and other Japanese firms supporting the system include Toshiba, NEC, Sharp, and Yamaha.



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# Behind the scenes

Bert Whyte

It is an article of faith in the world of audio that as the quality of a high-fidelity component system improves, the reproduced sound increasingly reveals a higher degree of fidelity to the sound of the original performance. Unfortunately, it is equally revealing of the flaws and technical shortcomings of the various storage mediums used for playback of recorded music. While prerecorded open-reel and cassette tapes have their devotees, the phonograph record continues to be the principal program source for music.

Whether an audio component system is very modest or the most expensive assemblage of audiophile exotica imaginable, the owners of these systems share a common complaint: They are outraged by the poor quality of a very high percentage of current phonograph records. They must cope with physical deformities of the record — pinch warp, dish warp, and combinations thereof.

Surface noise is, of course, the most irritating factor in the playback of phonograph records. Noise can be of an intermittent nature, such as ticks and pops, or of cyclic character, such as swishes and thumps. Then there is generalized steady-state noise such as hiss, crackles, graininess, and frying as well as low-frequency rumble-type noises. These can all arise in many areas of phonograph record manufacturing.

In the cutting of the master lacquer, low-frequency noise caused by rumble inherent in the cutting lathe is quite rare — but it can happen. As the cutting stylus cuts a record groove, a “thread” of the acetate lacquer compound is displaced. This “chip,” as it is called professionally, is removed from the groove by a vacuum suction tube

mounted very close to the cutting stylus. The angle at which the chip is removed and the speed of its removal can have an effect on the noise level of the lacquer.

The electroplating of the lacquer is a much more complex process than is generally realized, and there are many ways in which noise can be generated during this stage. The degreasing agent used to clean the master lacquer can

plow moves through earth. These are called horns, and the manner in which they are removed from the stamper also affects noise.

In the record pressing itself, there are many aspects which can generate noise. The vinyl record compound is singularly important, and while you see many record jackets stating the record is made from “pure virgin vinyl,” there really is no such thing. In

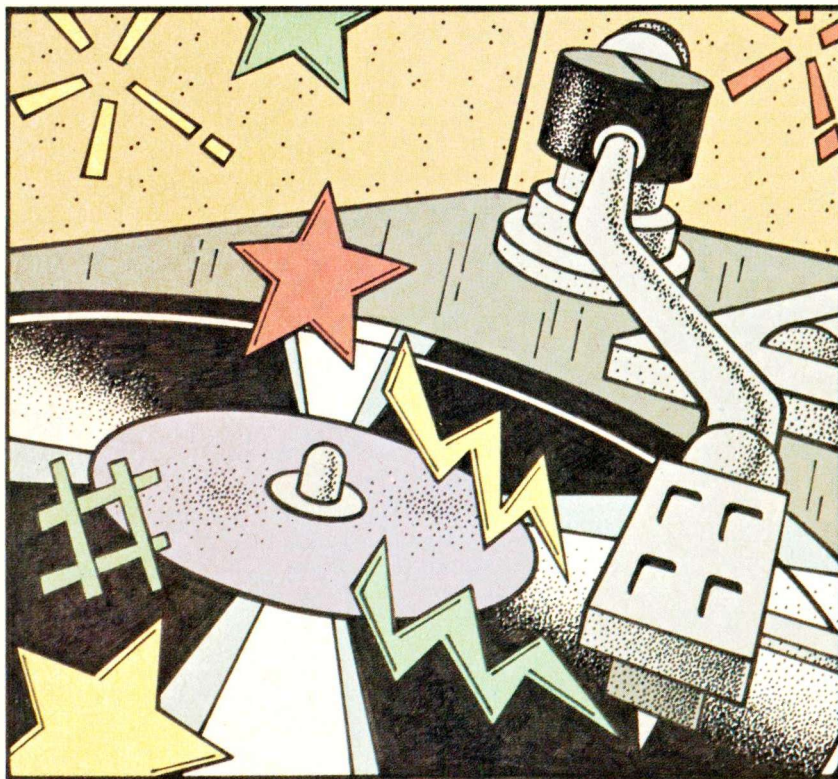
particularly gross cases, the pressing compound is a mixture of new vinyl plus various percentages of vinyl reprocessed from old records — returns from dealers, overruns, etc. — which are ground up, label and all, filtered to a certain degree and reused. In some justification of the “virgin” designation, some records are pressed from all new vinyl powder, but they also contain many ingredients such as lubricants (lead stearate), stabilizers, plasticizers, and sometimes antistatic agents. It is sad to relate that although one company has had an effective antistatic chemical for years, their

patent is about to expire. The agent has never been used since it would have added a half-cent to the cost of a record!

The duration of the pressing cycle can be a determining factor in both noise production and in the physical characteristics of a disc. There are other factors, too numerous to mention here, in the manufacture of phonograph records that can affect the ultimate quality of the record.

## Foreign Finds

For some years now, a number of audiophiles have bought the original foreign editions of classical recordings rather than our domestic pressings of the same recordings. For example, they



be a factor, and the type and quality of water and degree of filtration are also important. The type of silvering solution and its mode of application to the lacquer can affect noise, as can the amount of current and the speed of metal deposition in the initial plating, the manner in which the plated father is separated from the master lacquer, and the speed and type of plating used to grow the mother. The manner in which the backs of record stampers are ground may determine whether mold grain will be produced, which causes a low-frequency noise akin to rumble. When a lacquer is cut, the cutting stylus throws up tiny splashes of lacquer compound on each side of the record groove, much in the way a

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When speaking of the OTS (Optimum Tuning System), an easy-to-use Yamaha feature that automatically locks in the exact center of the tuned channel—for the lowest possible distortion, Stereo Review said, "The muting and OTS systems operated flawlessly."

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And there's more. Like the REC OUT/INPUT SELECT feature. These separate controls allow you to record from one program source while listening to another program source. All without disturbing the recording process. Stereo Review's comment was, "...the tape-recording functions of the CR-840 are virtually independent of its receiving functions." One could not ask for greater flexibility.

In summing up their reaction to the CR-840, Stereo Review said, "Suffice it to say that they [Yamaha] make it possible for a

moderate-price receiver to provide performance that would have been unimaginable only a short time ago."

And the CR-840 is only one example in Yamaha's fine line of receivers. For instance, High Fidelity magazine's comment about the Yamaha CR-640 receiver: "From what we've seen, the Yamaha CR-640 is unique in its price range."

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Now that you've listened to what the three leading audio magazines had to say about Yamaha receivers, why not listen for yourself? Your Yamaha Audio Specialty Dealer is listed in the Yellow Pages.



To obtain the complete test report on each of these receivers, write: Yamaha International Corp., Audio Division, P.O. Box 6600, Buena Park, CA 90622.

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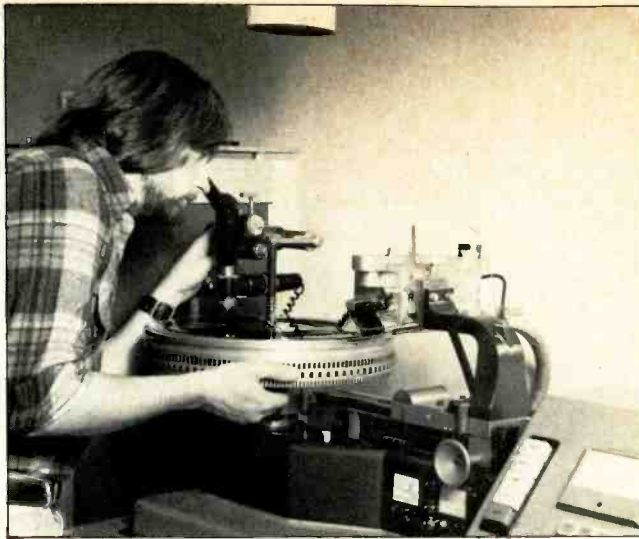
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A technician at Sterling Sound Studios in New York checks a master lacquer which he has cut for the Franklin Mint series.



would buy EMI records from England instead of pressings made by Angel Records in this country. Their reasoning was that the foreign pressings were of far better quality. This was amusing to some people, since many audiophiles abroad complained about the quality of recordings made in their country!

It can be fairly stated that the recent phenomenon of audiophile quality recordings had its genesis in the general dissatisfaction with domestic record pressings. By this time, most audiophiles know that the German company Teldec manufactures the records for many of the audio specialty record labels. Telarc and Crystal Clear are two companies that use the Teldec services. In general, the Teldec pressings are a considerable improvement over anything domestically available. Nonetheless, I have found their quality to vary in certain aspects. Some recordings are really first-class: Low in overall noise, few ticks and pops, and minimal warp problems. Others exhibit crackling noises and dish warp.

Mobile Fidelity pressings are made by JVC in Japan. Using very high quality CD-4 vinyl and obviously exercising great quality control over all the processing stages, the Mobile Fidelity pressings are the most nearly perfect I have ever encountered. It is not uncommon to play a whole side without a single tick or pop, and steady-state noises are usually not present. Their silent surfaces are eloquent testimonials to the fact that such records can be made, albeit at a higher cost per unit.

Is there any hope that such splendid pressings can be made in this country? Perhaps more to the point, can such good pressings be made consistently? Surprisingly, the answer is yes. I'm sure

most people have seen advertisements from the Franklin Mint in Pennsylvania. As well as manufacturing very high quality commemorative coins and medallions, they have been offering a wide variety of objets d'art. Commemorative or artistic porcelain plates and bird and animal figurines, and similar items are their specialty. Now they are offering classical recordings, such series as *The 100 Greatest Recordings of All Time* (surely an ambitious title and certainly subject to argument). Most of the music is leased from the major record companies; some of the material is on the old side, while other recordings are comparatively recent. It is how they manufacture their records which is of interest. Master lacquers are usually cut from the master tapes by Sterling Sound in New York. The lacquers are sent to Presswell Records in Ancora, New Jersey. Presswell then does the vitally important electroplating.

### Pressing Matters

In the electroplating process, Presswell uses many proprietary techniques to ensure high quality. For example, the water used is both deionized and distilled with triple-state filtration capturing particles down to a size of one micron. Initial electroplating is at low current level and slow deposition speed to ensure fine-grained metal plating. A special method of burnishing the backs of stampers is used to help reduce low-frequency mold grain problems. In most record plants, dehorning the stamper is accomplished by clamping the stamper to a special turntable, and, while the stamper is revolving, applying fine-grade jeweler's rouge with a pad and a certain amount of physical pressure.





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### 2. The programmable 16-station memory.

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*In conjunction with listening tests, Presswell Records clean room personnel check discs at regular points in the pressing run.*



Presswell feels that no matter how carefully this is done or how thoroughly the stamper is rinsed with water, there is often residual particulate material remaining on the stamper which causes noise.

Presswell does not use this method of dehorning, and instead uses a proprietary method that does not generate noise. Curiously, Mobile Fidelity Records insists that their stampers not be dehorned. They claim that to do so attenuates high-frequency response. Mobile Fidelity states that the first several playbacks of their records will have a certain amount of noise, but the burnishing action of the playback stylus will effectively dehorn the record so that subsequent playback will be from the quiet surfaces for which the label is noted.

At Presswell, a special clean room has been set up to press Franklin Mint records. The room is equipped with LENED automatic record presses, electronic dust precipitators, and has positive outward air pressure. All clean room personnel wear antidust gowns, head caps, gloves and shoe coverings. The Franklin Mint pressing compound is a very high purity vinyl containing an antistatic agent. A special dye gives their records a distinctive opaque burgundy color, and they weigh about 150 grams each, about the same as high-quality audiophile records. The pressing cycle is of the so-called "symphonic" variety with longer heating and cooling times to minimize problems of "non-fill." This is a condition in which the record grooves are not molded properly. The LENED presses automatically remove the flash — excess vinyl squeezed out of the press by heat and pressure — and automatically stack the records on spindles. This avoids

pinch warp and produces records which are quite flat. After every 50 pressings, the records are given an audio playback check. The results of all this care with Franklin Mint records are gratifying. Surfaces exhibit few ticks and pops, and steady-state noise is rarely encountered.

Equally encouraging is the record quality offered by Presswell in its regular pressing facilities. They use the same electroplating techniques and the same LENED automatic presses. They have been pressing the records for the London/Decca *Treasury Series* and for such special items as Luciano Pavarotti's *O Solo Mio* album. These discs are pressed at 120-gram weight, still quite a bit more than the common 95- to 105-gram variety. Pressed with a modified symphonic cycle, the examples I have played were quite satisfactory. The records were reasonably flat, few ticks and pops intruded, and cyclic and steady-state noises were either minimal or inaudible. I would have to say that these Presswell records were certainly the equal of most Teldec pressings and, in some cases, superior to them.

As you can see, there are many things that can go wrong in the production of a pressing, but it is gratifying to know that the foreign manufacturers do not have a complete monopoly on the production of high-quality pressings. While they are not as common as one would like, they can be had. ▲

*The plating operation for the Franklin Mint records is at Presswell Records in Ancora, New Jersey.*



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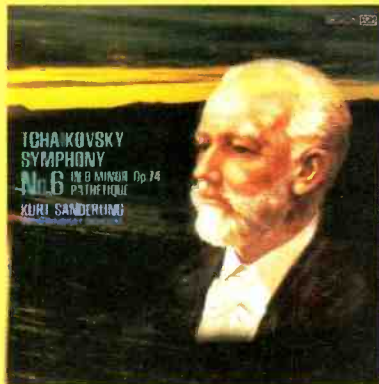
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# DISCWASHER® AUDIO SCIENCE™ SERIES

## Record Care, Part 1:

# Aqueous Cleaning vs. Organic Solvents

Electron microscopy (Figure 1) shows the principal cause of record wear: small particles of microdust, deposited from the air by gravity, are ground along the record groove by the stylus. Surface noise goes up. Sound quality goes down.



Figure 1

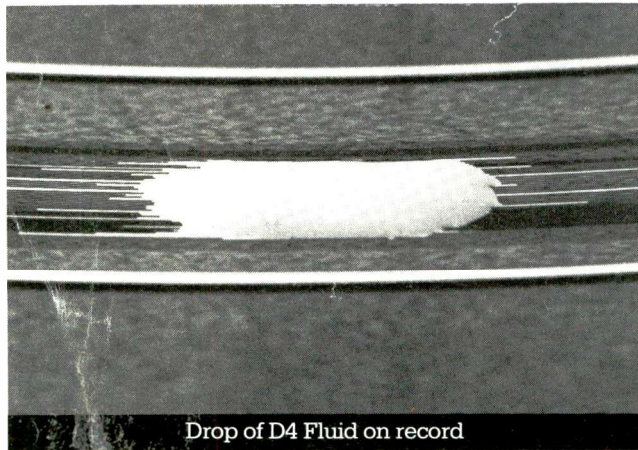


Figure 2

Figure 2 shows a drop of the aqueous Discwasher D4 Fluid, literally lifting dust and contamination out of record grooves. The extraordinarily complex D4 Fluid uses water pure enough for kidney dialysis, along with eleven chemically engineered additives that still results in lower dry-weight residue than most tap water. This formula is amazingly high in cleaning activity, uniquely safe for vinyl and vinyl additives, and preferentially "carries" contamination into the new Discwasher D4 pad.

In some record care products, organic solvents are used rather than water. Organic solvents such as ozone-gobbling chlorofluorocarbons, petroleum distillates (hexane, heptane) and alcohol concentrates are indeed speedy extractors and delivery solvents. They evaporate fast. Some organic solvents can dissolve vinyl stabilizers. Organic solvents may leave a "slick" looking record by treating the disc with other compounds carried in the solvent mix. In doing so, record contamination may also be dried back onto the disc in a nice even layer. Dust is often "held" to the record surface by "treatment."

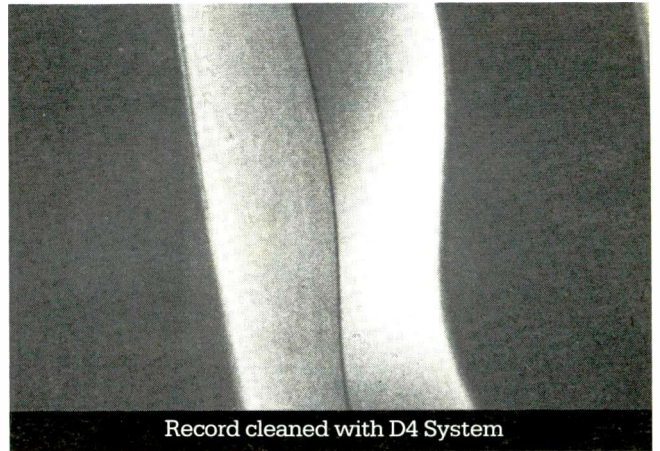
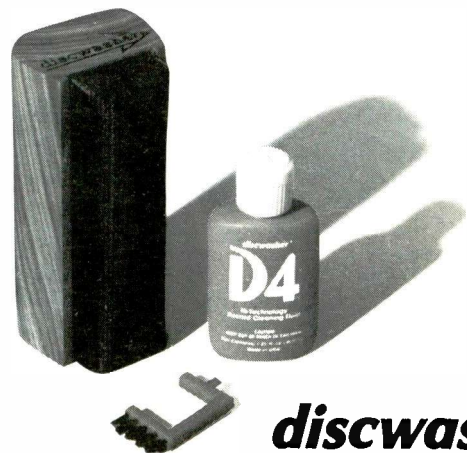


Figure 3

Electron micrograph (Figure 3) shows a record cleaned with the Discwasher D4 System. High technology record care leaves only a clean surface.



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