

The
Authoritative
Magazine
About
High Fidelity

Audio



**Mac's New 117
Tuner/Preamp
EXCLUSIVE TEST**

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**ARE RADIAL-
TRACKING
TONEARMS
REALLY BETTER?**

**GET THE
MOST SOUND
FROM 78's**

NEW
**ONE-BRAND
SYSTEM**
MINI-REVIEWS—
SANSUPS 6600
SUPER COMPO

REVIEWED
HITACHI
**DIGITAL AUDIO
RECORDER**
KENWOOD
KX-900
**CASSETTE
DECK**
MISSION 776
PREAMP



LINEAR TRACKING THE TURNTABLE

The linear tracking tonearm is without question the ideal way to recover information from a disc. It can virtually reduce horizontal tracking error to zero, eliminate crossmodulation and significantly minimize stylus and record wear.

But until now there hasn't been a linear tracking turntable whose overall performance truly measured up to the technology of linear tracking itself.

Pioneer's new PL-L800 has changed all of that.

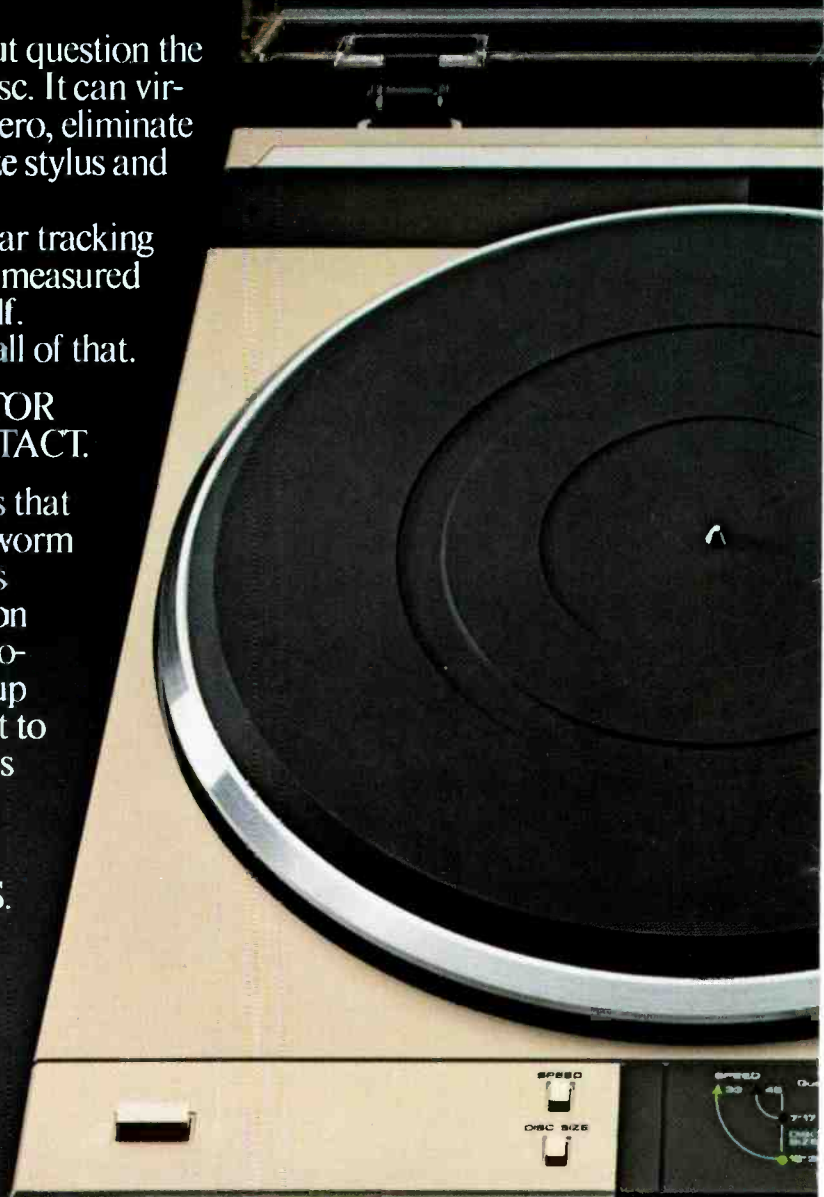
THE LINEAR INDUCTION MOTOR ELIMINATES MECHANICAL CONTACT.

Unlike other linear tracking tonearms that are driven by vibration-producing rollers, worm screws or pulleys, the PL-L800's tonearm is driven by Pioneer's exclusive linear induction motor. Through a process known as electro-magnetic repulsion, a magnetic field is set up that gently propels the tonearm, allowing it to track perfectly with no mechanical linkages to degrade performance.

THE POLYMER GRAPHITE™ TONEARM DAMPENS VIBRATIONS.

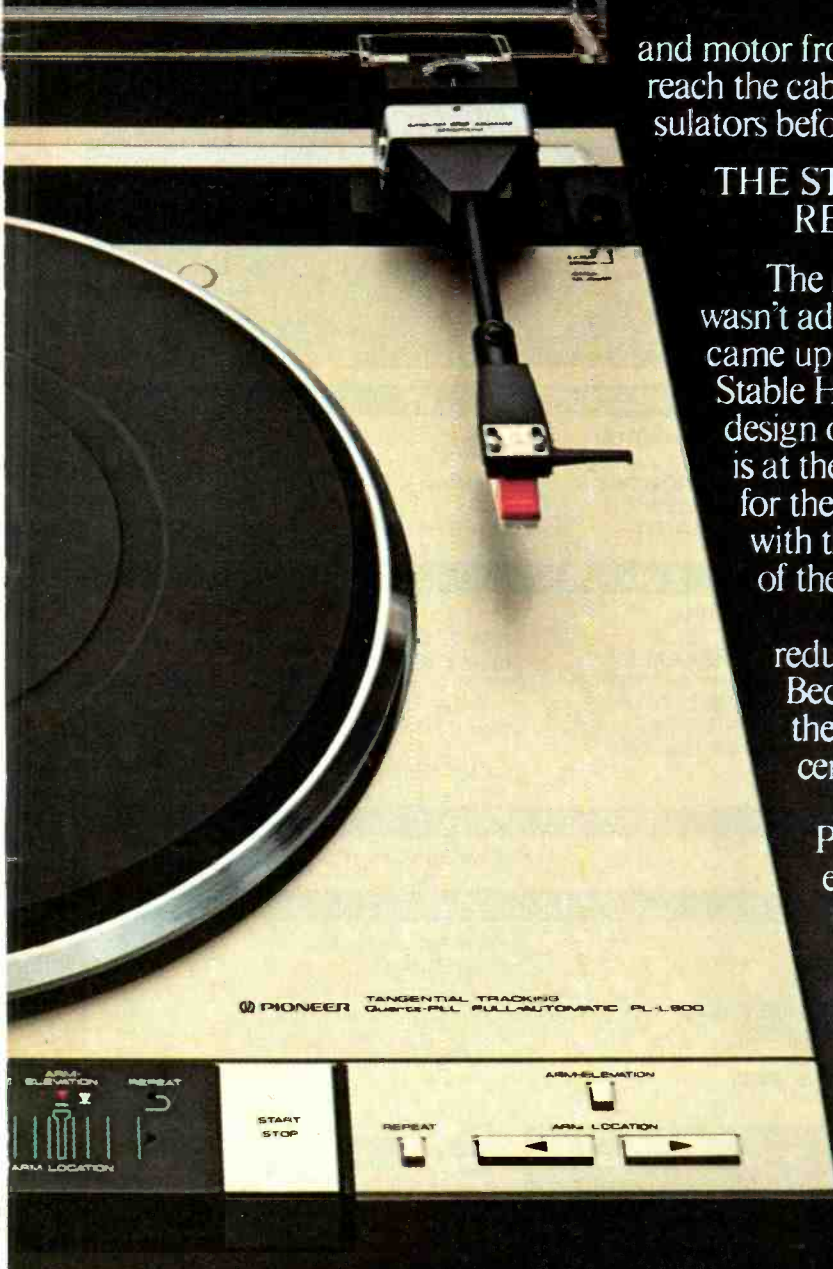
To minimize any tonearm resonance caused by acoustic vibrations, the PL-L800's tonearm has been constructed with an exclusive dampening material called Polymer Graphite™. The only thing we want you to hear through our tonearm is music.

Our Coaxial Suspension System, on the other hand, will absorb vibrations that occur when someone walks or dances too hard in a room, or accidentally drops the dustcover. Because inside the cabinet is a free-floating suspension system which isolates the tonearm, platter



THE PIONEER LINEAR TRACKING

ING FINALLY GETS LE IT DESERVES.



and motor from the rest of the turntable; vibrations that reach the cabinet are absorbed by the spring-coupled insulators before they can harm the reproduction process.

THE STABLE HANGING ROTOR DESIGN REDUCES WOW AND FLUTTER.

The most advanced turntable platter motor wasn't advanced enough for the PL-L800. So we came up with a new direct drive system called the Stable Hanging Rotor. The problem with the design of conventional motors is that the fulcrum is at the base of the motor, making it impossible for the platter motor's center of gravity to coincide with the fulcrum. And that results in a wobbling of the platter, known as wow and flutter.

The Stable Hanging Rotor system reduces the cause of this wow and flutter. Because the fulcrum lies immediately below the platter, it coincides with the platter's center of gravity.

And as if all this weren't enough, the PL-L800 also is equipped with Pioneer's exclusive moving-coil cartridge. It has such unusually high output that even a receiver or amp not equipped to handle most moving-coil cartridges can be used with the PL-L800.

If you find it hard to believe that a turntable could be as remarkable as the PL-L800, we suggest you visit your nearest Pioneer dealer and see and hear the PL-L800, along with our entire line of new turntables, for yourself.

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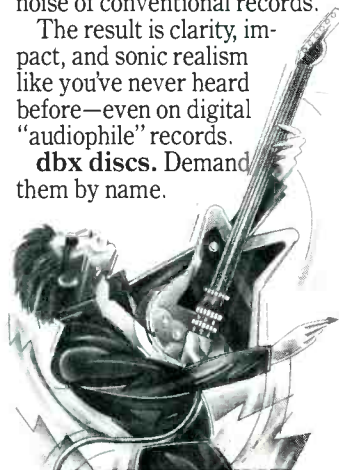
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Audio

JUNE 1982

VOL. 66, NO. 6



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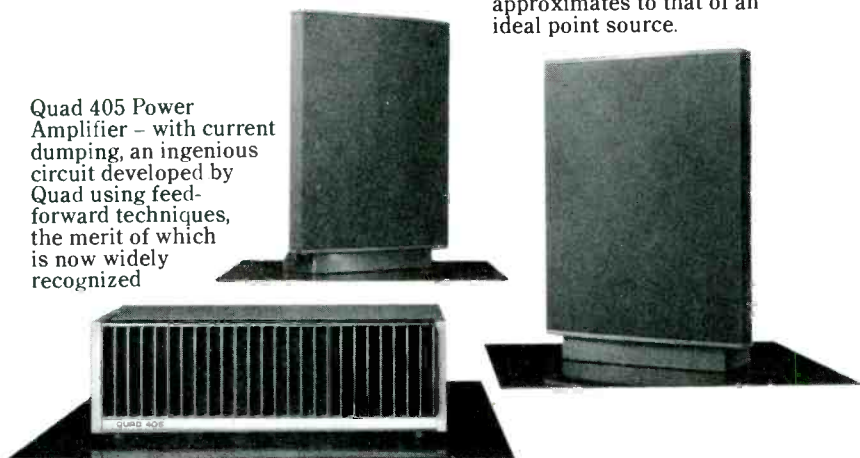
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So you want to know more about the Stereophoner? (See this space last month.) Maybe so, maybe not; it's only a bit of audio history. Either way, there will be a slight delay. In all fairness, I feel, some basic research should be done as to exactly what the 1957 contents of that small box might do to a mono signal fed through it, emerging as two signals. And so the whole mess of pottage (after the Meltdown) is on its way to the West Coast, where knowledgeable engineer friends will play with it.

We are not exactly a historical-minded profession yet, we in audio and hi-fi. Nor are our consumer-type allies who absorb our current output as often as they can afford it. Only a few of us, who have been around since audio's beginnings—not so coincidentally at about the time this magazine was founded—are finding ourselves more and more interested in what happened back *then*, in how we got where we are *now*.

There was audio before, of course. But institutionally and in engineering terms it was attached to contiguous areas, electrical engineering, radio, motion pictures. It took the First World War, radio, and then the astonishing developments of electrical sound, to bring the name audio towards some identity. Still another war had to pass before we actually set ourselves up as a professional field, complete with the Audio Engineering Society. All this when things finally got going again on a civilian basis, several years after WWII was over. It took awhile.

You will note that the first "new" automobiles after that war were dated as 1947 and 1948 models (a very few in 1946). These were basically prewar models, after the factories had reconverted from military use. The earliest audio, as such, took the same course; all the innumerable military and left-over civilian areas of electronics, suddenly shut down almost overnight in August of 1945, coasted along month after month with no power until the same basic conversion back to civil life could take place. It is not surprising, then, that our first issue as *Audio Engineering Magazine* came out in May of 1947. Precisely in tune with history! That was when things were getting started. Everywhere.



The LP record took a little longer—not much. It was formally launched a year after us, in June of 1948. Somehow, I have always felt that the coming of LP, an out-and-out modern updating of technology, marked a symbolical coming of age in the audio field and its semi-sibling, hi-fi. Do you realize, do you remember perhaps, to what level of degradation our civilian audio descended during the war years? Can you believe, you younger readers, that for every new record we bought, a 78-rpm, 10- to 12-inch disc, we had to turn in an old one as scrap? Records were made of shellac and shellac came from the Far East, which at the time was not habited by Westerners other than the military. There was no substitute, for the simplest of reasons—war. The record biz, like the rest of "nonessential" audio, was allowed to get along with whatever it had around on Pearl Harbor Day, December 7, 1941. Period. Essentially, that was what happened to all nonessential business, including cars. Yes, we could drive our old buggies if we wanted to, any old place (with the proper shielded headlight slits on the coasts) just so long as it wasn't military and we didn't use up our "A" coupons for gas, five gallons a week, rationed.

History! Too few of us know our own, out of these last years. Few audio people relish going back in time further

than their last big batch of hi-fi equipment, which could be maybe six months or a year or, in extreme cases, five years. After almost 40 of those years, audio as a whole still rates as an upstart field with scarcely even the beginnings of a history. Too new! We are not yet legendary.

After all, our very earliest major efforts are just beginning to turn classic in a properly historical way, like classic cars. And most of those efforts, still, came before the Big War, long before either audio or hi-fi had any formal place in the larger world. Incredible—45/45 stereo discs, wide range, back in 1931! Now there's an historical artifact for you, out of Bell Labs. But the historical urge that brought these discs out of oblivion in Bell Labs' files did not grow strong for 50 years, until the day before yesterday.

We are indeed now discovering our historical roots, our prehistory, so to speak. It seems, even today, to take a half century for the historical sense to emerge. We haven't given a thought, collectively, in the large, to our real youthful period, after 1947. Too soon? Not for some of us!

But for most of us, old audio stuff is just old audio. Out of date, unimportant, stupid, considering all the incredible things that are going on *now*. Maybe 99% of us, all types, are wrapped up totally in that *now*, month

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It is excursions into the past which give us shape and confidence for a present and a future.

by month, sometimes, it seems, day by day. It is indeed enough to keep us bewilderingly busy, alas.

I say alas, not because of any lack of appreciation—far from it—but simply because until we have history we have no dimension. As in Einstein, history, even our own, is the dimension of time without which the others are basically meaningless. Short-term. Myopic. Wrong-headed. Yes, you can get in and make your megabucks in audio (or you could, awhile back) and get out again, maybe safely. But as an industry, as a field, as a multifaceted, many-peopled endeavor, audio, hi-fi, cannot know where it is going unless it knows where it has come from. In the round. Stereo.

It is the past, excursions into the past, studies of the past, which give us shape and confidence for a present and a future. There is always a *now*. Every moment of history was, at some point, precisely as important as the instant-present *now* today (for those who were around). It was *now* in May 1947, as I remember. It was the same, if I remember correctly, in late 1931, when Bell Labs was recording in Philadelphia, somewhat clandestinely in the basement, and I was gallivanting around Boston, all unknowing. Nevertheless, *I Was There*, to misquote Edward R. Murrow. But for the accident of a few miles (and a few other li'l factors), I could have been down in that basement watching the 45/45 stereo grooves appear under the cutting stylus.

Why all this? No, not to be merely philosophical! Or is it philosophic? I've never much believed in abstract thought not designed to get down to the nitty gritty, and I see no reason at all for us to fuss about our history merely because it is elevating or cultural or something similar. History is useful simply because it *is*—or was. That dimension again. How can one work in the rigidly demanding medium of time, which waits for no one, without some perspective *in that very direction*? It's as though your right foot went forward without your left foot lagging—impossible. We *must* cultivate and understand our own budding history if we are not to fall apart and collapse in a heap. Which in these times is quite possible.

I can show you what I mean. To change analogies a bit, history in any area always seems to me to work in loops, ellipses if you will, or wave forms, highly symmetrical. A fad, any old fad, in this sense is easily defined: It is an uncontrolled oscillation. It goes way up, senselessly, then as quickly collapses in a heap. If not a zany piece of ellipse, then at least we may call it a peak. A more lasting development, any old development you wish, has a better and more consistent wave form. Get the idea?

But of far bigger importance are the long waves, the slow ellipses, that take years, decades, centuries, even millenia, to achieve their shape. Far too often, we miss them cold. We see only a straight line, shortsighted as we are.

We miss them in terms of billions of years: We are baffled by the time curve of the Big Bang and cannot yet see where it goes. (But Halley's comet will be back in 1986.) We have missed the curve of man's short existence, as witness those casually preserved footprints (a hi-fi recording in volcanic ash) of three little *homo habilis* (?) people millions of years ago, wandering along in a hitherto unimagined *now* which was as real to them as ours is to us. And we can easily miss our own "long" shapes of continuity and change! A mere 40 years of audio history is plenty long, with its full prehistory, to tell us a few things about shapes, now *and* tomorrow.

You see, we are in a terrible state of panic now because in a strictly competitive business way we are unable to see where, in God's name, we are going. Audio is sinking, overwhelmed by pictures! Audio and TV have to combine, which everybody believes will be to audio's cost! It really seems to look, to business people and designers who have so much at stake, as if the wave of audio, the ellipse of a half century, is in fibrillation or something. Television, instant picture messages, discs, tapes, digital everything, will simply bury us in vast mountains of sound/sight. We will be but the little tail of a great big TV kite, a tail so minuscule that we may not even be visible to those on the ground, no matter how hard they squint to look.

Well, am I not correct? Isn't that our prevailing mood? Isn't everybody in the biz trying frantically to get into some small corner of video, preferably a bigger corner or even a hefty segment—because, after all, hi-fi, audio for audio's sake, sound and sound alone, is dead. Or will be dead in a short while.

Bunk. I've said it before and now I'll have to begin yelling. *Bunk!* This is strictly the fad psychology in reverse. Suddenly, the smooth, useful curves of audio progress in so many areas go into meaningless oscillation? Could be, if pig-headed panic takes over in place of rational thought.

Not, though, if we take a better look at those shapes, for our antecedents, including the art of music, go further back and back into history and will go onward, we trust, in their accustomed symmetry of change—if we can only see. Music too, and our demand for music is most assuredly not going to stop overnight.

It is clear that the major shaping of reproduced sound with pictures, not really our field in the past except as a sideline, is indeed at a turn of its own, the shape extending all the way back to Edison. Note that his first experimental movie was a talkie, via semi-sync phonograph, and there were sound movies around 1913, recently exhumed; these are all part of the long sound/sight ellipse, as are the still shaky and undetermined videodiscs of the present moment. A majestic curve! And it will not move by wild oscillations. It will pay for all of us to see that shape.

The curve of audio is related but only parallel and overlapping. We are different. Surely, the era of pure sound entertainment is also at a turning point—it would have to be so. But sudden extinction? Hardly. Just an intelligent shaping (by those with good sight) at the turn. We will go on, go back if need be, to make new relationships with the listening art of music, with the seeing art of the moving picture. We will develop our fi *where it is needed*, as it assuredly will be. So, remember the Stereophoner (more later), which is but a piece of another curve within audio itself, soundspace, the sound field, the audio image. Curves within curves—that's history. **A**

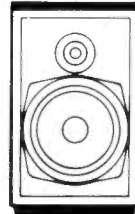
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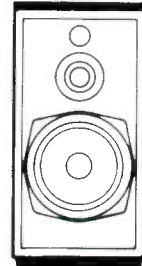
As with their predecessors, the fundamental design objective of these new speakers has been to achieve sound reproduction of the highest quality from enclosures attractively styled and craftsman-finished – yet at costs that will enable these benefits to be accessible to the widest possible audience of music-lovers, high-fidelity enthusiasts and home-entertainment seekers world-wide. Appropriately, therefore, the new models are to be known as **CARNIVAL 3**, **FESTIVAL 3** and **PAGEANT 3**.

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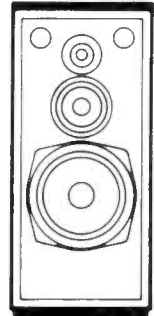
finished in fabric, yet which still retains in attractive proportion the real wood veneers traditionally associated with quality furniture. This has permitted full and appropriate emphasis to be placed upon the essentials of advanced acoustic design within a highly cost-effective format. The **CARNIVAL 3**, **FESTIVAL 3** and **PAGEANT 3** offer in consequence exemplary sound reproduction, pleasing, tasteful appearance and unrivalled value for money. And that's the truth...



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Save Tape and Time?

Q. Using a pickup, preamp, and tape deck with very good high-frequency response, and using a variable speed turntable, how much degradation would I get if I do the following: (1) Adjust the turntable speed for 66 $\frac{2}{3}$ rpm, (2) record a high-quality tape at 7 $\frac{1}{2}$ ips, and (3) play the tape at 3 $\frac{3}{4}$ ips? This would save half the duplicating time and half the tape.—T. Bainbridge, Milwaukee, Wisc.

A. Your procedure would involve doubling all frequencies on the phono disc so that, for example, 15 kHz becomes 30 kHz. Therefore, one question which arises is whether the record electronics of the tape deck can handle frequencies this high without significant loss. Another problem is that of record equalization, which would have to cater to frequencies going out to, say, 30 kHz instead of 15 kHz. Optimum bias might also vary; so might optimum bias frequency, because the chance of the oscillator frequency beating with audio frequencies would be increased. The only real way to find out how well (or poorly) your proposal works is to try it. From a practical standpoint, despite theoretical difficulties, it *might* work satisfactorily, but you would not save on tape. In recording at 7 $\frac{1}{2}$ ips you are using twice as much tape as you normally would for a playing speed of 3 $\frac{3}{4}$ ips. In playback at 3 $\frac{3}{4}$ ips, you are using half as much tape as you normally would for a recording speed of 7 $\frac{1}{2}$ ips; hence you break even.

Self-Service

Q. Having been interested in tape recording for some time, I've become increasingly accustomed to doing my own servicing on my tape decks. Is there a good complete manual or book on how to do all of the necessary alignments and adjustments of the electronics of tape recorders? I would like to know how to go about setting up the correct bias, equalization, etc. Also, please recommend open-reel test tapes.—Bill Lewis, Bakersfield, Cal.

A. I do not know of a single manual or book that will adequately cover service and alignment procedures for all, or most, or many tape decks. The way to acquire knowledge and com-

petence in this respect is to struggle with the manuals and procedures for a variety of decks until you discover what procedures they have in common and what procedures are unique to particular decks. Some of them, such as checking frequency response, will tend to be much the same, while others, such as adjusting bias and/or equalization, will tend to vary considerably. (*Editor's Note:* Howard A. Roberson's article, "Tape Recorder Maintenance," *Audio*, April 1982, p. 32, may help in this area.)

With respect to test tapes, I suggest that you write to (1) Ampex, 2201 Lunt Ave., Elk Grove Village, Ill. 60007; (2) Taber Manufacturing and Engineering, 2081 Edison Ave., San Leandro, Cal. 94577; (3) Magnetic Reference Laboratory, 999 Commercial St., Palo Alto, Cal. 94303; (4) Nortronics, 8101 West 10th Ave. North, Minneapolis, Minn. 55427, and (5) Audiotex, 400 South Wyman, Rockford, Ill. 61101.

Once, $\frac{1}{2}$, or $\frac{1}{4}$ Around the Track

Q. What is the difference between full-track, half-track, and quarter-track recording when using an open-reel deck? Does full-track recording have an advantage over the others?—R. Watson, Dover, Del.

A. Half-track recording uses a little less than half the tape width to record each of two tracks, which are separated by a small space called an island. Half-track permits recording either a pair of stereo signals in one direction of tape travel, or a mono signal in both directions. Specifically, in mono you record a signal on the upper portion of the tape and then reverse the reels and record on the lower portion (when the reels are reversed and turned upside down, what was originally the lower portion becomes the upper portion to be recorded).

Quarter-track recording uses a bit less than one-quarter of the tape width to record each of four tracks, separated by three islands. This permits (1) recording a pair of stereo signals first in one direction of tape travel and then a pair in the opposite direction, (2) recording a set of four quadrasonic signals in one direction of tape travel, or (3) recording four mono signals, entailing three reversals of the tape reels. If the four tracks are numbered 1

through 4, starting from the top, the first pair of stereo signals is recorded on tracks 1 and 3, and the second pair on tracks 2 and 4. Track 1 and track 4 are the left-channel tracks. Most decks offer only the first and third options listed above, while some offer the first option only.

Full-track recording occupies the entire tape width and permits only the recording of a mono signal in one direction of tape operation. The wider the track, the higher the signal-to-noise ratio, if everything else remains the same. Thus, full-track recording provides about 6 to 8 dB better S/N than quarter-track. On the other hand, the narrower the track, the less the reduction in treble response due to azimuth misalignment.

Why Elcaset?

Q. I own an open-reel deck, a fine cassette deck, and now I plan to purchase an Elcaset deck. It seems that this format is equivalent to the open-reel format but without the bother. I would like to know why it did not do well when it came out a few years ago, and if it will come into production again.—Michael Jamet, Bronx, N.Y.

A. Although there is an occasional rumor that the Elcaset format will be resurrected, majority opinion is that Elcaset is dead, and, in my view, rightfully so.

In light of continuing improvements in cassette tapes, in the heads available for cassette decks, in deck electronics, etc., the advantage of Elcaset became marginal. Further, Elcaset presented one format too many to a consumer already beset by: Open-reel, cassette, and cartridge formats; a variety of reel sizes and speeds in the open-reel format; a variety of tapes, with varying bias requirements, record equalization, and playback equalization; a variety of noise-reduction devices, and probably other variants I have forgotten to mention.

Returning to the basic explanation: Today the state of the cassette art permits essentially flat response from

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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about 20 Hz to 24 kHz with signal-to-noise ratio of about 70 dB (using Dolby C) and with low distortion and very low wow and flutter. While only the finest and most expensive cassette decks achieve such performance today, the pack is not all that far behind. And there is no sign that continued improvements will fail to materialize, so that the pack tomorrow will be where the leaders are today. Therefore, why Elcaset?

Clean But Soundless

Q. I recently purchased a combination head cleaner and demagnetizer cassette. The instructions state that a few drops of the fluid cleaner should be inserted in the open part of the cassette device. After following the instructions and going through a record-play run with this cassette, I heard no recorded sound during playback. When I try to play tapes that I recorded prior to use of the cleaner-demagnetizer cassette, the sound is muffled and dull. Have I done permanent damage to the tape heads? I rue the day that I bought this cassette.—Donald McHugh, Brooklyn, N.Y.

A. It is not certain that the heads have been ruined. Possibly the fluid, in combination with tape oxide, has coated the heads and made them inoperative because of excessive tape-to-head separation. Perhaps a careful cleaning in the conventional manner will restore the heads to correct operation. Unless your instruction manual indicates otherwise, apply isopropyl alcohol on a cotton swab to clean the heads, capstan, and pressure roller. Allow at least five minutes for everything to dry before checking your deck with a new cassette.

It is possible that the heads are okay but that the fluid leaked inside your deck and did some kind of damage. Another, but very small, possibility is that by coincidence you used the cassette device just at the time when a totally unrelated problem developed in your cassette deck.

Helpful Humidity

Q. My house is quite dry in winter, with a troublesome accumulation of dust. If I used a humidifier to cut down on the dust, would the moisture have any effect on my stereo equipment?—Michael Lemieux, Rouses Point, N.Y.

A. Assuming that you do not allow the humidity to go much above normal level, I doubt that use of the humidifier will adversely affect your audio system. In fact, it may be beneficial with respect to tape deck performance, preventing the tape from becoming so dry as to cause squeal. **A**

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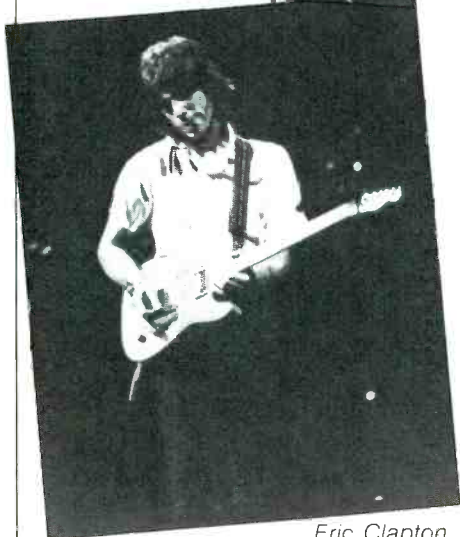
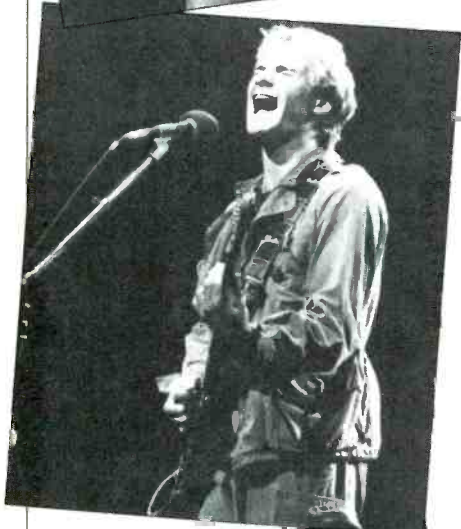
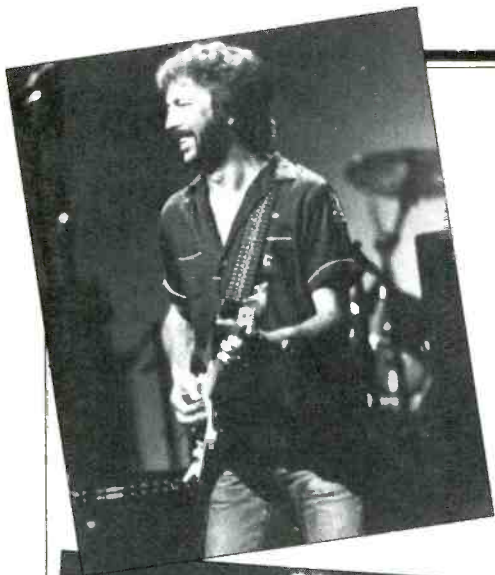


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THE COLUMN

MICHAEL TEARSON
JON & SALLY TIVEN



Eric Clapton,
Sting of The Police, and
Jeff Beck

The Secret Policeman's Other Ball:

Various Artists

Island ILPS 9698, stereo, \$8.98.

Sound: B+

Performance: A-

The last album in this series had Pete Townshend performing solo renditions of fave tunes, but otherwise, it was somewhat of a throwaway. This sequel is a far more substantial record. Not only are the performances themselves more consistent, but the album closes out with an ensemble playing Bob Dylan's "I Shall Be Released" in which all the featured artists combine forces, making it an entertaining moment.

In reverse order of appearance, the aging Donovan sings "The Universal Soldier" and "Catch the Wind," acknowledging his recent lack of productivity by reaching into his '60s repertoire. Phil Collins and Bob Geldof do acoustically the songs they ordinarily perform with their bands (Genesis and The Boomtown Rats, respectively), and fans of these groups should well enjoy this particular portion of the record. But for us, the meat of the record is to be found in the first seven cuts—Sting playing and singing "Roxanne" and "Message in a Bottle," and the long-awaited duets of Jeff Beck and Eric Clapton. Finally, the post-success guitar heroes of the '60s and '70s are stacked up side by side, trading choruses on "Farther on up the Road." Although Eric does a nice job of singing, when it comes to playing guitar the fluid Jeff Beck blows him away hands down. Eric dishes out clean, phase-shifting notes, but Beck is doing chromatic descensions, pull-offs, and playing his entire catalog of "things to do to impress girls." A magic moment.

Jon & Sally Tiven

Another Grey Area: Graham Parker

Arista AL 9589, stereo, \$8.98.

Sound: B

Performance: B

For his first album without The Rumour, Graham Parker has enlisted a crew of primarily American musicians and producer Jack Douglas in an attempt to get closer to the sound he hears in his head. If this is all he can come up with, these external moves



Graham Parker

were entirely gratuitous. The backing band sounds like they're trying to emulate the sound of previous Parker albums, and the production differs only in favoring some of the midrange frequencies rather than the high-end predominance of *The Up Escalator* and *Squeezing Out Sparks*. Aside from a little bit more precision in playing, *Another Grey Area* sounds almost exactly like every Graham Parker & The Rumour album.

In other words, there's one token reggae track per side, a strong opening track (with a melody lifted straight out of Squeeze's "Up the Junction"), and a smattering of basic Graham Parker compositions tinged with your liberal dose of bitterness. What does he have to be bitter about, aside from the generally lousy state of the world, aesthetic stagnation, and his inability to dent the American charts? He's got a nice flat in Chelsea, a decent record company advance, and at least other artists are doing decent renditions of his material.

But where is the brilliance promised on his first two records, what happened to the little guy with the big voice who was going to give both Bob Dylan and Stax/Volt a run for their money? Sure this is nice stuff, but he's kidding himself if he thinks it's great art. At this particular point in time he's interchangeable with Elvis Costello, just another guy writing songs to his enemies and himself with little aspiration to improve, or to make a coherent statement. Getting a new Graham

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Parker album used to be something to look forward to; now it's loaded with no surprises. It isn't outright junk, as is much of the vinyl chucked out in this industry where every pretty face is an artist, but by the standard set by *Howlin' Wind* and *Heat Treatment* the new Graham Parker album is nothing special.

John & Sally Tiven

Success Hasn't Spoiled Me Yet: Rick Springfield
 RCA AFL1-4125, stereo, \$8.98.

Sound: B— Performance: B

Making records is a whole different ballgame when you've got three hit

singles and a Grammy behind you, but despite the disclaimer in the album title Rick's previous album was infinitely superior. What you can get away with when you're reaching for success can easily become cliché after your music has been exposed to (and accepted by) the masses, and the self-plagiarism that pervades much of this album doesn't really pass for "Jessie's Girl, Part II." The worst thing about this not-bad-but-not-great album is that Rick seems to be aiming for the hit single on practically every track, and Keith Olsen (who produced parts of the last album and all of this one) has softened up the sound considerably. What once was rock is now pop, and the guy your



Rick Springfield

little sister used to play who wasn't half bad has become a lightweight.

This is not only unfortunate but unnecessary, as Rick at least used to be a big hard-rock fan and is capable of playing stinging leads. After writing songs for so many years with the sole purpose of getting a record deal and getting over to an audience, now that he's gotten over he doesn't know how to follow his more aesthetic and purist instincts. The motivation behind recording "Black Is Black" is questionable, nicking song titles from poor Hilly Michaels is unnecessary ("Calling All Girls"), and the choices of cover material are extremely weak.

All in all, this is a big disappointment even though it's passable stuff. "Kristina" and "April 24, 1981" provide the only moments where any kind of artistic progression is evident, and that's rather shameful. With opportunity at his fingertips and talent in his every bone, Rick Springfield has blown it. Sort of. Stay tuned for further developments of Rick Springfield, a.k.a. Noah Drake, because this guy ain't about to disappear overnight—*Success Hasn't Spoiled Me Yet* will most likely sell more copies than *Working Class Dog*, and he'll be back for another try in a year or less. Perhaps by then he'll be surrounded by people who can enhance his artistry rather than obscure it.

Jon & Sally Tiven

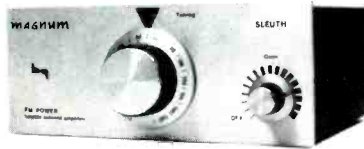


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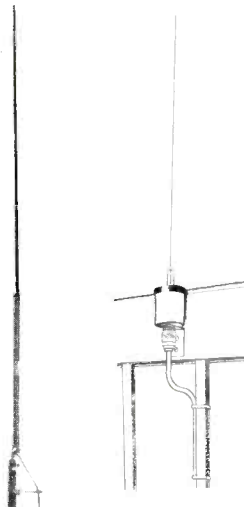
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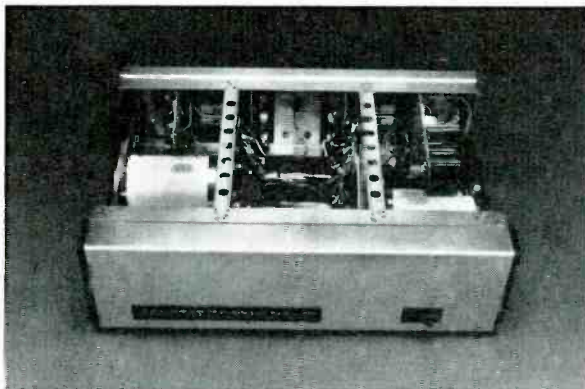
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English Settlement: XTC

Virgin/Epic ARE 37943, stereo, \$8.98.

Sound: B

Performance: B-

XTC is an English progressive/pop/New Wave band that has been responsible for some excellent singles and interesting albums, a cult favorite ready to explode into a major impact act at any moment. Unfortunately, their self-produced *English Settlement* (which is receiving the "big push" here) is simply not up to snuff for them. Andy Partridge comes up with one winner tune, "Senses Working Overtime," but the rest of the album is simply too self-indulgent, lacking in structure, and melodically forced to stand up to their previous work. Strangely enough, the British version of the album is a two-record set, and these songs are the most accessible from that package. Their record company would best be advised to compile an album of XTC's innumerable singles rather than these ill-fated sonic experiments. This is a good band gone wrong, which is a darned shame.

Jon & Sally Tiven

Speak & Spell: Depeche Mode

Sire SRK 3642, stereo, \$8.98.

Non-Stop Erotic Cabaret: Soft Cell

Sire SRK 3647, stereo, \$8.98.

Sound: B

Performance: B

This stuff is the latest rage in England, and if it should catch on in the U.S.A. it would be a record company's dream: Two-man synthesizer/vocal/drum machine groups that make records for next to nothing (and aren't exactly expensive to keep on the road). Part of the attraction is the sexual content of the lyrics, which is to say that these groups aren't exactly AM fodder with titles like "Sex Dwarf" and "Tainted Love." But the latter is a surprisingly infectious pop tune, and the music presented on these albums is far better than you'd expect. In a post-Gary Numan vein, these songs are tuneful and hook-laden despite their avant-garde trappings.

The only obstacle to this stuff catching on here is that the arrangements are fairly foreign to American ears, and by the standards of most radio stations both groups are unformattable. These guys are, for all intents and purposes, writing real pop tunes that are no more "out there" than Olivia Newton-John, but by the nature of their lyrical bent and choice of instruments they'll probably end up being treated like they're Miles Davis or John Coltrane.

Jon & Sally Tiven

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WHICH TRACKS BEST

A pivoted or a radial Tonearm?

PETER W. MITCHELL

Fans of straight-line tracking tonearms say that their favorite tracks better because its motion mimics the cutters head's movement, but a close analysis suggests that the chief virtue of radial-tracking tonearms is their low mass, not their straight-line tracking.

It used to be that the radial-tracking tonearm—which rides on a straight rail instead of pivoting in an arc from a base at one corner of the turntable—was a complex and delicate mechanical arrangement of bearings, cams, motors, and leaf switches sensing any deviation of the arm from the perpendicular. It was costly, unreliable, and suitable only for the most devoted and finicky audiophiles. But lately the resources of contemporary electronics have been focused on the concept, and the result is a new generation of radials which are relatively inexpensive to manufacture and not at all fussy to operate. No longer an exotic luxury, the radial arm is now a fully practical alternative to the conventional pivoted tonearm.

Photograph: Robert Lewis





When few radial arms were being made and sold, it didn't matter much whether claims for the inherent superiority of radial-tracking designs were really valid. But now, with radial arms competing vigorously for the turntable buyer's dollar, these claims are of interest to a great many audiophiles. Consider, for example, the following language in a typical recent advertisement: "Foremost is the linear tracking mechanism itself. Much superior to ordinary pivoted tonearms in that it plays your records in the same straight line across the disc as the cutting head which made the original master recording. Tracking errors and unbalanced side forces are virtually nonexistent. The result is a dramatic decrease in distortion and false coloration. And a strikingly audible improvement in stereo definition and real-life presence."

Putting aside the ad writer's customary exaggerations, is there really a solid physical basis for such claims? Do radial arms have a natural superiority arising from their unique mode of operation? Or are they just another gimmick?

Neither. Radials are not just a gimmick. But they are not automatically better than pivoted tonearms. To put them in a realistic perspective and help you decide what tonearm is best for you, I'm going to analyze the differences between radial and pivoted arms, and we'll play detective—trying to identify why some tonearms really do sound better than others.

The claims for radial-arm superiority can be boiled down to three basic virtues: Perfect tangency, no skating force, and low arm mass. We will examine each of these in turn.

Tangential Tracking

The original motive for developing the radial arm was the idea that it could mimic the motion of the cutting lathe, holding the cartridge precisely tangent to the groove while moving it along the radius from the edge of the record toward its center. Logically, this seems like it would be the ideal way, the only really "right" way, for a tonearm to operate. But the real world is not quite that simple.

If records were cut with constant pitch (i.e. with a constant spacing between successive spirals of the groove), then it would be easy to drive the tonearm inward at exactly the right speed to maintain the cartridge tan-

One goal of the radial arm is to mimic the tangential motion of the cutting head.

gent to the groove. But in fact modern records are cut with variable pitch; the groove spacing increases to accommodate loud passages, especially those with a lot of low-frequency energy, and decreases when the music is soft. Thus, the massive arm on the record cutting lathe is continually speeding up and slowing down, controlled by an "advance" signal from a preview head which samples the signal level on the master tape two seconds (one full revolution of the disc) before the music gets to the cutting head.

When the record is played, the tonearm must also track inward toward the center at a continually varying rate. To facilitate this, pivoted arms are made with extremely low bearing friction so that the stylus, as it tracks the spiral groove, can easily carry the arm inward with it. A small handful of radial arms (particularly those which float on air-pressure bearings) also have low enough friction to follow the groove without aid. But most radial arms have far too much bearing friction to be moved by the slight sidethrust provided by the compliance of the stylus assembly, and so they must be driven inward by motors. Lacking a preview mechanism to measure the varying groove pitch, most radial arms depend on a servo system to detect a deviation of the arm from its desired tangency and generate motor drive signals which move the arm inward until tangency is restored.

Thus, the traditional goal of the radial arm—to mimic the cutting head in its perfect and constant tangency—is only a theoretical ideal. In reality most radial ("linear-tracking" or "straight-line tracking") arms have a designed-in tangency error: The arm must deviate from perfect tangency in order for the servo to operate. Therefore, the tangency error is continually changing, departing from zero and being corrected when it becomes large enough to trigger the servo. The size of the error depends on the servo's response window: $\pm 0.5^\circ$ is typical. So, when we

compare a radial design versus a pivoted arm, we are not matching an error-free system against one with angular errors; rather, each type of arm has its own characteristic pattern of tangency error.

This is illustrated in Fig. 1, which shows the tangency error of a radial arm with a 0.5° servo window versus that of a pivoted arm having an effective length of 9 inches, an offset angle of 24° , and an overhang of 18 mm. The vertical scale is actually the "tracking error index" in degrees/cm, obtained by dividing the tangency error (in degrees) by the disc radius (the distance of the stylus from the center spindle, in cm). The equations for computing this tracking index are given in References 1 and 2. The innermost grooves on a typical 12-inch LP record are at a radius of 6 cm, while the outermost grooves are 14.5 cm from the center.

The distortion produced by lateral tracking error is proportional to this tracking index rather than to the actual tangency error in degrees. As Fig. 1 shows, the tracking index for a correctly designed 9-inch arm is only 0.13 deg/cm at worst and under 0.1 deg/cm over most of the record surface. A radial arm with a servo window of 0.5° has a tracking index which varies from 0.04 deg/cm in the outer grooves to 0.08 deg/cm in the inner grooves.

But this discussion is still theoretical. In the real world, in order to have a tracking error index as low as that in Fig. 1 with either a pivoted or radial arm, you would have to be very lucky or very skillful, because in real tonearms these theoretical differences in tracking error are usually swamped by the inevitable small imperfections in the installation of the phono cartridge in the headshell. Ideally, the cartridge body should be exactly parallel to the headshell axis, but slight twists of one or two degrees of arc are fairly common—especially since many cartridges and headshells still are made with curved contours instead of the straight edges which would make it easier to judge parallelism by eye. Errors of a couple of millimeters in the longitudinal position of the stylus in the headshell are also fairly common, particularly in view of the lack of precision in the procedures supplied for setting overhang in many arms.

Even if you are an experienced and careful installer of cartridges in headshells, you probably can't be certain of achieving an accuracy better than 0.5°

in alignment and about 1 mm in longitudinal position. (It may seem easy to set the longitudinal position in a radial arm, since the stylus should pass directly over the center of the spindle, but the spindle is 7.2 mm in diameter, so an error of only 14% of the spindle diameter still amounts to a full millimeter!) Figure 2 illustrates the tracking error index which these small errors will produce in a radial arm, individually and in combination; the dashed line shows the total tracking error when a servo wobble of 0.5° is added to cartridge alignment errors of 0.5° in angle and 1 mm in position.

For comparison, Fig. 3 shows how the tracking error index of the pivoted arm is affected by the same slight alignment errors. Unlike the radial arm, where positive and negative errors produce the same tracking distortion, the pivoted arm produces a more complex family of curves depending on the direction as well as the amount of the error. But it is clear that a tracking index of 0.2 deg/cm or greater can easily occur with both types of tonearm. As expected, the worst-case combinations of angular and linear shift in the pivoted arm yield larger amounts of tracking error in the pivoted arm than in the radial. But, remarkably, other combinations actually lead to lower tracking distortion in the pivoted arm than in the radial! In two of the curves in Fig. 3, the tracking error of the pivoted arm remains under 0.15 deg/cm over most of the disc surface.

At any rate, it seems clear that, under real-world operating conditions, radial arms can claim only a general tendency toward lower tangency error, not a clear-cut superiority. In fact, it can be argued that the design of the headshell is a more important contributor to accurate tangency than is the choice of radial or pivoted arm. A headshell that provides unambiguous seating of the cartridge without any possibility of twist, and is equipped with a precision jig for setting the stylus overhang, substantially improves the odds that the theoretically low tracking error of either type of arm will actually be realized in practice.

Of course, this doesn't mean that the question of tangency error in pivoted arms can simply be ignored. As Fig. 3 shows, the tracking error of a pivoted arm can be degraded by quite small geometrical errors, and many pivoted arms exhibit substantial amounts of tracking error because of incorrect

geometric design—even though the equations for minimizing tracking error in pivoted arms have been available to engineers for 40 years. Therefore, when installing a cartridge in a pivoted arm, you can't guarantee minimum tracking error just by being careful. As a precaution you also should use an alignment protractor such as the DB Systems DBP-10 or the Dennesen Soundtrackor to check and correct any errors in the arm's geometric design. With such an aid, the real-world performance of a pivoted arm can come close to achieving the theoretical minimum tracking error shown in Fig. 1.

Skating Force

If radial arms don't guarantee dramatically lower tangency error than pivoted arms, surely there is one area where their superiority is unquestioned: Perfect freedom from skating force. In radial arms the friction of the stylus in the groove produces a drag force which is directed along the length of the arm and so has no effect, but in pivoted arms the offset angle of

the headshell transforms part of that drag force into a sidethrust which pulls the cartridge toward the center of the record. Modern tonearms are equipped with anti-skating devices which cancel this thrust by providing an outward force of approximately equal strength.

The catch is that the drag, and thus the sidethrust, is not constant. It varies with groove modulation, increasing during loud passages and decreasing during soft ones. At best, the anti-skating device can only compensate for the average (or highest) value of the sidethrust. With a pivoted arm the varying sidethrust will cause continual slight variations in the effective tracking force on the two groove walls. Freedom from this, it is speculated, may be a significant area of superiority for the radial arm.

Such speculations, however, tend to ignore the actual values of the forces involved. The maximum level of the sidethrust, in a loud passage, is about 15% of the vertical tracking force. The minimum level in a soft passage is at least half of that value, i.e. 7% of the

Fig. 1—Tracking error index of a radial arm, light line, with a 0.5° servo window and that of a pivoted arm, heavy line, with a 9-inch effective length, 24° offset angle, and 18-mm overhang.

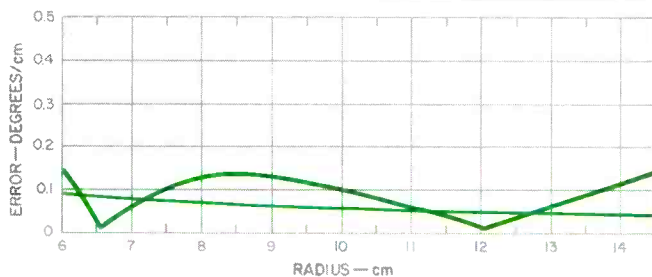


Fig. 2—Tracking error index of a radial arm, showing how various settings influence the index.

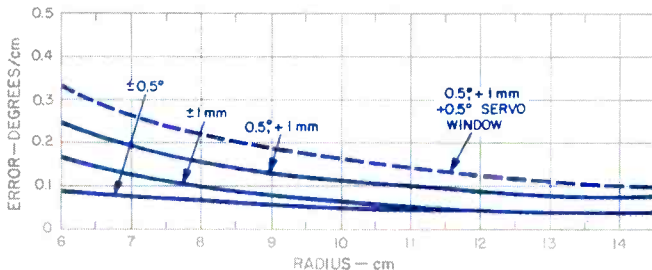
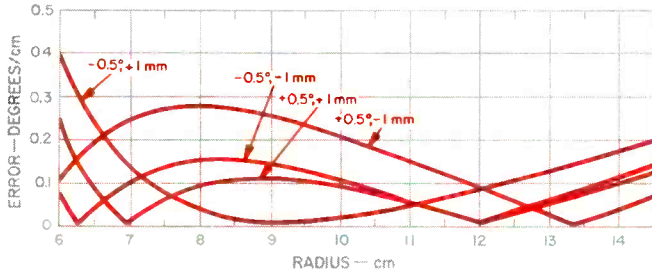


Fig. 3—Tracking error index of a pivoted arm, showing how various settings influence the index.



VTF. Thus, if we were to set the anti-skating force to a median value (11% of the VTF), the uncompensated sidethrust would only vary by $\pm 4\%$ of the VTF, i.e. 0.04 gram for a 1-gram VTF. Does anyone seriously believe that a 0.04-gram difference in the effective tracking force on the left and right groove walls could make any audible or measurable difference?

If we adopt the common approach of setting the anti-skating for optimum tracking of the loudest passages, we are effectively compensating for the maximum sidethrust, and the forces on the left and right groove walls will become unbalanced by 7% or 8% of the VTF at low modulation levels. (That is, the force on the left-channel wall will decrease by 8% and the force on the right wall will increase by 8% for a total difference of 16%.) Could this have a detectable effect on stereo imaging or on the resolution of subtle details during low-level passages?

Fortunately, this question can easily be answered by direct experiment, so you can decide it for yourself. Select a turntable whose anti-skating can easily be varied during play without disturbing the tonearm. Adjust the VTF and

cause variations of a few percent in the effective tracking force on each groove wall, it would be interesting to measure the dynamic forces on the stylus while actually playing a record and see if these sidethrust variations show up under real-world playing conditions. This experiment can be done, using a strain-gauge cartridge. The varying d.c. and infrasonic output from this type of cartridge is directly proportional to the deflection of the cantilever and thus to the instantaneous force bearing on the stylus.

Such a measurement was made a few years ago by Poul Ladegaard at Bruel & Kjaer, and Fig. 4 shows the result (reproduced from Ref. 3). The initial tracking force was set to 10 mN (1.0 gram), and portions of two records were played with the same cartridge mounted in three different tonearms. Each oscillogram in Fig. 4 shows the variation in effective tracking force during four seconds of music (two revolutions of the record).

This result is shocking. Instead of the variations of a few percent which might be caused by skating forces, we see the tracking force varying by 20%, 50%, and even more. What, you might

attributable to sidethrust variation. Note that with arm 3 (the heaviest of the three), tracking force variations of $\pm 20\%$ were found even when playing a record which looked perfectly flat. With arm 2, a typical medium-mass design, the force still varies by $\pm 10\%$ on a flat disc.

By itself, the tracking force is not important; as long as the net tracking force is high enough to keep the stylus in contact with the groove wall, it will continue to trace the groove. The real problem here is the varying deflection of the stylus cantilever, which is what is actually being measured in these graphs. With any operating cartridge the arm's tracking force bears down against the resilient compliance of the stylus assembly, and so any variation in force immediately produces a corresponding deflection of the cantilever (and vice versa). This has several deleterious effects:

1. As the height of the cartridge above the disc surface varies, the vertical tracking angle (VTA) and stylus rake angle (SRA) also vary, producing harmonic and IM distortion.

2. Up-and-down motion of the cartridge relative to the record surface produces a back-and-forth motion of the stylus along the groove, causing the music to be frequency-modulated. This is a form of flutter, and it tends to occur at rates of a few Hertz—precisely the rates at which the ear is most sensitive to flutter. Experiments have demonstrated that, under typical operating conditions, turntables often exhibit higher amounts of wow and flutter than their specifications indicate, and this flutter is closely correlated with the frequency and severity of the arm/cartridge resonance. Taming the resonance reduces the flutter.

3. As the cartridge shakes, its tracking force is modulated up and down—the stylus alternately digging in with too much force (creating the possibility of accelerated record wear) and nearly floating free with insufficient force for undistorted tracking of the groove. This is clearly seen in the upper row of Fig. 4; there are moments when the effective tracking force falls to zero, meaning that the stylus has completely lost contact with the groove. Of course, when the stylus is tracing heavily modulated grooves, a reduction of even 20% in effective tracking force may be enough to cause increased distortion and mistracking.

4. If the varying cantilever deflec-

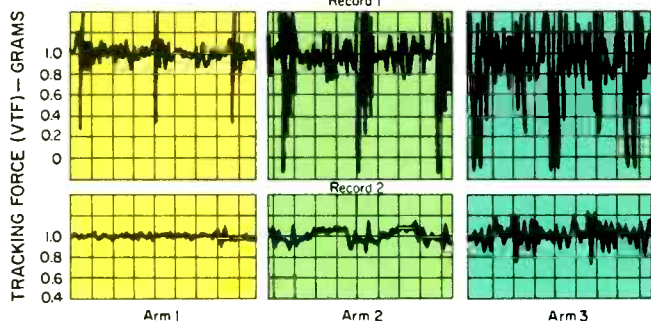


Fig. 4—Changes in vertical tracking force with changes in tonearm mass and with warped and flat records; see text.

anti-skating for optimum tracking of loud passages, and then play an extended low-level passage of music. While listening, reduce the anti-skating force to about half of its preset value (producing balanced forces on the two channels), and then raise it to normal (creating the unbalanced condition for low-level groove modulations). If you hear a clear difference in sound, you may be a candidate for a radial arm. Most people, with most playback systems, hear little or no difference in this test.

While theory indicates that the varying sidethrust in a pivoted arm will

ask, is going on to produce these results?

Tonearm Mass and Resonance

The answer is that the three tonearms had differing values of effective mass, arm 1 being the lightest. Record 1 (the upper row of three oscillograms) had a medium-sized warp, while record 2 appeared flat to the eye. What Fig. 4 shows is that under real-world operating conditions, with arms of typical mass and records of typical warp content, the effective tracking force is continually varying—and by much more than a few hundredths of a gram

tion is not purely up and down but involves any rotary or side-to-side motion, the stereo imaging will vary as well.

If you look closely at the oscillogram for arm 3, you will see that the wiggles are not random but regularly spaced, and analysis shows that the cantilever deflection is occurring at a rate of 7 Hz. This, of course, is no accident: The frequency of the arm/cartridge resonance (due to the arm's effective mass reacting with the pickup's compliance) is 7 Hz. If this frequency is substantially lower than about 9 or 10 Hz, the resonant system will continually be stimulated into oscillation by motor rumble and by record warps—not just the obvious ripples but also the smaller surface irregularities which infest virtually every disc. Moreover, in the real world the shelf on which the turntable sits is not motionless; it has its own resonances, stimulated by the infrasonic vibrations of street traffic, footfalls, refrigerator compressors, furnace blowers, etc. And since most turntable suspension systems become progressively less effective with decreasing frequency, these perturbations are readily transmitted to the record and the stylus.

There are two practical ways to stabilize the cantilever deflection. One is to use a damping mechanism such as the brush supplied with Shure and Stanton/Pickering cartridges, a Disc-Traker or Zerostat Z-track device, the silicone damping supplied with some tonearms, or the resonance-cancelling rubber decoupler built into the counterweight of some arms. (The most ambitious of the decouplers is perhaps that in the Dual arms, where the device is "tunable" to the mass and compliance of the cartridge used.)

The other approach is to keep the frequency of the arm/cartridge resonance above 8 Hz or so, where there will be fewer perturbations to stimulate it. In principle, this could be accomplished by lowering the cartridge's compliance, but the low-frequency tracking ability of any cartridge is proportional to its compliance, so a relatively high compliance is mandatory. Therefore, the only way to raise the resonant frequency is to reduce the effective mass of the cartridge and arm. Figure 4 testifies to the effectiveness of this approach: The oscillograms for arm 1, the low-mass arm, show virtually no variation in cantilever deflection on the flat record (lower

Being shorter and simpler, the radial arm is typically lighter than a pivoted arm.

curve) and almost instantaneous recovery from perturbations on a warped disc (upper curve).

It may seem that I have wandered away from the subject of this article, which is a comparison of pivoted and radial tonearms, but I really haven't. What I want to suggest is that the most important advantage of radial arms is simply that they are lighter than most pivoted arms. Being lighter, they are typically freer of the many problems described in the preceding paragraphs—resonance-induced flutter, varying VTA and SRA, blurred stereo imaging, and mistracking due to variations in effective tracking force. Being lighter, they approach closer to the tonearm ideal: Providing a stable platform for the cartridge and holding it at a fixed distance above the record for stable cantilever deflection and constant tracking force.

Radial arms are typically lighter than pivoted arms because they are shorter and simpler. As S. K. Pramanik explained in Ref. 2, the effective mass of the tonearm is mainly due to the cartridge and plug-in headshell—the items farthest from the tonearm's pivots. And their effective mass varies with the square of their distance from the pivots. A typical pivoted arm is about 9 inches long, while a typical radial arm is only 6.5 inches long; squaring these numbers, we get 81 and 42.25, indicating that when all else is equal, the effective mass of the radial arm is only half that of its pivoted counterpart.

Of course, the same reduction in effective mass can also be achieved in a pivoted arm—as Dual, SME, and Ortofon have successfully demonstrated—by redesigning the headshell, plug-in socket, and cartridge itself, halving the weight of each. The collaboration between Ortofon and Dual, for instance, has resulted in a tonearm/cartridge system whose total effective mass is only 8 grams.

Thus, when audiophiles graduate from older pivoted arms to radial arms and discover that they sound better,

what they are hearing is probably not the presumed superiority of straight-line tracking, nor a reduction in tangency error or skating force. They are simply hearing the benefits of a low-mass tonearm and cartridge combination in practice.

If this conclusion is correct, then the main virtue of radial arms is just a lucky accident which may well have had nothing to do with the designer's original goal! It is intriguing to note that when audiophiles discuss the observed advantages of radial arms, they tend to describe the very same benefits that other listeners have observed when switching to a low-mass arm (and the same benefits which other audiophiles have reported when damping was added to control the resonance of a tonearm): Better tracking, lower distortion, less flutter, improved stereo imaging, better resolution of inner detail, etc.

Conclusion

The average radial arm probably does sound better than the average pivoted tonearm because the radial arm, being shorter, has lower inertia and thus provides stable cantilever deflection and constant tracking force. But those pivoted arms which have been designed for radically lowered mass also exhibit these same virtues—and are fully the equal of radials in sonic performance. Since the weight of the cartridge body is a major contribution to the effective mass of a tonearm, it is fortunate that a growing variety of low-mass cartridges are becoming available.

The influences of arm mass and resonance on the quality of reproduced sound are well established and easily demonstrated. The advantages of straight-line tracking appear to be more theoretical than real. *A*

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GET THE MOST SOUND FROM

PETER MILTON

78'S

It's almost a truism that 78-rpm records are becoming very "collectible." There is scarcely a flea market or garage sale which does not have its quota of dusty old discs and early phonographs. Even old cylinders turn up. I recently rescued a pile of almost mint Edison Diamond discs from a decorator who was intent on nailing them to a steakhouse wall. If you consider that in 1927, just before the record industry started to decline, over 100 million records and nearly one million phonographs were sold in the United States alone, and that in 1946, 400 million records and nearly 3½ million radio-phonograph combinations were sold, you will understand why there are so many survivors.

There are still sufficient early records and phonographs to keep a reasonably representative collection affordable, although if your interests run to the quality machines, a good cylinder model, with an external horn made from oak, can cost you \$2,000.

Many audiophiles will be surprised to find that the restoration and collection of machines and records from earlier days almost amounts to a "sub-culture" which seems to have very little in common with mainstream hi-fi. There are several flourishing antique phonograph societies, whose ranks include mechanically minded tinkerers who delight in restoring very early phonographs, serious minded collectors who are intent on preserving part of

our technical history, and those who simply want to enjoy the music of an earlier era. Each aspect attracts its specialists; collectors of old cylinder machines, for instance, are not particularly interested in the art of restoring the sound from discs.

You might have, as I do, a collection of 78s kept from the pre-microgroove days, which were too important to discard but which were never reissued in the new format. Perhaps you have bought a pile of old discs and are curious to know how they sound. Our present technology makes it possible to reclaim most of the sound recorded in the old grooves with a degree of fidelity which would astound their original owners. Often the biggest problem is finding a turntable with the 78-rpm option.

There are purists who say that these discs sound best on the original machines. However, the masters always contained more information than the reproducers could extract, and there is little point in subjecting the grooves to stylus pressures of a half pound and more.

Looking back from our digital recording vantage point, it is tempting to say that the old records were noisy, distorted and, for all practical purposes, alike. There are obvious differences between cylinders and discs, but even among the latter there were wide variations. The most common sizes were 10- and 12-in. diameters, but many early discs were issued in sizes ranging from 5½ in. upwards. Even 20-in. diameter discs can sometimes be found.

The speeds also varied wildly. The predominant speed by 1925 was 78 rpm, used by Victor, which happened to be making the most records at the time. Edison used 80 rpm, as did Columbia and Okeh, and some Pathé discs were even recorded as high as 90 rpm. You might even come across some 1931 Victor records recorded at 33½ rpm.

When electrical recording started in 1925, 78 rpm was adopted for compatibility with as many discs as possible. In truth, the record speed was relatively unimportant since most phonographs had a speed control and the pitch was adjusted to the listener's taste.





Duke Ellington and The Andrews Sisters (CBS Photo).

It turned out that in order to use a simple worm gear with a 60-Hz synchronous motor, the actual speed was 78.26 rpm. If you wish to make a strobe for 78.26 rpm, using a 60-Hz line, the formula for the number of dots, N , is:

$$N = 7200 \div \text{rpm}$$

which gives 92 dots for 78.26, 216 for $33\frac{1}{3}$ and 160 for 45 rpm.

Before electrical recording made it necessary to standardize the speed, variations existed not only between companies but even between discs from the same studio. By replaying early discs to give the known pitch of early artists, variations of as much as 10 rpm can be found between recordings made on the same lathe. For this reason, a variable speed player is essential for old records.

There are also some old changers which can be picked up fairly cheaply. You should realize that the center hole was not standardized completely and present-day automatic changers can jam on early discs. If you happen to have a record which plays from the inside out, the trip mechanism will be very frustrating to say the least.

It's probably best to modify the deck radically to make, in effect, a standard manual turntable. Disconnect the trip mechanism and remove any side posts so that oversize records can be played. Before the early '60s, the tonearms were usually heavy clunkers with large amounts of bearing friction and no anti-skating adjustments. "The Ancients" recognized the problem of the inwards force due to the offset angle

and overhang of the stylus and called it "side-thrust" in those days. To quote the *RadioTron Designer's Handbook* (F. Langford Smith, Editor) published as late as 1953, "A moderate amount of side-thrust is not detrimental, because it helps to overcome pivot bearing friction. . . ."

A lightweight pickup with a miniature needle played at about $\frac{3}{4}$ ounce of tracking force as compared with the half pound plus of the soundboxes and early electrical phonographs, so the bearings did not need to be as good as present cartridges demand.

It makes sense to use a modern low-distortion, wide-range cartridge for the old 78s. The earlier pickups had needle tip resonances well within the audio range, with a 12- to 15-dB spike at 15 or 20 kHz not uncommon for a lightweight pickup. Also, intermodulation products increased the noise in the lower part of the audio spectrum.

A modern cartridge is smooth right through the audio range, and 78 tips are available for most cartridges. Shure has a dozen in their range, from the N44-1 for the M44, at \$12.25, to the VN478E at \$64. If you intend to get into the 78 side of things seriously, Stanton will be able to help considerably since they produce a full line of cartridges for studio use. The 500 cartridge with the D5217 is very robust and can cope with playing weights of up to 7 grams.

A modern cartridge needs a good arm if it is to function well, though it is



Stephane Grappelli and
Django Reinhardt



outside the scope of this article to survey a wide range of arms. I have used an SME arm in its various forms since they were first introduced and although the knife-edge arrangement has been a little balky at times, I have found that this arm has stood up to long periods of laboratory use. My current choice in arms would be the SME 3009 R. The headshell in this model is removable, which helps considerably if you use several different cartridges.

The increased interest in 78s has also been noted by several turntable manufacturers, and Thorens offers the TD-126 IIIB, an excellent choice. If you are fortunate, you may be able to find a Lenco variable-speed turntable, which can, if need be, wind at speeds up to 90 rpm. Collectors know the value of the Lencos and they are becoming rare. Dual's CS-608 is a three-speed automatic turntable which I had a chance to check for a review last year. It is a moderately priced machine, sporting a lightweight arm with the Dual anti-resonance filter. The controls are placed conveniently outside the dust cover, and its styling allows it to blend unobtrusively with other hi-fi components. Depressing either of the two speed buttons gives a choice of normal $33\frac{1}{3}$ or 45 rpm; depressing both buttons selects the 78-rpm speed. A cartridge is supplied with the turntable, and a stylus for 78-rpm recordings, using a 2.6-mil tip, is available. The Dual machine is unique because it is the first hi-fi turntable in several years to have the 78-rpm option and a moderate price.

A turntable rotating at the correct speed and a cartridge with a 2.6-mil stylus are the very minimum requirements for playing old 78 records. We live in a world which has the luxury of international standards, and because an item is of a standard size today, we tend to think that it was always so. In the latter days of 78s, the groove was standardized so that today's "standard" styli could trace a new 78 groove without touching bottom. At the same time, the radius was small enough to allow the stylus to ride in the groove without jumping. This is a great idea, provided that the disc is in perfect shape and has been cut to the standard shape.

Unfortunately, today's standard sty-

lus tends to float in the bottom of the wide, shallow Pathé record grooves and ride on the top of the narrow-groove Edison high-speed discs. One remedy is to use a truncated tip, which allows contact with the groove walls but does not reach the noisy groove bottom. In addition, even if the groove was cut to present-day standards, a steel needle soon chops out its own path, leaving a crop of filings embedded in the walls for good measure. The truncated tip and a selection of styli of differing radii should be part of the toolkit of a serious audio historian. Perfect tracing is the key to good sound from old records just as in the very latest digital types. The GIGO rule still holds: no amount of subsequent treatment can remove the distortion caused by poor groove tracing.

The steel needle was not the only groove-tracing device in use. Both diamond and sapphire were frequently employed and in fact, Edison employed a 0.75-mil diamond tip for his Blue Amberol cylinders. It is fairly safe to assume that all the discs you are liable to meet will be either hill-and-dale or lateral types. Victor Emerson, at the turn of the century, did introduce a cutter which produced 45-degree modulation in an attempt to produce a compatible record for both types of soundbox (and getting round Edison's strong patents on the vertical process), but the issue was very short-lived. It is fairly obvious that a standard stereo cartridge will reproduce both types, but there are two very practical objections. The first is that surface noise is a product of contact with the roughness of the groove wall and produces random motion in both the vertical and the lateral planes. A stereo cartridge responds to noise from all directions but produces the signal from only one. Consequently, the signal-to-noise ratio is unnecessarily degraded. The second objection is particularly important for laterally cut grooves.

The groove has always been cut by a chisel-shaped cutter, operating at a constant groove depth. Therefore, although the groove is always the same width along the radius of the disc, the effective groove width (in terms of what the stylus tip sees and must negotiate) varies, being widest at the

crest of the wave and narrowest at the zero crossings. This causes the stylus to ride up and down in the groove twice per cycle. The narrowing of the groove gives the name "pinch effect" to the consequent distortion, which is primarily second harmonic in nature.

Many solutions were found for this problem, all centered on eliminating the output in the vertical plane, and ranged from cartridges which were completely rigid vertically, and cartridges with a fairly rigid stylus bar on a pivot permitting only lateral movement, to long flat cantilevers which rode over the vertical movement without transmitting its effect, like a good set of shocks.

The easiest solution, since we are now blessed with a stereo cartridge, is to link the two positives and negatives together for lateral recordings and to parallel the two channels but with one side reversed for vertical discs. A switch can be installed at the base of the tonearm, or if you have two cartridges, the wiring change can be made in the headshell.

It is possible to use the stereo/mono switch and a phase reversal switch if one exists on the preamplifier, but not advisable. The unavoidable phase changes in the input section of the preamplifier tend to prevent complete cancellation between channels; the result usually sounds much cleaner if the connections can be made close to the cartridge.

The noise coming from the early discs is primarily caused by the material used for the pressing. The plastics industry was in its infancy at the beginning of the century, and the most ur-



Franklin D. Roosevelt
(CBS Photo)

gent need was for a hard material which would stand up to the pounding of the heavy soundboxes. Many materials were tried, from celluloid and hard rubber to Bakelite.

Shellac, a product of an insect native to India and the Far East, produces relatively quiet, smooth surfaces but is easily destroyed during the first few playings. Shellac in 78s was reinforced with Indiana limestone and Pennsylvania slate, materials calculated to resist wear and grind the stylus down to the shape of the groove. Bits of the needle, left behind in the groove, add to the overall noise, and the method of harvesting the shellac left a lot to be desired. The insects (*Carteria Lacca*) were scraped off twigs and were shipped, along with bits of bark, sand and other tropical rubble, to be ground up for the basic record material. In addition, when shellac became more difficult to obtain, up to 25% reclaimed material, including the record labels and any bottles that happened to be thrown in with the day's garbage, was mixed in. The quality of the record material was variable, to say the least.

The whole pressing and reproducing process naturally left a considerable amount of debris in the groove. Not all of it will be steel filings. Careful music lovers used to use fiber or thorn needles to protect the grooves, and custom-made jewel needles were available.

I once asked a record dealer for the best way to clean and restore old 78s. His reply was that the needle would push the dirt aside as it travelled the groove, so there was little need for cleaning. I did not have that reply in mind, since a modern cartridge, playing at one gram, would skate over the particles and so produce more noise.

The standard method is to scrub the records lightly with a mild detergent, followed by thorough rinsing. If records need sprucing up and have a lot of fingerprints, they might be cleaned with a window cleaning spray such as Windex. The important thing is not to do more damage to the records than has already been done.

I have a spare Watts Manual Parastat and have found that the nylon brush at the center does a fine job of dislodging debris. A mild detergent works very well, but if you wish to be really scientific, Discwasher's Special Shellac Formula, which has been developed specially for 78s, gives excellent results. If you use a brush or a felt pad for your 78s, label it clearly and keep it just for that purpose. If you accidentally use it on your vinyl discs, there is a risk of particles embedded in the fibers damaging the grooves.

Shellac discs are very fragile and broken records can be a problem. Edison made his Diamond discs a quarter inch thick, which helped to preserve them, but the thinner 12-in. Victors break easily. I asked my dealer friend how to mend a broken disc. Like a true salesman, he suggested that since his network of associates could probably locate a replacement within a few days, it would be a lot less trouble to

throw the pieces away. There is a solution for clean breaks, however. Two pairs of hands are needed for the repair, which only works if the grooves are intact.

Place the pieces on a flat surface and fit them together carefully. In most cases it can be done so that the crack is nearly invisible. Holding the parts together with a slight pressure, apply a spot of instant cement, Krazy Glue for instance, to the outer guard band and to the center near the label, being careful to avoid the grooves.

Capillary action will draw the glue down into the crack, where it will set. Do not be tempted to put the glue on the broken edges before fitting them together because the glue's extremely rapid setting makes it almost impossible to make any fine adjustments. When the first side has been glued, turn the record over and apply the glue to the other. With a bit of care and a lot of luck, the crack will be largely inaudible.

Once the purely mechanical aspects of providing the correct turntable speed and stylus type have been settled, the more interesting part of adjusting the sound quality can begin.

The early presses were not sophisticated and the temperature of the machine, the pressure, heating and cool-

Fig. 1—Recording characteristics used by various producers of 78-rpm records and their deviation from the present-day RIAA curve.

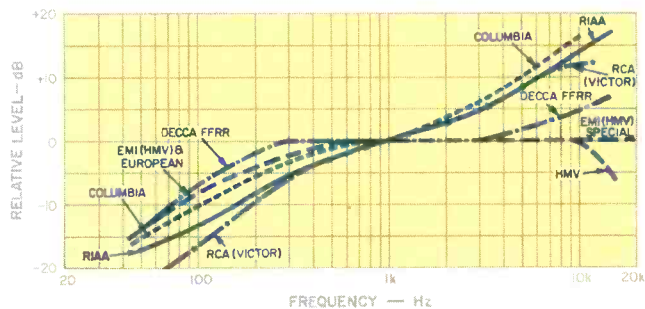
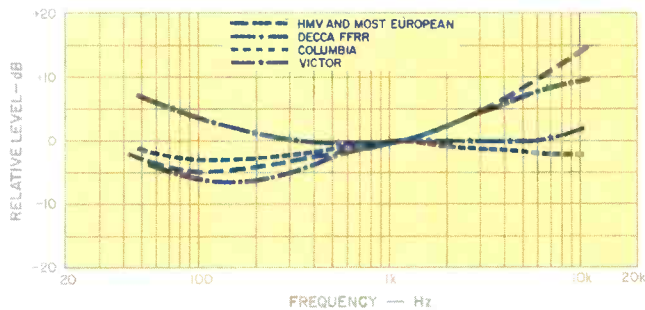


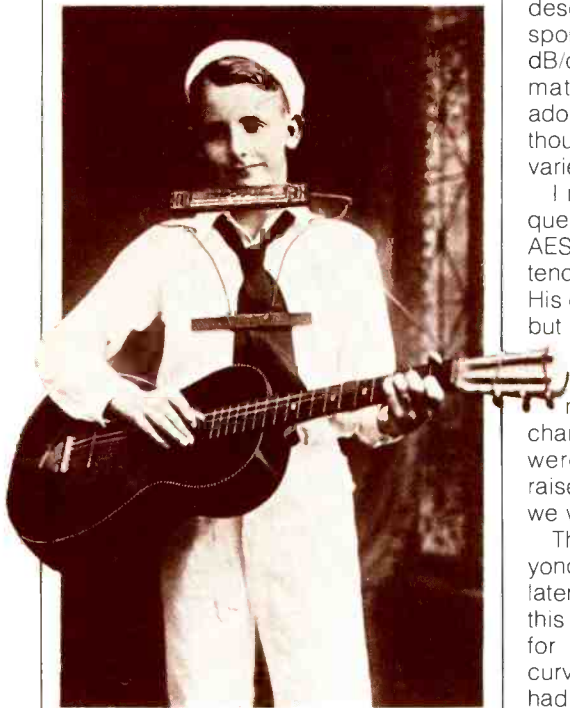
Fig. 2—Tone control or equalizer settings required, after RIAA "de-emphasis," to flatten the various recording characteristics.



The Dixie Duo, Eubie Blake and Noble Sissle; below, Les Paul at age 11.

ing cycles were completely under the control of the individual operator. Conditions could change during the course of the day; the ambient temperature could change, and operator fatigue could alter the cycle time. Because of these factors, the tone quality of the records used to vary, even when taken from the same batch. To add further to the confusion, the recording characteristics were not formalized until very late in the history of 78s—almost with their dying gasp, in fact. This requires either a very forgiving ear or a preamplifier capable of six or seven different equalization curves.

Every 78-rpm record will require its own tone control settings and special treatment. You might even find that two different styli are needed to extract the best sound from the groove. The easiest course is to tape your results once you are satisfied with them. Be sure to connect the deck to an EQed output of the preamplifier, since the normal connection bypasses the tone control in many preamps. The correct frequency equalization is just as essential for 78s as it is for vinyl discs. The difference is that there was no general agreement on which curve should be adopted. Today we have the luxury of being able to press the button marked



“phono” and know that any record made during the last 25 years will be equalized to within a dB or so of the nominally flat frequency response required by the rest of the system.

In their classic paper on electrical recording in 1926, Maxfield and Harrison pointed out the need to record at constant velocity at low frequencies to conserve space, and to pre-emphasize the highs to improve the signal-to-noise ratio. The recording system they described had a flat frequency response extending out to 6 kHz and a 6 dB/octave roll-off starting at approximately 250 Hz. Most companies adopted this, particularly in Europe, although the turnover frequency was varied between 200 and 300 Hz.

I raised the question of turnover frequency with a fellow member of the AES whose recording experience extended well into the days of the 78s. His comment confirmed my suspicions but did not help my search for useful standards.

“We adopted 250 to 300 Hz as a rule,” he said, “but our recording characteristic depended on what we were trying to do. Sometimes we raised the turnover to 500 Hz or more if we wanted a quieter recording.”

The hill-and-dale records went beyond 6 kHz in 1926, as did some of the later acoustical lateral-cut discs, but this can be taken as the starting point for the early Victor's. The standard curve, published by HMV in Europe, had a 250 Hz roll-off and was -3 dB

at 13 kHz, with the special recordings extending to 20 kHz.

When these records are played back using equalization intended for stereo discs, the high frequencies require a considerable amount of boost to compensate for the RIAA roll-off, and the difference in the bass turnover frequencies causes a rise in output of about 6 dB between 100 and 200 Hz. The Decca Record Company adopted the treble pre-emphasis suggestion and boosted the highs by 6 dB at about 12 kHz and used a turnover frequency of just under 200 Hz.

In the United States, the high frequency pre-emphasis was adopted wholeheartedly, and a characteristic very similar to the RIAA was used above 1 kHz. Columbia used a turnover frequency of 300 Hz, but Victor used about 600 Hz.

Figure 1 shows the recording characteristics plotted in the normal way for the most common European and American records, and for the sake of comparison I have included the RIAA curve. Figure 2 is a more useful adaptation of Fig. 1. I assumed that the regular RIAA equalization would be applied to the record and, by showing the difference between the RIAA and the nominal 78 curves, obtained the control settings required to bring the 78 discs back to a flat output. For instance, the 250 Hz turnover frequency used by HMV produces $+5$ dB with respect to the RIAA curve when referred to 1 kHz, and so requires a re-



The original Benny Goodman Four at a recent Newport Jazz Festival (Photo: George Gilmore); below, The Mills Brothers (CBS Photo).

duction of 5 dB at this frequency. The high frequency lift is quite beyond a current preamplifier, although the full lift, without a steep cut filter to remove the worst of the surface noise, would be intolerable.

The serious audio archaeologist will find that a separate equalizer is essential to the restoration of old discs. A single octave equalizer is only of limited use, since in addition to compensating for the different record characteristics, a sharp band-stop filter is extremely useful for removing the resonances and blasting effects which seemed to abound. A $\frac{1}{2}$ -octave graphic equalizer is much more useful since the visual display will allow you to set the equalization to the curves of Fig. 2 very easily and the bandwidth of the system can be adjusted to suit the frequencies actually recorded. There is no point in following the theoretical curve out to 10 kHz if there is only needle scratch. My most useful piece of equipment for the restoration of the sound is Technics' SH-9010 Stereo Universal Equalizer. There are five bands on this unit, each band capable of being shifted from $\frac{1}{3}$ to 3 times the nominal frequency. The bandwidth can be altered so that the Q factor ranges from 0.7 to 7.0, and the boost or cut is variable over a range of 12 dB. If five overlapping

bands are insufficient, then the channels can be cascaded to give 10! One side can be used for accurate equalization, and the other can be used to chase out resonances. The disadvantage of this machine is that I found it so much fun to use that I spent more time setting it up than listening to the records!

Expanders have their uses, and of the currently available units I would suggest the dbx 3BX. Expansion should be used with caution to avoid unnatural effects, but when used discreetly in the highs, a lot of the hiss can be tamed. You might find the compression feature an advantage. In the early days of acoustical recording, some of the singers used to lean towards the horn when they were belting out the high notes. If these coincided with the resonances in the horn, an unnatural blasting effect occurred. This can be tamed to some degree by compression. It seems that the recording engineers of those days had to resort to manual compression. If the soprano would not allow for the limitations of the machine, the engineer would sometimes rush out just before a crescendo and haul her away from the horn!

I have also found Phase Linear's Model 1000 Series II noise-reduction system very useful for removing the hiss. The auto correlator system exam-

ines the frequency content of the signal as it passes through the preamplifier and reduces the bandwidth for low-level notes, so that the hiss is removed. At higher levels, where the hiss would be effectively masked, the bandwidth remains untouched. The threshold of operation can be adjusted, which makes the unit a very useful tool for restoration. I found that I had to approach the expansion feature with some caution, since it operates over the entire band and can bring out the clicks and pops. But then you can always add a click and pop remover.

I have been secretly disappointed recently. Hi-fi has approached perfection so closely that tinkering at home seems pointless. It was a thrill to be the first person on the block with a home-made electrostatic speaker and a Williamson amplifier, and this era is certainly long since passed. I am familiar with digital techniques and am looking forward to living with a DAD player and a digital cassette machine. I admire the perfection in audio which they promise and look forward to being freed from the need to worry about the quality of my signal source. But, you know, tinkering with those cranky old discs has brought a whole new dimension to audio. It is spelled F U N. And that, to me, is what a hobby should be about. A



Cybernet sheds light on Digital Audio Disc Players... WITH LASER TECHNOLOGY

Another technological breakthrough in the Kyocera Series

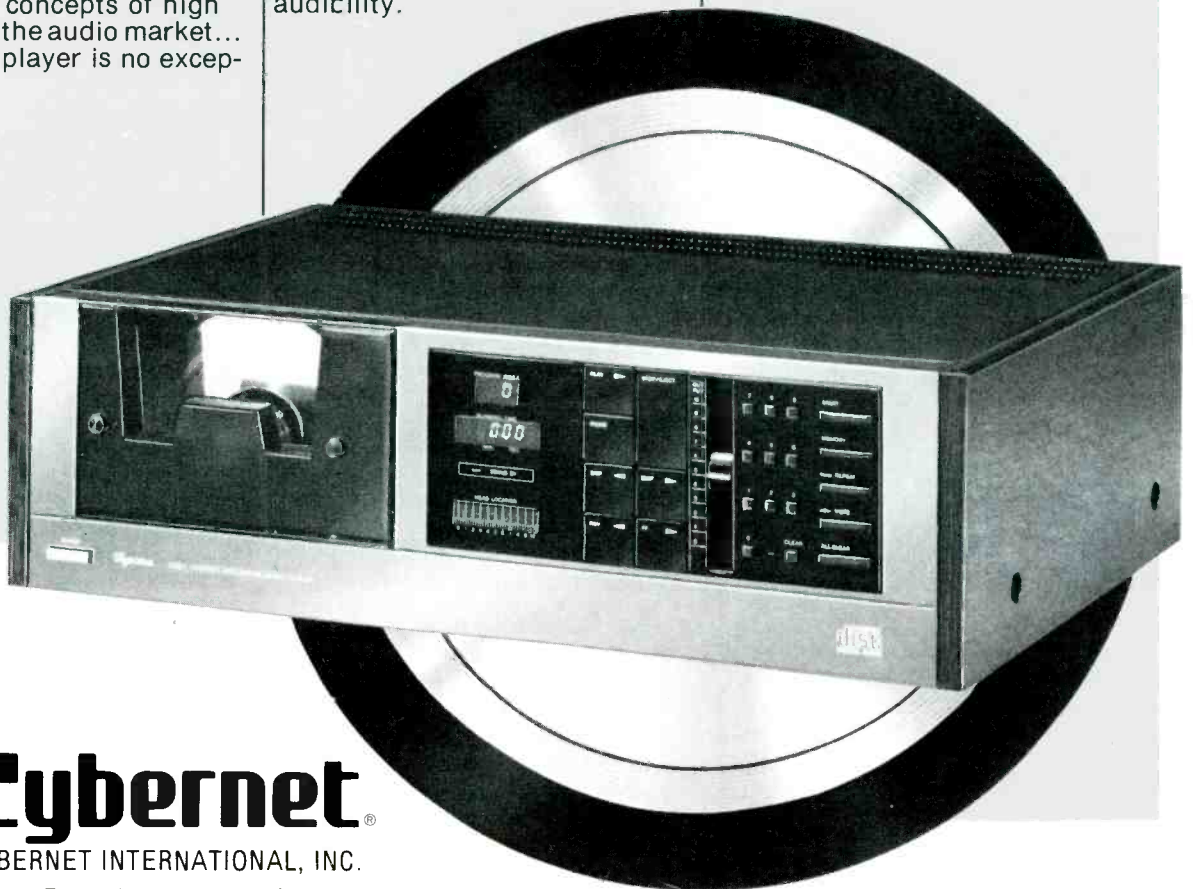
Recently there has been a lot of stimulating conversation about the newest breakthrough in audio technology...the Digital Audio Disc player (DAD). An innovative concept which utilizes a miniature 4 $\frac{3}{4}$ " diameter encapsulated metallized disc capable of being programmed with over sixty minutes of stereo recordings.

Until now, the talk has been more speculative than factual and production has been limited to laboratory prototypes and demonstrator models. Yet speculations and promises are not the areas that have enabled Cybernet to become a leader in bringing new concepts of high technology to the audio market... and the DAD player is no exception.

Our new Model DA-01 Digital Audio Disc Player utilizes the proven principles of laser / optical scanning found in quality video disc systems, in which there is no contact between the disc and the playback head. By eliminating needle or head drag, wear and the inherent distortion are virtually eliminated. The DA-01 player provides all the superb quality for which digital audio is becoming known, with a full 90dB dynamic range; frequency response of 20-20,000Hz; 90dB S/N ratio and an impressive 90dB channel separation. Harmonic distortion at less than 0.05% is beyond the limits of audibility.

The convenience features are remarkable. Encoded programming information combined with feather touch electronic controls enables program repeat; scanning; pause; skip; rewind and programmable electronic memory index. A functional LED digital panel displays program, running time and head location.

In all, the DA-01 player fulfills what DAD promises, with a quantum leap in digital audio technology. Look for it soon at leading audio retailers.



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ONE-BRAND SYSTEMS

Sansui

6600

SUPERCOMPO



In an effort to cover more equipment in our relatively limited space, with specific attention to areas where there is increasing consumer interest, we inaugurate Audio Mini Reviews of One-Brand Systems. In these reviews we will focus on the relative worth of features, with an eye on the cost/value ratio; discussion of specs will be kept to a minimum, but we will always keep in mind the engineer's axiom—to

measure is to improve. We invite your comments.—E.P.

Sansui, as with many other makers of audio equipment, gained its reputation by turning out scores of fine tuners, amplifiers, cassette decks, speakers, and turntables over the many years of its existence. Now, however, Sansui has turned its attention to those music lovers who would rather not have to pick and choose among

scores of products, those who simply want a well-matched, compatible set of components, preferably already housed in an appropriate equipment cabinet. Perhaps most basic of all, these folks want a system that can be assembled and interconnected easily.

Such a system is Sansui's Super Compo Model 6600. It consists of an integrated amplifier (Model A-7); a separate tuner (Model T-5); an auto-

matic-arm-return, belt-driven, single-play turntable (Model FR-D25), already equipped with an induced-magnet phono cartridge (Model SC-37); a cassette deck (Model D-150M); a pair of simulated walnut-grain, three-way speaker systems (Model S-47), and a simulated walnut-grain cabinet on casters (Model GX-75A) for housing everything except the speakers.

Speakers and, to a lesser extent, phono cartridges are areas which strongly influence the system's overall

musical balance, and here the experienced audiophile will spend more of his available dollars because pay-back, in terms of sound quality, is so large. Purchasers of this system can buy it minus the speakers if they prefer, and since so much depends on this choice, we strongly suggest some comparison listening to other speakers. While Sansui has eliminated a troublesome task by factory-installation of the phono cartridge, this is another area where the buyer may wish

to exercise an option since the cartridge included will sound rather bright due to its increased treble output. This brightness will, however, be a good thing if the listening room has lots of drapery, a plush rug, or overstuffed furniture: Such furnishings soak up treble notes and can easily destroy musical balance.

While the integrated amplifier has most controls common to such a unit (a program selector, bass and treble tone controls, master volume control, balance control, and a pair of tape monitor switches), there are two controls normally found only on much higher priced equipment. The first is a record selector switch, which enables recording one program source, such as a tuner, while listening to a different program source, such as a record. The other useful but rarely found control is a *continuously variable* loudness control. Unlike fixed-position loudness switches, this control permits correct compensation when listening at lower levels, which yield audibly "thin" bass and muffled treble. The control lets you correctly adjust these tones so that they are balanced with mid-frequencies. The flashing power-level indicator lights are also worthwhile in that they let you know instantly if you are listening at levels that tax the amplifier's capabilities and lead to distortion.

As the rating chart shows, the amplifier section more than met its power and distortion ratings, while preamplifier hum and noise (signal-to-noise ratio) was also a bit better than claimed. Frequency response of the phono section was off by a bit more than claimed, but this was actually due to the loudness control feature praised a moment ago. Even set to the "Flat" position, it still adds a bit of bass boost (about 1 dB, which is barely audible) and therefore affects overall response of all program sources fed through the amp-preamp combination.

I liked the simplicity of the tuner's front panel. Signal strength is indicated by a series of tiny lights at the left of the well-calibrated dial scale, while center-of-channel tuning, so critical to proper FM reception, is indicated by a pair of tiny arrows which move with the illuminated pointer. As you get close to a station, an arrow tells which way to tune to complete the process perfect-

ONE-BRAND SYSTEM RATINGS

Manufacturer: Sansui **Model:** Super Compo 6600
Overall Rating: Worth the asking price.
Dimensions: Cabinet, 18-15/16 in. W x 37⁷/₁₆ in. H x 14³/₄ in. D.
Price: \$1,300.00.

Component & Specification	Claimed	Measured	Rating
<i>Power Amp Section (A-7)</i>			
Power/Channel, watts	45	48.5	🎵🎵🎵
Rated THD, %	0.05	0.03	🎵🎵🎵
<i>Preamp Section (A-7)</i>			
Freq. Resp., Phono, dB	RIAA ±0.5	RIAA ±0.75†	🎵🎵🎵
Phono S/N, dB	80	81	🎵🎵🎵
<i>FM Tuner Section (T-5)</i>			
50-dB Quieting, Stereo, dBf	37	41	🎵🎵
S/N, Stereo, dB	72	63 (78 mono)†	🎵🎵🎵
THD, Stereo, 1 kHz, %	0.15	0.20	🎵🎵🎵
Separation, 1 kHz, dB	40	40	🎵🎵🎵
Ait. Chan. Selectivity, dB	60	60	🎵🎵🎵
<i>Turntable/Cartridge Section (FR-D25 & SC-37)</i>			
Freq. Resp. (Hz-kHz), ±dB	20-20	20-20, +3.2, -0	🎵🎵
Separation, 1 kHz, dB	20	25.2	🎵🎵🎵
Rumble, DIN B, dB	65	67	🎵🎵🎵
Wow & Flutter, % w rms	0.03	Unmeasurable	🎵🎵🎵
<i>Cassette Recorder Section (D-150M)</i>			
Freq. Resp., ±3 dB, Hz-kHz			🎵
Normal Tape	30-14	29-13.5	🎵🎵
Chrome Tape	30-15	29-15	🎵🎵
Metal Tape	30-15	26-15	🎵🎵
S/N, with NR, dB	68	67.2	🎵🎵🎵
Wow & Flutter, % w rms	0.05	0.043	🎵🎵🎵

Rating System

🎵 = Poor; 🎵🎵 = Good; 🎵🎵🎵 = Very Good; 🎵🎵🎵🎵 = Excellent; 🎵🎵🎵🎵🎵 = Superb.

General Comments

Power Amplifier: Sound quality beyond reproach, could have better circuit protection. **Preamp:** Slight bass emphasis (see text), superb loudness control arrangement. **Turntable & Cartridge:** Slight treble peak (see text), simple but reliable construction. **Tuner:** FM very good, AM acceptable; easy-to-use tuning indicators. **Cassette Recorder:** Suggest using premium tapes, tape selection system a bit confusing. **Overall Rating:** 🎵🎵🎵

By purchasing separate components, it would be hard to duplicate the 6600 Super Compo's performance and features at a comparable price.

ly. There are few other controls: AM and FM selector buttons, a muting/stereo switch, the large tuning knob, and a power on/off switch. As do so many tuner makers, Sansui supplies a simple wire dipole antenna; if you are really serious about wanting superior FM reception, I strongly recommend

substitution of a good outdoor FM antenna.

You'll note that the signal-to-noise ratio shown in the rating chart (63 dB) fell short of the 72 dB claimed, but I hasten to explain that most of the extraneous signal read on my test instruments was not audible noise in the

usual sense, but 19,000-Hz signal which is part of the stereo pilot signal used in FM broadcasting. Normally, I would criticize such a high level of residual 19 kHz, because it can affect tape recordings made from FM programs. It can also upset operation of noise-reduction systems, such as Dolby, found in most tape decks. Fortunately, in this case, Sansui has built a filter into the recorder, so the high level of 19 kHz coming from the stereo FM tuner does not harm recordings made from FM programs.

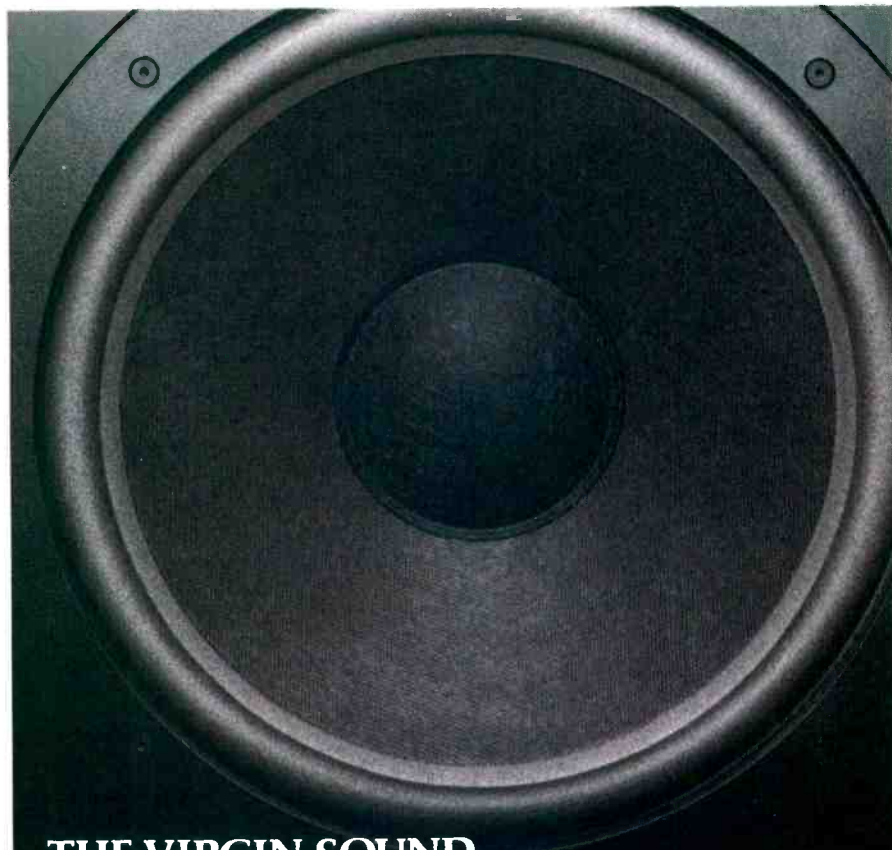
The D-150M cassette deck is able to handle the three most popular tape types properly, but even with metal tape, overall frequency response cannot go beyond 15,000 Hz because of the 19,000-Hz filter which is always in use. For most ears, that's adequate, and the excellent signal-to-noise ratio obtained when the Dolby NR system is in use, as well as the very steady tape motion (note the extremely low wow and flutter of 0.043%—even better than the 0.05% claimed), make this an ideal deck in its price class. Somewhat simpler tape selection switching (it's too easy to hit the wrong combination of buttons) would have made things a bit easier for the user, but that's relatively minor.

The FR-D25 turntable is dependable and easy to operate with its automatic arm return but is otherwise devoid of the frills which tend to raise prices. I was not fully satisfied with the cartridge included in the package. Even connected to the phono inputs of the A-7 (where presumably optimum interface should exist), the cartridge exhibited a high-end peak (excessive treble brilliance). Secondly, the cartridge requires a tracking force of 2.5 grams—more than I like to apply to records these days. I felt that the tonearm of the turntable itself was capable of handling better cartridges with lower tracking forces and, in fact, I substituted a medium-priced pickup for the one supplied. The results were good.

Purchasing separately, it would be hard to duplicate the performance and features of the Sansui 6600 Super Compo system at its price—even if you discard the supplied cartridge. Hi-fi experience counts—and Sansui has it!

Leonard Feldman

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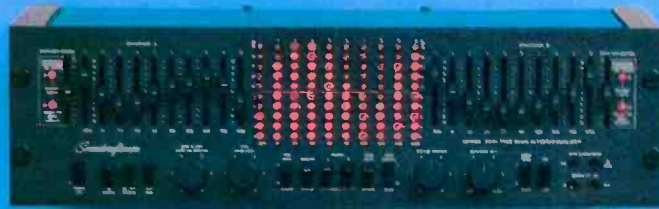
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exclusive **Differential/Comparator**[®] circuitry which eliminates the possibility of "clipping" the music signals as they pass through this crucial link in the component chain. The **Differential/Comparator**[®] is also utilized in our Scan-Alyzers to guarantee absolute accuracy in the room analysis process. Adequate headroom is thus assured. The Soundcraftsmen **Class H** "signal-tracking" and **POWER MOS-FET** amplifier designs provide substantial dynamic headroom while producing up to 250 watts* of **continuous** power, with vanishingly low noise and distortion.

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*250 watts per channel @ 8 Ohms, 20Hz to 20KHz with no more than .09% THD. Hardwood end panels shown available at slight extra cost.

1

HITACHI PCM-V300 DIGITAL AUDIO RECORDER

Manufacturer's Specifications

Signal Mode: NTSC TV format.

Binary Encoding Format: EIAJ Standard (EIAJ STC-007).

Number of Audio Channels: Two.

Sampling Frequency: 44.056 kHz.

Quantizing: 14-bit linear quantization.

Error Detection and Correction: 16-bit CRCC and P & Q correction words.

Frequency Response: 20 Hz to 20 kHz, ± 0.5 dB.

Dynamic Range: More than 85 dB.

Harmonic Distortion: Less than 0.01% (1 kHz).

Wow and Flutter: Below measurable range.

Record/Playback Time: 120 minutes with T-120 (VHS) tape cassette.

Line Input Level: 300 mV rms.

Line Output Level: 1.0 V rms.

Digital Dubbing Output: 1.0 volt, p-p.

Headphone Output Impedance: 8 ohms.

Power Requirements: 120 V, 60 Hz.

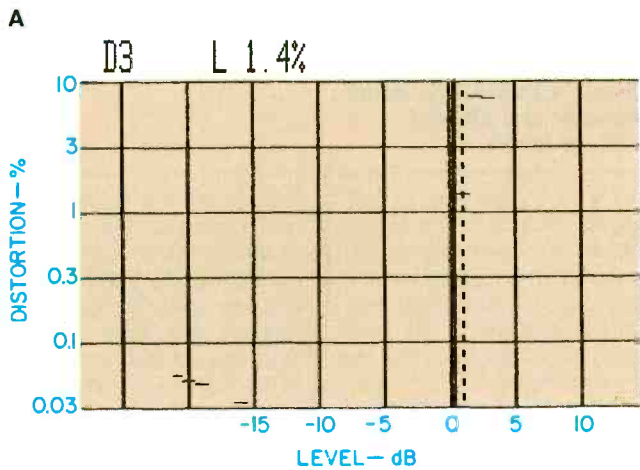
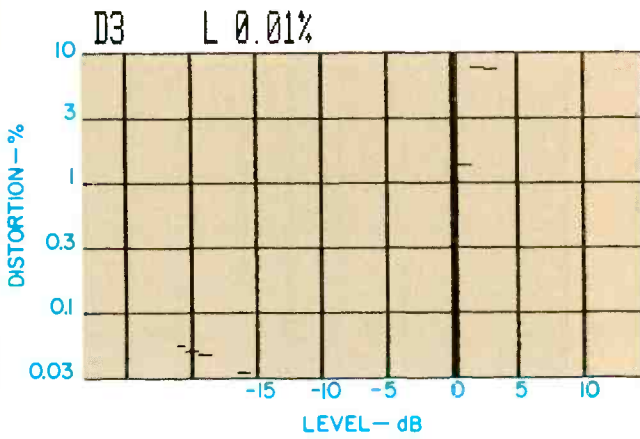
Dimensions: 17 $\frac{1}{8}$ in. (43.49 cm) W x 10 $\frac{5}{8}$ in. (26.98 cm) H x 12-1/16 in. (30.63 cm) D.

Weight: 41.8 lbs. (18.81 kg).

Price: Approximately \$3,200.00.



To make the job of editing a digital audio tape somewhat easier and more exact, Hitachi has devised an "Address Search" system.



A
B
Fig. 2—At 0-dB record level (A), third-order distortion produced by the PCM-V300 was 0.01%, but if record level goes over 0 dB by as little as 1 dB, distortion rises to 1.4% (B).

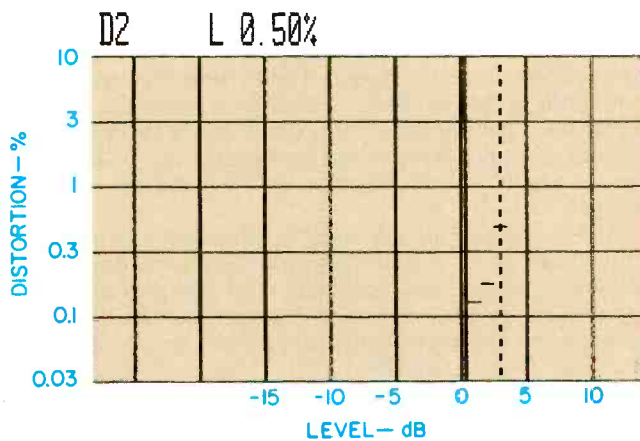


Fig. 3—Second-order distortion produced when recording level by +3 dB measured only 0.5% exceeding maximum

button identified as "After Rec," the purpose of which I was unable to determine. The main power on/off button is located to the left of these controls, and to their right is a mute button (for momentary muting while recording).

Further to the right is an "Address Search" button which works in conjunction with an "Address Counter" display, the regular four-digit tape counter display, and three "Address Search" setup touch buttons at the upper right of the front panel. As anyone who has operated a VHS-type VTR knows, trying to find an exact spot on a tape is not the easiest task in the world. To make the job of editing or electronically "splicing" a digital audio tape somewhat easier and more exact, Hitachi has come up with this clever address search system. Adjacent to the four-digit counter display is another four-digit display called "Address Counter." By means of three associated buttons, the user can set up this latter counter to show any four-digit number desired. When the "Address Search" button below the cassette compartment is touched, the tape will fast-wind in either direction until the main counter reaches the same number as the address counter. This feature is provided over and above the usual memory rewind, which, as with any VTR or audio recorder, only stops the tape transport at "0000" on the main counter. For added convenience, a button called "Shift" allows you to enter the setting shown on the main counter into the address counter's display without having to crank up to the desired number the hard way, one digit at a time. A counter reset button, buttons for choosing peak-hold or normal level meter indications, memory on/off and "Function" (NORmal or Digital-Dubbing) are arranged in the same row as the address and counter buttons; appropriate indicator lights within the display and meter area above tell the user at a glance just what functions and buttons have been depressed. Two rows of 16 LED indicator bars each serve as the record-level metering system for this unit and, as has been true of all PCM processors or recorders tested to date, an additional indicator flashes when 0-dB levels are exceeded, illuminating the word "Over." Useful range of the metering scales extends from an arbitrary 0 dB, or maximum safe record level, down to -40 dB.

A few additional controls and indicator lights are behind a small swing-door at the lower right of the front panel, near the stereo headphone jack. These include a rotary tracking control, a pre-emphasis on/off switch, a rotary control identified by the letters "DSL" (which, I am told, stand for Data Slice Level Control and have something to do with improving the machine's ability to detect digital data from a variety of tapes, even if they are recorded on other machines), and three indicator lights which flash when digital dropouts occur. Additional indicator lights at the very top of the unit tell when "P" and "Q" error correction is taking place, when pre-emphasis is being employed (for even greater signal-to-noise ratios than are otherwise obtained), when the output has been muted (because no tape or an improperly recorded tape is being played back), and when the dubbing function has been selected. A cassette eject button, dual-concentric record level controls, and a small output-level control complete the rather elaborate front panel layout of this unit.

The clarity and purity of sound using reference headphones with the PCM-V300 is difficult to describe properly.

The version of the PCM-V300 recorder I tested was equipped with pairs of line-in and line-out jacks on the rear panel, dubbing in/out jacks, and another pair of jacks labelled "Audio In/Out" whose function remained a mystery to me in the absence of an owner's manual.

Measurements

Just about all the measurements for the PCM-V300 were made using the Sound Technology Model 1500A tape tester. Figure 1 shows that record/play frequency response at 0 dB and -20 dB is almost perfectly flat from 20 Hz to 20 kHz. Note that the vertical scale has been expanded to 2 dB per division, as against the usual 10 dB per division. Had I not resorted to this expanded scale, the two response curves would have simply appeared as straight lines superimposed on the fixed scale lines of the graphs.

Figures 2A and 2B illustrate once again the nature of "overrecording" in a PCM or digital recording system. So long as recording level remained at 0 dB or lower, I obtained a third-order distortion reading of 0.01% (Fig. 2A). (If ultra-low recording levels are used, distortion tends to rise again, as can be seen by the increasing level of the "blips" at the lower left of the graph, which are visible beginning at around -15 dB record level and below.) However, if I went over the maximum record level even by 1 dB (Fig. 2B), third-order distortion jumps right up to 1.4%; by pushing even higher to +2 or +3 dB above the normal 0-dB record level, distortion would approach 10%, as can be seen by the appearance of the two "blips" near the top of the graph at the right.

While I normally don't measure second-order distortion on analog tape recorders (since third-order products dominate), I decided to measure that parameter for the Hitachi PCM recorder simply to gain some insight as to the nature of an overload recorded waveform. I was not surprised to find that even at a +3 dB record level, second-order distortion measured only 0.5% (Fig. 3), indicating the overload in a digital recorder tends to produce very much the same sort of "square-wave" clipping which is common in an amplifier when it runs out of power supply voltage. In this case, the digital system has simply run out of "words" with which to represent signal amplitudes higher than 0 dB. The waveform becomes "flat-topped," tending towards a square wave which, of course, is made up primarily of odd-order harmonics (3rd, 5th, 7th, etc.) with very little even-order harmonic content.

Overall signal-to-noise ratio, measured without any weighting curve, was 81.5 dB (Fig. 4). I should note, however, that what noise there was that contributed to this reading was primarily in the high-frequency region above 15 kHz. Even at 16 kHz, the actual spectral noise level for the third octave about that frequency measured 85.3 dB. Had I elected to use "A" or CCIR/ARM weighting for this measurement, S/N results would have been beyond the capability of the test instrument, in excess of 90 dB below reference (maximum) recording level.

Channel separation for the PCM-V300 was also far beyond anything attainable with an analog tape deck. In Fig. 5 I have plotted separation versus frequency; at 1 kHz, separation measured 71.5 dB between channels! Even at the 20-

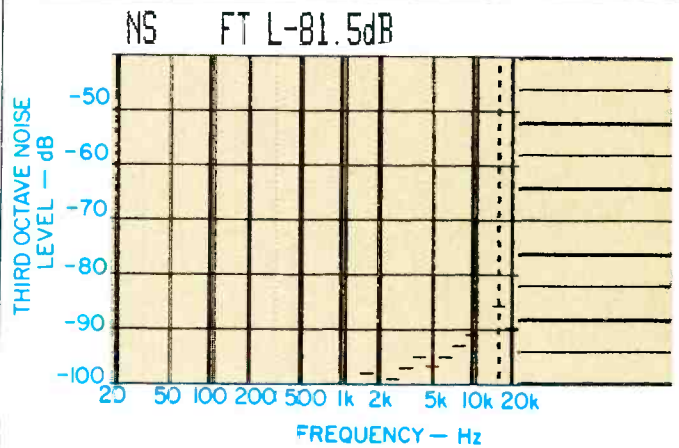


Fig. 4—Unweighted S/N ratio, referred to 0-dB record level, measured 81.5 dB with most of the noise contributions coming at high frequencies.

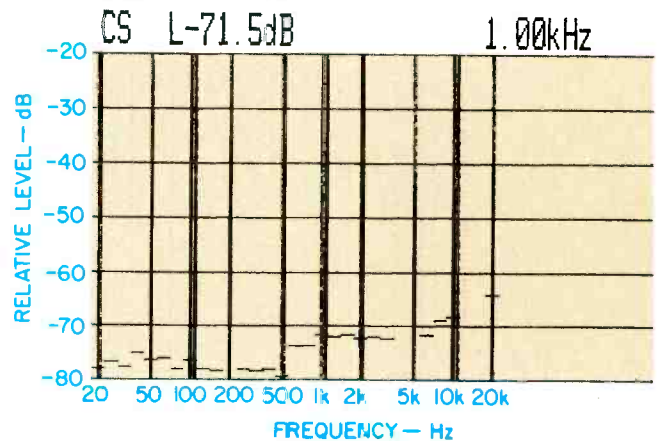


Fig. 5—Separation vs. frequency, Hitachi PCM-V300. At 1 kHz, channel separation measured 71.5 dB.

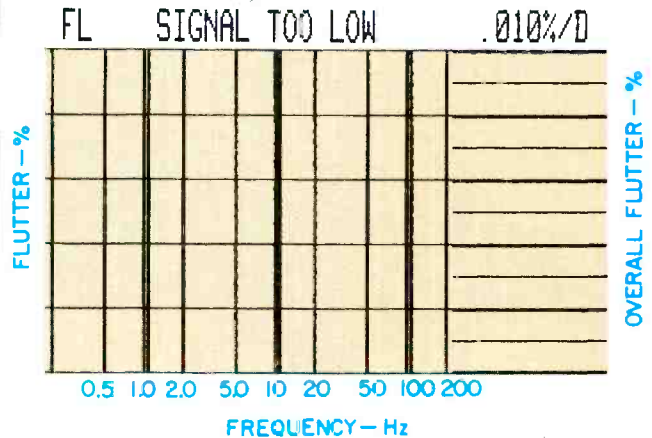
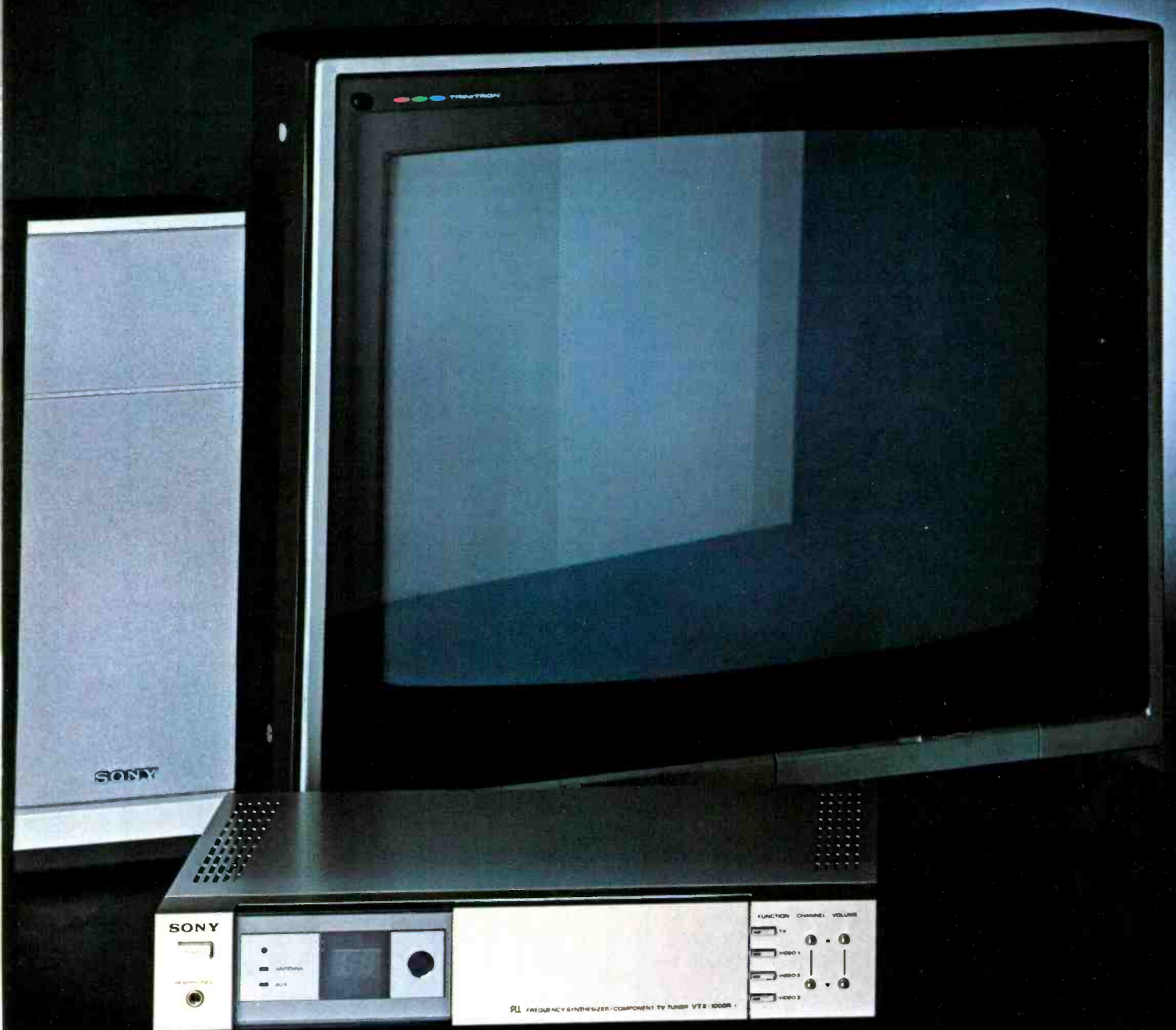


Fig. 6—As with all digital recording systems tested to date, wow and flutter for the Hitachi PCM-V300 was too low to measure.

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If there *are* deficiencies in the playback of digitally recorded music, they remain in the amplifiers and speakers we must use.

kHz frequency extreme, separation was still around 65 dB, and I suspect this reading may have been the result of capacitive coupling between the two output cables connected between the unit and the test instrument rather than actual crosstalk, which theoretically should not exist in any digital recording system.

Finally, in what is fast becoming a familiar "non-graph" in these tests of digital tape recording equipment, Fig. 6 shows that there was not enough wow and flutter in the system for my sensitive test instrument to detect. Note that the instrument *would* have been able to detect wow and flutter values as low as 0.01% if they had existed, but as in previous tests, the instrument simply responded by telling us "SIGNAL TOO LOW." I expect one of these days it's going to tell me to stop bothering with such unmeasurable inputs!

Use and Listening Tests

Hitachi was kind enough to send a tape containing a few selections of digitally recorded music. I listened to these through a top-grade set of reference headphones first, so as to eliminate all other analog reproducing equipment from the signal path except the necessary final transducers (the phones) and the phone amplifier stages that Hitachi elected to incorporate into their PCM-V300. The clarity and purity of sound obtained is so extraordinary that it is difficult to

describe properly. Suffice to say, it is excellent!

A reader recently wrote to me, criticizing my enthusiasm for digitally recorded and reproduced sound. This reader suggested that I sounded as though I had discovered a new plaything and was being childish in my exuberance for digital audio. Well, perhaps I am, but I would suggest that the first time *you* hear digital sound, reproduced over a fine audio component system, you may not be able to restrain your enthusiasm either. The musical selections, which ranged from classical, to electronic organ, to pop, were played again, this time over my reference speaker system, and I was equally impressed.

There are those who will argue that the steep filter requirements of the EIAJ Standard format (which cuts off all audio above 20 kHz at a very sharp rate) is a detrimental aspect of this type of recording, one that prevents absolutely "faithful" musical reproduction. If true, I must confess I can't detect any problems caused by this limitation. In fact, all things considered, digitally recorded music comes as close to the "real thing" as anything I have heard to date, and I suspect that if there *are* deficiencies, they remain in the amplifiers and loudspeaker systems which we must use to reproduce this new kind of program source—amplifiers and speakers which, for the foreseeable future, remain wholly analog.

Leonard Feldman

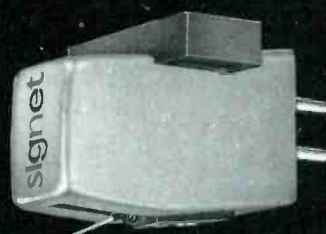
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2

McINTOSH MX-117 TUNER-PREAMP

Manufacturer's Specifications

FM Tuner Section

Usable Sensitivity: 11.2 dBf (2.0 μ V/300 ohms).

Fifty-dB Quieting Sensitivity: Mono, 19.1 dBf; stereo, 39.5 dBf.

Signal-to-Noise Ratio: 70 dB minimum, both mono and stereo.

Harmonic Distortion: Mono, 0.18%; stereo, 0.38%, maximum.

Alternate Channel Selectivity: 78 dB minimum.

Image Rejection: 100 dB minimum.

Stereo Separation: 45 dB minimum at 1 kHz.

AM Tuner Section

Sensitivity: 75 μ V (external antenna).

Signal-to-Noise Ratio: 45 dB min. IHF or 55 dB @ 100% modulation.

Adjacent Channel Sensitivity: 30 dB minimum.

Image Rejection: 65 dB minimum from 540 kHz to 1600 kHz.

Frequency Response: +0, -6 dB from 20 Hz to 3.5 kHz.

Preamplifier Section

Frequency Response: +0, -0.5 dB, 20 Hz to 20 kHz.

Rated Outputs: Main, 2.5 V; line, 1.25 V; headphone, 750 mV; tape, 250 mV.

Distortion: 0.02% max. @ 2.5 V output from 20 Hz to 20 kHz.

Input Sensitivity for 2.5 V at Main Out: Phono, 2.2 mV; high level, 250 mV.

Signal-to-Noise Ratio: Phono re: 10 mV in, 90 dB A wtd., 80 dB unweighted; high level re: 250 mV in, 100 dB wtd., 90 dB unweighted.

Input Impedance: Phono 1 and 2, 47 kilohms and 50 pF; high level, 47 kilohms.

Output Impedance: Main, less than 100 ohms; line, 600 ohms; phono, 8 ohms; tape, less than 200 ohms.

Equalizer Control Response: \pm 12 dB at 30 Hz, 750 Hz, and 10 kHz.

General Specifications

Dimensions: Panel, 16 in. (40.64 cm) W x 5-7/16 in. (13.81 cm) H; chassis, 13 in. (33.02 cm) D; knob clearance in front of panel, 1 1/4 in. (3.17 cm).

Weight: 24 lbs. (10.8 kg).

Retailer Reported Price: \$1,399.00.



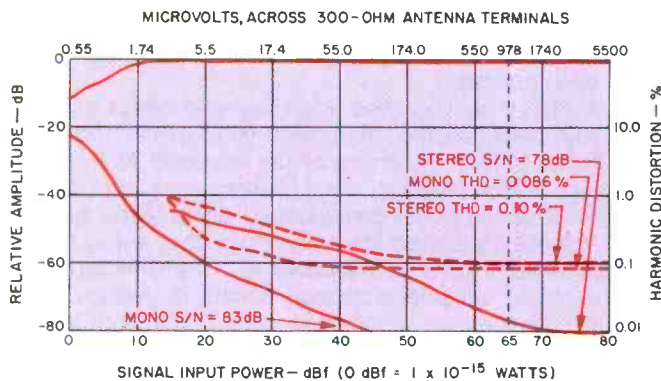


Fig. 1—Mono and stereo quieting and distortion characteristics, FM tuner section.

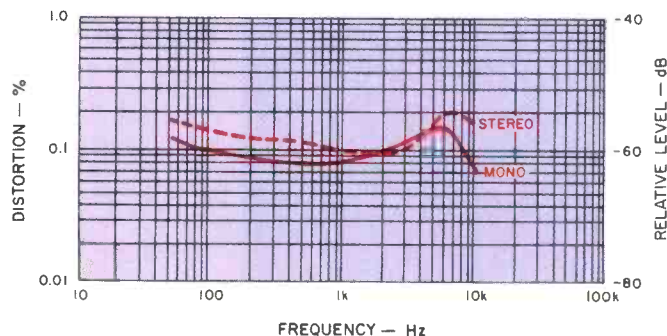


Fig. 2—Harmonic distortion vs. frequency, FM tuner section.

McIntosh Laboratory Inc. remains one of the few companies that continues to offer a high-fidelity component which incorporates both FM/AM tuner circuitry and preamplifier-control circuits. For those audio enthusiasts who do want to include radio (and particularly high-fidelity stereo FM radio) as a program source in their audio systems, this combination, on a single chassis, makes a great deal of sense; so much so, in fact, that I have always wondered why most other manufacturers have not offered this type of component. After all, it permits the user to choose any power amplifier he or she requires, allows for the incorporation of two turntables as well as two tape decks, and offers the versatility of a separate preamp-control unit while at the same time incorporating a top performing stereo FM/AM tuner.

Front Panel Layout

The MX-117 has the unmistakable McIntosh front panel look, with its anodized gold and black finish, gold/teal illuminated nomenclature, and exclusive PANLOC mounting system which has become a tradition on Mac equipment. A large, well illuminated cutout area of the panel contains the calibrated AM and FM dial scales, an evenly spaced "logging scale" (calibrated linearly in 0.1 increments from 0 to 10), seven small indicator lights (which denote program source selected as well as selection of interstation muting during FM listening), and a 14-LED solid-state tuning indicator system, consisting of 10 small dots arranged in a vertical row, a small bar which illuminates to denote stereo signal reception, and three bars which tell if you are tuned below, above or exactly to center frequency when listening to an FM station.

A conventional flywheel-coupled tuning knob is positioned to the right of the dial area. All remaining front panel controls are neatly arranged along the lower section of the panel. These include a six-position program source selector switch at the lower left (AUX, AM, FM, FM mute, phono 1, and phono 2), three tone controls to the right of center

(McIntosh prefers to call them equalizer controls, since they do divide the audio spectrum into three parts, as opposed to simple bass and treble tone controls which usually control wider swaths of frequencies), a dual-concentric balance and loudness control, and a master volume control at the lower right. Six pushbutton switches, plus a stereo headphone jack, are located to the left of center of the panel. A red button serves as the power on/off switch, while the contrasting black buttons handle such functions as tape 1 or tape 2 monitoring, tape copying from either connected tape deck to another, and stereo/mono selection. The loudness control arrangement found on the MX-117 is different from any I have previously encountered, and I shall have more to say about its action presently.

Rear Panel Controls

Stereo pairs of input jacks and a chassis ground terminal are located at the extreme right of the rear panel of the MX-117. Inboard of these are two pairs of "Main" output jacks, line-out jacks (designed to operate into 600-ohm loads), the tape-out jacks (for connection to up to two tape decks), and vertical and horizontal oscilloscope output jacks which may be connected to McIntosh's Maximum Performance Indicator or to any oscilloscope for observation of multipath phenomena during orientation and optimization of an FM antenna. A pivotable AM loopstick ferrite antenna is located at mid-panel, and next to it is an FM preselector switch which introduces additional tuned-circuit filtering for additional r.f. selectivity in the event of strong-signal overload conditions. Normally, this switch is left in the "out" position.

External AM, ground, and 300-ohm FM antenna connection terminals of the "push to insert wire" spring-loaded type are at the upper right of the rear panel, and alongside is a standard coaxial connector for use with 75-ohm transmission lines. Three switched and two unswitched convenience a.c. outlets complete the rear panel layout. Up to 600 watts of power can be drawn from all of these a.c. receptacles, combined.

The design of the McIntosh MX-117 is extremely well balanced such that all sections seem to work equally well.

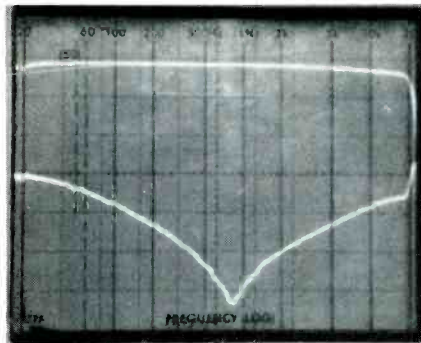


Fig. 3—Frequency response and stereo FM separation.

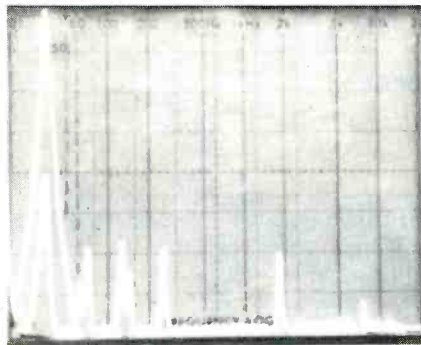


Fig. 4—5-kHz crosstalk components.

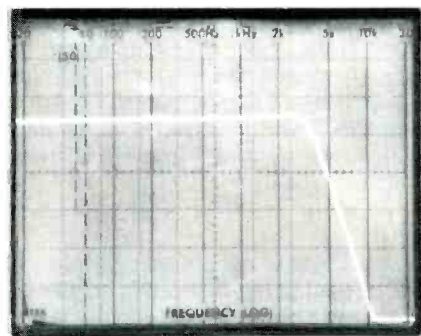


Fig. 5—Frequency response, AM tuner section.

Circuit Highlights

The FM front-end employs five sections of an 8-section variable capacitor (four, when the preselector switch is in the "out" position). As with most of the switch functions of the MX-117, even the preselector switching is accomplished electronically, with a d.c. voltage controlling pin semiconductor diodes which do the actual switching. Front panel selector switching, for example, simply switches control voltages which turn FET analog switches on or off. Since the actual switches are located near the input jacks, pickup noise and high-frequency losses are minimized compared with conventional mechanical switching arrangements.

A double-tuned MOS-FET r.f. amplifier and a balanced MOS-FET mixer are used in the FM front-end. A MOS-FET buffer amplifier is used between the local oscillator and the mixer. The oscillator is fine tuned by a varactor diode oper-

ated by a correction voltage derived from a patented McIntosh circuit called Automatic Frequency Lock (AFL) which turns on a "lock" voltage when perfectly centered tuning has been reached.

The FM i.f. section uses five integrated circuit amplifier and four piezo-electric filters, for a total gain of 140 dB. A full Foster-Seeley discriminator (as opposed to the more common Ratio Detector discriminator) completes the i.f. system. The composite demodulated signal feeds the stereo FM multiplex section, the heart of which is a new type of phase-locked-loop stereo decoder IC. This IC incorporates an automatic variable-separation control (to reduce background noise during weak-signal stereo reception) and tri-level digital waveform generation (which eliminates interference from SCA signals and from the sidebands of adjacent channel FM signals). Suppression circuits for 19 and 38 kHz are used to attenuate any residual carrier components following multiplex decoding. The FM muting circuit employed in the MX-117 operates by detecting ultrasonic noise and by sensing correct center tuning of the detector circuit. Muting of the audio signal is done with a positive-acting FET switching circuit.

The AM tuner section employs a three-section tuning capacitor and a special AM r.f. amplifier which maintains constant selectivity, constant sensitivity, and high image rejection across the entire AM band. An autodyne circuit is used for the AM mixer, and two double-tuned transformers are used in the AM i.f. section. A 10-kHz "whistle filter" is included in the AM tuner section, as is a two-section AVC filter for lower distortion at bass frequencies.

The phono preamplifier-equalizer section uses an IC operational amplifier whose differential input stage has been optimized for low noise and low distortion. The feedback network, which also provides RIAA equalization, employs 1% metal film resistors and 5% polyfilm capacitors. The gain of this preamp section is just over 41 dB. As for the unusual loudness control arrangement referred to earlier, it uses the same sort of IC operational amp as in the phono preamp stages. Two feedback loops are employed, one flat, the other conforming to the Fletcher-Munson equal-loudness contours. A potentiometer (the front panel "Loudness" control) placed between these loops makes it possible to select any curve from flat response to full loudness compensation. Once the contour is set by the user, it remains fixed and independent of the position of the master volume control. The equalizer-amplifier also uses a low-noise operational amplifier. Three other op-amps are arranged in the circuit equivalents of three tuned circuits, each resonant at one of the three equalizer center frequencies.

The output amplifier of the MX-117 is a push-pull, complementary Class AB circuit which uses a signal-inverting differential stage at its input. The amplifier drives the main and line outputs as well as the headphone jack. A turn-on delay circuit, using a light-emitting diode/light dependent resistor network that transmits no signal for two seconds after power is applied, also operates to turn off signals almost instantly when power is turned off. This arrangement serves to keep turn-on and turn-offs of the tuner-preamplifier transient-free.

The stations I normally receive with little audible background noise came through nicely, and dial calibration was as close to perfect as any I have seen.

The power transformer of the MX-117 is triple shielded (copper strap, silicon steel strap, and steel outer shell) for minimum hum and radiation. A full-wave bridge rectifier with 3330- μ F filter capacitors provide the d.c. voltages which are applied to positive and negative supply regulators. The dual-polarity 18 volts of d.c. needed for the low-level amplifier stages are supplied by IC regulators.

FM Measurements

Figure 1 is a multiple plot of mono and stereo quieting characteristics and mono and stereo total harmonic distortion characteristics (at 1 kHz) of the FM tuner section of the MX-117. Usable sensitivity in mono measured 10.8 dBf (1.9 μ V, 300-ohms) or a bit better than claimed, while in stereo, usable sensitivity was determined by the stereo switching threshold, which occurred at 15 dBf (3.1 μ V). The more important 50-dB quieting point was reached in mono at a very low signal strength of only 12 dBf (2.2 μ V), while in the stereo mode, that degree of quieting was reached at a signal input level of only 27.5 dBf (13.0 μ V), about as low as I have measured for any stereo FM tuner. McIntosh, as usual, continues to give ultra-conservative specifications. For the MX-117 they claimed only a minimum of 70 dB of signal-to-noise ratio in mono and stereo FM. In fact, the unit tested produced S/N of 83 dB in mono! Even in the stereo mode, where S/N is generally poorer, I still obtained a reading of 78 dB for an input of 65 dBf (approximately 1000 μ V); with somewhat stronger signals, the S/N improved even further, to 80 dB!

Distortion, too, was considerably better than claimed by McIntosh. Under strong-signal conditions (standard test conditions at 65 dBf), harmonic distortion for a 1-kHz signal at 100% modulation measured 0.086% in mono and almost as low, 0.10%, in stereo. Nor was this low level of distortion limited to mid-frequencies, as can be seen in Fig. 2, which plots distortion as a function of modulating frequencies.

In Fig. 3, a 'scope photo of a spectrum analyzer multiple sweep, the upper trace represents output from the left-channel main output with a left-only signal modulating my FM generator and sweeping from 20 Hz to 20 kHz. The lower trace was obtained by subsequently measuring the output of the right channel under the same modulation conditions, and it is therefore a measure of stereo separation versus frequency. The vertical scale is 10 dB per division in this and all other 'scope photos. At 1 kHz, separation measured an impressively high 55 dB (as opposed to McIntosh's conservatively guaranteed 45 dB); at the frequency extremes of 100 Hz and 10 kHz I measured 37 dB and 35 dB respectively. In Fig. 4, the sweep mode was changed, so that this time the sweep was linear from 0 Hz to 50 kHz, with the lightly visible scale corresponding to 5 kHz per horizontal division. The tall spike at left is a 5-kHz output from the modulated channel. Contained within that spike is the representation of the opposite (unmodulated) channel output, while to the right of these are various cross-talk products at harmonics of 5 kHz as well as any residual 19-kHz or 38-kHz subcarrier output products. All of these extraneous output products were at least 60 dB or better below the desired reference output level. Note, too, that separation at the relatively high 5-kHz frequency was ap-

Fig. 6—Control range of bass, midrange, and treble equalizer controls.

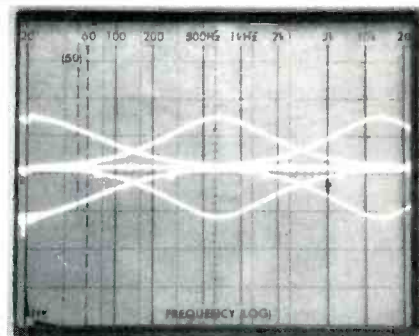
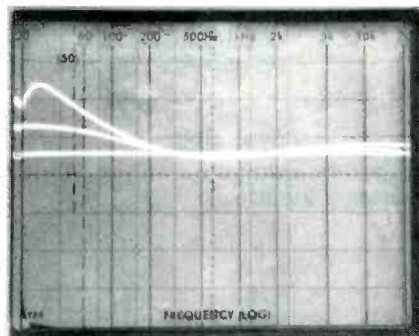


Fig. 7—Response obtained with various settings of the continuously variable separate loudness control.



proximately 40 dB (the difference in "height" between the two spikes at 5 kHz—one within the other—at the left of the display). Muting threshold was set to 17 dBf (3.9 μ V), an ideal signal level for this type of muting circuit since it allows the listener to enjoy reception of marginally quiet signals while still benefiting from the interstation muting feature. I measured an alternate channel selectivity of 80 dB for this sample. SCA rejection, under conditions of a modulated 67-kHz SCA subcarrier injected at 10% of total modulation of the main carrier, was a very satisfactory 60 dB below reference output level; stereo subcarrier product rejection was in excess of 65 dB.

Although it is not my practice to spend too much time testing the AM sections of AM-FM tuners (most of them are simply so poor in performance they are not worth bothering about), I do, as a matter of course, measure at least the frequency response. As can be seen in Fig. 5, I was pleasantly surprised to find absolutely flat response down to 20 Hz (most AM tuners tend to roll off bass severely below 50 to 100 Hz or so). While response to 3.5 kHz may not seem like "hi-fi" reproduction to most listeners, it is actually better than the result obtained from most of the AM sections of combination AM-FM tuners or receivers that I measure.

Preamp and Control Section Measurements

McIntosh Laboratory has chosen to publish their specifications relating to the audio portions of the MX-117 in a way that predates the new IHF/EIA Amplifier Standards, whereas I adhere to the newer Standards. Since this would make it difficult to compare published specs with my test results, I decided to make both types of measurements. In that way,

The AFL did not prevent zeroing in on weak stations located close to stronger ones—a complaint lodged against less sophisticated forms of a.f.c. circuitry.

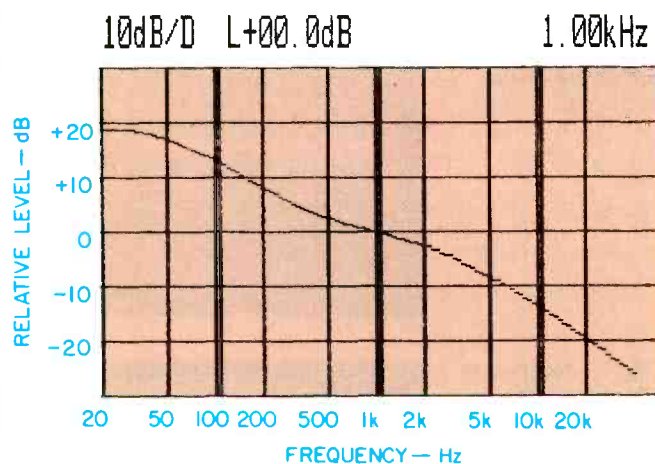


Fig. 8—Phono section response, using a constant input.

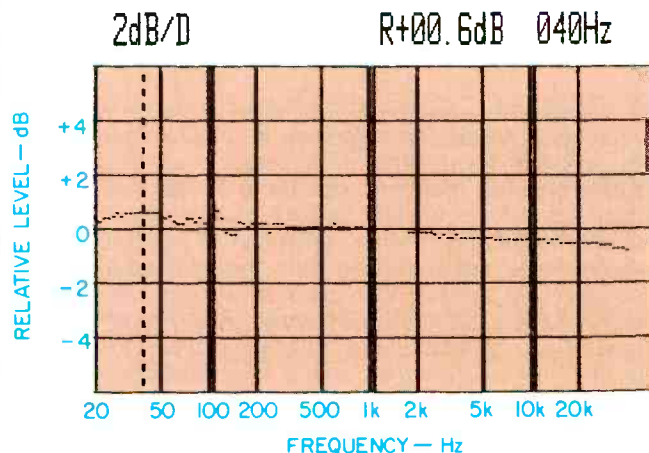


Fig. 9—Phono section response, using an inverse RIAA input. Note the expanded scale.

readers interested in comparing results to those obtained for other products where the IHF/EIA standard was used will be able to do so, and anyone wishing to compare results with McIntosh published specs can do so as well.

IHF/EIA phono input sensitivity measured 0.45 mV. This corresponds to almost exactly 2.2 mV as claimed by McIntosh for the higher 2.5-volt output. As for the high-level inputs, 50 mV of signal was required to deliver the reference 0.5-volt output, and this too corresponds exactly to the 250 mV spec called for by McIntosh for their referenced output level of 2.5 volts.

Figure 6 illustrates the range of control of each of the three equalizer controls provided on the MX-117. The frequencies at which the three equalizer controls are centered make for an extremely versatile range of control. The action of this unit's unique loudness control is illustrated in the series of response curves plotted by means of a spectrum analyzer and reproduced in the 'scope photo of Fig. 7. Note that only a moderate amount of treble compensation comes into play as the control is advanced towards more contouring of the signal.

Frequency response of the phono preamp-equalizer section of the MX-117 was plotted using a Sound Technology 1500A test instrument and an associated video printer. In Fig. 8 we see the familiar RIAA playback curve obtained by feeding a constant amplitude, swept-frequency signal into the phono inputs. The plot extends from 20 Hz at the left to 40 kHz, with double vertical lines indicating 100, 1000 and 10,000 Hz. The 0-dB reference has been established at 1 kHz, as shown. In Fig. 9 the vertical sensitivity of the plot has been expanded so that it is 2 dB per vertical division (instead of 10, as in the previous display). Also, the signal applied to the phono inputs has been subjected to inverse RIAA equalization so that, in theory, if perfect RIAA equalization were incorporated in the MX-117, a straight line would be obtained. As you can see, maximum deviation from this ideal was 0.6 dB at 40 Hz (where the dotted line cursor is positioned for a readout at the lower right of the display); moving the cursor to the maximum deviation in the high-frequency region produced a maximum deviation from absolute RIAA accuracy of only 0.5 dB at 18.5 kHz.

Signal-to-noise ratio of the phono section was first measured in accordance with the IHF/EIA standard, which calls for a 5-mV input at 1 kHz and adjustment of the volume control so as to produce an output of 0.5 volt. Under these conditions, and using an A-weighting curve, a reading of 84.4 dB was obtained. Spectral distribution of the noise, in one-third octave bands, is plotted in the frequency/amplitude grid of Fig. 10. When I adjusted input and output levels to correspond to the measurement method used by McIntosh (10 mV of input), a repeat of the S/N measurement plot as shown in Fig. 11 yielded a ratio of 91.9 dB, fully 2 dB better than claimed. Signal-to-noise ratios obtained via the high-level inputs (AUX 1, AUX 2, or Tape) were above 100 dB, or beyond the 1500A test instrument's measurement capability.

Distortion of the amplifier section measured far below the minimum specification supplied by McIntosh. For an input level of 250 mV (high-level inputs) and an output of 2.5 volts, THD measured 0.0017% and 0.0018% at 1 kHz for the left- and right-channel outputs respectively. For a 20-Hz signal input, results were 0.005% and 0.0049%, and for a 20-kHz input signal of the same amplitude, the distortion readings were 0.003% for either channel. Phono overload measured an acceptable 105 mV at 1 kHz. Overall frequency response was down by -1 dB at 14 Hz and 41 kHz, while the -3 dB points were observed at 10 Hz and 78 kHz.

Use and Listening Tests

As usual, McIntosh has come up with another fine high-fidelity component in the MX-117. The design is extremely

The intangible qualities of durability, care in assembly, and the almost custom craftsmanship distinguishing all McIntosh products are present here.

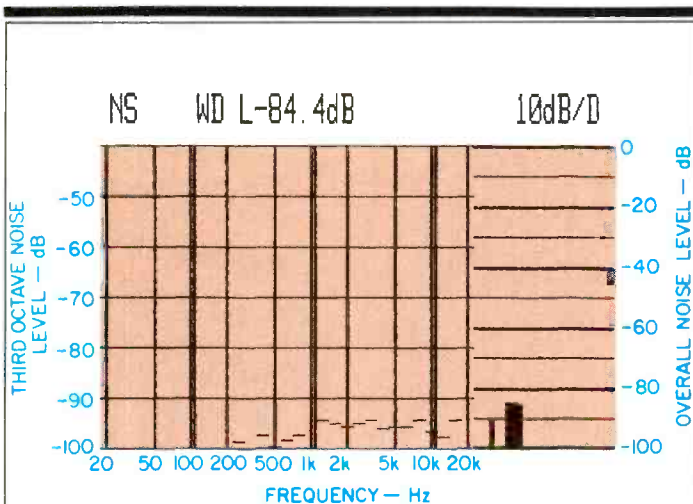


Fig. 10—Phono S/N measurement, using IHF/EIA input and output reference levels.

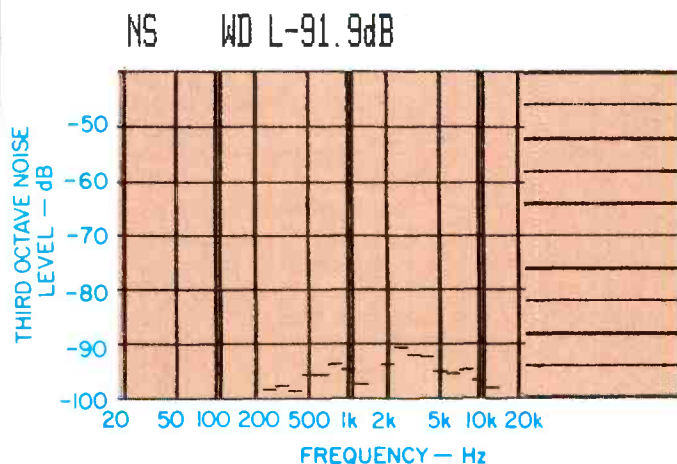


Fig. 11—Phono S/N measurement using McIntosh input level reference of 10 mV.

well balanced such that all sections of the product seem to work equally well. The FM tuner section was very sensitive. The stations I normally expect to receive with little audible background noise (plus a few I don't often receive in "listenable" fashion) came through nicely, and dial calibration was as close to perfect as any I have seen—from one end of the dial to the other. The Automatic Frequency Lock circuit, for all its fine "hold" on the stations I tuned to, did not prevent me from zeroing in on weak stations that were located very close to stronger ones—a complaint often lodged against less sophisticated forms of a.f.c. circuitry. Stereo separation

was excellent, and even when I expected to hear background noise when tuning to certain familiar weak stereo stations, the noise was far less obtrusive than expected. This, no doubt, was thanks to the inclusion of the automatic stereo noise suppression circuit with its variable stereo separation circuitry.

The phono preamplifier circuitry produced no audible hum or noise even when reproducing extremely soft passages from records having wide dynamic range. There was also no evidence of overload during peak groove excursions in audiophile records which I auditioned on the MX-117. Bass reproduction was tight and completely unclouded and open. Treble tones were reproduced with no trace of harshness or fuzziness and with excellent transient signal clarity.

To all of these attributes must be added the intangible qualities of durability, care in assembly, and the almost custom craftsmanship which distinguish all McIntosh products. Most McIntosh equipment owners consider these non-obvious qualities to be worth fully as much, if not more, than the more obvious features found in equipment made by their favorite hi-fi component maker. Under those circumstances, what appears to be a relatively high price for this tuner-preamplifier may be a bargain, after all.

Leonard Feldman

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3

EMPIRE 600 LAC PHONO CARTRIDGE

Manufacturer's Specifications

Type: Variable reluctance, moving iron.

Stylus: 0.3 × 3.0 mil diamond.

Frequency Response: 20 Hz to 28 kHz, ±1.75 dB.

Separation: 30 dB at 1 kHz, 17 dB at 12.5 kHz.

Recommended Tracking Force Range: 1 to 2 grams.

Static Compliance: 28.8×10^{-6} cm per dyne.

Load: 47 kilohms, 150 pF.

VTA: 20°.

Output: 4 mV at 3.54 cm/S.

Price: \$175.00; user-replaceable stylus, \$87.50.

Empire's 600 LAC is the top model in their Dynamic Interface series of six phono cartridges, and it bears some resemblance to the slightly higher priced EDR.9. Both use the same kind of Large Area Contact (LAC) stylus and feature the Inertially Damped cantilever construction. This method involves the use of a tiny bar of iron, really a miniature tuning fork, inside the hollow cantilever which damps the resonance of the moving mass and raises its frequency. Effective tip mass is specified at 0.6 mg, somewhat higher than the EDR's 0.3 mg but still significantly below average. (As a matter of interest, some highly regarded MC cartridges have a tip mass of over 1 mg.) The

cantilever is made from tapered aluminum, and it is boron-vaporized to give it extra strength.

Three magnets are used, one of Indox and two made from samarium cobalt, which helps to keep the weight down to just over 5 grams. The cartridge comes complete with mounting hardware, stylus brush, and a small screwdriver.

Measurements

For test purposes, the 600 LAC cartridge was mounted on the arm of a Luxman PD-375 turntable and the tracking force set to 1.5 grams, a value in the middle of the recommended range. The anti-skating force was turned to about 1.7 grams for the initial tests.

As shown in Fig. 1, the frequency response was within 0.5 dB from 40 Hz to 12 kHz, falling slightly from 14 kHz and maintaining that level to 20 kHz. Using the CBS STR-120 wide range test record, it was ascertained that the output rose to a maximum at 26 kHz, falling from 30 kHz. Channel separation was a high 32 dB in the midrange, falling to 22 dB at 10 kHz and a very creditable 11 dB at 20 kHz. Square-wave resolution was excellent (see Fig. 2), and the

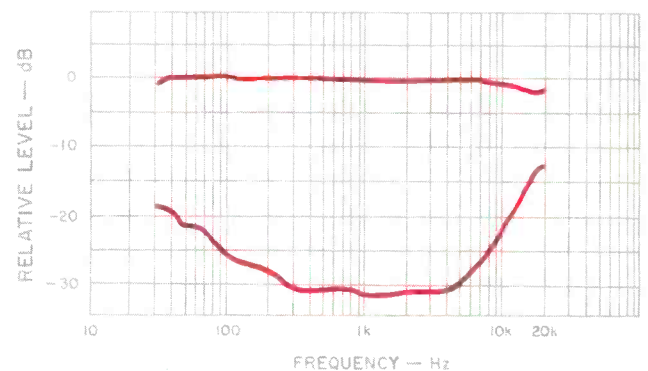
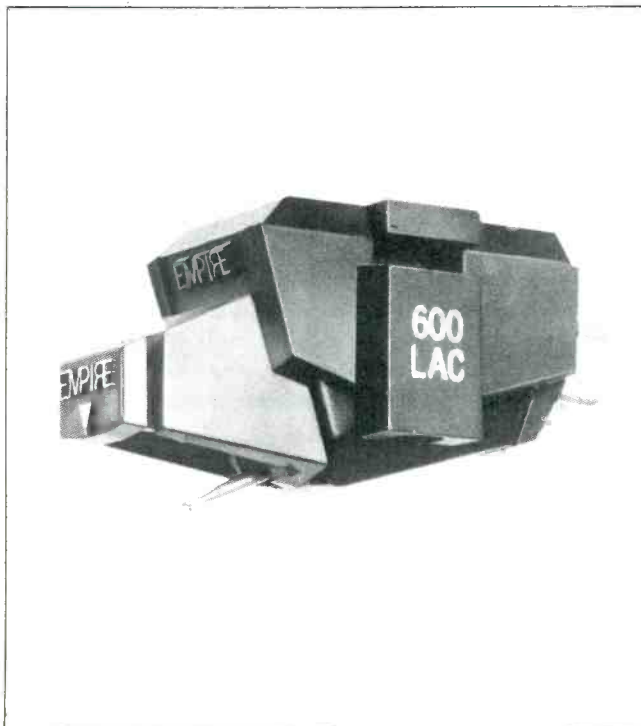


Fig. 1—Frequency response and separation, Empire 600 LAC phono cartridge.

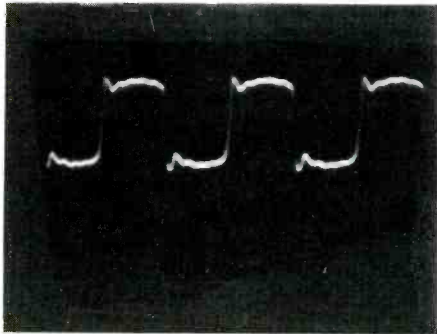


Fig. 2—Square-wave response.

normal overshoot was well-damped. Channel balance was within 0.5 dB. Trackability was 24 cm/S at high frequencies (10.8 kHz pulsed) and also at the low frequencies (400 Hz and 4 kHz), increasing to 31 cm/S at mid-frequencies (1 and 1.5 kHz). Using the DIN 315-Hz test record, levels up to 70 microns were tracked by increasing the tracking force to 1.7 grams. All bands on the Shure ERA—III big drum sec-

tion were negotiated with no trouble, but some distortion was noticed on the high velocity level five of the flute test on the ERA—IV test record. IM distortion was less than 2% up to 12 cm/S, increasing sharply to 5% at 25 cm/S. Output measured 3.95 mV at 3.54 cm/S. Inductance was 370 mH. Finally tracking angle was checked, and it was found to be exactly 20° as claimed.

Use and Listening Tests

As usual, a wide selection of records was used for the listening tests, including digital, direct discs and dbx recordings. Sound quality was notable for a clean bass with a smooth midrange and a good transient response, rather than an overemphasis of transients which can cause an unpleasant harshness. Large-scale orchestral works sounded spacious, while the stereo image was stable and well-defined. Complex scores were resolved with a nice sense of detail, and solo instruments had a satisfying presence. While the EDR.9 has a better trackability, this is probably academic as I experienced no trouble using the 600 LAC with heavily modulated records such as the *Sheffield Tower of Power* or any other record featuring high-amplitude big drum passages. All in all, the Empire 600 LAC offers performance that comes remarkably close to that of the EDR.9, which is one of my standards.

George W. Tillett

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An even better Ruby.

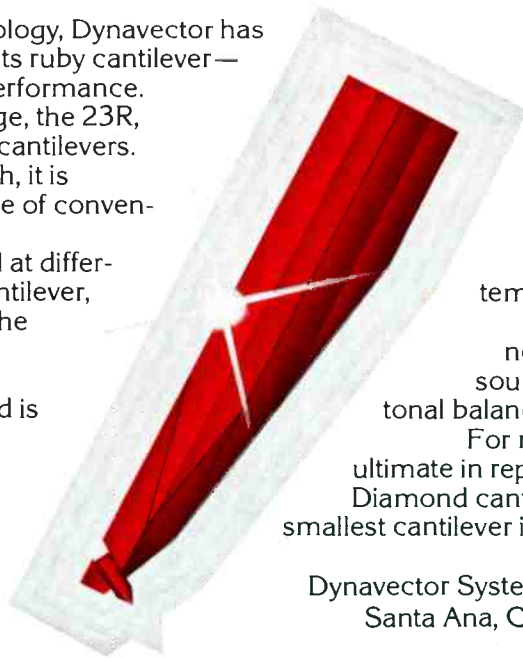
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4

**KENWOOD
KX-900
CASSETTE DECK**

Manufacturer's Specifications

Frequency Response: 25 Hz to 16 kHz, to 18 kHz with metal tape.

Harmonic Distortion: 0.8% at 0 VU.

Signal/Noise Ratio: 67 dB with Dolby NR.

Input Sensitivity: Mike, 0.25 mV; line, 77.5 mV.

Output Level: Line, 390 mV; head-phone, 50 mV to 8 ohms.

Flutter: 0.04% wtd. rms

Wind Times: 90 seconds for C-60.

Dimensions: 17-5/16 in. (440 mm) W x 4-13/16 in. (123 mm) H x 14-11/16 in. (373 mm) D.

Weight: 15.2 lbs. (6.9 kg).

Price: \$400.00.



The Kenwood KX-900 cassette deck offers a number of features based upon its built-in RAM (random-access memory) microprocessor and logic-controlled drive system. The eject, power on/off, and timer (record/off/play) switches are at the very left of the front panel, and the light-touch, logic-controlled transport switches are at the far right. This separation from the cassette compartment, next to the eject button, is not common, but there is no disadvantage to the user—it might even be better for the right-handed. The switches have large touch plates, making for very easy actuation, and there are status lights for each function with the exception of fast winds.

When the RAM switch is set to *Counter M.* (Memory) *Index*, pushing *Play* and the appropriate wind bar simultaneously will secure a fast wind to counter zero and then an immediate switch into play mode. If *Stop* is used with a wind bar, that function is obtained when zero is reached. If the RAM switch is in *Search*, the action is similar, but the stop/play occurs at the beginning (rewind) or end (fast forward) of the piece being played. If *Rec Mute* is pushed just momentarily while recording, recording continues without the signal for five seconds. The pause indicator flashes and stays on at the end of the period, at which point the deck switches to record/pause. If longer muting is needed, *Rec Mute* is held in for that time, but there is no automatic pause at the end. Recording can be initiated with a push of just *Rec*, and a flying-start recording also requires only *Rec*. All of these transport/recording conveniences will certainly benefit many. Obtaining record mode with *Rec* only, however, could lead to inadvertent errors from a straying digit.

When the RAM switch is set to *Memory*, the deck is readied for programming for automatic playback of up to 15 selections in any desired order. The LED-type memory display shows single digits up to "9" and a dot and digit for 10 and above: "5" for 15, for example. The selection number is stepped for insertion by the *Program* button and entered with the *Memory* button. *Memory Call* displays, in order, the number of all selections programmed. Any false entry can be removed with *Clear*. Along the same row as these buttons are the bias-adjust pot with a helpful center detent, the tape-select switch (*CrO₂*, *FeCr*, *Normal*, *Metal*), the Dolby NR switch (*Off*, *On*, *Filter Off*), and the dual-concentric record-level pots. The knobs on the switches and pots are on the small side, which makes turning somewhat difficult. The designations are silver on a dark background, and good illumination is needed for easy reading. At the top of the panel is a light-green Dolby NR status indicator, rather out of the way and low in intensity to catch the user's attention. On the other hand, the fluorescent bar-graph meters are very bright, easily read under any lighting condition. At zero and above, the segments are red-orange, calling attention to the possibility of distortion. At "-1" and above, there is a short-time peak hold, which is an additional plus for these peak-responding meters.

Jacks for headphones and left and right microphone inputs are at the bottom right of the panel, with the mike/line selector switch just above. The line in/out phono jacks are on the rear panel.

An examination of the internal construction of the Kenwood deck showed excellent soldering on the p.c. boards

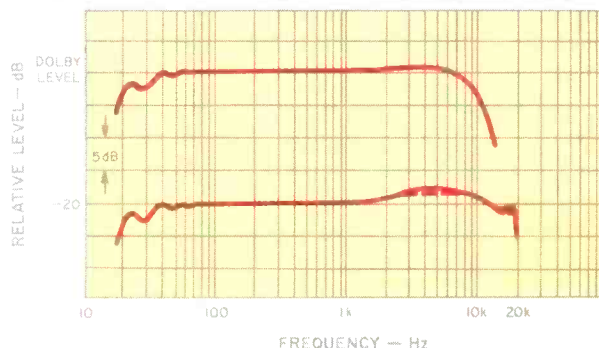


Fig. 1—Frequency responses with BASF Professional I tape with and without (---) Dolby B NR.

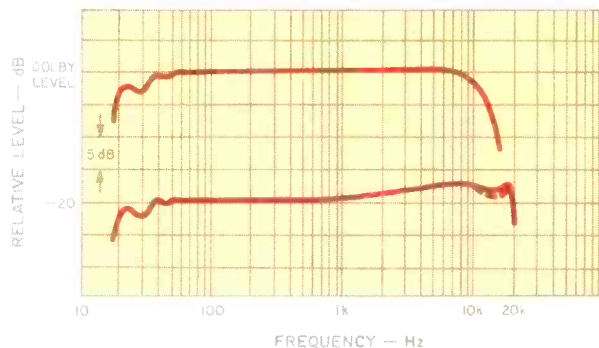


Fig. 2—Frequency responses with Maxell XL II-S tape with and without (---) Dolby B NR.

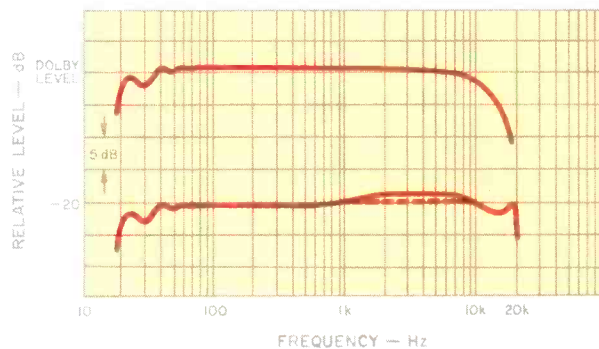


Fig. 3—Frequency responses with TDK MA-R tape with and without (---) Dolby B NR.

The Kenwood KX-900's record and playback responses were all quite good and superior to the deck's specifications for all three tape types.

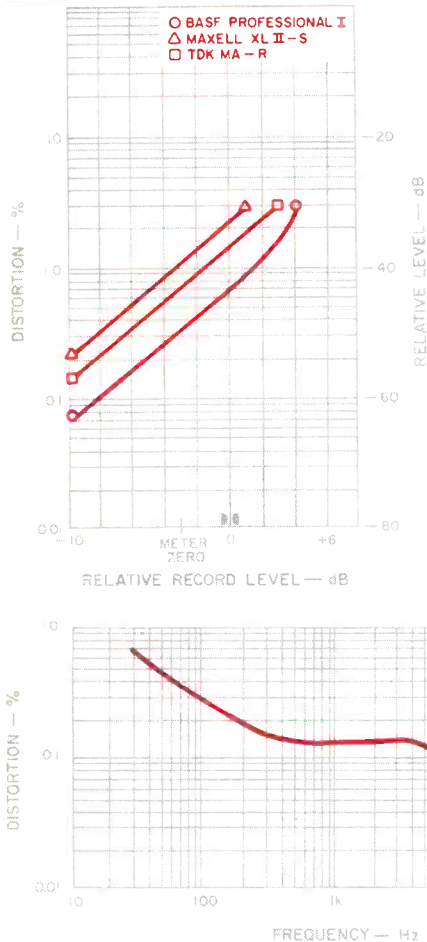


Fig. 5—Third harmonic distortion vs. frequency with Dolby B NR at 10 dB

below Dolby level with TDK MA-R tape.

Fig. 4—Third harmonic distortion vs. level at 1 kHz with Dolby B NR.

with interconnections made primarily with wirewrap and multi-pin cables. There were labels for the various adjustments, and all of the parts were identified. Of particular interest was the two-motor drive with a good-size flywheel.

Measurements

At first check, there was a large high-end roll-off in the playback of a test tape. Adjustment of head alignment gained the satisfactory result of all points within 2 dB of standard at both equalizations. This emphasizes the possible need for alignment after the shipment of any recorder. Play speed was on the high side, 1.3% fast, and play-level indications were slightly high. The record/playback responses were given a quick look with pink noise and the 1/3-octave RTA. In general, the best results were obtained with bias adjust set close to the recommendations in the owner's manual. A large number of tapes were matched very well, and BASF Professional I, Maxell XL II-S and TDK MA-R were selected for the detailed testing. (Especially good matching was also found with Sony SHF, TDK SA, Sony FeCr, and most of the metal tapes. TDK SA-X, on the other hand, seemed to need more bias than could be set.)

The swept record/playback responses were run both with and without Dolby B NR, at Dolby level and 20 dB below that. The plotted results for the three tapes are shown in Figs. 1 to 3, and the 3-dB down points are listed in Table I. All of the responses are quite good and superior to the specifications. The flatness at Dolby level is certainly worthy of note. In most cases, there was a rise in the response between 2 and 10 kHz, reaching 2 dB or over with both the Type I and II tapes. Increased bias would have brought this hump down with greater reduction in level at the highest frequencies, such as in Fig. 3. The phase jitter of a 10-kHz tone in playback was 25°, fairly good. The output polarity was the same as the input during recording, but was reversed in playback. Bias in the output during recording was very low. With XL II-S tape, the bias control had a ±4 dB range at 10 kHz. The multiplex filter was down 3 dB at 15.8 kHz and 37.2 dB at 19.0 kHz, excellent attenuation. Erasure of 100 Hz with metal tape was 60 dB, a very good figure. Separation and crosstalk at 1 kHz were 57 dB and over 80 dB down, respectively, both outstanding results.

The third harmonic distortion was measured with the three tapes from 10 dB below Dolby level to the points where HDL₃ = 3% while in Dolby mode. Figure 4 depicts the results, which are excellent for the Type I BASF Professional I but less so for the other tapes. Signal-to-noise ratios referenced to both Dolby level and the 3% points shown are listed in Table II. The figures are really very good, but the lower values for the Type II and IV tapes reflect the higher distortion levels evidenced in Fig. 4. HDL₃ was also measured as a function of frequency at -10 dB from 30 Hz to 5 kHz with Dolby NR and TDK MA-R tape. The distortion is fairly low in mid-band, and the rise at the low end is moderate. At 5 kHz and above, the distortion level was dropping—unusual, and much better than the typical deck.

Input sensitivities were 0.19 mV for mike and 74 mV for line. The mike input overload point was a rather low 13 mV, first evidenced with flattening of the positive peaks. The input overload for line, in contrast, was more than high

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

Tape Type	With Dolby B NR				Without Dolby NR			
	Dolby Lvl		-20 dB		Dolby Lvl		-20 dB	
	Hz	kHz	Hz	kHz	Hz	kHz	Hz	kHz
BASF Professional I	20	9.7	20	18.8	20	9.8	20	19.0
Maxell XL II-S	21	11.7	20	20.5	21	11.7	20	20.7
TDK MA-R	20	13.0	20	20.9	20	13.0	20	20.9

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

Tape Type	IEC A Wtd. (dBA)				CCIR/ARM (dB)			
	W/Dolby NR		Without NR		W/Dolby NR		Without NR	
	@ DL	HD=3%	@ DL	HD=3%	@ DL	HD=3%	@ DL	HD=3%
BASF Professional I	63.3	67.1	55.2	58.4	61.4	65.2	52.0	55.2
Maxell XL II-S	65.0	65.9	57.3	58.0	64.2	65.1	54.4	55.1
TDK MA-R	62.2	64.9	54.2	56.6	61.2	63.9	51.8	54.2

The KX-900 matches up very well with a large number of tapes, so good results can be easily obtained.

enough: Somewhere over 22 V. The line input impedance was 41 kilohms at 1 kHz with the input pots at mid-position. Output clipping appeared at a level equivalent to +14 dB relative to meter zero. The line output was 390 mV at meter zero, dropping to 320 mV with a 10-kilohm load—indicative of a source impedance of 2.12 kilohms. The headphone output was 47 mV to 8 ohms. There was adequate volume with all of the headphones tried, except perhaps for high-level freaks. The level meters had a very fast response, reaching zero with a 5-mS burst. Decay time for 20 dB was 0.5 S, also on the fast side. The bar graphs consist of 12 segments each, from “-20” to “+8.” Calibration of each of the steps was excellent, with those from “-10” to “+8” within ±0.2 dB, one of the most accurate seen to date.

Tape play speed varied 0.02% at most with time, and there was substantially no change with other line voltages. Flutter was consistent from one end of a cassette to the other and from one tape brand to another, but it was on the high side. Typical values were ±0.14% weighted peak and ±0.09% weighted rms. Wind times were 85 seconds for a C-60 cassette, logic-transport response times were about 1 second, and run-out to stop was 2 seconds.

Use and Listening Tests

Tape loading was a simple drop-in-and-push operation. Access for maintenance was excellent with the clear door cover removed. All controls and switches were completely reliable throughout the testing, but it was a little frustrating at times trying to check settings if room lighting was dim. Considerable advantage was taken of the various search and memory features, including RAM. Timer start in record or play was just fine, with a three-second delay after turn-on. *Rec Mute* seemed to have the just-right approach: Automatic muting and stop (record-pause) for RAM use, or

longer mutes by holding the button. The convenience of going into record with just one button was quite obvious, but I remained skeptical because of the error possibilities mentioned earlier.

The fluorescent bar-graph meters were very easy to read with any room lighting because of their brightness and excellent action. The peak holds of about one second were extra helpful with the slightly fast decay. Record levels were set very quickly as desired, although there was a little fussing because of the small knobs on the dual-concentric record-level pots. The bias adjust was an essential part of the matching to many different tapes. The instruction manual was well written, with lucid text on RAM and memory functions. Illustrations were well done and pertinent to the text, and the list of reference (deck setup) and recommended tapes is most desirable and helpful in a cassette deck instruction manual.

Listening tests included pink noise and discs for sources. Among the records were the dbx-encoded version of Chalfont's *The Empire Strikes Back* and Mobile Fidelity's recording of Holst's *The Planets* with Solti and the London Philharmonic. In all cases, the metering aided recording in obtaining good levels without evident distortion. The metal tape showed the least sensitivity to overload distress. There was a slight shift in the sound balance from the original; sometimes it seemed to be a case of more presence—different, but not negative in character. Pause and stop sounds were slightly out of tape noise.

The Kenwood KX-900 has a number of features providing convenience for the user, and these, when combined with its performance level, represent good value when compared to other decks in the same price range.

Howard A. Roberson

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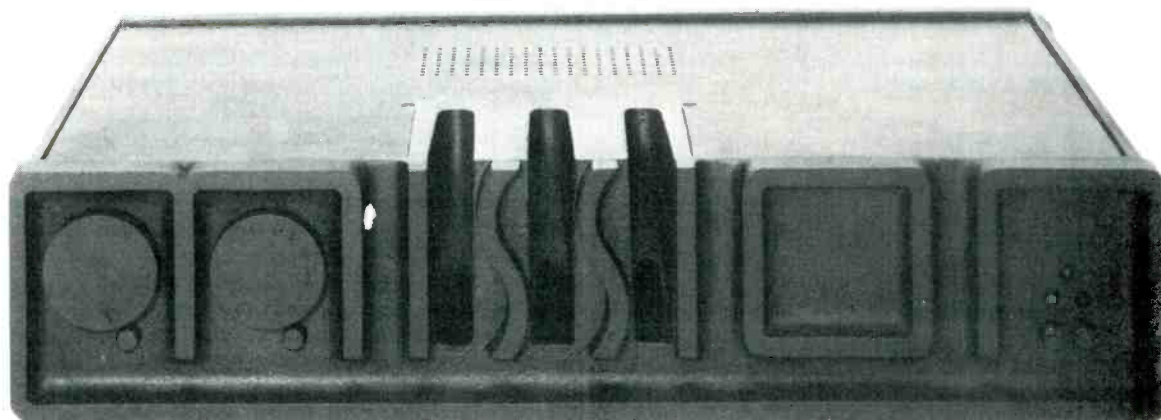
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5

MISSION 776
PREAMP**Manufacturer's Specifications****Input Sensitivity:** Phono, 2.0 mV for 1-V out; line, 100 mV for 1-V out.**Phono Overload:** 150 mV at 1 kHz.**Nominal Output Level:** 1 V rms.**Maximum Output Level:** 11 V peak.**Phono Input Impedance:** 47 kilohms, 150 pF.**Output Impedance:** 250 ohms.**Signal-to-Noise Ratio:** Phono, 80 dB, A wtd., re: 5 mV input; line, 95 dB, CCIR wtd., re: 200 mV input.**THD:** Less than 0.05%, 20 Hz to 20 kHz.**SMPT E IM:** Less than 0.05%.**TID:** Zero.**Frequency Response:** Phono, RIAA, ± 0.2 dB; line, 20 Hz to 20 kHz, -0.1 dB.**Weight:** 25 lbs. (11.36 kg).**Price:** \$997.00.

I had not ever heard of Mission Electronics until their impressively heavy carton arrived, containing their Model 776 preamp. As my local deliverer handed the package to me, I felt sure that a mistake had been made and that the company had actually sent their matching power amplifier (the Model 777). The mystery was solved when I opened the package and discovered that Mission Electronics (with facilities in Canada and the U.K.) chose to use a *very heavy* casting as the foundation for this preamplifier, which is quite "lightweight" in terms of control features and switches. As stated in their preamble on design philosophy in the owner's manual, the folks at Mission "strongly believe in straight line amplifier design, eliminating all unnecessary, fancy and harmful features offered by most designs on the market." While I would certainly agree that the heavy casting (which manages to sculpt the letters M I S S I O N in the form of a massive front panel) is not "harmful," it certainly is "fancy" and, with all due respect, "unnecessary."

Leaving aside the aesthetic question of whether one will be attracted to this extremely robust design package, I do wish that Mission had not gone quite so far in eliminating the extras. While the volume control is easy enough to identify, since it has a circle of progressively larger dots molded into the knob, the source selector doesn't identify which dot is for which program, nor are the positions of the

tape monitor and the mono/stereo pushbuttons labeled. While this potential confusion will probably not be a factor after the first couple of uses, I do not think it would have harmed the design at all had the front of the casting carried tiny nomenclature letters. There isn't much more to say about front-panel controls because I've just named them all.

There is a fair amount to say about the circuitry of this preamp, which I must admit, is superbly conceived and equally superbly crafted and assembled. The 776 is modular in construction. The few switches and connectors used are of extremely high quality, in some cases of military grade, with gold-plated contacts. The layout of modules minimizes the length of interconnecting tracks, and most circuit paths are doubled up on both sides of the printed circuit modules to reduce resistance. Where coupling capacitors were needed in the signal path, polyester-film capacitors have been mixed and doubled up to reduce what Mission terms the "sonic signature" of one type or make. Similarly, 1% metal-film resistors are used throughout the preamp.

Perhaps the most unusual part of the design is the power supply, which is actually derived from two rechargeable, sealed batteries which provide 25 V d.c. at 1.5 ampere/hour capacity. The supply voltage goes through two stages of filtering, first 10,000 μ F and then 2,200 μ F, and then is

separated into two channels, which are decoupled by means of 4.7- μ F polyester-film capacitors. Mission's intent with this design is to ensure no line-induced hum, low input impedance over the audio spectrum, and high interchannel rejection. The battery recharging system is interesting in that when the preamp is actually playing, all a.c. line input is cut off; when it is not in use, the system goes into full-charge mode, switching over to trickle charge when the battery is within 97% of full charge. Mission says that the battery will deliver optimum performance for at least 20 hours of continuous use.

The phono stage of the 776 uses a low-noise differential amplifier followed by a current-pumping, voltage-amplifier stage. There is no arbitrary roll-off of the RIAA curve at the low end in order to ensure phase accuracy at extreme bass frequencies. Overall feedback in this stage is less than 10 dB at 20 Hz. The line amplifier stage is a simple common-emitter stage followed by a current-pumping voltage amplifier. Overall feedback in this stage is less than 20 dB with an output impedance of 200 ohms.

The preamplifier module has a gain of 54 dB, making it suitable for all moving-magnet cartridges and some high-output moving-coil cartridges. Input loading for the cartridge can be changed by inserting appropriate low-noise input resistors across the input plug-in component sockets on the rear of the preamplifier.

The back panel of the 776 features a detachable line cord and a line fuse housing, the preamp output jacks, tape output jacks, tape in jacks, AUX and phono input jacks, a ground terminal, and a balance control which is outside the signal path of the preamplifier and can be adjusted in 1 dB steps to a maximum of 4 dB. Balance adjustments are achieved by switching parallel resistors in the feedback loop.

Measurements

Input sensitivity (for 0.5-V output) measured 1 mV at 1 kHz for the phono inputs and 55 mV for the line (high) level inputs of the Model 776 preamplifier. The phono inputs were able to handle 180 mV of input before overload distortion of the phono-equalizer stage was evidenced. Total harmonic distortion, via the line inputs, measured a mere 0.0025% at 1 kHz, increasing insignificantly to 0.02% at 20 Hz and 20 kHz, still well below the published figures of 0.05% and certainly orders of magnitude below audibility. SMPTE-IM distortion measured 0.0045% (for nominal 1-V output), and I could detect no trace of intermodulation products when I attempted to measure CCIR or IHF IM distortion using the equal-amplitude twin-tone method which applies to these two types of tests.

Signal-to-noise ratio for the phono inputs measured a very high 87 dB, while for the line inputs it was 90 dB. Both measurements are referenced to 0.5-V out, with 5-mV input in the case of the phono circuits and 0.5-V in for the line amplifier. Despite the fact that during operation of the Model 776 all a.c.-line input current never gets beyond the cord, there was nevertheless an improvement noted when the line cord was physically disconnected from the rear of the unit, and it was in this mode that the above readings were obtained. Since S/N figures with the cord connected were

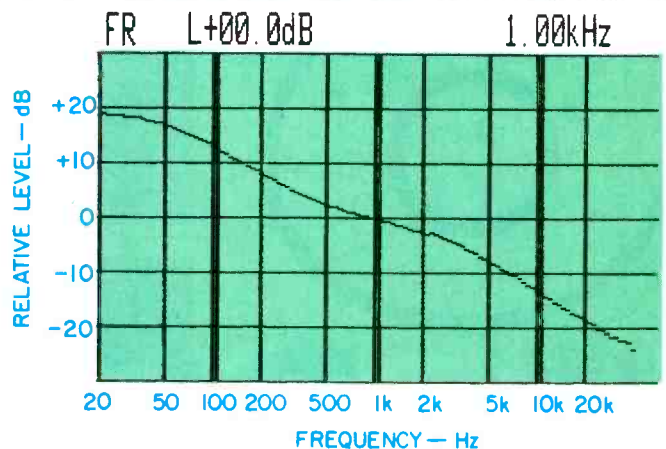


Fig. 1—RIAA playback characteristic.

between 2 and 4 dB worse, I would urge users of this preamplifier to connect the cord only when recharging the battery and when not using the preamplifier during music reproduction.

I plotted the RIAA response curve for the Mission 776 from 20 Hz out to beyond 20 kHz, and the results are shown in the video printout of Fig. 1. Notice that there is no roll-off observed at the extreme bass end of the curve, confirming Mission's claim that they allow the RIAA equalization network to continue all the way down to infrasonic frequencies. While this makes for excellent bass reproduction and accurate phase response, it does demand that a very high-quality, rumble-free turntable be used with this equipment, especially since there is no built-in subsonic filter circuitry. Even moderately warped recordings could have an adverse effect on sound reproduction quality given this kind of extended boost in the RIAA response curve.

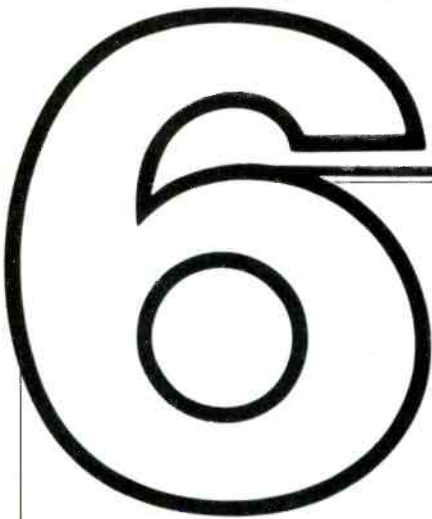
Use and Listening Tests

Certainly, the sound reproduction quality of this preamplifier comes about as close to the idealized "straight wire with gain" as that of any preamplifier I have auditioned in recent months. My own feeling is that even though Mission wants the product to be as free of extra frills as possible, having a second tape-monitor circuit for tape-to-tape copying would in no way detract from the straightforward signal-path approach they espouse. I rather wish that I had had the company's matching (and 10 pounds heavier) Model 777 through which to listen to the 776, so that I might have judged the system as a whole. The owner's manual deals with both of these products, alternately skipping back and forth in its discussions from the preamplifier to the amplifier as if they were meant to be purchased as an inseparable pair. Stacked above each other, they would read:

**MISSION
MISSION**

Alone, the 776 seems, somehow, like a Mission that's incomplete. . . .
Leonard Feldman

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GAM ELECTRONICS STEREO ONE FM ANTENNA

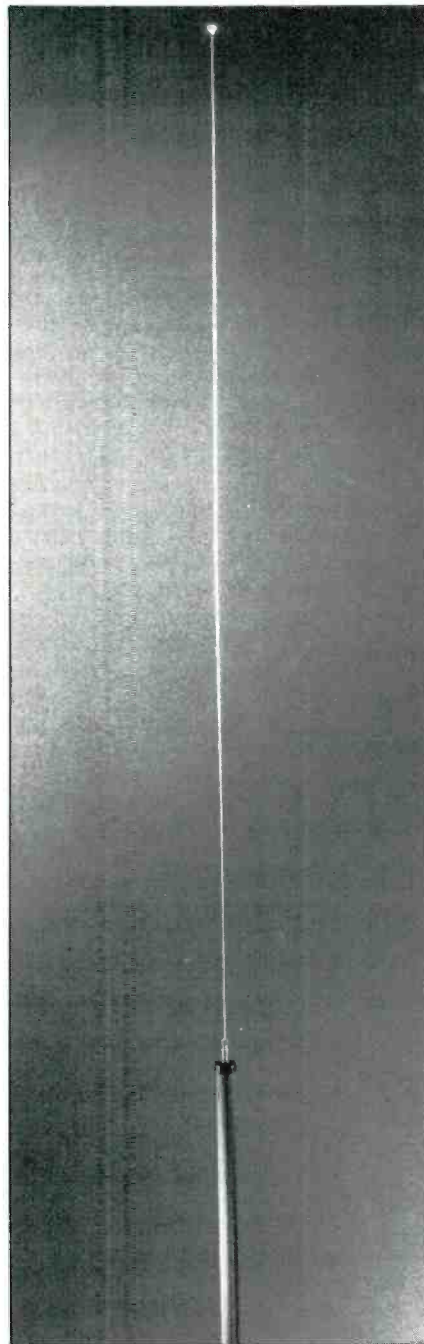
Price: \$69.95.

GAM antennas, I learned, are manufactured in Manchester, N.H. by GAM Electronics, Inc. who also specialize in the design and manufacture of high-gain communications antennas. The FM antenna, which I tested in my lab, is marketed in the U.S. by Castle Marketing and in Canada by Mari-Tech Systems, Inc. There were no performance specifications supplied with the unusually configured antenna other than the claim that it "gives up to twice the power of conventional dipole antennas" and that it is "suitable for either indoor or outdoor use."

The GAM Stereo One antenna consists of a stainless-steel whip which is mated through silver-plated, brass couplings to a precision base transformer which is hermetically sealed within a high-impact PVC tube. A heavy-duty aluminum base bracket allows for mast or windowsill mounting. When fully assembled, the Stereo One measures 76 inches in height. It is extremely light, however, weighing a mere 12 ounces. Connection terminals are intended for 300-ohm twin-lead cable, but a 75/300-ohm balun transformer can be used at either end of the transmission line should you want to

Table I—Field strength readings of two antennas.

Frequency, MHz	Call Letters	Signal Strength, μ V	
		Dipole	GAM
89.9	WKCR	180	290
97.1	WYNY	380	650
104.3	WNCN	120	180



use a 75-ohm coaxial downlead for reduced noise pickup or because your tuner is only equipped with that type of input.

While I was very much impressed with the performance of the GAM Stereo One, I must warn prospective users of two things which may dictate against its use in certain circumstances. The antenna is omnidirectional. That is, it is equally sensitive to signals arriving from "all points" on the compass. The "whip," after all, is intended for vertical orientation, which means that it does not even have the familiar "figure-8" directionality of a simple half-wave dipole. Normally, I would be wary of such an omnidirectional FM antenna, particularly in mid-city locations where multipath problems abound or in near-suburban areas where features of the local terrain or man-made structures also cause signal reflections. While my own lab's location fits the second of these descriptions, I was both surprised and gratified to find that the GAM Stereo One did not aggravate multipath distortion problems in my area.

The second precaution which should be observed results from the excellent gain characteristics of the antenna itself. Particularly when mounted outdoors and located fairly close to transmitters, the Stereo One is going to present an unusually strong signal to the antenna terminals of your tuner or receiver. As even the representatives of the company were quick to admit, low-quality tuners equipped with poorly designed front-ends are likely to be overloaded when presented with such powerful input signals. No such problems should be encountered when using mid-priced to high-end tuners or receivers which have adequate r.f. circuitry.

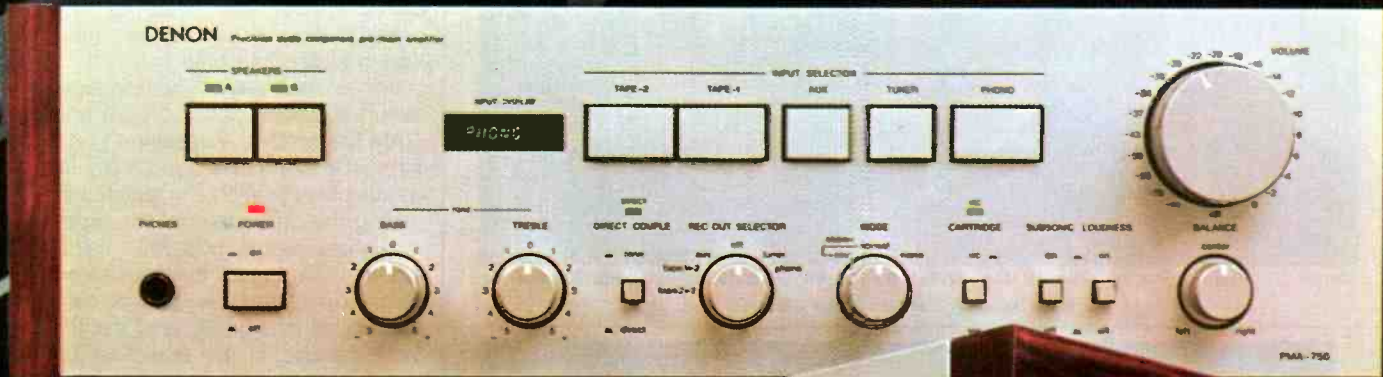
Measurements

To be fair in testing the GAM Stereo One, I decided to treat it as though it

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...and our \$399. DRA-400.
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The GAM Stereo One can be recommended as an excellent alternative to the Tee-shaped antenna made from 300-ohm twin-lead.

were an indoor antenna. In that way, I was able to compare its gain with that of a standard half-wave dipole of the type normally supplied with most tuners and receivers, the simple Tee shaped from 300-ohm cable. From previous experiments involving antenna testing, I know that if I were to mount this (or any other) antenna on my roof, at an elevation of approximately 30 feet above ground level, signal strengths observed would increase by a factor of from 10-to-1 to 50-to-1. (My lab is located approximately 20 airline miles from most of the FM broadcasting antennas in the New York metropolitan area.)

For a meaningful comparison between a conventional dipole and the GAM Stereo One, I positioned both antennas at the same spot in my lab (at ground level). With my assistant optimizing the orientation of the dipole for maximum signal pickup, I recorded signal strengths for three received signals, one at the low end of the dial, another at mid-band, and the third at the high-end of the dial. The experiment was repeated, using the GAM Stereo One and observing signal strengths for the same three stations. In the case of the GAM Stereo One, no specific orientation was needed, since it was positioned vertically. Table I shows the results obtained. Readings are in microvolts, into a 75-ohm impedance. (A transformer was used between the antennas and the input terminals of my field strength meter.)

From these measurements, it is clear that the GAM Stereo One does provide substantially more gain than an ordinary dipole—even one oriented for best reception. While I would still recommend a multi-element, directional outdoor FM antenna for best possible reception under all conditions, the GAM Stereo One would make an ideal window-mounted antenna in such instances where rooftop antennas are impractical or impossible. It would also make an excellent indoor antenna alternative to the less-than-ideal flexible-wire dipoles normally supplied by FM hardware manufacturers. The unit was obviously designed and made by people who know a great deal about antennas and what makes them work well.

Leonard Feldman

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Philadelphia Fidelity

Dear Editor:

Bert Whyte's story in the June 1981 issue, "The Roots of High Fidelity Sound," brought memories of that period. I was stationed in Philadelphia as Superintendent of Service for the Electrical Research Products Inc., commonly known as "ERPI." ERPI was the theater division of Western Electric which installed and serviced sound picture recording equipment in the studios and reproducing equipment in theaters throughout the United States and the world. Your article reminded me of our part in servicing the equipment used in the first demonstrations of stereo.

The year was 1933 when a demonstration was put on at the Franklin Institute in Philadelphia. The results were so well received that a second show followed for the general public at the Philadelphia Academy of Music. Three sound channels were used. The speakers were set up on the large

stage, hidden from view by a scenic stage set. The microphones were placed in the rehearsal room off-stage in another part of the building.

A trial run was made for the engineers and technicians at which I was present. Joe Maxwell came on stage to tell us what we were about to hear. The large stage was darkened and someone was heard sawing off a board or plank which dropped to the floor. A voice on the far side called out, "Hey Joe, throw me the hammer." "Sure Mike, here it is." One needed only a little imagination to picture the action as the hammer dropped at Mike's feet. The demonstrations included the effect of frequency response from the early phonograph reproductions and the improvements made over the years. Sound was made to appear over the heads of the audiences. Finally the symphony and chorus were heard as if in place with the orchestra in the pit, but still no sign of a performer. A soloist was heard

backstage and the sound of her voice came on stage to the center, and as she seemed to actually step across the footlights, it was unbelievably realistic. Something strange was happening that would never be forgotten.

A day or two later the demonstration was repeated for the general public with the addition of a control console placed in the balcony for conductor Leopold Stokowski to control frequency and volume of the three channels as well as lead his orchestra by remote control.

These demonstrations were truly the first on a grand scale of three-dimensional sound and could be called "The Roots of Stereo."

Robert S. Barnes
Baldwin, New York

Erratum

The correct price of the classical album *Mahler: Fourth Symphony* (CBS MY 37225), reviewed on page 24 of the April issue, is \$5.98.

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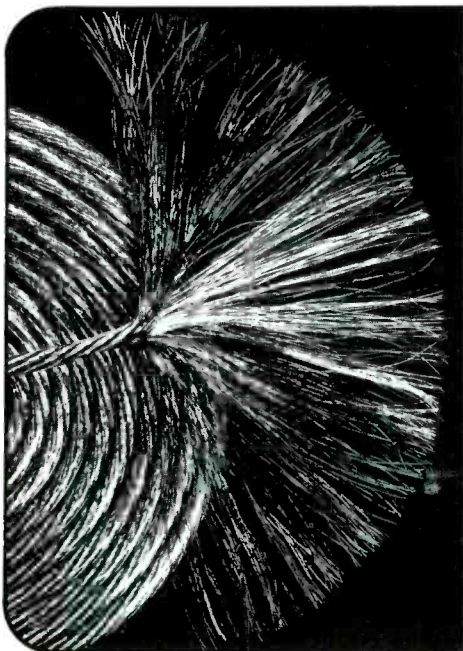
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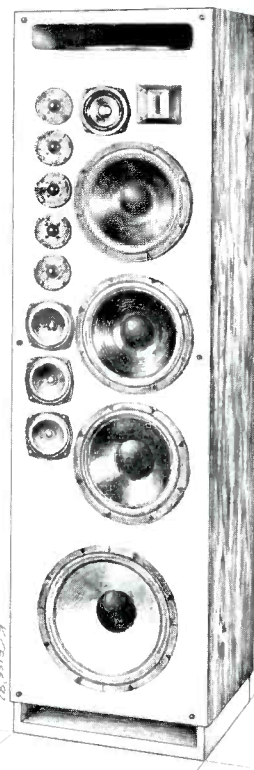
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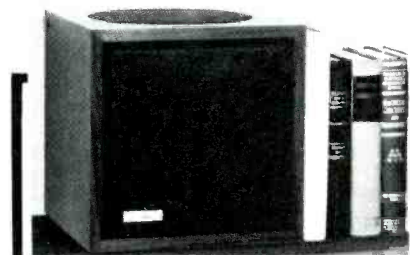
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We would therefore like to call your attention to a recent issue **HOTLINE #18** of the **INTERNATIONAL AUDIO REVIEW** in which Mr. Moncrieff offers an especially lucid and comprehensive description of the underlying philosophy and unique design properties of our **GNP LEAD CYLINDER** (Pat. Pend.) loudspeaker system. We believe you will find it informative and interesting, particularly since Mr. Moncrieff appears to have described our loudspeaker system better, and more clearly, than we sometimes do ourselves in our own writings. (Reprints will be available from **GNP** upon request.)

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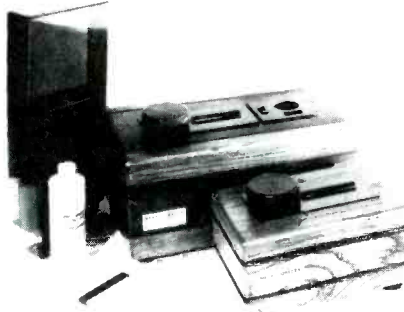
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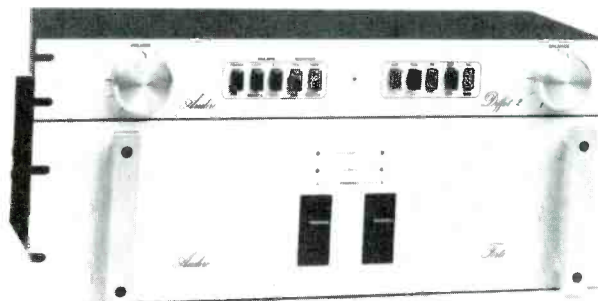
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The term audiophile was coined many years ago and has become part of our language; it is a rare person who doesn't know what it means. With the video boom well underway, it follows that we now have a new breed of super-hobbyist—the videophile. Perhaps because it is such a relatively new term, some people might have a little trouble defining videophile. Is it just a person who watches television a great deal? Hardly. Well, how about those people who own videocassette recorders? You're getting warmer. What about the guy who owns a videodisc player as well as a VCR? That helps. We could go on like this, but the truth is that a videophile is much more involved.

The videophile is fascinated with a very broad spectrum of video products and video technology. Like his counterpart in audio, the videophile has a goal, which is to attain the highest quality of visual information. Although it is true that a few years ago a number of audiophiles regarded video with some disdain, it is equally true that many of these same audiophiles have now become avid videophiles as well. As in audio, there are videophiles in various manifestations, from the entry level to the high end. The high-end videophile is quite likely to be equipped with a component TV system consisting of a monitor, matching component TV tuner, and remote control (like the new Sony Profeel); a large screen video projection system, and a number of videocassette recorders, probably including an industrial model. He may own a ¾-inch U-Matic re-



The Guard Stabilizer/RF Converter completely removes Kopyguard signals.

order complete with electronic editor, as well as several advanced color video cameras. He is likely to have both laser optical and CED videodisc players. Our videophile may also own certain instrumentation, like an oscilloscope, a color bar or dot generator, and a spectrum analyzer. Now a new type of specialized equipment has been appearing on the video market in the form of processing amplifiers, video image enhancement units, "Kopyguard" stabilizers and r.f. modulators, distribution amplifiers, and multi-switching consoles. The videophile will certainly be interested in the extra control and versatility this equipment will permit in signal processing.

Some months ago, I reported that quite a few of the duplicators who issue prerecorded videotapes—mostly of movies—were encoding their tapes with what is known as a "Kopyguard" signal. The avowed purpose of this

signal is to prevent unauthorized copying of the program from one VCR to another. If copying is attempted, the result is a scrambled, distorted, unusable picture. As I pointed out, you can't blame these companies from trying to protect their copyrighted movie programs. However, on certain models of television sets, mostly of American manufacture, when people buy these Kopyguard-encoded videotapes and in a perfectly honest straightforward manner try to play them back, all they can get is a violently rolling, jittery picture. In fact, the sync circuitry on their TV sets is so poor that the Kopyguard signal makes these videotapes unplayable.

In that earlier column, I reported that Kopyguard "killers" or "stabilizers"—black boxes preventing the picture distortion—had appeared on the market. Some of these units are better than others, and a few are, to put it charitably, quite marginal. Now Vidicraft of Portland, Oregon, has introduced the Guard Stabilizer/RF Converter, and it is the best device of this type I have encountered. The \$195 unit has an attractive black anodized metal enclosure, with blue front and rear panels, and measures 7 inches W × 4¾ inches D × 2 inches H. The stabilizer is supplied with a plug-in a.c. converter which furnishes 12 volts d.c. to power the unit. A red pilot light is on the front panel, along with a rotary switch to select channel 3 or 4 and to turn the unit on and off as well as a rotary potentiometer with locking control to stabilize the picture. On the rear panel are in and out RCA jacks for

The Vidicraft Proc Amp, which helps to improve video images.



Like his counterpart in audio, the videophile has a goal, which is to attain the highest quality of visual information.

video and audio, an audio level control, and a VHF output.

The hook-up of the stabilizer is simplicity itself. The video and audio outputs of a VCR are fed into the unit, and the VHF output of the stabilizer feeds directly into the antenna input of the TV set via the supplied RCA F cable. In

use, the unit is switched to channel 3 or 4, whichever is appropriate for the particular area, and the lock control is slowly advanced from its fully counterclockwise position. It is very easy to achieve a stable picture with slight adjustment of this control, although, in some cases, coordination with the

tracking control on the VCR may be necessary. Once the picture has stabilized, however, no further adjustments are needed.

What makes this Vidicraft stabilizer so handy and easy to use is the inclusion of the r.f. modulator. Most anti-Kopyguard units, especially the cheapie models, lack this and therefore require two VCR units in order to link up with a TV set. The Vidicraft unit affords versatility since it can be used for any video and audio input—from a video camera, a videodisc player, a VCR, and even a computer. The Guard Stabilizer/RF Converter is particularly effective because it completely removes the Kopyguard signal, making the copying of tapes very easy. I need not make any moral preachments here or question the ethics of such a practice; such things are best left to the individual's conscience.

Vidicraft's Proc Amp (processing amplifier) is considerably more complex than the stabilizer and can accomplish some very worthwhile improvements in a video picture. The Proc Amp is housed in the same type of enclosure as the stabilizer and measures approximately 9¼ inches W × 2½ inches H × 6½ inches D. It is a.c. powered or can be battery powered with 12 volts d.c. The front panel has a luminance level meter; a mode switch to select color, bypass, and monochrome and turn the unit on and off; a gain control for luminance level, and gain and phase controls for chroma. All controls have center-detent positions for neutral balance. The rear panel has one RCA video input jack and four RCA video output jacks. Hook-ups with VCRs, a video camera, or portable VCR are fairly simple and in all cases include the Proc Amp in a processing loop.

The luminance level control acts like the contrast control on a TV set. With the aid of the luminance level meter, the control actually adjusts the contrast ratio of the black-and-white picture component of the TV signal. Turning the luminance control fully counterclockwise completely removes the TV picture and produces "video black." Advancing the control clockwise brightens picture images. This control can thus provide professional quality fade-ins . . . fade-outs. By going to

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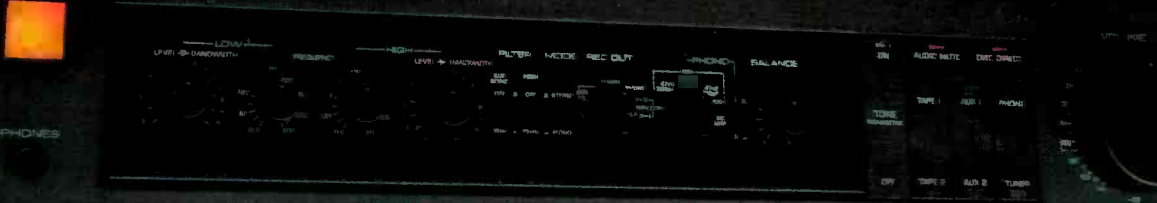


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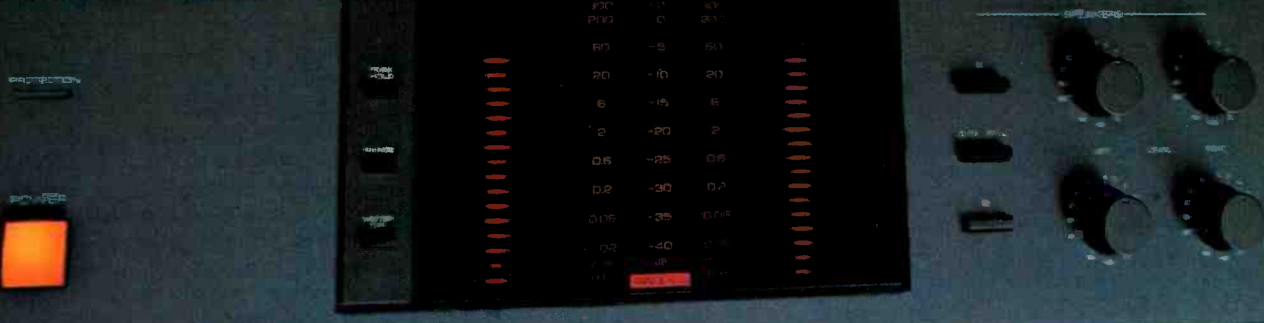
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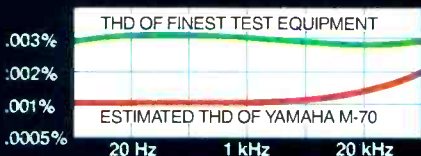


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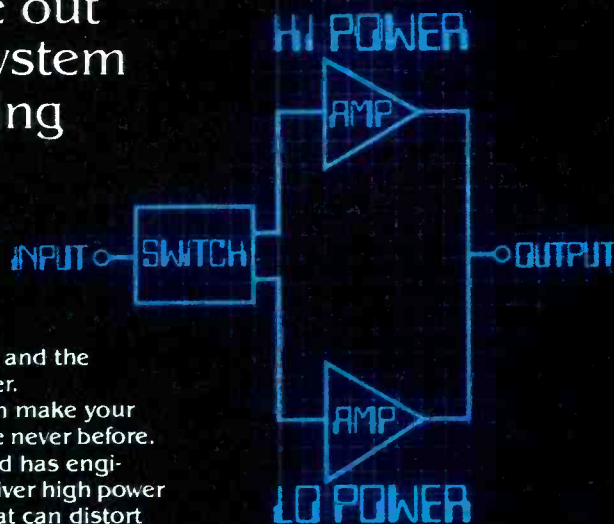
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One of the most
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allow remote control of
contrast intensity and hue
in regular TV viewing.

"video black," a completely black picture can be recorded at the beginning of a tape, up to the point where program begins, thereby avoiding all the dancing, jiggling, snowy hash of blank tape. The chroma gain control is analogous to the intensity control on TV sets. The detent position is unity gain, full counterclockwise produces a black-and-white picture, and full clockwise a picture with highly saturated colors. Its -36 to $+8$ dB range is far more than is available in TV sets and is valuable when correcting videotape color errors. The chroma phase control acts like the hue or tint controls on TV sets, but here, too, the range is much greater, plus or minus 0° to 35° . Full counterclockwise rotation of this control produces green, and at full clockwise, magenta. But whatever processing correction or enhancement you are undertaking, on videotape or TV screen, switching to the bypass mode will return the picture to its original or unprocessed condition. A flick of the switch back to "color" gives an instant comparison, so judging the effects of the processing is easy.

Another feature of the Proc Amp is that it provides four distribution amplifiers to permit simultaneous recording on four VCRs without reduced signal voltage. One of the neatest things about the unit is that it can be set up to allow remote control of contrast (luminance) intensity and hue in regular TV viewing. In setting up, it is necessary to use a VCR and an r.f. modulator, but since the most annoying things in TV viewing are channel-to-channel and scene-to-scene color shifts, it is worth the trouble to be able to control them from an armchair. This set-up also requires that you use the tuner of the VCR when changing channels. In TV sets without video inputs but with remote controls, the remote facility is lost. In a component TV system like the Sony Profeel, it is possible to have full wireless remote control plus (with a couple of wires) the remote control of contrast, intensity, and hue via the Vidicraft Proc Amp. I found this \$349 unit very easy to operate, and it performed flawlessly during my fairly extended tests of its operation. The serious videophile will find it an invaluable tool, and the unit will be of aid to the neophyte as well.

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BEHIND THE SCENES

BERT WHYTE

Most audiophiles, even those who are relatively inexperienced, learn early on that the catch-phrase "concert hall realism" is much abused and indiscriminately applied as a quality achieved by almost all hi-fi equipment. Or so the copywriters would have you believe. The audiophile is aware that what he ultimately is trying to achieve is the closest simulation of the live listening experience, whether the music be of the pop persuasion or from the vast resources of the classical repertoire. To this end, most audiophiles continually upgrade their systems to achieve ever higher levels of sonic sophistication. Some truly dedicated audiophiles spend large sums of money improving their systems. Unfortunately, the acquisition of expensive stereo equipment is no guarantee that the elusive sense of realism will be secured. I have heard some absolutely awful sound from some of the most expensive components. Almost invariably, the poor sound was not the fault of the equipment (although quality can vary widely even in expensive units) but in the manner in which the system was set up and, most especially, the acoustic environment in which it operated. For some strange reason, even experienced audiophiles with high-quality stereo systems do not regard the acoustics of their listening rooms as a vital element in playback of music. Too many audiophiles look upon room acoustics as a most arcane subject, and their knowledge of it is at best rudimentary. They admit to a continuing feeling of frustration in their efforts to improve the simulation of the live listening experience.

But there is a new way of acoustically treating listening rooms to achieve this purpose, far beyond what audio equipment can achieve on its own. My awareness of it began at an AES convention several years ago. I was roaming around the exhibits and ran across Alpha Audio of Richmond, Virginia, a company unknown to me. The genial president of the company, Nick Colleran, introduced me to the product they were displaying, an acoustical material known as Sonex. Sonex is an open-cell polyurethane foam supplied in 4 x 4 foot charcoal gray sheets, in 2-, 3-, and 4-inch thicknesses. It is



Bert Whyte's listening room, in which sound-absorbing Sonex was used in an LEDE installation.

configured in what is called the "indented" or female pattern and the "wedge shaped" or male pattern. (You have probably seen the wedges used in anechoic chambers, and the wedge pattern of Sonex is the same, although the wedges are on a much smaller scale.) Sonex is also supplied in 15 x 15 inch, 2-inch thick wedge-shaped "audiotiles" in silver, blue, brown, orange, and green. Because of the wedge pattern, one square foot of Sonex has 450% more surface area than a square foot of flat foam, and there is almost 100% absorption from 500 Hz to 1.5 kHz with the 4-inch thick Sonex.

Nick Colleran told me about the use of Sonex in recording studio control rooms, in a rather radical configuration known as "live end-dead end" (LEDE) and promulgated by Don and Carolyn Davis of Synergistic Audio Concepts in California. Traditionally, most studio control rooms have their monitor speakers mounted near the front and ceiling boundary, surrounded by reflective walls. The mixing console is in the front third of the studio, where

the mixer can face the monitors, usually no more than 10 feet in front of him. The rear side walls and the rear wall are ordinarily made as absorptive as possible. Hence, the "live" reflective end of the control room is in the front, and the "dead" absorptive end is in the rear. Although many aspects of studio control room acoustics are quite controversial, a number of engineers feel the Davis' LEDE approach, in which the "live" end is in the rear of the control room and the "dead" end is at the front of the room, has some unique advantages. Not the least of these special qualities is the very uniform absorption characteristics of Sonex. When the walls and ceiling of the front of the control room are covered with Sonex, both the absorption and the wedges work together. The wedges provide surfaces to interrupt and break up standing waves so that any energy that might be reflected is diffused. The absorption comes into play along with the diffusion to prevent close-order early reflections which, if the Sonex were not present, would reflect off the hard live wall and combine

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Too many audiophiles look upon room acoustics as a most arcane subject, and their knowledge of it is at best rudimentary.

out of phase with the direct sounds of the monitor. This would produce nasty comb-filter effects, with subsequent frequency anomalies. With the elimination of the close-order early reflections, the mixer hears just the direct sound of the monitors and is not influenced by room acoustics.

After discussing some of the professional studio applications of Sonex with Nick Colleran, I had a brainstorm. It occurred to me that there should be no technical reasons why Sonex would not work in an LEDE configuration in a home listening room. The different circumstances might require some modifications, but I didn't think they would be too difficult. Nick agreed at once and said that as soon as I measured my room and knew the requirements, I could start construction of the first residential LEDE listening room.

First came some basic choices. With orange carpeting in my 12½ x 24 foot listening room, I decided the standard charcoal Sonex would make an attrac-

tive color contrast. I selected the 3-inch thick Sonex because it is definitely superior to the 2-inch, especially in the lower frequencies, and is almost on a par with the 4-inch thickness, without its bulk and greater expense. As a rough rule of thumb, the front dead end of the room should be one-third of the room's total length—in my case, 8 feet. My ceiling height is also 8 feet, so it worked out very nicely to use four of the standard 4 x 4 foot sheets of Sonex on each side wall, and six of the same sheets on the back wall. The 6-inch space was pieced in by cutting strips from another Sonex sheet. For the ceiling, I chose the light silver-colored 15 x 15 inch "audiotiles," both for the desirable color contrast and ease of installation as compared to handling large sheets over one's head! The live end of my room is wood-paneled. Diffusion and the avoidance of long path lengths which would accentuate standing waves are provided by record cabinets on each

wall and rear speakers (for use in ambience recovery, ambisonics, etc.).

If you undertake construction of an LEDE room, it would be worthwhile to look into several other matters before proceeding. For example, how structurally rigid is the room? Large unbroken areas—the ceiling, floor, and perhaps the walls too—are subject to diaphragmatic "flexing" which can accentuate certain room modes and cause boominess and muddy, over-resonant bass. Because of the flimsy nature of most ceilings, nothing much can be done to avoid excessive flexure. However, the Sonex "audiotiles" will afford a little help because of their absorption and diffusion properties. I am fortunate that my listening room is on a concrete slab. In most homes, especially those of recent construction, wooden floors are prime sources of flexure. If your playback equipment is in the listening room with your loudspeakers (the usual arrangement), such floors can be troublesome sources of structure-borne feedback. One partial solution is to run a 2 x 6 piece of lumber diagonally under the floor joists. This can be held in place and exert upward stiffening pressure by means of one or two adjustable support columns lowered or extended by a worm gear.

Walls can also benefit from stiffening. Dennis Lockhart of Charlotte, North Carolina, built the second residential LEDE listening room. His room dimensions are almost identical to mine and his construction is essentially the same. To stiffen his walls, Dennis cemented together two ¾-inch, 4 x 8 foot sheets of high density particle board and used enough of these fabricated sheets to do the job. The 1½-inch thick particle board and its weight exerted just the right amount of pressure. There still was some flexure, but the resonance was changed and room modes were better damped for a cleaner bass. If a room is on a concrete slab and the paneling is heavy enough so that it can be screwed and glued to the studs, the spaces between the studs can be filled with dry beach sand.

Next month I'll detail the finishing of my LEDE listening room, report on its performance, and discuss some of the ramifications of this new technique. **A**

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Now Technics lets you hear nothing but the sound of the source. Introducing the SV-P100 Digital Cassette Recorder.

No tape hiss. No wow and flutter. Not even head contact distortion. With Technics new SV-P100, they no longer exist. The result—now you listen to the actual music... the source, not the tape or the tape player.

Utilizing the Pulse Code Modulation (PCM) digital process, the SV-P100 instantaneously translates musical notes into an exact numerical code, stores them on any standard VHS cassette, then "translates" them back into music on playback. Duplicate tapes are exactly the same as the original. Thus, every recording and every copy is a "master."

The revolutionary size of the new Technics SV-P100 recorder (17"x11"x10") is the result of state-of-the-art semiconductor technology. The built-in videotape transport mechanism brings the convenience normally associated with conventional front-loading cassette

decks to a digital application. Tape loading is now fully automatic. And, frequently used controls are grouped together on a slanted panel with LED's to confirm operating status.

Despite its compact size, the SV-P100 recorder offers performance beyond even professional open reel decks. Since the digital signal is recorded on the video track, the space usually available for audio can therefore be used for editing "jump" and "search" marks. The unit employs the EIAJ standard for PCM recording. And, in addition, editing and purely digital dubbing are easily accomplished with any videotape deck employing the NTSC format.

Technics new SV-P100 is available at selected audio dealers. To say that it must be heard to be appreciated is an incredible understatement.

Technics
The science of sound.

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