Audio®

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Winter CES—Audio Barometer?

DIGITAL RECORDING

LIRPA 5 Kg TONEARM

Leach—DOUBLE-BARRELED AMPLIFIER


PIONEER
OUTPUT LEVEL
PIONEER STEREO AMPLIFIER SA-9800
VOLUME
FUNCTION
BALANCE
CARTRIDGE LOAD

AND SO IS THE FIGHT ABOUT TUNERS.

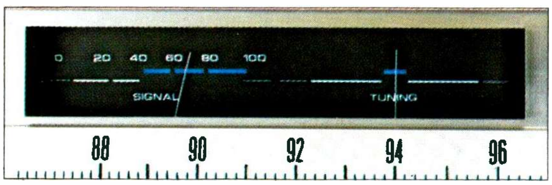
At one time the struggle between amplifiers was won by the amp that had the most muscle. And the tuner that brought in the most stations also brought in the most acclaim.

Today, there's one series of amplifiers whose technology has put it in a class by itself. And now, with Pioneer's new TX 9800 tuner it's met its match.

While other tuners offer features that just sound great, every feature in Pioneer's TX 9800 helps to produce great sound.

Unlike ordinary tuners that are content with ordinary circuitry, the TX 9800 has a new Quadrature Discriminator Transformer that works with Pioneer's exclusive PA 3001-A integrated circuit to reduce distortion to 0.05% at 1 KHz and raise the signal-to-noise ratio to 83 dB. Whew!

Many of today's tuners use sophisticated low pass filters to remove the 19 KHz pilot signal that's present in every stereo broadcast. But while they're effective in removing the pilot signal, they're also effective in removing some of the music.



SIGNAL STRENGTH AND CENTER TUNING METERS FOR A DRIFT-FREE PERFORMANCE.

INSTANTANEOUS FLUROSCAN METERING THAT LETS YOU WATCH EVERY PERFORMANCE WHILE YOU HEAR IT.

The TX 9800 has Automatic Pilot Cancelling Circuitry that makes sure every part of the music is heard all of the time. And that distortion is veritably unheard of.

The crowning achievement of most tuners today is the sensitivity of their front end. And though it's much to their credit to bring in weak stations, it means nothing unless they can do it without spurious noise or other interference.

The TX 9800's front end has three dual gate MOSFET's that work with our five gang variable capacitator to give you an FM sensitivity of 8.8 dBf. And also make sure that your favorite music is not disturbed by what's playing elsewhere on the dial.

And while most tuners today give you one band width for all FM stations, the TX 9800 gives you two. For both AM and FM. A wide band that lets you bring in strong stations loud and clear. And a narrow one that finds even the weakest station on a crowded dial and brings it in without any interference.

All told, these scientific innovations sound mighty impressive. But they wouldn't sound like much without an even more impressive tuning system.

The TX 9800 has a specially designed Quartz Sampling Lock Tuning System, that fortunately, is a lot easier to operate than pronounce.

Simply rotate the tuning dial to your desired station. When the station is tuned exactly right a "tune" light comes on. By releasing the tuning dial you automatically lock onto that broadcast. And automatically eliminate FM drift.

By now, it must be obvious that the same thinking that went into Pioneer's new amplifiers has also gone into their new line of tuners.

So just as Pioneer ended the class struggle between amps, they won the fight between tuners. With a technical knockout.

PIONEER®
We bring it back alive.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VOLUME
FUNCTION
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MONITOR
FILTER
SUBSONIC
HIGH
TUNER
AUX
BASS
TURNOVER
TONE
TREBLE
BALANCE
LEFT
RIGHT
LOUDNESS
MUTING
MODE
STEREO
CARTRIDGE LOAD
POWER
PHONES
METER

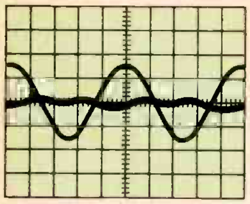
THE STRUGGLE BETWEEN THE CLASSES IS OVER.

For years people have clashed over which amplifiers are best. Class A or Class B.

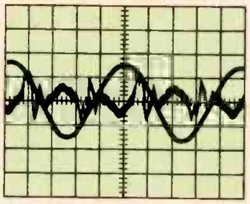
Expensive Non-switching Class A amplifiers are known to offer the lowest levels of distortion. At the same time, they also offer the highest operating temperatures.

And while Switching Class B amplifiers increase efficiency, they also increase distortion.

So if you're not paying through the nose for a heat-producing Class A amplifier, you'll be paying through the ear for a distortion-producing Class B.



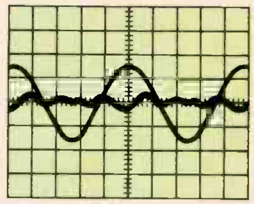
CLASS A AMPLIFIER.
LEAST DISTORTION
BUT MOST HEAT.



CLASS B AMPLIFIER.
MOST DISTORTION
BUT LESS HEAT.

At Pioneer, we believe most of today's Class A and Class B amplifiers are pretty much in the same class. The class below Pioneer's SA 9800.

Pioneer's Non-switching SA 9800 offers the efficiency found in the finest Class B amplifiers. With a distortion level found in the finest Class A. An unheard of 0.005% at 10-20,000 hertz.



SA-9800.
LESS DISTORTION, LESS
HEAT, AND MORE POWER.

And while you're certain to find conventional power transistors in most conventional amplifiers, you won't find them in the SA 9800. You'll find specially developed RET (Ring Emitter Transistors) transistors that greatly increase frequency response. So instead of getting distortion at high frequencies, you get clean clear sound. Nothing more. Nothing less.

Instead of slow-to-react VU meters that give you average readings or more sophisticated LED's that give you limited resolution, the SA 9800 offers a Fluroscan metering system that is so fast and so precise it instantaneously follows every peak in the power to make sure you're never bothered by overload or clipping distortion.

And while most amplifiers try to impress you with all the things they do, the SA 9800 can even impress you with the one thing it simply doesn't do. It doesn't add anything to the sound it reproduces. An impressive 110dB S/N ratio is proof of it.

While these features alone are enough to outclass most popular amplifiers, the SA 9800 also offers features like DC phono and equalizer sections and DC flat and power amps that eliminate phase and transient distortion. Cartridge load selectors that let you get the most out of every cartridge. And independent left and right channel power supplies.

Obviously, it took revolutionary technology to build the SA 9800. But the same technology and skillful engineering that went into the SA 9800 also goes into every amplifier in Pioneer's new series.

At Pioneer, we're certain that others will soon be entering the class of 9800. And though they all may be built along similar lines, in terms of value Pioneer will always be in a class by itself.

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We bring it back alive.

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April 1980

Audio

Vol. 64, No. 4

"Successor to RADIO, Est. 1917"

Feature Articles

Equipment Profiles

Record Reviews

Audio in General

About the Cover: Digital recording looks as if it will shortly be the "Big Frog" in the recording pond; for some basics on digital technology, see the first part of Daniel Minoli's series on page 54. The recorder is an analog model, courtesy of Studer ReVox. Photo: Photographic Illustrations, Philadelphia.

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Introducing the new Dual 839 cassette deck.

Consider what it would be like to own one.

The new Dual 839 is so different from all other cassette decks that, rather than list its many features, we'll guide you through them as if the 839 were in front of you.

First, the 839 is bi-directional in record and playback. This doubles the length of every cassette.

You'll notice there's no door between you and the cassette compartment. Insert a cassette and it will lock in precise alignment. That's Dual's Direct Load and Lock system. (A subtle but important touch; any slack in the tape is immediately taken up.)

Follow us carefully on this next one. Even when the tape is in motion, you can pull it out and replace it with another . . . and the previous mode resumes automatically. Useful? When the tape nears the end at a crucial moment, you can have a new tape in place without missing a beat.

The 839 is just as innovative in playback. If a tape made on another deck is too sharp or too flat, no problem. Playback pitch can be varied over an 8 percent range.

And previously recorded tapes with clicks, pops and disc jockey interruptions can be cleaned up electronically—smoothly and permanently. Dual's fade/edit control lets you do that with complete confidence, because it functions in playback.

Back to recording. The peak-level LED indicators react faster than any other metering system. And more accurately, because they're equalized. They read the full processed signal—including the high frequency boost other decks add but only Dual reads. No more risk of overloading a tape into distortion.

There's still more. Much more. Full metal record and playback. 6-way bias/equalization. Two-motor, twin-capstan drive system. Computer logic solenoid-activated controls. Switchable multiplex filter. Switchable limiter. Line/mic mixing. Two-way memory stop with automatic replay. Headphone level controls. And operation by external timer or optional wireless remote control.

What about the 839's audible performance? The specifications can give you a hint. Wow and flutter ±0.03 percent WRMS. Frequency response from 20 to 20 kHz, ±3 dB. Signal-to-noise better than 69 dB.

Of course, there's a price for all the 839 offers: $850. If that seems to be more deck than you really need, there are three other new Dual cassette decks. They start at $330, and they all feature the Direct Load and Lock system, DC servo motors, twin-belt drive systems, tape-motion sensor/protectors and equalized meters.

For complete details on all four Dual cassette decks, please write to us directly: United Audio, 120 South Columbus Avenue, Mt. Vernon, NY 10553.

Dual

Audio

Editor
Eugene Pitts III

Assistant Editor
Kay Blumenthal

Design
Frank Moore

Advertising Coordinator
Carolynn Sumner

Associate Editors:
Edward Tatnall Canby, Bert Whyte

Senior Editors:
Richard C. Heyser, B. V. Pisha
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Contributing Editors/Artists:
Tom Bingham, Herman Burstein, Ted Costa, John Diliberto, Leonard Feldman, Joseph Giovanelli, Edward M. Long, C. G. McProud, Gary Roseman, Jon Sank, Donald Spoto, Gary Stock, Michael Tearson, George W. Tillett, Jon Tiven

Publisher
Jay L. Butler

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Robert J. Krefting, President
Francis P. Pandolfi, Vice President and Group Publisher
Michael Brennan, Vice President and Gen. Manager
Leon Rosenfield, Circulation Marketing Director
William Ganz, Advertising Marketing Director
Gary Fisher, Director of Business Operations
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Susan Hayes, Associate Business Manager
Gertrud Borchardt, Production Director

ADVERTISING SALES
Jay L. Butler, Publisher,
1515 Broadway, New York, N.Y. 10036
Telephone (212) 975-7247

West Coast Sales Office:
Jay Martin, AUDIO, CBS Publications,
3807 Wilshire Blvd., Suite 1201,
Los Angeles, Calif. 90010.
Telephone (213) 487-5880.

Classified Advertising:
Carolynn Sumner, AUDIO,
1515 Broadway, New York, N.Y. 10036
Telephone (212) 975-7530

Continental European Representative: V. B. Sanders, International Publishers Advertising Service, Raadhuisstraat 24, P.O. Box 25, Graft-De Ryp, Holland. Telephone, 02997-1303

England: The Paul Singer-Lawrence Media Group, 54 Burton Court, London SW 3 SY4, England. Telephone, 01-730-3592

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480

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Step up to the 481, a 3-Head deck utilizing Nakamichi's exclusive "Crystalloy" cores and "Discrete-Head" technology. All the features of the 480 plus the greater dynamic range of a discrete 3-Head format.

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For those who demand "off-tape monitoring," the 482—a 3-Head deck similar to the 481 but with two complete sets of electronics and Double-Dolby so you can hear exactly what *has* been recorded *as* it is being recorded.

The 480-Series starts at under $500. For more information, write to Nakamichi U.S.A. Corp., 1101 Colorado Avenue, Santa Monica, CA 90401.

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Tape guide

Herman Burstein

Precise Gausstimates

Q. I am puzzled and disappointed about the use of some pocket magnetometers I read about in Audio *quite some time ago (early 1972). I purchased the R.B. Annis Co. Model 20 magnetometer which deflects full scale in a 10-Gauss field, having been led to expect residual magnetism on the order of 2 to 5 Gauss in the heads and guides of my tape deck. Unable to get any reading, I then purchased Annis' more sensitive Model 25, which deflects full scale in a 2-Gauss field. Again needle deflection was minimal, about 0.2 Gauss using the clip-on probe, even when the deck had been used for 15 hours since the last demagnetization. Thinking that possibly mine is an exceptionally "clean" deck, I tried measuring the residual magnetism in a friend's deck (different make), but I got equally low readings. I have reason to believe that both magnetometers are working properly, since the more sensitive model clearly registers the earth's magnetic field of about 0.2 Gauss horizontal and about 0.5 Gauss vertical; also, both meters indicate a field strength of about 0.2 Gauss at the tip of one of my screwdrivers. I have been careful with both meters to avoid overdriving them with any strong magnetic field.*

As far as I can tell, there are no conditions under which my tape deck has residual magnetism of even 0.25 Gauss, which is less than that of the earth's field. Finally, I have never heard the effects of failure to demagnetize the heads. Thus, after years of scrupulous demagnetization every four hours, I am forced to the conclusion that demagnetization has been a waste of time. I will appreciate any enlightenment you can give me.—Mark Cannelora, Santa Cruz, Calif.

A. I have not encountered a definitive study of the problem of magnetization in tape machines. The one who suggested that this may be a greater problem than most persons realize is Bert Whyte, Associate Editor of *Audio.* What I know is principally what I have heard from others, including manufacturers of tape machines, principally home machines. It is quite possible that in better grade machines, such as those owned by you and your friend, adequate precautions have been taken against magnetization, and that machines of lesser quality face problems such as described by Mr. Whyte.

In my own case, my experience was much like yours — virtually no difference in magnetometer reading before and after magnetization; I used two different demagnetizers, one substantially more powerful than the other. Yet manufacturers do constantly warn us (with an occasional exception) about the buildup of magnetism in the heads and guides. Should this happen, there is no question that the result would be an appreciable increase in noise and loss of high frequencies. Therefore, the advice to demagnetize periodically seems to be a precaution against something that might happen but often doesn't. Since there is no harm in demagnetizing, nothing much seems lost by taking the precaution. Incidentally, the usual prescription is to demagnetize after every eight, not four, hours of use.

Ferrite or Wrong?

Q. I own two tape decks, and in both cases the playback head wears rapidly. Is it possible to use ferrite heads as replacements? A local repairman told me that the switch to the ferrite heads could not be made. I am not convinced at all.—Helmut Kranz, Philadelphia, Pa.

A. I know of no reason why you couldn't use long-life ferrite heads as a replacement. It would be necessary to obtain a head with the required mechanical features for mounting on your deck. In addition, the new record head must have electromagnetic properties similar to your old one to eliminate or reduce the need for changes in bias current and audio drive current. You should be able to get additional useful information from a maker of replacement heads, such as Nortronics.

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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Latest sales figures show that Maxell is the fastest-growing brand of recording tape in the country today.

It's not surprising.

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So no matter which tape you play in the group, you're assured of a great solo performance.

Pick up a few and put together a group of your own.

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Audio etc.

Edward Tatnall Canby

Inevitably some press events come at the worst possible time for those of us with regular deadlines, but this one just had to be attended. Both Bert Whyte and myself, representing this magazine, were on the spot to hear Bell Labs present an astonishing collection of early test hi-fi discs, gold-sputtered masters, no less, made in 1931 and 1932 in—believe it or not—both mono and *disc* stereo—and housed in the Rodgers and Hammerstein Archives of Recorded Sound in New York, a division of the New York Public Library. The discs were of music played by the Philadelphia Orchestra under Leopold Stokowski, recorded in the Academy of Music in Philadelphia during both rehearsals and actual concerts.

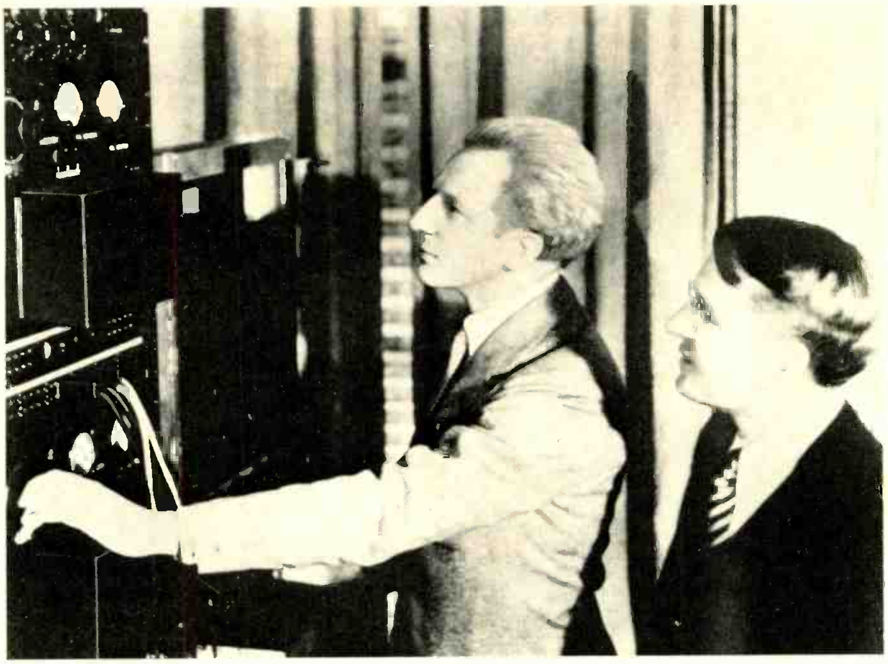
Stokowski — at the very top of his career! And *disc stereo in 1932?* This just had to be heard. Those proverbial wild horses could not keep us away. And mind you, this was when Bell Labs was leading everybody in the new electrical recording, every aspect, from disc cutters to sound movies (Vitaphone discs, 16 inches at 33⅓ rpm)—and even stereo, it now turns out. I have been fascinated historically by early stereo recordings from around 1952 or so, and the Bell Labs recordings were 20 years before—more than 25 years before the earliest commercial stereo discs of 1958.

Alas, it is my duty to report on this epochal sound demonstration. I don't know Bert's reaction, but as for me, I was disappointed. The records were fine, as I found out later. But the demo, as put on by the very outfit that practically determined the course of our history, was more than ineffective—it was downright misleading. After so much speechmaking, and such a buildup, I suspect many in the small audience went away muttering so *that's* the best they could do? Even with a charitable allowance for the "crudity" of such early experiments, the average and uninformed music listener and, especially, the hi-fi man would rightly have gone away unimpressed, at least by the sound itself, gold-sputtered or no. "Well, waddya expect? Not bad, considering. Forty-nine years! Back in the Stone Age of electrical recording. Frankly, though, I wouldn't want the stuff around my hi-fi system."

After two minutes of actual demo, I decided I would reserve all judgment on the recordings until I got to my own objective home listening grounds and could play the derived LP of Stokowski samples that had been prepared. From Bell Labs, in that extraordinarily progressive era, these recordings simply *had* to be better than what we heard. So let me tell you, first, what seemed to be wrong with that demo. And let the climax of this article, as at the demo itself, be the recordings.

I suppose we can't expect eminent scientists to be dramatists. There, we surely can be charitable and understanding. The speeches at this presentation went on and on, from the Chairman of the Board on down and, on the part of the Library, the honorable and venerable David Hall, well known to all of us for writing about and producing records. But the best speech, the most unassuming as well as informative, was that of the man who actually made the recordings, who was called back to supervise the restoration of the collection — Arthur C. Keller. Now *that* was a bit of drama! And nicely underplayed — he gave us a fine sense of the reality of that occasion, when Bell Labs was lucky enough to get, so to speak, the use of the Philly Orchestra as an experimental sound source to check out all sorts of newly developed audio gear, including the stereo process on disc. Keller did not declaim and boast; he was modest. Yes, the mikes were special calibration jobs, the Western Electric WE 640 (another arm of Ma Bell), which, he thought, were omnis — but some discussion revealed that perhaps there was indeed a slight directionality to these microphones, which could account for some of the rather dead and close sound in the records. Yes, he thought that might be true. Good little discussion.

David Hall's remarks about his Library were to the point; prior to the Rodgers and Hammerstein Archives, the New York Public Library had nowhere to house its increasing acquisitions of recorded material. So true! When the "Music Division" of the Library was located in the big main building at 42nd Street and Fifth Avenue, all the records were "stored," hopefully for future cataloging. Do I remember! Years ago, Philip Miller of the Library took me down in some sub-basement to see for myself. It wasn't his fault; there were no funds. I was aghast. Hundreds of unopened boxes, just as they had come in from the record companies each month, year after year, for decades. Not a box even sampled, let alone cataloged. All that was changed when the Rodgers and Hammerstein opened up in Lin-



Stokowski (left) and Harvey Fletcher, Bell's Director of Physical Research, during playback at Constitution Hall.

coln Center, with funds to do the job. So the Stokowski recordings are indeed going to a splendid home with all the correct "archival" facilities.

You get the idea. Speeches, on and on. I did not hear one mutter of "Let's hear the MUSIC!" from the well-bred audience on hand. So finally, the big anticlimax.

Demos Are Delicate

I have attended a thousand public playings of recorded music in large spaces, and put on a few of my own. I tend to fear the worst and am often justified. Under the best of circumstances, this is never an easy proposition. And, unfortunately, many otherwise excellent engineers and executives are thoroughly unaware that there are problems involved — and often good solutions, given the right planning. Most seem to think that all you do is to get hold of an amplifier, er, some amplifier or other, and a couple of good loudspeakers — i.e. good for the home living room — and just play what you have to play. After all, the sound is already there in the recording, isn't it? Not true! A very large part of it is in the playback.

One look at this Bell Labs setup and I began to have my doubts. A small modern auditorium, very wide and shallow, with a large stage up front. And totally dead. Excellent for speech! The Chairman of Bell Labs spoke into his microphone at the rostrum but the mike was dead. No matter. Every word was clear, even at conversational level. Others didn't bother, and just talked from their chairs. You could hear. But what sort of an auditorium was this for musical reproduction? With so much sound absorbing, you might just as well be out of doors in some wide-open space. Some of us would have taken one look and sent out for lots more amplifiers, preferably disco.

On the very wide stage, two tiny speakers were set up, far, far apart. Squat bookshelf type, big enough in the living room but awfully diminutive in this much larger space. In front of them was the forward rostrum, plus tables, chairs, what-not, extensively laid out *between* the speakers, and neatly blocking one or the other for many listeners, including myself. I was in the center but could not see the right-hand speaker. Nor hear it, thanks to sound absorption. The audio source in this case was a tape, seven-inch reel. That part of the gear was properly set up against the back wall and out of the way, though it would have been better still down on the floor or out of sight entirely.

So the music at last began. Such a muffled sound! And not nearly loud enough. That is, for an auditorium of this size and a large symphony orchestra playing very powerful music. Moreover, it seemed to be astonishingly distorted. There was strain and stridency, coming out of the general muffled effect, at every climax. Too much — it just couldn't be. Bell Labs gave us to understand, remember, that these were remarkable examples of early wide-range recording, and Bell Labs surely knows.

Distorted Perspective

If you are going to reproduce the Philadelphia Orchestra on a stage large enough to hold most of that orchestra in person (though things might be a bit crowded), then you must provide some illusion of size and power. This was NOT a home living room. But you must also understand that in a dead space — as in the great outdoors — and at a high volume, too, any distortion that is present will seem worse than it is. A sad fact of our listening nature. (Conversely, good indoor playback acoustics make distortion seem less, as with a small radio playing in the kitchen or the bathroom.) So, with those relatively small speakers, so very widely spaced apart, we were doomed before we started. Especially in mono. Most of the more than a hundred Stokowski excerpts in this collection (out of some 6,000 discs stored by Bell Labs all these years) are, of course, in mono.

In that space, the mono recordings became a point source, or rather, two point sources, whichever one was nearest you. We older souls can, on occasion, readjust our ears to the mono situation we used to know so well. But younger people of the stereo age would find this sort of point projection of a mono original particularly difficult. Reflection, diffusion of the sound is one helpful answer. There was none. Result? Artificiality and a seeming heightening of distortion. Not a good listening experience.

Was the distortion actually in the recording? The more I listened, the more I felt that it could not be. An excerpt from Wagner's *Tristan* began; as the strings soared up, ever louder, the stridency was dreadful. Strings, of course, always show up distortion of the common harmonic sort, as who doesn't remember. (In older times we were mercifully spared, thanks to the prevailing cut-off somewhere around 4 kHz.) Of the audio elements involved here, I began to suspect the speakers, which would be overdriven, most likely, before the amps reached their own stage of acute distress. Look! This was a "small" auditorium, granted, but even so its cubic volume (clumsy term for rounded internal spaces) was enormously greater than any imaginable living room. And well padded, too. SOMEBODY should have realized, ahead of time, I say. But is Bell Labs (and Rodgers and Hammerstein Archives) really aware of all that goes on in the outside world — say, the sort of sound we now get in the disco biz? I suspect not.

Could be wrong — I'd like to see the Chairman of the B. in a disco and, in

A Telarc Digital

Tour De Force!

Tchaikovsky "1812" Overture; Capriccio Italien; Cossack Dance from Mazeppa
Erich Kunzel conducting the Cincinnati Symphony Orchestra

It's stirring, familiar music. Superbly played by the Cincinnati Symphony under the sensitive baton of Erich Kunzel. And captured with all its warmth and emotion in the 100-year-old Cincinnati Music Hall. But what of the huge bells? And what of the fabled cannon? They are there—literally in full force—providing dramatic proof of the superiority of digital mastering of the untapped capabilities of today's disc recording.

Not For Every System

We'll be perfectly frank: not every system—even some of the finest—will be able to successfully track the remarkable grooves on this record. And even if your cartridge and tone arm can track the record, the full impact of the sound may escape you unless you own an outstanding amplifier and speaker system. In short, this record will challenge every part of your system in every respect.

Most difficult to track and reproduce is the authentic 19th century cannon whose initial "crack" as the powder is ignited is

This 12x enlargement shows the incredible groove modulations during the cannon shots ...probably the most demanding low frequency signals ever cut on disc.

followed by pressure waves as low as 6 Hz which can easily be seen on the finished disc. Even with maximum recommended tracking force, many tone arm/cartridge combinations may be incapable of following these remarkable groove excursions*. And the "boom" is well below the useful range of all but the most sophisticated speaker systems, coupled to amplifiers with generous reserves of power.

At the other end of the scale, the tumultuous bells provide a challenge to high frequency tracking and a stringent test of the mid-range and tweeter components. Add the full resources of the Cincinnati Symphony—captured as only the Soundstream digital system and Telarc microphone technique can—and the result is a record which will challenge your ideas about equipment performance and the limits of disc recording capabilities.

This landmark recording is just one of several new digitally-mastered Telarc releases. Available at most Audio-Technica dealers and wherever audiophile recordings are sold. If not available locally, write us today for our current StandarDisc catalog of digital, direct-to-disc, and advanced analog recordings. AUDIO-TECHNICA U.S., INC., 33 Shiawassee Ave., Fairlawn, Ohio 44313. Dept. 40A

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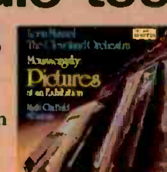
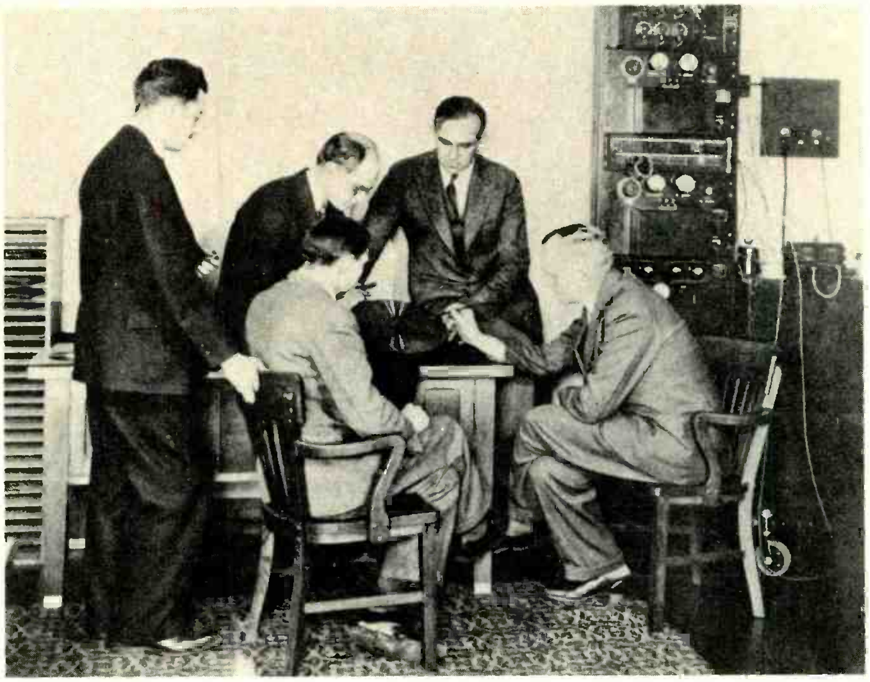
TCHAIKOVSKY Symphony No. 4, Lorin Maazel, Cleveland Symphony TEL-10047

MOUSSORGSKY Pictures at an Exhibition/Night on Bald Mountain Lorin Maazel, Cleveland Symphony TEL-10042



AUDIO-TECHNICA PROFESSIONAL AND HOME PRODUCTS FOR BETTER SOUND



Bell Labs' Development Group c. 1930 included (clockwise from left) P.B. Flanders, J.P. Maxfield, A.C. Keller, H.C. Harrison, and D.G. Blattner.

fact, wouldn't put it past him. Amiable soul. So it was a matter of not putting two and two together? I do not know where the "blame" could be placed, if anywhere. And after I had heard the records at home (the LP of excerpts) I felt extremely charitable. So the demo fizzled! Not so the recordings. Which is what matters.

Why were these extraordinary musical examples of Stokowski at work in his prime ignored for a half century, almost? Simple enough. They were not made as musical projects but simply as informal behind-the-scenes tests of equipment, thanks to Stokowski's well-known great interest in anything to do with recording. It was a superb chance to produce a real sonic workout for developmental material — no more. It was luck, indeed, that the fragmentary sonic results were saved at all, once they had done their work. The gold sputtering technique was a recent Bell Labs improvement at the time, replacing noisy graphite as a base for plating; also the use of vinyl plastic. The discs are preserved in the form of golden platters, 12-inch, with the characteristic wide center holes of an intermediate "generation" in the pressing process. Apparently they are not suitable for use in the present day pressing cycle, but a way to transfer them to tape was quickly found and clearly must have given impetus to the whole restoration project — if I am right, the ingenious new Stanton/Pickering forked stylus that will play a "negative" groove, i.e. a ridge. Marvelous idea!

Right here, our demonstration left a lot of questions hanging. Does this imply that the old gold sputtered masters are negatives, with raised ridges? Nobody said. I didn't get close enough to see.

WE 640 mikes, slightly directional — but what cutters (and how many)? Again, nobody said and I'd like to know. Surely they were advanced magnetic. *What cutting medium?* Was it still wax? Nobody said in so many words. If wax, then these remaining masters were definitely not wax, as could easily be seen — are they sputtered vinyl or metal with some coating? Nobody said. Anyhow it seems apparent that these golden masters are not the original cuts. Or so I began to think. Well, it wasn't exactly a technically minded audience.

Why sputter them — for nondistribution? If I had more time I could find out.

Answers At Home

Well, I went home and in due time found that the sound was indeed a lot better than it had seemed at the demo. Home sound for a reviewer represents neutrality out of long familiarization; one hears "through" it into the recorded sound itself.

For mono, after a bit of listening via one speaker, I set up an enhancement: QS decode (throws a lot into the back speakers of a surround system) and maximum Advent SoundSpace delay, which if I am right does synthesize useful sidewise random cross-relations between two channels, in this case identical mono. What I heard was a good and realistic space, a sonic "box" which was long but narrow (it did have some width, at least), like a squashed concert hall. Not bad for the music and it brought out its best sonic qualities, which was my intent. Some distortion, yes. Characteristic strained sounds at higher levels, typical of much earlier electrical recording. But not bad — not nearly as unpleasant as at the demo. The quiet passages were lovely, clear and wide range. Something, for December of 1931! There is a complete *Roman Carnival Overture* and an *Invitation to the Waltz* which, judging by the lengths, were taped together from two 78-rpm sides each. (They didn't say.) Wonderful fiery performances, especially the extraordinary Berlioz *Carnival*, if with some distracting vagaries in the levels here and there. Gain riding? The rest is in haphazard, incomplete fragments though most of Moussorgsky's *Pictures* (Ravel) is there, a mix of mono and stereo.

Ah stereo! Bell Labs says its disc stereo grew out of a curious double-band experiment whereby filters sent lows into one disc cutter and highs into another on the same record, the two played back (in sync!) for a wide tonal range otherwise impossible with available amps. So they say. It was this system, later consolidated into a single groove via a lateral-vertical cutter (Keller again) that was adapted to stereo. But how? Didn't say. Was this a fake stereo of sorts, highs to the right, lows to the left? Or did they somehow shift over to two *full-range* bands, after all? There were some two-band stereo cuts, two pickups, among the Stokowski segments. Also, clearly, single-groove cuts, lateral/vertical: The excerpts on our LP all run typically around 3:30 to 3:50, one 78-rpm side — ONE groove.

Well, my ears say it was the real thing, however they did it. Lovely spatial presence, even startling. Excellent sonic quality, too, comparable to the mono. Some fluttery instability of image, a bit of "hole-in-the-middle," characteristic of early stereo — and lots of separation. Especially in *Gnomes* (*Pictures*) when suddenly the violins take off and fly across stage, left to right, then straight back. Somebody fiddling with the 1932 controls.

Final note: Those violins *did not change in sound* as they flew from one side to the other. This could only be real, honest stereo. Stereo as of 1932 and fi as of 1931 — I heard it myself. That's what I wanted to know.

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AIWA AD-M700 3-HEAD METAL TAPE COMPATIBLE CASSETTE DECKS

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Aiwa's AD-M700 cassette decks in contemporary-styled silver or in a black rack-mount handle cabinets have a 3-head Double Dolby* NR configuration. So do some high-priced decks. What the high-priced decks don't have is Aiwa's unique V-cut head geometry to cancel out low-frequency contour effect, i.e., get rid of the roughness. While the record and playback heads are placed in single housing, they are completely separate, allowing each head to have the ideal gap width for its specific purpose. This provides low noise recordings with extended frequency response.

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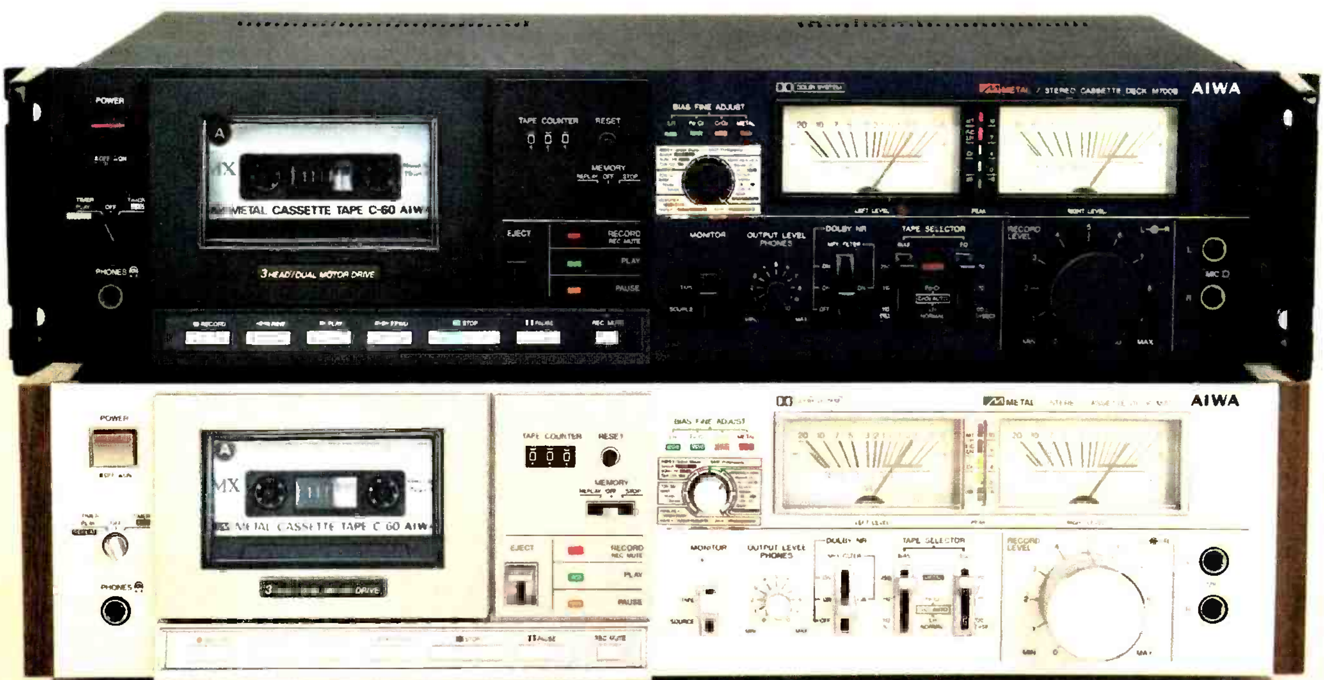
*Dolby is a trademark of Dolby Laboratories, Inc.



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The Onkyo CP-1030F

That's the secret of Onkyo. The unique ability to take you several steps beyond pure technology ... to a world of more exciting sound. And we provide it in all our components ... beginning with turntables.

■ The Onkyo CP-1030F Fully-Automatic Turntable is an outstanding example. It takes far greater advantage of today's most sensitive high-compliance cartridges ... providing more precise record groove tracking, while silencing out vibrations from record warp, the turntable motors, even sound

The Onkyo TA-2080

waves produced by your speakers.

The CP-1030F is rich with important new concepts ... a low mass, straight line carbon-fiber tonearm ... infrared sensors for smoother automatic tonearm control ... Quartz-locked direct-drive accuracy ... and a new triple-insulated suspension. All combine to produce purer sound. And the CP-1030F is just one of five advanced new turntables from Onkyo.

■ In stereo cassette tape decks too, Onkyo achieves more perfect sound. The Onkyo TA-2080, for example, provides a computerized control system called "Accu-Bias" ... which automatically assures that every recording you make is superior, including new metal tapes.

Every tape has a different bias setting requirement ... even two tapes of the same formulation from the same manufacturer. "Accu-Bias" automatically senses each tape's unique bias needs, then makes the precise system adjustments to provide it. Brighter, cleaner high notes are the reward.

The Onkyo TA-2080 also provides a rich and important array of other high performance features. 3-Heads with a 2-motor/2 capstan drive system ... a Dolby* noise reduction system with switchable MPX filter and two channel calibration controls ... both VU meters and 10-step LED peak indicators. And the TA-2080 is just one of four Onkyo cassette tape decks.

■ Onkyo integrated stereo amplifiers provide an extraordinary...and unique ... sound experience. Their special Super-Servo circuitry totally eliminates the sonic "ghost signals" common to DC power amplifiers. As a result, each instrument and voice sounds purer and more individually real ... regardless of volume level. You'll experience—perhaps for the first time—stereo with a fully discernible third-dimension.

There are three Onkyo integrated stereo amplifiers to select from. All with Super-Servo, LED peak power indicators, and other advanced features. A companion series of three Onkyo stereo tuners is also available.

■ Of all our components, the most widely known are our stereo receivers. And with good reason. Their FM sections are clearly superior ... picking up weak stations noiselessly and strong stations without distortion. And Onkyo was the first to revolutionize receiver design with Quartz-Locked FM tuning and the unique

The Onkyo A-7090

"Human Touch Sensor" control.

In all, there are 6 Onkyo AM/FM stereo receivers ... with the incredibly advanced TX-8500 MK-II paramount among them. With 160 Watts per channel**... digital FM frequency display ... a memory to preset up to seven FM stations ...

The Onkyo TX-8500 MKII

and a built-in Dolby* FM circuit ... the Onkyo TX-8500 MK-II is one of the most advanced receivers ever conceived. And it's just one of 6 Onkyo receivers to pick from.

■ In speaker systems, few are as innovative, accurate and impressive as the Onkyo F-5000 3-way, Phase Aligned Array™ Speaker System. The F-5000 delivers more exciting sound ... with precise three-dimensional imaging.

Speaker alignment is one of the reasons. Even more significant is the unique Onkyo planar woofer,

The Onkyo F-5000

planar midrange, and Direct Drive Membrane™ Tweeter.

Gone are the sound interference patterns and phase cancellations that cone shaped speakers always provide. Instead is a listening experience with the same true frequency relationships of the performance.

■ Experience "the secret of Onkyo" now, at your Onkyo dealer. Hear audio components so advanced, they transcend mere technology.

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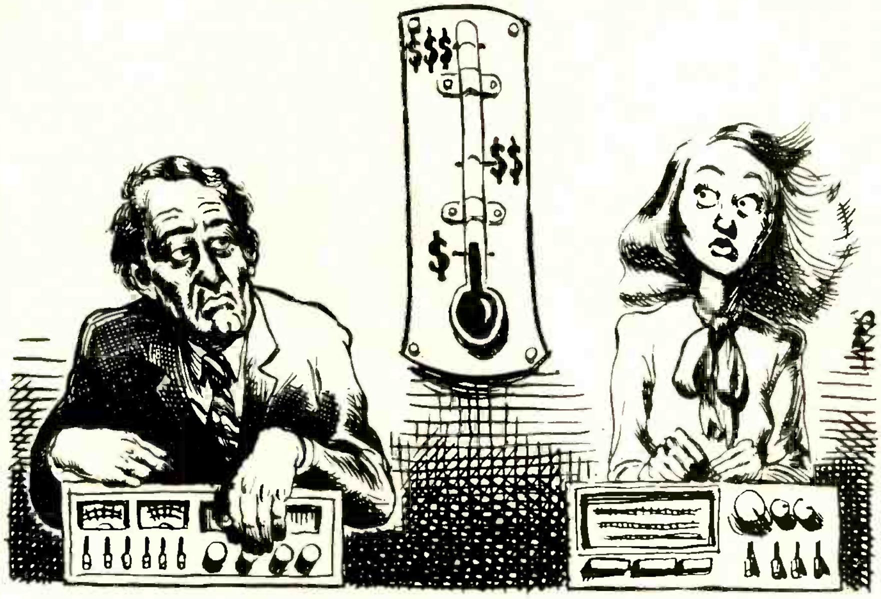
*TM of Dolby Laboratories ** Min. RMS at 8 ohms both channels driven from 20 to 20,000 Hz with no more than 0.05% total harmonic distortion.

Behind the scenes

Bert Whyte



The 1980 Winter CES in Las Vegas was widely anticipated as a barometer of the audio industry. After what could charitably be called a lean year in 1979, manufacturers and dealers alike were anxious to get a reading on the prospects for 1980. The first day of the show seemed encouraging — good attendance, a definite undercurrent of optimism, and apparent enthusiasm for some of the new product offerings. Alas, by the next morning the barometer was falling, and there was a pervasive gloom as it became apparent that many key dealers, especially those from the East, were "no-shows." Quite a few of the manufacturers I spoke to were openly disappointed with the show and weren't sanguine about the financial state of the industry. One speaker manufacturer bitterly commented to me that after all his trouble and the expense of exhibiting, he had opened up exactly one new account.

I am not trying to be Pollyanna, and though the audio industry is most certainly depressed, I don't think it is really quite as bad as many would have you believe. For one thing, I think many industry people are still in a state of shock after finally realizing that the audio industry is indeed undergoing a traumatic recession for the first time in its existence. I'm not trying to give a phony, hyped-up pep talk or any of that "buckle down Winsocki" jazz, but in spite of the industry's very real problems, this is still a very viable business. The great preponderance of American households do not yet have a single piece of audio equipment — surely an untapped market that needs a concentrated effort and a different approach. Certainly in all the burgeoning new technologies, there are opportunities for the creative mind. I think too that we have come dangerously close to saturation in many of the traditional areas of audio commerce. It is time for new directions and also time we took a long hard look at ourselves, friends.

Perhaps one of the reasons for the down-in-the-mouth attitude at the show was the oft-repeated observation that there wasn't much really new or exciting. While generally true, there were some interesting items worth more than a casual look. This time around, with no apologies, I am not even going to attempt a semi-catalog survey of what is new in the various component categories. One is simply overwhelmed by the sheer numbers of what is available. Thus, I shall limit my observations to what I thought was important, useful, and contributory to the enjoyment of music.

PZM Mikes

Crown International, heretofore known for their high-quality amplifiers, preamps, etc. has begun producing a very unusual microphone, the PZM, or "pressure zone microphone." Originally developed by Ed Long (of "time align" fame), one of this magazine's Contributing Editors, and his associate, Ron Wickersham, the PZM operation is based on the principle that, within a few millimeters of a rigid surface, the incident and reflected sound waves from a pair of equal level signals add coherently. Very close to a boundary, such as a floor, the signals are still in phase after being stopped and reflected by the boundary. This creates a pressure zone right at the surface of the boundary, where the instantaneous pressure is uniform, and response is not a function of the angle of incidence. In his original experiments, Long used a half-inch Bruel and Kjaer microphone, placed so that its diaphragm was within a few hundredths of an inch and parallel to a stage floor (rigid boundary) and *not* facing the sound source; ordinarily the mike diaphragm would be vertical or nearly so. He found that a PZM maintains a flat response and does so for all the angles of incidence in the hemisphere surrounding it. The sound is cleaner and truer because the signal is free of anomalies caused by the phase cancellation of direct-with-reflected sound.

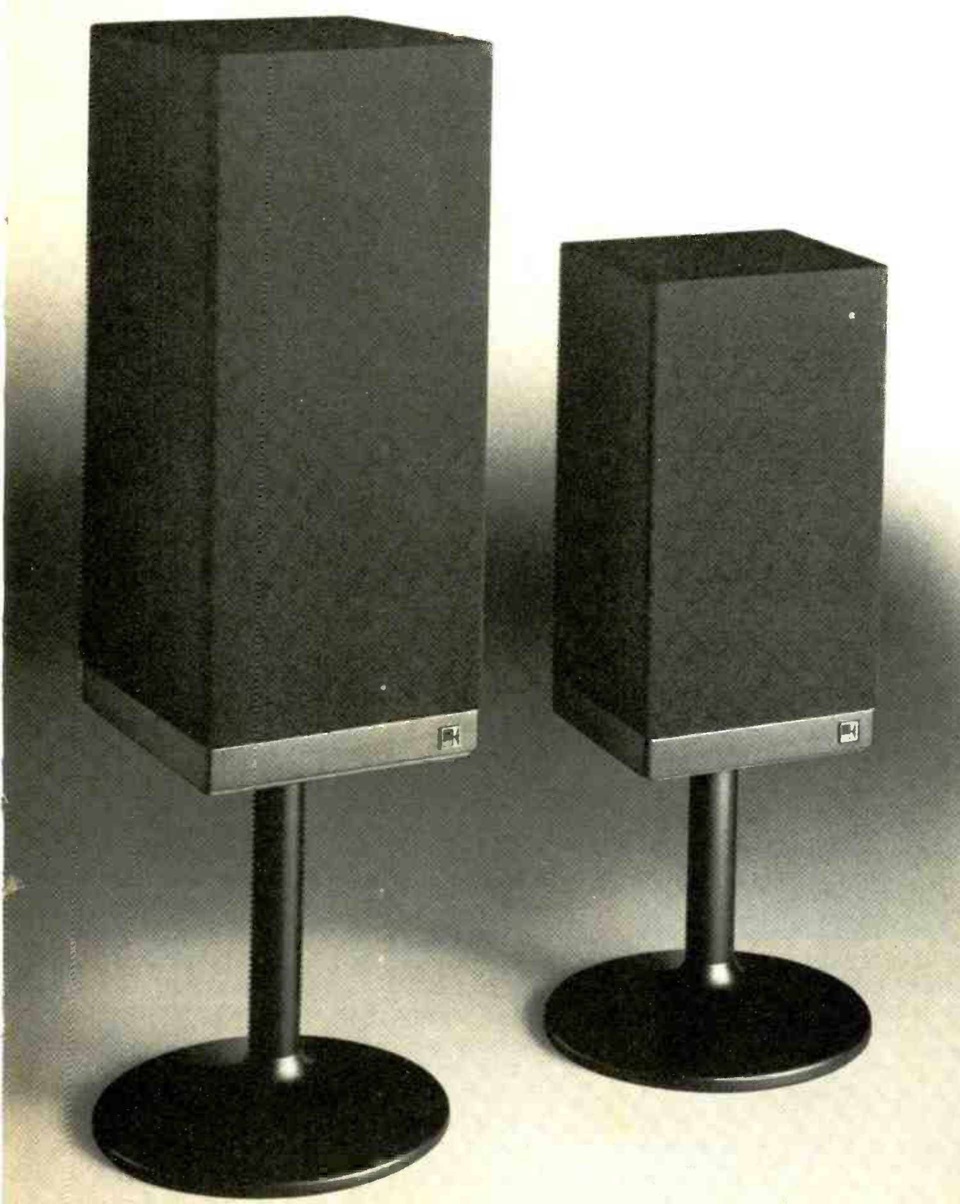
Crown has an exclusive license to build the PZM microphone based on Long's research. The firm's general purpose model is a 5 X 6 inch, ⅛-inch thick aluminum plate, with the XLR mike connector mounted on it. The finely machined microphone cantilever features an approximately ¼-inch electret mike capsule mounted on it so that its diaphragm is parallel to and about 1/12,000 inch above the plate. Standard power supply is a combination transformer, battery, and phantom power supply contained in an approximately three-inch metal cube. With the elimination of phase-cancelling and comb-filtering effects, the PZM is very accurate with a smooth, wide frequency response. The design lends itself to simple miking techniques, and the PZM can handle sound levels of more than 150 dB. It can even be placed inside a kick drum! Best of all, the Crown PZM will be priced around $375.00, including power supply. It gives a whole new dimension to miking techniques, and much work has been done with concert recordings.

Dennesen Electrostatics exhibited

KEF Model 304
on optional stand ULS II

KEF Model 303
on optional stand ULS I

Elegant, Efficient, Effective.



The traditional KEF accuracy in music reproduction now combined with a higher level of efficiency..... Whether for use with amplifiers up to 100 watts or music centers as small as 10 watts, the two new KEF speakers—Model 303 and Model 304—can achieve surprisingly loud volume levels without any sacrifice of the tonal quality for which KEF is world-famous.

Visit your authorized KEF dealer for a thorough demonstration.

For his name and product information write to: KEF Electronics, Ltd., c/o Intratec, P.O. Box 17414, Dulles International Airport, Washington, DC 20041.

In Canada: Smyth Sound Equipment, Ltd., Quebec J4H 3V7.

KEF The Speaker Engineers

some unique designs in several product categories. The most intriguing was their DEI linear tracking, air bearing tonearm. On a superbly machined brass support base is a slide track drilled with a series of tiny inlet holes. This is connected via flexible tubing to a special low-noise air pump. Riding on the slide is an extremely lightweight plastic "saddle," and mounted on the saddle is an ultra-thin carbon fiber arm. The air pump maintains a positive pressure through the outlet holes of the slide bar, and the plastic saddle and arm carrier thus ride on a frictionless air bearing. The pump is capable of handling most cartridge weights, and there are several interchangeable arms of different mass. It is uncanny to gently touch the support saddle and "feel" the action of the air bearing. Tracking abilities are phenomenal with this kind of setup. For cartridges of very high compliance, this is an arm that will finally do them justice. The $1,000.00 price includes the air pump. Also shown by Dennesen was their DEI turntable isolation base. This features special pneumatic dampers with a fundamental resonance of 3.2 Hz, and it is claimed to virtually eliminate acoustic feedback. Most turntable bases can be fitted to the unit, which costs $325.00.

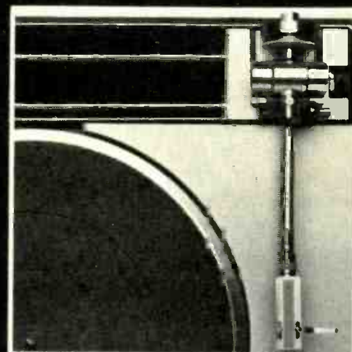
Preamps and Discs

Charlie Woods, the genial head of Audionics of Oregon, was proudly showing the production versions of his Space and Image Composer, with its Tate system SQ decoder and synthesizer. As you might expect, most people are using the unit for its synthesizer functions, finding out what interesting out of phase information is lurking in the grooves of their favorite records. With four matched ADS speakers the sound was great with interesting interchannel dynamics and, with some recordings, an impressive panorama and proscenium effect. Also demonstrated was the RS-One, Audionics' new Class A preamplifier. Essentially a purist design, with a computer-designed RIAA section claimed to be flat within 0.2 dB, the unit also features the same unique axial tilt circuit as on the image composer. This enables ±7 degrees of electronic correction of the mechanical misalignment of the stylus in the groove.

By now, most of you are aware of the dbx-encoded discs and their companion Model 21 disc decoder. The reasons for their design were the extension of usable dynamic range and the virtual elimination of surface noises. I have tried the system at home, and in general it works quite well. However, it is a system that is source limited: It is only as quiet and

THE PHASE 8000 IS AS CLOSE TO PERFECT AS YOU CAN GET.

SIGNAL/NOISE: –78dB.
WOW & FLUTTER: 0.013%.
TRACKING ERROR: 0.
SKATING FORCE: 0.



No other turntable can match the Phase 8000, because no other turntable has such advanced motors. You can't buy a quieter turntable. Or one with as low wow & flutter. Or one that tracks better.

The Phase 8000's tangential tracking tone arm keeps the stylus in perfect 90° tangent with the grooves. It's the same way the master disc was cut, so the motion of your stylus is identical to the cutterhead stylus. There's absolutely no tracking distortion. No crosstalk. No skating force that can actually re-cut your grooves.

NEW LINEAR MOTOR ELIMINATES MECHANICAL LINKAGE

Other manufacturers have tried to move tangential tone arms with worm gears. Belts. Rollers. All with the same sad result: Mechanical connections pass on the noise and vibration of the motor.

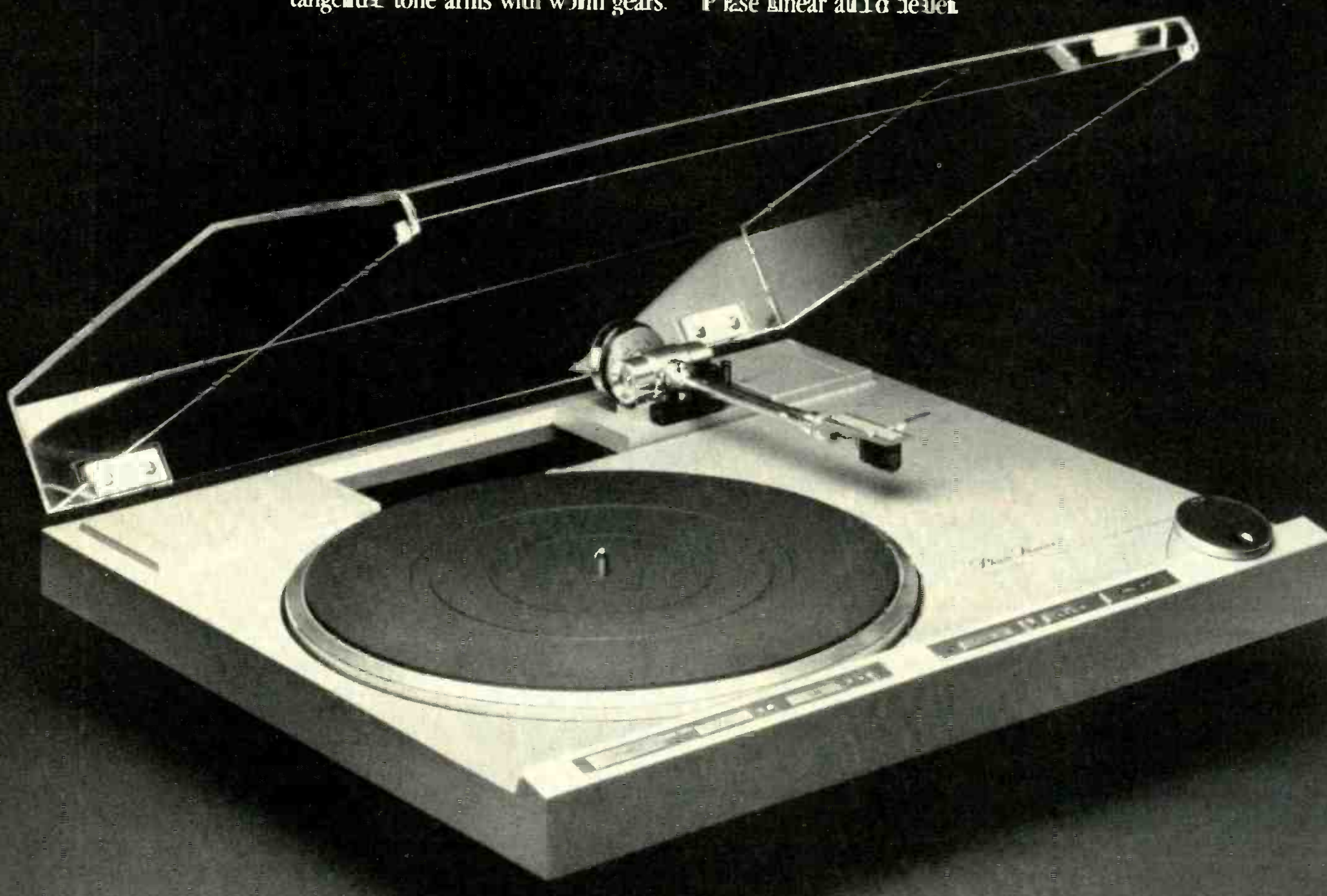
The Phase 8000 solves this problem with an ingenious Linear Motor. The tone arm base is a permanently magnetized armature that glides along guide bars above electro-magnetic coils. The arm moves by direct induction—not mechanical connection. So there's virtually no noise.

Inside the tone arm, an opto-electronic detector cell senses the slightest tracking error, and instantly sends correcting signals to keep the arm on track.

NEW QUARTZ-PLL DIRECT DRIVE

Our new slotless, coreless Stable Hanging Rotor DC motor virtually eliminates "platter wobble." Quick start/stop. Speed deviation is lower than 0.002%

If you want to hear all these technical advantages translated into musical improvements, contact your Phase Linear audio dealer.



Phase Linear Corporation, 20121 48th Ave. W., Lynnwood, WA 98036 *Phase Linear®*

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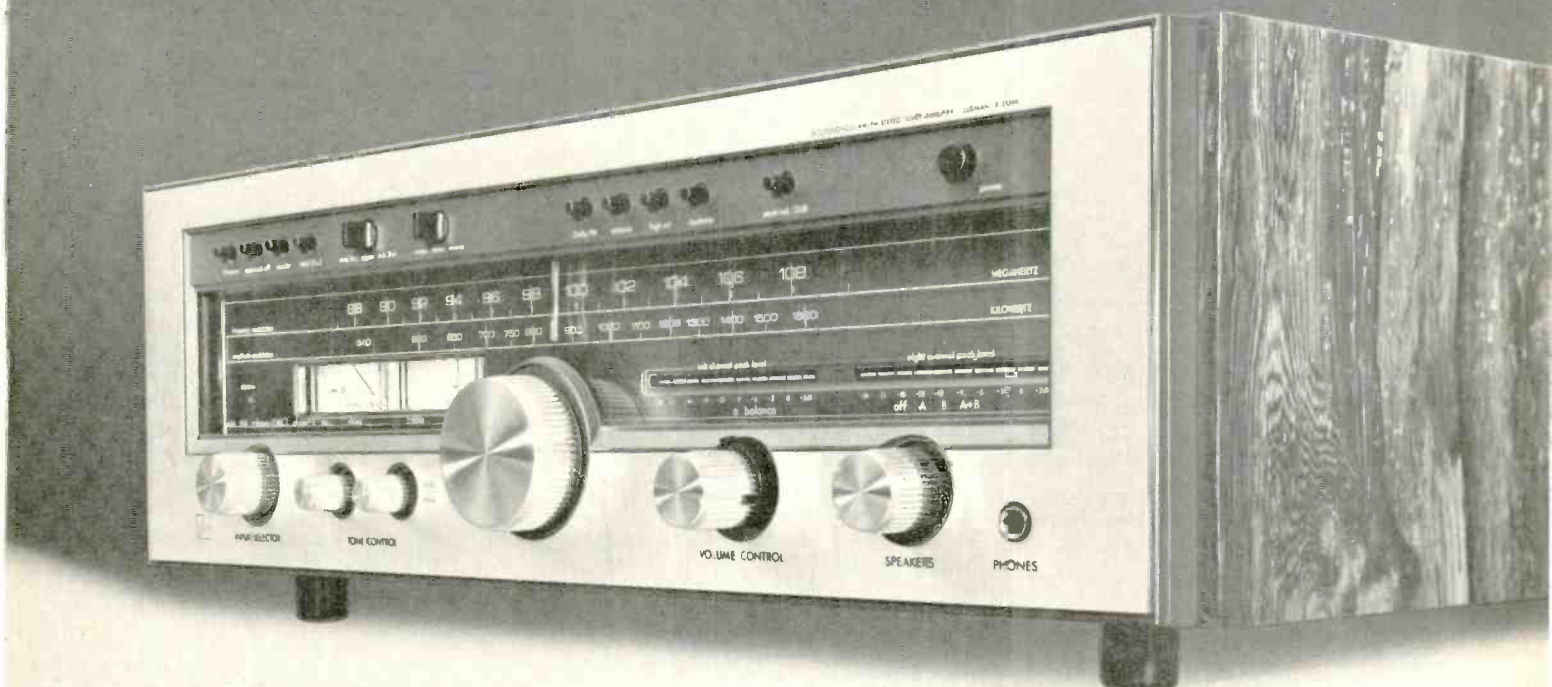
displays only as much dynamic range as the master tape from which it was encoded. Jerry Ruzicka, the dbx vice president who is the guiding light behind this project, got the bright idea that if he could find a source of digital masters, encoding them onto dbx discs would really give an honest-to-God 85 to 90 dB of dynamic range. And all this without recourse to an actual digital record playback system — a sort of sonic "have your cake and eat it, too." Well, Jerry found M&K RealTime Records ready to cooperate. Previously, they have been known for their excellent direct-to-disc recordings. They recently hied themselves to Vienna, where they used a Sony 1600 digital recorder to make a series of recordings with the refugee orchestra, The Philharmonica Hungarica. Understandably they concentrated on old warhorses like Tchaikovsky's *Romeo and Juliet* and *Nutcracker* suites, *The Sorcerer's Apprentice, Espana*, and *The William Tell Overture*, with six albums in all. At the CES demonstration, I wasn't too happy with the sound of the playback system, but there was no question that the vaunted 90 dB of dynamic range had indeed been captured on the discs. (As I related in my recent column on dynamic range, there are going to be some merry old speaker blow-ups with these recordings!)

Holding forth at the Showboat Hotel was John Dunlavy of Audio Standards Corp. As I have said before, he is one of the few people in this industry who truly deserve the "genius" label. John has done it again. His new Model FP-3A preamplifier is one of the most advanced designs extant, with specs which are sure to be challenged by many who won't believe them. The preamp is an entirely FET design, using *no* inverse feedback loops. All stages have slew rates exceeding 500 volts per microsecond. Square wave distortion is not measurable at 10 volts, peak to peak, nor is TIM at the same levels. THD and IM distortion are less than 0.01 percent at 10 volts, p-p. Noise is within 3 dB of thermal agitation — in other words, near the theoretical limit of the laws of nature! All these are claims, but John was equipped as usual with his imposing array of test equipment, including HP spectrum analyzers, and proved many specifications on the spot. How did the preamp sound? Sensational, but then it was being played through John's new speaker system, so I'll have to wait to hear this preamp with a variety of systems I'm familiar with before I can make an assessment of the unit itself.

As to John's DDRL-3, Dual Directivity Reference Loudspeakers, this impressive system will likely find a home only where the "man wears the pants." There are rectangular cabinets housing 15-inch woofers, one on the bottom, one on the top. In between them is a cylindrical unit containing six midranges and three tweeters. That's for each side! The speakers stand almost seven feet high, so you see what I mean about their probable ownership. They feature a switchable pattern of either directional or omnidirectional; I liked the omni better. The speakers are time and phase coherent, and John states they will handle one kilowatt on short duration musical peaks. He also claims distortion is less than 0.3 percent THD at 90 dB SPL at one meter for any frequency from 30 Hz to 20 kHz. I didn't have a chance to listen as much as I would have liked, but on some really high-quality recordings, the sound was truly impressive for smoothness, imaging, really solid bass, and "non-sizzly" top end. Further judgment must come with extended listening, which I hope will occur within a few months. All in all, two very impressive products, appealing to the advanced audiophile who can afford $1,800.00 for the preamp and $3,000.00 a pair for the speakers.

Next month I'll cover some of the other notable components from the Winter CES and report on a visit with Gene Czerwinski, the "high priest of dynamic range" at Cerwin-Vega. ▲

LUX R-1120A



TOMORROW'S TECHNOLOGY IN TODAY'S RECEIVERS

Lux remains in the forefront of product development because we refuse to rest on past achievements. For Lux, today's best is just not good enough for tomorrow's audiophile listener!

Excellent examples of this Lux philosophy in action are found in the Lux Tuner-Amplifier R series: the R-1030, R-1040, R-1050, R-1070 and the fantastic top-of-the-line R-1120A. Rated at 120 watts per channel from 20 to 20,000 Hz, both channels driven into 8-ohm loads, the R-1120A has no more than 0.02% IM or harmonic distortion.

Check the typical advanced technological features incorporated into the R-1120A, such as:

- The emitter ballast driver and triple diffusion planar type power transistors, radically new semi-conductors serving the realtime processed DC amplifier section, with high frequency cutoff reaching 200 MHz; a perfect complement to the triple diffusion planar output transistors with their 60 MHz high frequency cutoff.
- The MC head amp employing specially selected FETs in a new complementary input circuit configuration inherently resistant to extreme and internal electrical noise sources. This exclusive circuit automatically adjusts its gain according to the Impedance of the phono cartridge used.
- The exclusive CLL (closed-loop lock) tuner system which precisely adjusts all stages of the FM section—from front end to the detector—for optimum reception of the tuned frequency. An improvement over the best of the conventional tuner technology, the quartz locked synthesizer system, the CLL tuner system's accuracy is used to trigger Lux's innovative Accutouch tuning mechanism which produces a momentary electro-mechanical tuning knob lock at the point of exact station tune-in.

The sophistication of the internal circuitry of the R-1120A has been realized in scaled-down form in other less expensive tuner-amplifiers of Lux's R series. And the elegant styling and rosewood finished cabinetry maintained throughout the line.

The receiver designs of tomorrow can be seen at your Lux dealer today.

R-1030

R-1040

R-1050

R-1070

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Audioclinic

Joseph Giovanelli

Designing an Infinite Baffle Speaker System

Q. I intend to build a 9.5-cubic ft., infinite-baffle enclosure, employing a 12-in. woofer, an 8-in. midrange, and a 3-in. tweeter. I will use crossover points at 800 and 5,000 Hz.

I have a friend who has this identical setup, and I like the tight, gutty sound his system produces. I feel, however, that some male voices sound slightly "honky."

My friend, not being an engineer and unable to obtain the necessary information, took pot luck with a separate compartment which he built around the midrange and tweeter speakers. This compartment measures approximately 20 x 7 inches, with a partition separating the two compartments. No absorbent material is used in the tweeter side, and only two walls of the midrange side are lined with ½-in. thick material.

The rest of the enclosure is adequately lined with 3-in. thick absorbent material. I believe that the "honky" sound might be caused either by insufficient space in the midrange compartment or by improper or inadequate use of absorbent material.

Should more absorbent material be used? If so, on how many walls?

— Name withheld.

A. There can be a number of causes for the "honky" sound you have mentioned. Such a sound is probably the result of some kind of peak in the response. A term such as "honky," however, is vague, so there isn't much clue as to where the peak may be occurring. It may be the result of cone breakup in either the woofer or the midrange speakers. It also could be the result of a lack of absorbent material in the midrange compartment of the enclosure. This lack of insulation may be more of a problem if the midrange compartment is rectangular in shape. The more a compartment approaches such a rectangular shape, the more likely it will be for a resonant frequency to occur directly as a result of the shape of the compartment — an organ pipe effect.

It may not even be necessary to subdivide your speaker enclosure, especially in those cases where the midrange and tweeters are of the "sealed-back" design. Even if such a design is not employed, if the cones are relatively stiff, they will not be affected significantly by the excursions of the woofer cone.

Assuming, however, that it is necessary to retain the midrange compartment, I suggest that you do not partition it to provide a tweeter compartment. Further, I suggest that you use some sound-absorbent material on all four walls, the exact amount of which will depend upon the acoustical results you hear.

The "honky" or "chesty" sound of which you speak may be the result of the woofer having a resonant frequency which falls within the mid-bass portion of the audio range, say 90 Hz. There may be no cure for this unless you are willing to try some mass loading of the cone. This means putting some clay, or other substance which can be readily removed, in the center of the dust cover. Sometimes it is a good idea to spread out the added mass over more of the cover which helps reduce cone breakup as well as lower the resonant frequency of the woofer. Mortight or similar material works well for this application.

If woofer resonance is not the problem, it is likely that the cabinet itself contributes to the sound. Perhaps there is not enough bracing on the back panel or even the baffle. These panels should be very solid. If they vibrate, they will add sound of their own.

If the cabinet is not the problem, chances are that the sound-absorbent material is either inadequate or insufficiently applied. Be certain that the material used is intended for the absorption of sound. A lot of experimenting must also be done to insure that you have used the right amount.

Sometimes a boomy quality can be the result of a simple thing like using a wire gauge which is too small. This will reduce the damping and, in turn, will exaggerate any resonant peaks that the woofer may have.

Even though it does not relate to the problem as you have stated it, I must mention this: Many of the woofers available today have such low, free-air resonances that their cone motions cannot be controlled in cabinets of 9.5-cubic ft. volume. The result could be premature bottoming of the voice-coil on strong bass passages. A

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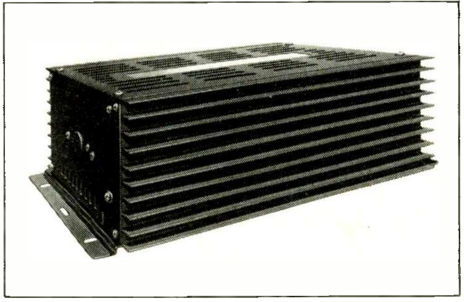
Our best.

And here's why.

The Jensen R430 AM/FM Stereo/Cassette Car Stereo Receiver is our top-of-the-line. Our best. And for a lot of very good reasons.

Its functions.

Advanced functions that really make a difference in your music.



Functions like Dolby® Noise Reduction for clearer reproduction of Dolby-encoded cassettes and FM broadcasts.

And a function like Loudness Compensation of +6dB at 100 Hz to improve bass at low volumes.

Interstation FM Muting lets you tune out annoying between-station noise when tuning. While an FM Local/Distant switch allows you to optimize the receiver's sensitivity for strong or weak signals.

The R430 even offers separate bass and treble controls.

Bi-Amplification.

It's a function worth knowing about. Because of the real difference it can make in your music.

The Bi-Amplification function of the Jensen R430 uses a low level passive crossover to split the audio signal into low- and high-frequency bands. The low frequency signals are then sent to one set of amps. And the high signals are sent to another set of amps.

From these amps, the high signals are fed to one set of speakers. And the low signals are routed to another set of speakers. A much more effective use of power.

But what does bi-amplification mean? It means the R430 will provide lower distortion... and higher listening levels... with a given power input. No small feat.

It gives you a second, completely different way of listening to your music. With the option right at your fingertip.

A separate power amp.

Actually four OTL amps; two for each channel. This trunk-mounted unit accompanies the R430 to deliver a Continuous Average Power Output of 30 watts per channel. Plenty of low-distortion power, excellent heat dissipation, an ideally suited component to handle the R430's bi-amp mode.

More features.

Electronic feather-touch switches command a whole array of functions.

LED indicators glow when they're engaged.

And a unique Automatic Tape Alarm helps prevent damage that causes wow and flutter. If a cassette remains engaged when the ignition is turned off, lights flash and speakers beep, reminding you to remove it.

Respectable specs.

Great sounding music is the result of great specs. And with specs like the R430's you can imagine why we're so proud of its sound.

Total Harmonic Distortion is 0.4% at 52 watts; 1kHz. The Frequency Response measures out at 30 to 18,000 Hz (−3dB). And the Weighted FM Signal/Noise Ratio (less Dolby) is 68dB.

Is it any wonder why we say the R430 Receiver is our best?

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Dear editor

Mike on Music Mountain

Dear Editor:

I want to congratulate Ed Canby for his marvelous detective work and nostalgic reporting of the Music Mountain concert and its recording techniques (*Audio*, November, 1979). I'm in a unique position to tell Ed and the *Audio* audience exactly how astute were his guesses about the miking and mixing techniques, for, you see, I am the recording engineer for Music Mountain.

By the by, Ed, it is a bit frustrating for me to be reading about myself in such an indirect way. I really would like to have met you, for I feel that I know you already through your writings. So, Ed Canby is invited to the Green Room any time next season at beautiful Music Mountain for the behind-the-scenes meeting that didn't quite occur this past year.

Well, did E.T.C. guess correctly what types of mikes were used at Music Mountain and how they were used? Not to keep you in suspense, the answer is, essentially, yes. That well-hidden and spaced rear pair of mikes are not omnis as surmised, but cardioids, pointed somewhat to help minimize the effect of the distracting audience noise that Ed describes so well. The object of these mikes is to capture the hall ambience. If the audience were not present, I would most certainly choose omnis for that role and hang them in the same "ideal" spot. Fortunately, there is enough random reverberation in that part of the hall to permit the use of the cardioids, which favor the musical ambience and lower the direct sound of the crowd 3 to 6 dB below that which omnis would have picked up.

The close, front pair are two mikes close to each other, as Ed saw. But (from his vantage point) he must have mistaken the cross bar of the stereo bar mike holder for one of the microphones, for he surmised that the mikes were an M-S matrix. In fact, they are a crossed pair of cardioids at about 110 degrees (not 90 degrees) to each other, and with the capsules close together. This is a sort of a cross between X-Y and O.R.T.F. techniques and works best at this distance from the quartet.

On home speakers optimally set up, the result will be a naturally appearing left-to-right image as if you were sitting in Ed Canby's ideal Music Mountain seat. By the way, if the setup were M-S matrix, the mikes would be at 90 degrees and one would be a cardioid facing front, the other a figure eight facing sideways, not an omni.

If (and I hope) Ed comes backstage later this year, then maybe we will discuss the custom mixing, taping, and monitoring equipment used to record Music Mountain. But at this time I've got to get back to preparing the tapes for 1979-80 broadcast. This year the concerts will be broadcast on the Eastern Public Radio Network, in the Midwest and West on a selected network, and in New York City on WNCN-FM. I like to think that this method of recording Music Mountain closely reproduces the musical balance and acoustic ambience that a visitor to a concert in Gordon Hall receives.

Bob Katz
New York City

Rating the Ratings

Dear Editor:

Last August I was given a promotional copy of Sparks' latest album, **No. 1 in Heaven,** along with assurance that I could turn it into an art project or something if I didn't like it. I had to agree with Jon Tiven's D+ performance rating in November's Column.

This week, a friend brought over The Eagles' **The Long Run** for me to audition, and Jon Tiven is (nearly) right again. I do, however, view his F+ rating as too severe. On the basis that the Eagles at least managed to produce what appears to be music on the album, consistency in rating would seem to indicate some increment above that accorded to Sparks' electronic noise.

Frank Stephans
Durham, N.C.

Errata: Tonearm Geometry

In the January, 1980, article "Tonearm Geometry and Setup Demystified," equation 4 (page 77) should read as follows:

Mounting center =

$$\sqrt{L^2 + r_1^2 - 2Lr_1\cos(90-a)}.$$

Equation 6 (page 78) of this article should be:

Angular error =

$$90 - OA - \arccos\left[\frac{R^2 + L^2 - (L-OH)^2}{2RL}\right].$$

TRENDS FOR THE FUTURE

Gary Stock

Gaining insight into a huge, tumultuous event like the Consumer Electronics Show while actually *there* is a bit like trying to analyze the suspension system of a truck as it runs you over. Too much happens too fast. It is only in the recovery room, surrounded by relative calm, that one begins to put things in order. Now, a couple of weeks after this year's show, surrounded by the 36 pounds of paper — press releases, brochures, white papers, and notes — which I brought back, the diverse, occasionally contradictory movements of this fascinating business are a bit clearer, and some judgments can be made as to where we are headed, audio-wise, in the '80s.

The receivers of the '80s will probably look quite different from their predecessors and use different circuit design approaches as well. As typified by two new Sony receivers, the STR-V45 and STR-V55, introduced at the January show, and by earlier receiver introductions from Toshiba, Sansui, and SAE, digital station read-out with frequency synthesis may soon replace the conventional capacitor tuning system and the slide-rule dial found in most receivers today. Aside from their obvious convenience, frequency-synthesizing tuner sections often have lower distortion than conventional tuners because they eliminate mistuning and thermally induced drift. They can also easily accommodate microprocessor-based station-memory systems and station sampling functions that play a few seconds of each of several stations when activated (both are found in the Sony receivers). Moderately priced receivers may retain conventional FM front-ends but acquire digital read-out as a cosmetic addition, in the opinion of some observers, a few of whom see the majority of mainstream receivers taking on digital read-out within the next two years.

At the same time, many receivers and integrated amplifiers may acquire pulse or switching power supplies, which have much less bulk than conventional supplies. This in turn could reduce the profile of most receivers to a fraction of current size, rendering most '80s receivers slimline units (at least by contemporary standards). As seen in some of the current mid-priced Yamaha and Lux receivers, as well as in top-of-the-line units from most other receiver suppliers, moving-coil pre-preamplifier stages are increasingly common and will probably show up in most of the mainstream receivers of this decade as well. Gone forever, more than likely, will be the slide-rule dial, needle-type FM tuning meters, and suitcase-like bulk of today's receivers. All of the aforementioned developments, by the way, will be helped along by the increasing availability of large-scale integrated circuits incorporating whole microprocessors, switching supply regulators, pre-preamplifiers, digital display sections, and other complete stages.

Tonearms and Turntables

Four new turntables and arms using the radial-tracking principle were demonstrated at the January show, bringing to more than a dozen the total number of such units offered currently. Technics introduced their intriguingly compact SL-10, about the length and width of a record jacket, which employs a short servo-controlled arm assembly mounted in the dust cover, along with an integral Technics moving-coil cartridge. According to Technics spokesmen, it may be the first of an entire line of straight-line tracking tables from that company. Yamaha showed a second prototype version of the radial-tracking turntable they demonstrated in Japan last year; it is a servo-controlled full-length arm, driven by a worm gear, integrated with a quartz-locked direct-drive platter system, and it's exceptionally handsome to boot. It may become Yamaha's top-of-the-line turntable next year. ReVox debuted a less expensive version of their widely acclaimed B790 radial tracking turntable, the new unit to be called the B795. It has precisely the same "Linatrack" over-the-disc swing-out arm assembly found on the B790, with a simplified direct-drive motor system. And finally, Dennesen demonstrated their separate straight-line tracking arm, the ACLT-1, which is floated by compressed air and therefore requires no elaborate servo-correction systems.

These introductions, coupled with the earlier debuts of radial tracking units from Aiwa, Goldmund (France), Phase Linear, and Harman-Kardon, point to a renaissance for the principle, which enjoyed a brief popularity in the mid-'60s and then entered a long Dark Age. A number of factors have contributed to this. Improvements in disc software and in the remainder of the playback chain have proven the once-disputed sonic advantages of the radial-tracking concept. Far Eastern manufacturers have just about exhausted the sales advantages of promoting direct-drive and phase-locked-loop drive systems and may see the radial-arm principle as "The Next Big Thing" in turntable marketing because of its cosmetic attractiveness and distinctiveness. The fact that several large Japanese firms have chosen this time to introduce radial-tracking tables as their top-of-the-line units supports this concept, particularly given the monolithic character of product development in that nation. (Lux and Mitsubishi are reputed to have straight-line units nearing the market, too). And, according to at least one source, research into radial-tracking systems for video disc players has been spun off into the analog record-playing field. Whatever the cause, the straight-line tracking trend appears to be taking hold; although the first generation units are expensive, it is likely that prices will fall to mainstream levels as production economies and competition take effect, in much the same pattern that characterized direct-drive turntable prices over the past several years. Thus, the last major evolutionary step of the phonograph before the age of the digital disc begins will probably be to the radial arm.

The Video Disc

To the surprise of many industry observers, there were *two* production model video disc players at the January show. One was Magnavox's Magnavision player, which has been available in limited quantities for about a year. But a video disc unit from Pioneer, slated for introduction in early 1980, was also present. Pioneer has been manufacturing for some time an optical player for industrial use, as part of a joint venture with MCA, but the consumer model player had not been expected to be publicly shown to large groups for another several months.

The Pioneer consumer unit, like its industrial cousin and like the Magnavox unit, uses the Philips/MCA format, a 12-inch silvery disc, spinning at 1800 rpm, whose patterned surface is read by a miniature, low-power laser element. As such, it has all the virtues of that format. The Pioneer unit is amazingly versatile because of its slow- and fast-motion, frame-indexing, and freeze-frame capabilities, and it's also completely free from disc or stylus wear. In addition, it has some features the Magnavox player does not — a full function remote-control system and, more important, an optional digital audio disc adaptor for playback of digital music-only discs (this adaptor will not be immediately available, however). The Pioneer player is also fairly expensive by comparison with the stylus-type players that will be introduced in the next 18 months by RCA, Matsushita, and JVC (see "RCA Shows SelectaVision," March, 1980 *Audio*), which are all expected to cost about $500 for the basic unit. According to company representatives, the Pioneer unit will have a price "under a thousand dollars," although how much under is not yet known.

The global corporate politics of the video disc race are incredibly complex and constantly changing, so it is difficult to draw any firm conclusions from the Pioneer showing and announcements. It is felt in many quarters that the introduction of the Pioneer unit will improve the chances of the Philips/MCA format of being eventually adopted worldwide, and some also feel that its introduction could serve as the "icebreaker" that would propel other companies that have demonstrated prototype optical players, such as Mitsubishi and Sony, into the marketplace with Philips/MCA systems. But it is still too early in the game to do more than guess at who will ultimately set the video disc (and digital audio disc) standard. All that is clear on the subject is that 1980 will be an eventful year.

Ambience Synthesis

Ambience synthesis or time-delay systems are unquestionably one of the growth categories of the audio industry; three more new examples of the genre were introduced at the January show, as well as production models of one long-awaited prototype design. Koss made its first venture into high-fidelity electronics with the K/4DS, a digital time-delay system with built-in rear-channel amplifiers that has a number of distinctive control features, including extensive facilities for ambience-augmented headphone listening. The Koss unit is also notable for its simplification of control settings: Initial delay times and recirculation densities are selected by picking one of four master acoustic settings — auditorium, concert hall, theater, or club. Audio Pulse introduced its sleekly styled Model 1000 "third generation" time-delay unit, a digital system that includes a dynamic range expander and separate continuously variable delay and ambience controls. Bose demonstrated its Spatial Expander, a charge-coupled, time-delay device designed to be used with the Bose Spatial Control Receiver (which contains the rear-channel amplifiers), Bose 901 front speakers, and Bose rear-channel speakers. It is a single-delay system, with reverberation. Carver Corporation, whose C-4000 preamplifier created such a stir at last January's show, was finally showing and shipping production units of that model. In addition to its "Sonic Holography" circuitry, which is said to more accurately localize instruments and other sounds in space, the Carver unit includes an ambience synthesis system with 35- and 50-millisecond initial delays, variable reverberation density, and two built-in 25-watt rear-channel amplifiers.

The continued interest in ambience synthesis systems, and in devices like the Carver unit's Sonic Holography circuit, point up the fundamental fascination American audiophiles have with reproducing the acoustic and spatial settings of musical performances, as well as the inadequacy of most simple two-channel music systems in this regard. Few who have heard a properly set-up time-delay system question the validity of the principle or the sensory loss that comes from turning the secondary channels off. Now, five years or so after the final collapse of quadraphony, the growing popularity of ambience-synthesis systems is clear evidence that audio buffs do not object to four loudspeakers in one room, to the reproduction of a fully three-dimensional sonic image, or even to the substantial expense entailed in these. Rather, their rejection of four-channel sound was a rejection of questionable musical values — the surround sound, middle-of-the-orchestra effect — and the difficulties associated with lack of standardization and proper set-up of the systems, as well as the varying abilities of the different generations of decoders and demodulators. It appears here that manufacturer interest is following consumer interest, so that in the '80s we may well see a resurgence of multichannel sound.

Loudspeakers

Although no single speaker at the January CES stood out as an earthshaking new development, there were a number of innovative new loudspeakers shown and several clearly identifiable trends. The ranks of the three-piece satellite type were expanded by a new three-piece four-way system from ReVox, called the Triton, by new minispeakers from Cerwin-Vega, Mesa, Design Acoustics, and Technics, and by new subwoofers from Intersearch, Cizek, and Ohm among others. The satellite system appears to be enjoying steadily increased popularity, as well as a new measure of acceptance from hard-core audiophiles who once dismissed the principle out of hand. It is just possible that this could become one of the dominant speaker formats of the '80s, as pressures for living space increase and a growing number of newly awakened music listeners are exposed to its decor-related attractions.

Exotic materials and principles also left their mark on this year's crop of speakers. Phase Linear demonstrated three new speakers, two with ribbon tweeters and beryllium midrange domes, and one with a boronized dome midrange and tweeter. Wharfedale showed their new TSR (Total Sound Recall) series, which employs some drivers made of a chalk-filled polypropylene compound called Mineral Filled Homopolymer. Dayton Wright demonstrated an improved electrostatic speaker using their gas-filled cell principle and a new piezoelectric super tweeter; the unit is called the XG-10. Infinity showed three new moderately priced speakers, the RS_a, RS_b and Reference Studio Monitor, all with polypropylene bass driver cones and EMIT planar-dynamic treble units. Both the range of synthetic materials and alloys available to the speaker engineer, and the research and production facilities necessary to make full use of them, have expanded substantially in the past couple of years, particularly in the Far East, and substantial advancements in the price/performance ratio of loudspeakers are likely to result. In particular, wide-range ribbon and planar-dynamic systems, which enjoy most of the advantages of conventional electrostatics without their drawbacks and high cost, are showing up in greater numbers and may, like the satellite system, be among the stronger speaker formats of the coming decade.

Digital Recording

The establishment of an Electronics Industries Association of Japan technical standard for home digital recording equipment, which defines 44.056 kHz as the sampling frequency and a 14-bit linear system as the bit format, has brought a number of new PCM adaptors for video cassette recorders onto the scene. Five were present at the January show, including units from Sharp, Toshiba, Sanyo, Technics, and a new EIAJ-compatible Sony unit, the PCM-10. All of the units have signal-to-noise ratios of approximately 85 dB, harmonic distortion under 0.05 percent, and frequency response flat from 20 to 20,000 Hz, ±1 dB or better. They also incorporate peak program meters to monitor input levels (most digital recorders hard-clip when overdriven), and dual microphone preamplifiers.

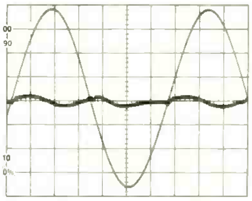
For those with the working capital — the adaptors are generally in the range of $4,000, and the recorders another $1,500 or so — these devices will put digital recording capabilities into the home and enable amateur recordists to make demo tapes with performance quality superior to that of most studios. The sophistication of the recordings will be limited, due to the limited number of channels and the absence of overdubbing facilities, but the sound will be superb. Whether that means that the VCR/adaptor combination will have any major impact on the high-fidelity industry, particularly with digital discs and metal-particle cassette decks here or soon to arrive, is a difficult question to answer. Some limited-scale prerecorded software programs for the machines have been initiated, but the prices will probably always be considerably higher than for a disc or analog tape. And, with a couple of exceptions, the semi-pro recording area has found that lack of versatility limits the utility of VCR/PCM combinations, so very few demo tapes or album master tapes have been made utilizing such equipment. It may be that the PCM adaptor will have a Kerensky-like role during the transition from analog to digital eras — one of easing the changeover without a permanent place in the new order. On the other hand, compact VCR/PCM systems may become the new versions of the Nagra, two-channel recorders intended primarily to preserve live musical events. Only time will tell.

The clarity of Class A sound and the high efficiency of Class A/B power.

JVC engineers, among the most innovative in the world, have achieved a technological breakthrough. Now the clean, clear, less distorted sound of Class A amplification is available with the high efficiency of Class A/B type amplification. That means no excessive heavy power supplies, and minimal heat build-up.

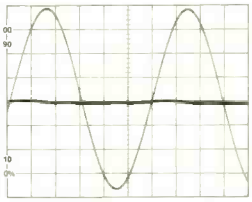
Traditionally, the Class A/B amplifier has been predominant, simply because it is three times more efficient than the Class A type. However, the Class A/B amplifier achieves that efficiency by permitting its power output transistors to switch on and off, leading to switching and crossover distortion, and producing substantially reduced high fidelity performance. On the other hand, engineers knew that while Class A amps had the advantage of cleaner, less distorted output than Class A/B, they produce enormous amounts of heat and require extremely heavy power supplies.

Innovative engineering by JVC solved those problems, by introducing The Super A Amp. A classic, no compromise amp. THD is as low as 0.005% and linearity is higher than with conventional Class A/B power amps. And at the same time the efficiency of the Super A amp is equal to that of Class A/B amps, even with high power output. The transient response, slew rate and rise time are all greatly improved. And there is no TIM (Transient Intermodulation), or crossover distortion.



Conventional Class-A/B AMP

The jagged line at center of the graph indicates the amp is generating switching and crossover distortion as its output transistors switch on and off. These are displeasing types of distortion, because they contain many odd and high-order harmonics.

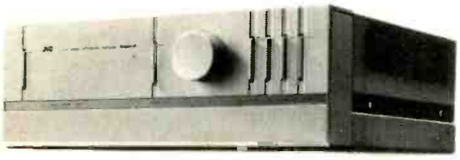


JVC's Extraordinary Super-A Amp

The center line in the above graph represents waveform distortion, which is at a minimum. This indicates that the amp is generating very little distortion, containing very few odd-order harmonics, resulting in smooth reproduction and velvety sound.

A-X9 Integrated Amplifier.

100 W RMS/Chan. thru 8 ohms 20-20 kHz less than 0.005% THD: MC & MM phono sections dual tape & phono inputs. Speaker outputs. Not shown: A-X5 Integrated amplifier 70 RMS/chan. thru 8 ohms 20-20 kHz less than 0.005% THD: MC & MM phono sections dual tape & phono inputs. Speaker outputs.



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Borgia Column

Nadine Amadio

The high fashion world of hi-fi— or a closer look at the "Sin" pickup arm

The average hi-fi enthusiast is relatively sane, indeed he displays an above average insight into audio technicalities. Nevertheless, there is a streak of wild romanticism in his make-up that paves the way for high-fashion in hi-fi.

A classic example is the remarkable elevation to superstar status of the Italian-made pickup arm, the Prendi-su-Braccio Peccato or, as it has come to be known in good plain English, "The Sin" pickup.

Does the name have a poetic ring? Does it have vaguely erotic connotations? Would Rossini have included it among his "Sins?" Has there been some heavy underground publicity or is it just some quirk of chance that has transformed a pleasantly average piece of equipment into an audio prize?

Surely there must have been some organized promotion of one sort or another in the centers of "sound" influence to achieve a result as totally irrelevant, but as tyrannically "in," as this year's trend in long or short hair.

I remember once, during a particular period when I was dabbling in philosophical and mythological encapsulation, I christened a well-known New York hi-fi salesman as "The Cortlandt Street Oracle."

This, of course, was in no way intended to be derogatory to that gentleman's commendable habit of selling stock in the most persuasive fashion, nor of his ability to expound on the virtues or virtuosity of his more spectacular equipment. It was rather the large and ardent clientele waiting, palpitating for every crumb of information falling oracularly from his lips that inspired his rechristening.

These same eager clients carried his prophetic words to the farthermost corners of this far-flung continent. Were these, like Henry V, the makers of fashion?

However, back to the cannonized "Sin" pickup. Let us look at this four-star fashion fetish in the cold light of a Borgia morning.

Our aim is not to reduce a nice clean-cut, Italian boy-next-door pick-up to a social outcast, but rather to look beneath the bright stainless steel smile and trendy wrappings and see if there is any real muscle there. Any tonal biceps on the arm, as it were.

Maybe it's not the product that's at fault but the image making. Inflation is a problem in any form and inflation calls for a little iconoclasm, as our Latin friend will surely agree. Of course, in the old days, we had more subtle and, one might say, more tasteful methods of dealing with little Italian upstarts. Forgive the outburst, but my country's honor is at stake!

Many aspects of the "Sin" arm are undeniably attractive — high mass is (ironically perhaps) ideal for the "Sin" moving-coil cartridge. If one intends to "sin," one usually does not wish to be lightweight about it.

Nevertheless, the resonances that become apparent when the 'Sin" is excited cannot be excused. If you peer closely at your bass speaker, you will find it pumping in and out distractedly in phase with the low-frequency oscillations introduced by the Peccato pickup. All I can say is "Quel Dommage!" or better still, "Che Peccato!"

And I must warn that under the sunny, virile Italian charms of your "Sin" arm, there lurks an ill-tempered and moody despot. Does high-fashion hi-fi cater to masochists, or does the enthusiast delight in inconsistent and willful behavior from his equipment?

You'll find the "Sin" difficult to set up correctly, and if you so much as alter the tracking weight by an eyelash, you will have to completely readjust the bias and anything else you can think of.

So don't expect your "Sin" to warble along as sweetly as any Caruso or any well-paid Venetian gondolier. Expect problems, even if they are fashionable problems.

Of course, if you don't have "ears" or if you don't like being the odd man out or if you are ashamed to admit you don't have any vices — not even one "Sin" — then go ahead and buy one.

Harman Kardon introduces low negative feedback design. High Technology Separates with low THD *and* inaudible TIM—for incredibly clean, open sound.

For the last few years, audio manufacturers have been rushing to bring you newer, lower THD (Total Harmonic Distortion) levels in their amplifier sections. And every year, they've accomplished this objective the simplest way they could. By adding more and more negative feedback, a form of electronic compensation that feeds the amplified music signal back through the circuit.

Unfortunately, this universal "cure" for THD—high negative feedback, typically 60-80 dB—creates a new form of distortion. It's called Transient Intermodulation Distortion, or TIM. And it's much more audible than THD. TIM causes music to become harsh, metallic and grating. And the spatial relationship of the instruments to become vague, smearing the image.

At Harman Kardon, our new 700 series amp and preamp give you low THD figures, too. But we did it the right way—by properly designing the amplification circuitry to deliver low THD even before we apply negative feedback. That keeps our negative feedback at just 17 dB. And our TIM level at just .007%. Well below the audible threshold.

The result is pure, clear, transparent sound and stereo imaging that places instruments and vocals precisely.

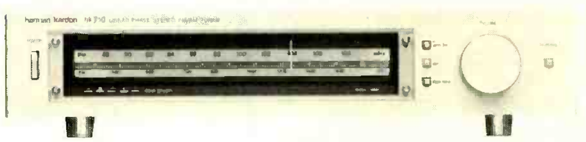
Beyond TIM.

Of course all the Harman Kardon components incorporate our traditional ultrawideband design, which provides fast transient response and phase linearity. We also use discrete components instead of integrated circuits, because ICs create their own IC distortion.

But beyond these major design considerations, we've also paid attention to all the small details.

In the hk725 preamplifier, for instance, we used fixed resistor pushbuttons for tone controls. They introduce less distortion than rotary knobs. We also incorporated DC coupled FET front ends in both our 8-stage phono section and our high level stage. Again, less distortion, and improved signal-to-noise ratio.

On the hk770 power amplifier, we used two separate toroidal power supplies, which eliminate cross-talk and hum. And DC coupling which provides tighter, more articulate bass.



Performance matched separates.

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The hk715 digital quartz-locked tuner gives you a full complement of features. It locks in to the channel center every time. And stays there, drift-free. It also has a memory subsystem that lets you store up to 8 stations and recall them instantly at the touch of a button.

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In 1970 Harman Kardon introduced the first cassette deck with Dolby NR. In 1980, we're bringing you the first cassette deck with the new Dolby HX headroom extension circuitry. The hk705. With the Dolby HX headroom extension circuitry, you get an added 10 dB of high frequency headroom, as well as a 68 dB signal-to-noise ratio. That's comparable to open reel decks that cost twice as much. And thanks to Dolby HX and metal tape capabilities, the 705 provides an impressive frequency response of 20-19,000 Hz (±3dB).

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Part I

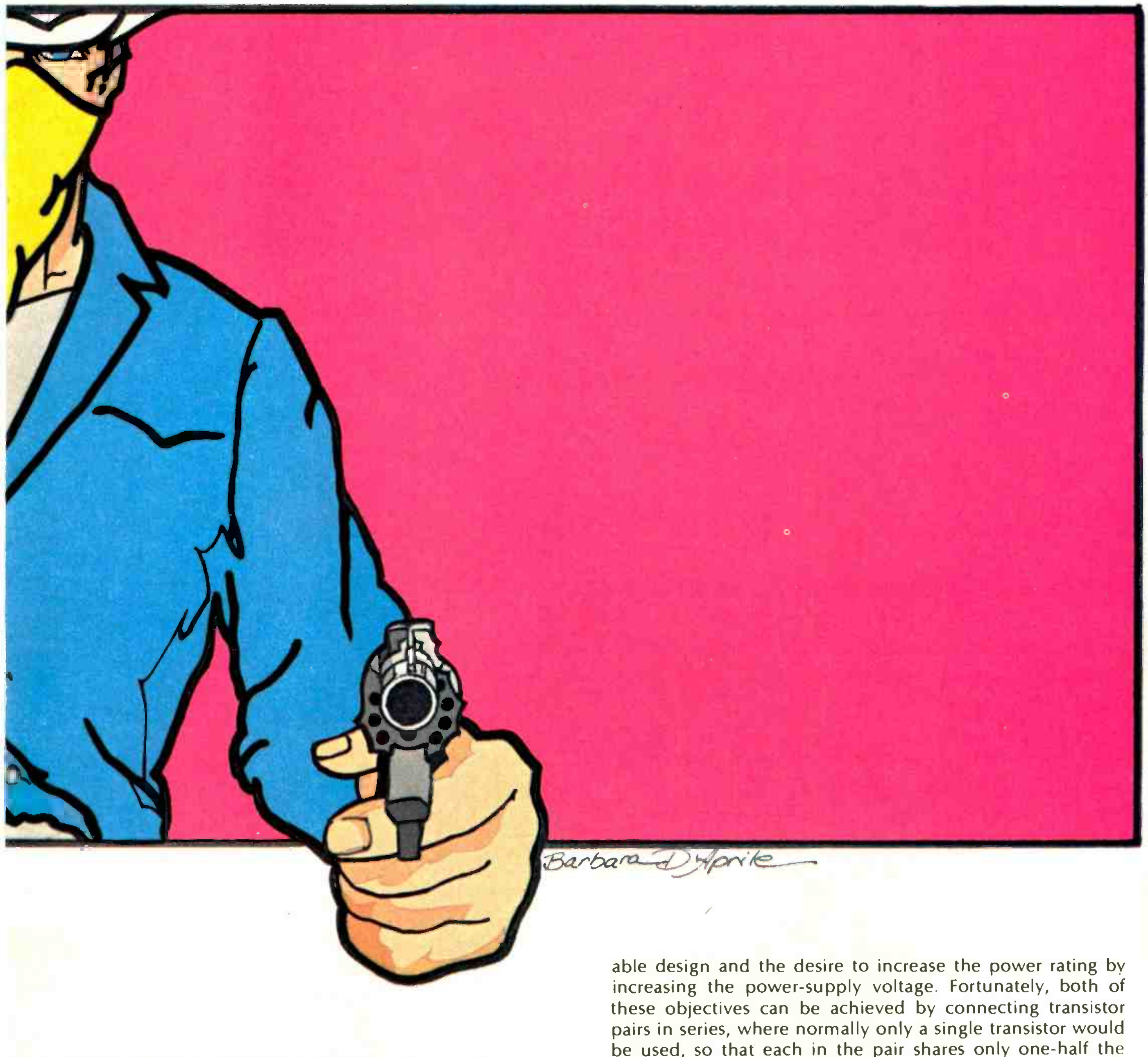
W. Marshall Leach, Jr.

Introduction

Everyone who enjoys building audio gear has probably given thought to constructing a high-power amplifier which will drive even the most inefficient loudspeakers to super loud levels. When it comes to power, most people agree that the higher the power reserve in an amplifier, the better the sound. There is a simple and logical reason for this. Audio signals can have very high peak power levels that run 10 to 20 times the average power level. Thus the peak power output capability of the amplifier becomes an important consideration if it is not to clip on peaks. As an example, let us consider an amplifier rated at 100 watts average power. (This is erroneously called "watts rms." The abbreviation "rms" stands for "root mean square" and is correctly used only in the specification of the amplitude of a.c. voltages or currents, e.g. volts rms or amperes rms, but not watts rms.) Because the power rating is measured with a sine-wave signal which has a peak-to-average power[1] ratio of only 2, it follows that the peak power capability of our 100-watt amplifier is 200 watts. With audio signals having a peak-to-average power ratio of 10 to 20, the amplifier could be operated at an average power level of 10 to 20 watts if it is not to clip on peaks. With a typical loudspeaker efficiency of 0.5 percent, only 50 to 100 milliwatts of undistorted acoustic power could be obtained. This corresponds to a sound pressure level in the reverberant field of a normal listening room of 99 to 102 dB. Should this be insufficient or if the amplifier is to be used in large rooms or outdoors, a higher power rating will be required.

Associate Prof., Georgia Institute of Technology,
School of Electrical Engineering,
Atlanta, Georgia 30332.

How much power is enough? This is a question which will certainly receive many answers, depending on who is asked. Someone with efficient loudspeakers who listens to quiet chamber music may say 10 watts. The audiophile with the latest inefficient loudspeakers who likes to demonstrate them at ear-splitting levels with the newest direct-to-disc recording may say the sky's the limit. However, most people probably consider a power rating of 250 watts per channel to be an adequate rating for a so-called high-power amplifier. From the standpoint of circuit design, 250 watts represents a power level which is about the maximum that can be achieved without compromises in the design, exorbitant costs, or both. The only method that can be used to increase the power rating of an amplifier is to increase the peak-voltage swing capability of its output signal. This can be done by designing it with a higher voltage power supply, strapping it,



or by adding a transformer between the amplifier and the load which steps up the output voltage. To increase the power supply voltage can require circuit design compromises such as the use of a quasi-complementary output stage rather than a fully complementary one. Strapping and a stepup transformer are also design compromises. Both effectively reduce the load impedance seen by the amplifier which can cause overload or excessive triggering of the amplifier protection circuit. Also, the transformer is incompatible with a direct coupled design, and it can cause intolerable phase shifts and distortion at very low frequencies.

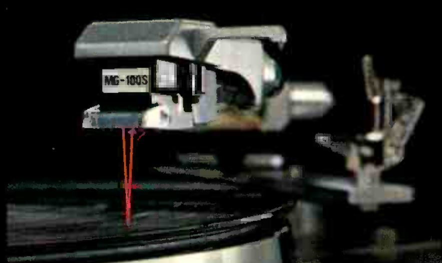
Transistors are inherently low-voltage, high-current devices. Therefore, reliable circuit designs require that the voltage across transistors be held to a value that is low enough to permit them to safely deliver the load currents required for the maximum desired output power. This is especially important when reactive loads such as electrostatic loudspeakers or highly inductive crossover networks must be driven. Thus, there is a basic conflict between the requirement for a reliable design and the desire to increase the power rating by increasing the power-supply voltage. Fortunately, both of these objectives can be achieved by connecting transistor pairs in series, where normally only a single transistor would be used, so that each in the pair shares only one-half the total voltage that a single transistor would be required to drop. With this technique of using series-connected transistors, a power rating of 250 watts can easily be achieved without design compromises.

Dynamic distortions such as transient intermodulation distortion (TIM) and slewing induced distortion (SID) are important considerations in any design. Both are primarily a result of an insufficiently high-frequency overload margin in the critical low-level input stages combined with an overdose of lag compensation in the following stages that determine the gain-bandwidth product of the amplifier. Therefore, large-signal bandwidth and open-loop linearity become important design considerations in any amplifier if dynamic distortions are to be eliminated. The techniques for minimizing both dynamic distortions and static distortions (e.g. total harmonic distortion and intermodulation distortion) can be conflicting (1). A proper design should consider all distortion mechanisms equally without optimizing the circuit to specifically minimize any one at the expense of the other. For-

The new

The micro processor controlled turntable that automatically selects and plays the tracks you want to hear.

Push the wireless remote control button and select track 1, track 3, track 6 or any other. The micro processor automatically moves the arm to play the selected track. You can repeat the same track, select another or play



the entire record over again all by wireless remote control. And there's an LED readout to indicate the track being played.

Since you can select the music you want to record, making tapes from your record collection becomes easier and more convenient than ever before.

The MT6360 Linear Drive turntable is not only great for really enjoying the music you like, but it's a sophisticated audio component with some extraordinary design features.

Fisher's exclusive Linear Drive. With Linear Drive, the only moving part is the platter itself. So, there's

virtually nothing to go wrong. And, no inherent turntable noise. (For you audiophiles, wow and flutter is just 0.035% and rumble is a low –70dB).

There's a lot more. There's a servo circuit that continuously monitors and locks in record speed. Plus a strobe light and fine speed control so you can monitor the accuracy of speed and alter pitch.

The MT6360 has a viscous-damped "floating" tonearm with a specially designed integral stereo magnetic cartridge. And there's even a muting circuit to eliminate that annoying "pop" you hear when the tonearm touches down.

It's what you'd expect from the new Fisher. We invented high fidelity over 40 years ago. And never stopped innovating. So check out the new MT6360 at your Fisher dealer. One demonstration of the automatic track selector will change, forever, the way you listen to records.

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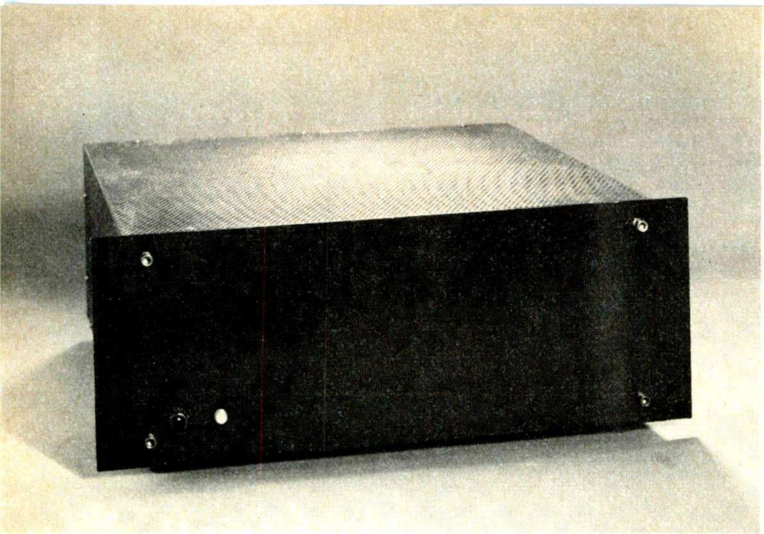


tunately, this is possible if the amplifier is designed to reject supersonic and inaudible input signals that can overload the critical low-level input stages and if sufficient local negative feedback is used in each stage to eliminate the need for excessive lag compensation for stability and freedom from oscillations.

Oscillation problems can certainly be one of the most perplexing problems that can plague a negative feedback circuit, particularly for the home builder. Therefore, frequency stability is a primary consideration in any amplifier design, and it, too, can require compromises in other design objectives. For example, an amplifier with two stages of voltage gain is probably the best-known circuit configuration. By operating both stages at a maximum gain, static distortions in the closed-loop amplifier can be minimized because this maximizes the negative feedback. However, when the gain of any stage is increased, its bandwidth is automatically reduced since the gain-bandwidth product of any stage is fixed by the particular transistor used in that stage. This decreased bandwidth can cause excessive phase shifts at high frequencies, requiring an overdose of lag compensation to prevent oscillations. The excessive lag compensation increases the amplifier susceptibility to dynamic distortions. In addition, the slewing rate can be degraded to an unacceptable level.

A good overall amplifier design philosophy is to use two stages of voltage gain followed by a current gain stage that is operated with a voltage gain of unity. The current gain stage is the power output stage which supplies all load current to the loudspeakers. Because high-current transistors have a lower gain-bandwidth product than low-current transistors, it is logical to operate the output stage at unity voltage gain so that it will have a maximum bandwidth. In this way, phase shifts in the output stage can be minimized, thereby reducing the amount of lag compensation required for stability. There are two commonly used ways to realize a unity-gain output stage. The first is to operate both the driver and the output transistors in the common-collector of emitter-follower configuration. This results in the highest gain-bandwidth product in the output stage. The second method is to operate the driver transistors in the common-collector configuration and the output transistors in the common-emitter configuration. In this case, the emitters of the driver transistors and the collectors of the output transistors are connected to the loudspeaker output, and the bases of the output transistors are driven from the collectors of the driver transistors. Because this connection forms a negative feedback path from the collectors of the output transistors back into the emitters of the driver transistors, a large reduction of static distortions in the output stage can be realized. It is felt, however, that the first connection results in a more stable and better sounding amplifier. This is because the output transistors in the second connection are operated in their slowest configuration. The driver transistors are forced to supply a higher and higher share of the load current as the frequency is increased, which in turn causes the high-frequency output impedance of the amplifier to increase, resulting in a reduced high-frequency damping factor. In addition, the feedback loops formed by the driver and output transistors involve 100 percent voltage feedback around a very high gain loop, and this makes such an output stage susceptible to oscillations which can be load-dependent and may not show up under normal testing. Although the first connection exhibits a higher static distortion, this can be overcome by operating the output stage at a higher bias current which causes the amplifier to operate Class-A over a larger signal swing.

The second stage of voltage gain drives the output stage. For a unity-gain output stage, this second stage must put out a signal equal in voltage amplitude to the loudspeaker output signal. Thus, it should be operated at a high gain in order to minimize the signal level that is required to drive it. When this is done, it follows that this stage will have the lowest bandwidth of any stage in the amplifier because of the limitations imposed by a fixed gain-bandwidth product. Therefore, it is this stage which determines the dominant pole in the amplifier and the stage which should be lag-compensated for frequency stability and freedom from oscillations.

The input stage to the amplifier also deserves special consideration. This stage must have two signal inputs, one to which the amplifier input signal is applied and the other to which the feedback signal is applied. The output signal from the input stage must be proportional to the difference between these two signals. A differential amplifier is a logical choice for this circuit. The design of the differential amplifier is very important, for it is this stage that primarily determines the susceptibility of the amplifier to dynamic distortions. First, it must have a bandwidth that is very much greater than that of the second stage to minimize the amount of lag compensation required for stability. This is achieved by operating the stage at a low gain and by lead compensating it for increased bandwidth. Second, it must have a sufficient bias current in order to drive the high-frequency capacitive input impedance of the second stage. If this bias current is insufficient, the slewing rate of the amplifier will be degraded. Third, the input stage should be designed so that it rejects any supersonic and inaudible input signals that lie outside the large-signal bandwidth of the second stage [2]. If these design objectives are properly achieved, the amplifier will be essentially free of dynamic distortion mechanisms: It cannot slew or produce transient intermodulation distortion before it clips.

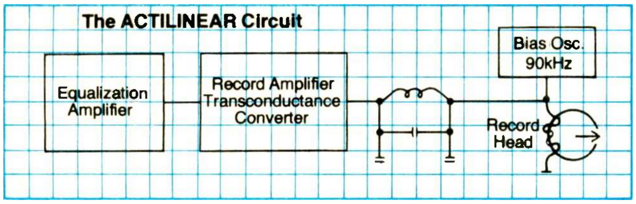
The circuit architecture or topology is important in any power amplifier. To minimize static distortions, a fully complementary design is important. This is especially true for the critical output stage which must supply the full load current to the loudspeakers. A complementary circuit theoretically cancels the predominant even-order nonlinearities of the active devices, leaving only the odd-order nonlinearities to be cancelled by the negative feedback. To minimize these before overall negative feedback is applied to the circuit, it is important to use local negative feedback in each internal stage. In this way, the open-loop distortion can be made sufficiently low so that the overall negative feedback is not so high that an overdose of lag compensation is necessary for stability. With a careful balance between local feedback and overall feedback, it is possible to achieve a higher overall feedback ratio at high frequencies because of the reduced need for lag compensation, which reduces both static and dynamic distortions.

This article describes an amplifier which has been designed with these objectives and considerations in mind. The circuit has been designed so that transient intra-loop signal over-

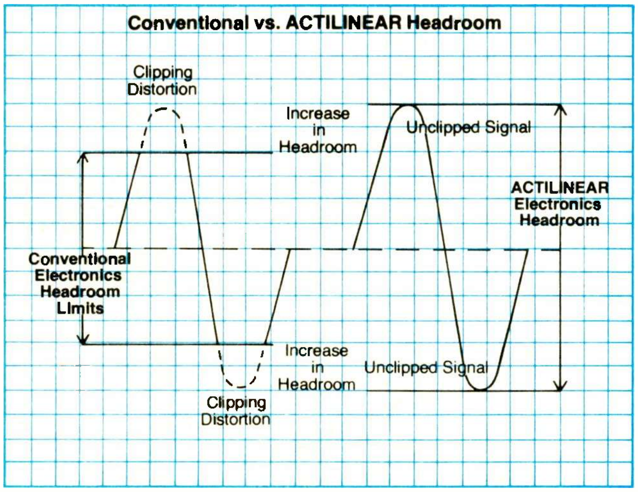
ACTILINEAR (Patented) — DYNEQ (Patented)

Two of the most important new words in tape recording

Problem:
Traditionally, tape recorder electronics have had insufficient headroom to fully exploit the greater performance capability of the new high coercivity tapes, such as metal tape. The goal of Tandberg engineers was to improve the headroom of tape recorder electronics by 18-20 dB so it can be used with metal tape.



Cause:
In conventional recording systems the summation of record & bias current in the record head is done through passive components, leading to compromise solutions which have their distinct and pronounced weaknesses—primarily a limited headroom for the signal.

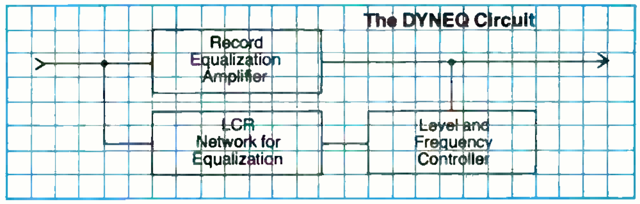


Solution:
Tandberg engineers developed & patented a new recording technology without these compromise solutions (See curves above). In the new ACTILINEAR system, featured in our TD 20A open reel and TCD 340A & TCD 440A cassette recorders, the passive components have been replaced with an active Transconductance amplifier. Among the benefits of this new recording system are:

- Up to 20 dB more headroom.
- Less Intermodulation due to Slew Rate limitation.
- Improved electrical separation and less interference between bias oscillator and record amplifier.
- No obsolescence factor—usable with any type of tape available now or in the years to come.

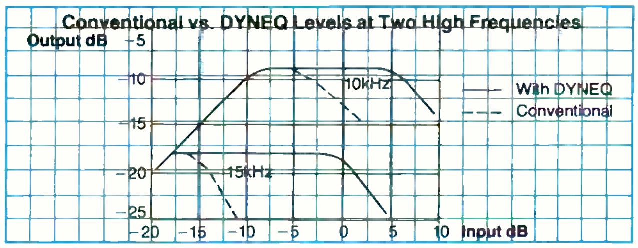
Problem:
High frequency limitations inherent in the cassette (i.e., low speed) medium. Tandberg engineers have developed an exclusive, Patent-pending circuit that is not just a technical refinement, but a fundamentally new approach to the matter.

Whereas ACTILINEAR overcomes the limitations of electronics at *any* speed, DYNEQ overcomes tape limitations at *low* speeds.



High frequency saturation (overload) is of particular importance with today's new direct-to-disc and digitally-mastered recordings as they deliver more energy in the high frequency range than ever before.

Cause:
The high frequency overload—i.e., "the cassette sound"—of which tape recording purists complain is not simply a question of reaching a point where the tape can hold no more signal. At high frequencies, excessive input levels not only produce enormous amounts of distortion, but actually lower the signal level played back from the tape. In other words, once you have reached the saturation point on the tape, the more signal you try to put in, the less you actually get out.

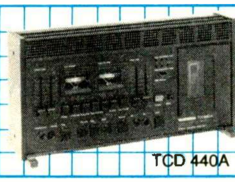


Solution:
If, just at the point where high frequency saturation (overload) begins to occur, you could automatically lower the amount of record treble boost supplied by the equalization circuit, you could increase the high frequency output of which the tape is capable, and drastically lower high frequency distortion (See curves above). In brief, this is precisely what Tandberg's exclusive new dynamic equalization circuit does.

Yet another benefit is that the DYNEQ circuit, featured exclusively in Tandberg's TCD 440A cassette deck, not only gives improved performance with the new metal particle cassettes, but also delivers a *significant* improvement in performance with today's better premium tapes.


TD 20A

TANDBERG
Setting the standards in tape recording for over 30 years


TCD 440A

Perhaps *the* most important word in tape recording.

Tandberg of America, Inc., Labriola Court, Armonk, NY 10504.

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load cannot occur, even with ultra-fast square-wave signals applied to the input. Because no internal stage is subject to transient overload problems, the amplifier is theoretically free of TIM distortion and it cannot slew. When properly constructed, the amplifier can be used with the finest associated equipment. It is highly stable with reactive loudspeaker loads such as electrostatic loudspeakers. Because it is capable of delivering large high-frequency transient current demands to the loudspeaker, its sound is clean and free from the so-called "transistor sound," even with music which contains loud high-frequency material and percussive sounds. In the critical midrange region, the feedback ratio is sufficiently high so that the midrange retrieval and definition are primarily determined by the source material. Although the circuit is d.c.-coupled from input to output, its low-frequency response is rolled off below 0.3 Hz. This low-frequency roll-off is accomplished by the feedback circuit rather than with a coupling capacitor in the forward signal path. By rolling off the d.c. response of the amplifier, the loudspeaker is protected from d.c. offset voltages and currents which could result from temperature effects or from a d.c. offset at the output of the preamplifier. However, the 0.3-Hz roll-off frequency is sufficiently low so that the phase shift at 20 Hz and higher is negligible [3].

Circuit Description

The complete circuit diagram of the amplifier is shown in Fig. 1. The circuit is a fully complementary design which is direct-coupled from its input to output to ensure full reproduction of even the lowest bass frequencies without phase shift distortion. A fully complementary circuit means that there is a pnp transitor for each npn transistor and vice versa. Although expensive, this approach assures low static distortion performance [1] [4] [5], especially for a single or dominant pole design that does not use maximum negative feedback, which is the present case.

The input stage consists of transistors Q1 through Q6. Q1 through Q4 are connected as a complementary differential amplifier. (As far as the author can determine, the use of the complementary differential amplifier in power amplifiers was pioneered independently in the late 1960s and early 1970s by John Curl, Bascom King, and Daniel Meyer [6].) To reduce the voltage across the transistors in the differential amplifiers to about one-half the power supply voltage, transistors Q5 and Q6 are added to the circuit and are connected in a common base configuration. By connecting the input transistors in series in this manner, each transistor in the input stage has a voltage across it that is no more than about one-half the power supply voltage. The bias current in the input stage is set at 4 mA by resistors R13 and R14. A constant current source in place of these resistors was not used to set this bias current because only the common-mode rejection ratio of the differential amplifiers would be improved. This is meaningless when it is not required to drive the differential amplifiers in the differential mode, as would be the case when driving an amplifier from a 600-ohm balanced line.

The addition of Q5 and Q6 to the input stage converts the differential amplifiers to what is called a cascode amplifier [7]. Transistor Q5 in cascode with Q1 acts like a single common-emitter transistor which has almost negligible internal feedback and a very small output conductance. Similarly, Q6 is in cascode with Q3. The gain of the input stage is set by the emitter degeneration resistors R9 through R12 and the collector resistors R15 and R16. It is approximately 6 dB. Capacitors C4 and C5 lead compensate this stage by cancelling a pole in its transfer function at 20 MHz.

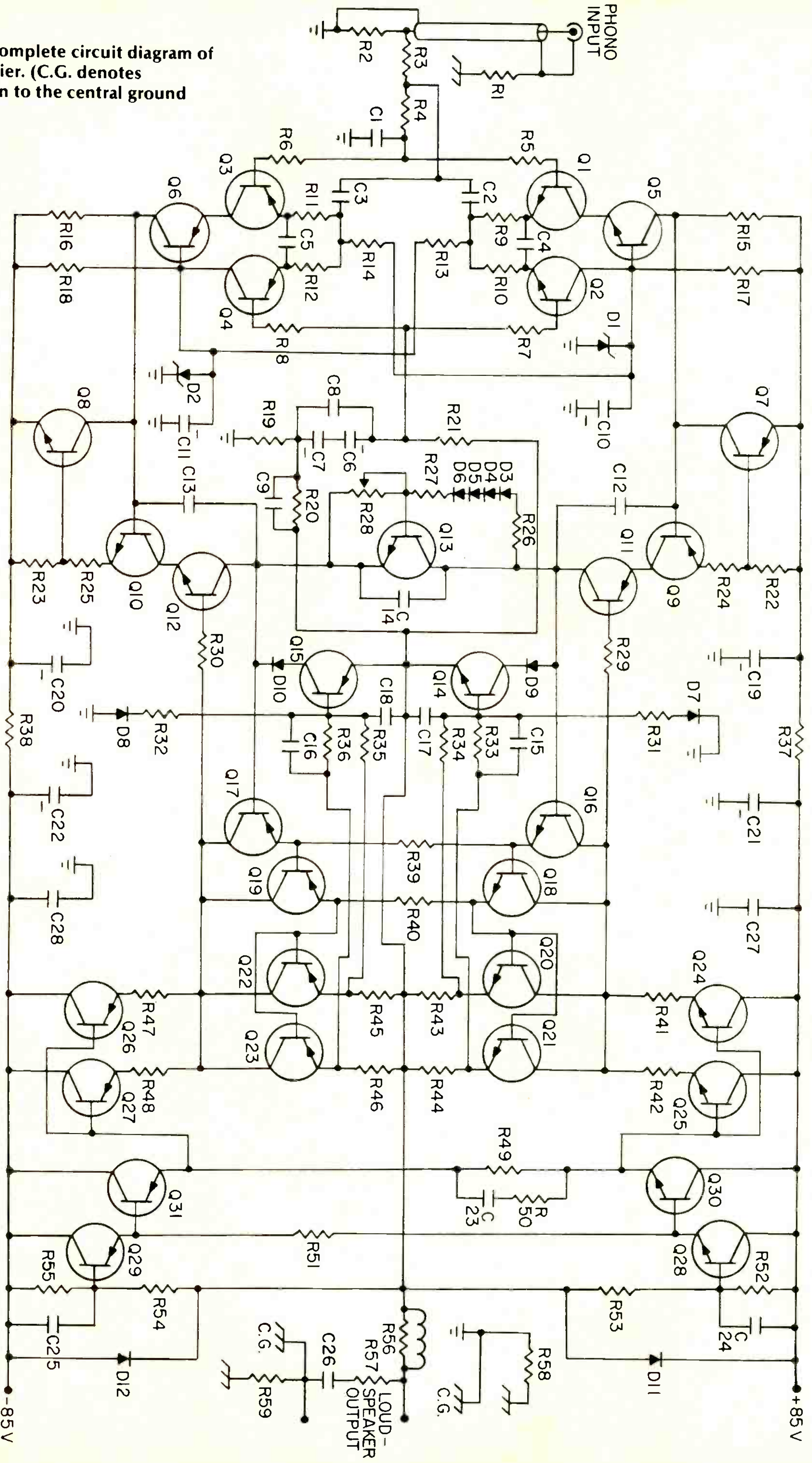
The connection of capacitors C1, C2, and C3 and resistors R3 and R4 to the input stage forms a second-order active low-pass filter [2] to protect the amplifier from inaudible and unintentional ultrasonic signals such as bias signals from a tape recorder, multiplex subcarrier signals from an FM tuner, or oscillations from a defective preamplifier. The upper -3 dB frequency of this filter is about 40 kHz. Above this frequency, it rolls off at 12 dB per octave. The filter alignment is the linear phase Bessel alignment, and it exhibits less than 0.11 degrees of phase shift distortion at 20 kHz. Rather than being a separate outboard active filter preceding the power amplifier, this filter is an integral part of the amplifier input stage itself. In addition to protection from possible damaging ultrasonic signals, the Bessel filter performs the important function of suppressing those mechanisms which cause dynamic distortions such as TIM and SID. With the filter, it is impossible for the amplifier to slew before it clips [3]. In addition, intra-loop current overshoots in the differential amplifiers are suppressed to a level much lower than that at which TIM and SID would occur. Thus, the amplifier is essentially free of dynamic distortion mechanisms.

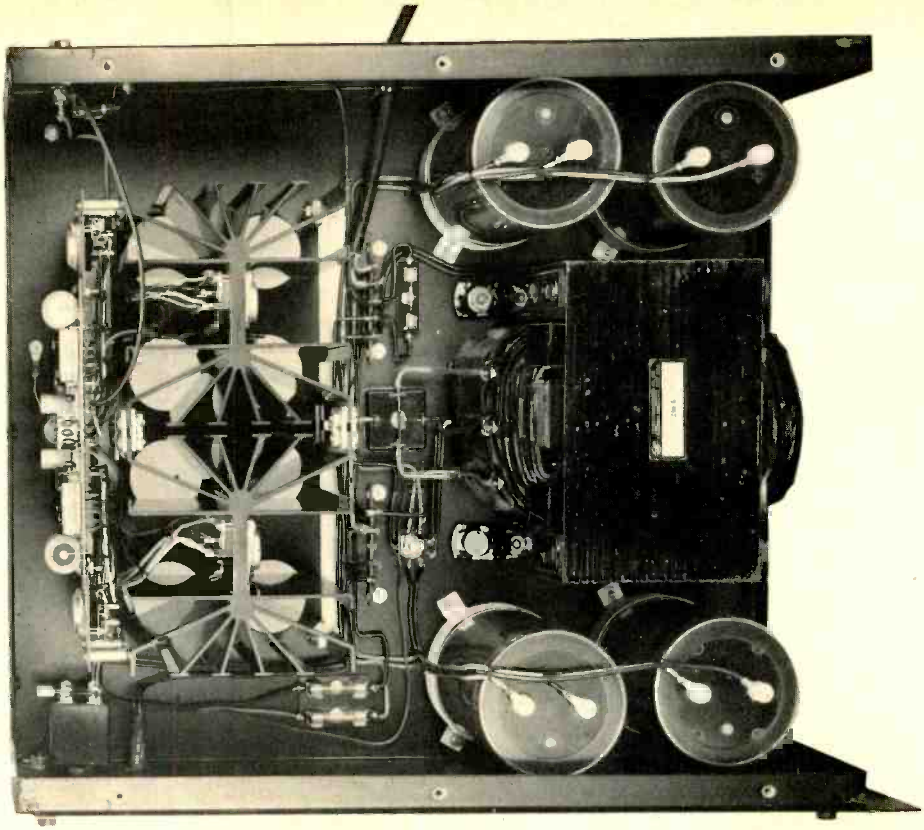
The second stage of voltage gain consists of transistors Q9 through Q12. To the author's knowledge, this is the first amplifier circuit to employ this particular cascode configuration. Transistors Q9 and Q10 act as complementary common-emitter amplifiers. Local negative feedbeck for intra-loop linearity is provided by the emitter-degeneration resistors R22 through R25. The collector output signals from Q9 and Q10, respectively, are connected to the emitter inputs of Q11 and Q12, respectively. Because Q11 and Q12 act as common-base amplifiers in the forward loop signal path, the addition of these two transistors to the circuit converts the second stage of the amplifier to a complementary cascode amplifier. However, unlike ordinary cascode amplifiers, the bases of Q11 and Q12 are not maintained at constant voltages. Instead, negative feedback signals derived from the output stage are fed back into the bases of Q11 and Q12 to cause these transistors to act as dynamically varying collector loads for Q9 and Q10. (The operation of this stage will be further explained after the output stage is described.)

Transistor Q13 is connected as a temperature compensated constant voltage source which regulates the bias current in the output transistors. Negative thermal feedback is provided by diodes D3 through D6 for thermal stability of the output stage. Mounted on the main heat sinks with the output transistors, these diodes sense the heat sink temperature to maintain constant quiescent bias current in these transistors when the heat sinks heat up under load. There are two main heat sinks, and two of the bias diodes are mounted in series on each. Potentiometer R28 is used to adjust the bias for minimum distortion.

The signal is coupled from the collectors of transistors Q11 and Q12 to the bases of the main output transistors by the Class-A discrete Darlington driver stage formed by transistors Q16 through Q19. The advantages of this Darlington driver configuration have been discussed in [4]. In brief, the very high input impedance to the drivers presents a load impedance to transistors Q11 and Q12 that is essentially independent of the loudspeaker load impedance. This makes it possible to operate the second stage at a very high gain in order to minimize static distortions in the amplifier. The extremely low output impedance of the Darlington drivers makes it possible to bias the output transistors for zero crossover distortion in the Class AB mode. Thus, biasing the amplifier in the inefficient Class A mode or the use of feedback to dynamically vary the bias voltage for a quasi-Class A mode of operation will result in no improvement in performance. The reason for this is that the output impedance of the driver stage is low enough so that the output transistors operate at their maximum bandwidth, which is equal to their gain-bandwidth product. Because this is greater than the unity-gain loop bandwidth of the amplifier, the speed of the ampli-

Fig. 1 — Complete circuit diagram of the amplifier. (C.G. denotes connection to the central ground point.)





fier is not set by the speed of the output transistors but by the stages that drive it.

The main output transistors in the output stage are transistors Q20 through Q23, which are operated in the emitter-follower or common-collector configuration for maximum bandwidth. They are biased in the Class AB mode for minimum distortion and minimum power dissipation. In the Class AB mode, all output transistors are conducting during no or small-signal inputs. However, as the input signal dynamically increases, two of the output transistors will progressively conduct more and the other two will progressively conduct less during any half cycle of the input signal until the latter two transistors cut off. During the signal transition through the zero signal or crossover region, all output transistors are conducting and the amplifier operates Class A. This eliminates all traces of the spike in the distortion waveform caused by crossover distortion.

The collector voltage across each output transistor is varied dynamically with the output signal to reduce the voltage across these transistors to one-half the voltage each would have to drop in a conventional design. This greatly improves the reliability of the output stage because high-power transistors can reliably deliver high load currents only at low collector to emitter voltage. This dynamic variation of the voltage is accomplished by transistors Q24 through Q31, which operate in the Class A mode. Because resistors R52 and R53 are equal, the voltage at the base of transistor Q28 is equal to the loudspeaker output voltage plus one-half the difference between the positive power supply voltage and the loudspeaker output voltage. Similarly, because R54 and R55 are equal, the voltage at the base of Q29 is equal to the loudspeaker output voltage plus one-half the difference between the negative power supply voltage and the loudspeaker output voltage. If the relatively small base-to-emitter voltage drops for transistors Q24 through Q31 are neglected, it follows that the voltage at the collectors of Q16, Q18, Q20, and Q21 is forced to vary so that it is always approximately halfway between the loudspeaker output voltage and the positive power supply voltage. Similarly, the collector voltage for transistors Q17, Q19, Q22, and Q23 is dynamically varied so that it is halfway between the loudspeaker output voltage and the negative power supply voltage. Thus, for the 85-volt positive and negative power supplies, the output transistors can never have more than 85 volts across them. This is 55 volts less than the rated open base breakdown voltage of 140 volts for these transistors. The output stage is therefore operated conservatively to prevent the transistors from operating outside their safe operating area. To the author's knowledge, such a technique for dynamically varying the collector voltage of the output transistors in a power amplifier was first published in 1974 by James Bongiorno [8].

There have been other methods described recently for varying the supply voltages to the output stage in power amplifiers that involve diode or-gates which abruptly switch in which the output signal level exceeds the threshold of the or-gate, e.g. the so-called Class G circuits which typically use a poorly regulated high voltage power supply to provide transient peaks. Although these circuits are more efficient and thus can be designed with lighter heat sinks and transformers, the present technique is much preferred because it dynamically varies the collector supply voltages to the output transistors so that these voltages linearly track the output signal. Although this is a more expensive approach, it circumvents the problem of switching distortion which can be caused by the higher voltage power supplies switching in on high power peaks.

The dynamically varying collector voltages for transistors Q16 through Q23 are fed back to the bases of transistors Q11 and Q12 in the second stage of voltage gain. Because the base-to-emitter voltage drops for Q11 and Q12 are small, it follows that the voltage across Q9 and Q10 is approximately one-half of what the voltage would be in a conventional design. The other one-half is dropped by Q11 and Q12. The bases of Q11 and Q12 are the signal inputs to an internal negative feedback loop that encircles the output stage. This is a unique feature of the amplifier which greatly reduces static distortions produced in the output stage. Thus, the feedback signal to the differential amplifiers contains fewer distortion components, permitting the differential amplifiers to be operated at a lower gain for lower dynamic distortions, greater frequency stability, and a higher slew rate.

The protection circuit consists of transistors Q7, Q8, Q14,

and Q15, and diodes D7 through D12. The amplifier output voltage and current are sensed by Q14 and Q15 to automatically limit the output current in the event that the loudspeaker wires are accidentally short circuited or if a severely reactive load is driven which could damage the output transistors. With a short circuit on the output, the protection circuit will limit the peak output current to about 6 amperes. With a load resistance of about 2 ohms or greater, it will not limit. When the limiter circuit is tripped, Q14 or Q15 saturates, which short circuits the base drive signal for Q16 and Q17. Because this short circuits the collector outputs of Q11 and Q12 to the amplifier output terminal, these two transistors must be protected by limiting the maximum current they can deliver. This is accomplished by transistors Q7 and Q8, which sense the current drawn by Q9 through Q12 and limits it to approximately 30 to 35 mA. Diodes D11 and D12 are damper diodes that protect the output stage from inductive transients which can be caused by an excessively inductive load impedance. Diode D7 prevents Q14 from limiting on negative output signal swings while D8 prevents Q15 from limiting on positive swings. Diodes D9 and D10 protect Q14 and Q15 from inductive transients. All diodes in the protection circuit are fast-recovery, low-capacitance diode types, minimizing false triggering of the limiter circuit and assuring a quick recovery should limiting occur. Capacitors C17 and C18 slow the response of the limiter so that it will not trigger on fast transients. Capacitors C15 and C16 suppress oscillations that could occur in the limiter circuit if it is triggered.

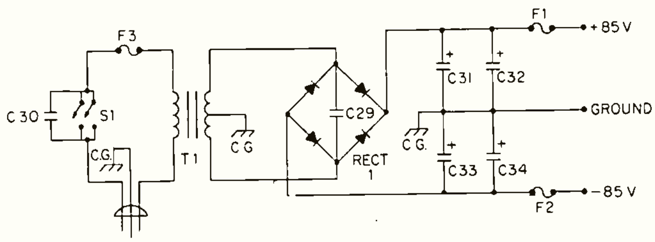


Fig. 2 — Circuit diagram of the amplifier power supply.

Although limiter circuits have a bad reputation among some audiophiles, they are a necessary evil in any application where the amplifier will be moved around or where the loudspeaker leads will be connected or disconnected during operation such as in sound reinforcement work. It is recommended that the amplifier be built with the limiter to protect the circuit in the event of construction errors. After the amplifier is operational, transistors Q14 and Q15 may be removed to disable it. However, this is not recommended. Without the limiter, the amplifier can be seriously damaged in the event that the loudspeaker output leads are accidentally short circuited. An excellent discussion of the design of amplifier protection circuits such as the voltage-current sensing limiter used in this design is given in [9].

The feedback network consists of resistors R19 through R21 and capacitors C6 through C9. This network has two feedback paths — an a.c. path and a d.c. path. The signal outputs from these two paths are summed to form the total feedback signal. The a.c. loop is formed by resistors R19 and R20, which set the closed-loop gain of the amplifier at approximately 26 dB. The d.c. feedback network continuously monitors the loudspeaker output voltage for a d.c. offset which could damage the loudspeaker. If a d.c. offset voltage appears at the output of the amplifier, it will be fed back with no attenuation through R21 into the differential amplifiers, where a correction voltage will be generated to cancel the offset. Capacitors C6 and C7 in series form a non-polar electrolytic that determines the lower -3 dB frequency of the amplifier which is 0.3 Hz. Below this frequency, these capacitors become open circuits and remove the a.c. feedback to the inverting input of the differential amplifiers. This gives 100 percent d.c. feedback for stability of all d.c. bias voltages and currents in the circuit. The phase shift associated with the gain roll-off below 0.3 Hz is less than one degree at 20 Hz. Capacitor C8 is a metalized polyester capacitor which bypasses the electrolytics at high frequencies.

One of the most important considerations in the initial design stages of an amplifier is the specification of the desired gain-bandwidth product. This is the upper frequency at which the open-loop gain has reduced to unity. When this frequency is divided by the desired closed-loop gain, the upper -3 dB frequency of the closed-loop amplifier is obtained. The gain-bandwidth product is another example of how the uncertainty principle affects almost everything in physics and engineering. The higher the gain-bandwidth product of an amplifier, the wider its bandwidth and the lower its distortion. However, the higher the gain-bandwidth product, the more susceptible the amplifier is to oscillations. This is especially true for the case of reactive loudspeaker loads, since they can be connected to the amplifier by so-called "high definition" cables that exhibit high capacitive load effects on the amplifier. (It is felt that some of these cables are marketed with erroneous and deceptive claims. The fact that a number of them have caused some amplifiers to self-destruct is evidence of their high capacitive loading effect. Some amplifiers oscillate with capacitive loads and can either self-destruct or sound different, particularly if the capacitive load trips the protection circuit. If the amplifier does not misbehave with these cables, it is doubtful that the loudspeaker will sound any different with them than with an equivalent gauge zip cord.) It was decided at the start of this project that stability margin would not be sacrificed for gain-bandwidth product and that the amplifier would be designed for unconditional stability in the sense that its square wave response, with the signal applied after the Bessel input filter, would exhibit no overshoots or ringing and that the amplifier would remain stable if its open-loop gain were reduced. Conditionally stable amplifiers can be designed for extremely low static distortion levels by staggering pole zero combinations in the open-loop gain function at frequencies below the unity loop-gain frequency, thus achieving very high levels of feedback. Such amplifiers are available on the commercial market and their design has been discussed in the literature [10]. However, it is felt that conditionally stable amplifiers are more susceptible to dynamic distortions and load-induced oscillations. In addition, their stability margin is reduced should the open-loop gain of the amplifier decrease with age.

During the experimental phase of this design, it was found that a 10-MHz gain-bandwidth product could be obtained with no square wave overshoots. The amplifier is stable with a higher value at the expense of a slight overshoot in the square wave response. However, it is felt that the 10-MHz figure is adequate, for it gives a closed-loop upper -3 dB frequency of 500 kHz when the amplifier is operated at a closed-loop gain of 20. Once the desired gain-bandwidth product has been specified, it is possible to design the input stage to set the slewing rate of the amplifier. This was chosen to be 80 volts per microsecond, a figure that is about 10 times that required to reproduce a full power sine wave at 20 kHz without slew-rate limiting. Conversely, the slew rate is high enough so that the amplifier can reproduce a full power sine wave up to a frequency of about 200 kHz. However, the builder is cautioned never to try this test, for the output transistors could be damaged. For a gain-bandwidth product of 10 MHz and a slewing rate of 80 volts per microsecond, the required ratio of the transconductance to bias current for the transistors in the input differential amplifiers can be cal-

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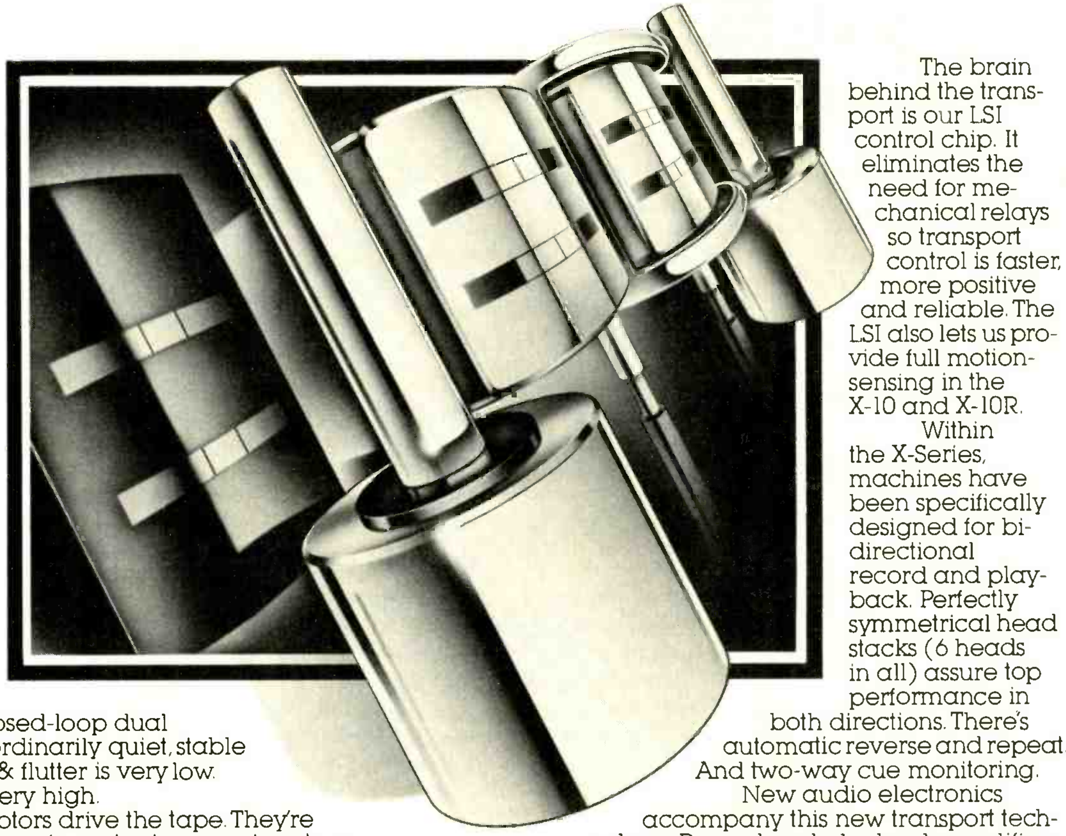

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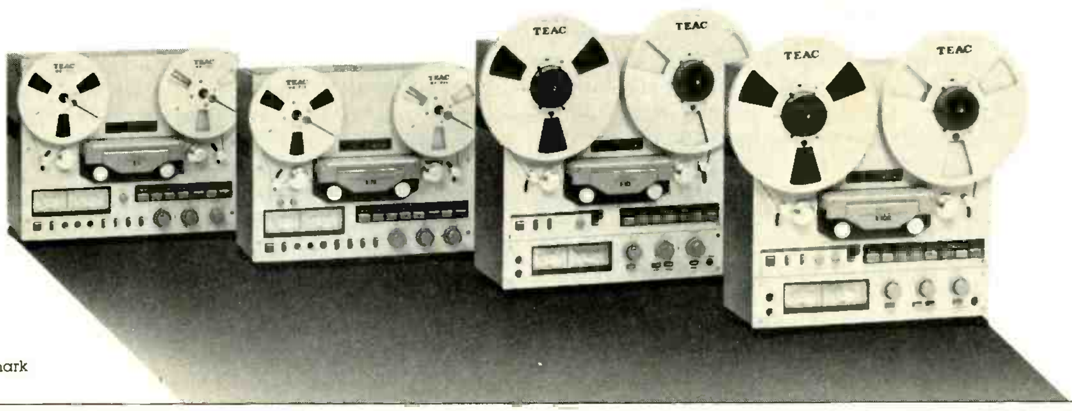

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culated [11]. It is 0.79 Mho per ampere. Thus for the 4-mA bias current in the differential amplifiers, the required transconductance of this stage is 0.0031 Mho. This value is achieved by the addition of the 270-ohm emitter degeneration resistors R9 through R12. Capacitors C4 and C5 lead compensate this stage by cancelling a pole in its transfer function at 20 MHz. The gain-bandwidth product of the overall amplifier is set at 10 MHz by capacitors C12 and C13 in the second stage of gain. These capacitors also act as pole-splitting capacitors to increase the frequency of higher order poles in the second stage for a better stability margin. Capacitors C9, C24, and C25 complete the frequency compensation of the amplifier. C9 lead compensates in the feedback network to cancel a 2-MHz pole that occurs in the current gain of the output transistors. C24 and C25 stabilize the internal negative feedback loop that encircles the output stage.

By taking the present approach to design the amplifier for a specified slew rate and gain-bandwidth product, the use of nonlinear Class B slew-enhancement techniques in the input stage to increase slew rate as described in [10] can be avoided. Another technique which is used by some designers to achieve a high slew rate is to operate two identical amplifiers in a bridged or strapped configuration. The slew rate of the bridged combination is twice the slew rate of the unbridged amplifiers. However, the highest frequency at which the bridged combination can reproduce a full power sine wave without slew rate limiting is not doubled; it is equal to the large-signal bandwidth of the individual amplifiers. Thus bridging cannot be used to increase large-signal bandwidth as can be achieved by increasing the slew rate of the individual amplifiers.

The power supply is shown in Fig. 2. The transformer is a heavy duty, 12-ampere transformer weighing 38 pounds. Because the power supply voltage is plus and minus 85 volts, it is necessary to use 100-volt or higher capacitors in the power supply filter because the next lowest standard voltage for electrolytic filter capacitors is 75 volts. Unfortunately, it is very difficult to locate large-value 100-volt electrolytic capacitors, especially on the money saving surplus market. In the author's amplifier, two 8,600 - µF capacitors were connected in parallel for each power supply filter. This gives a total power supply capacitance of 34,400 µF. This value can be increased, but it is felt that any improvement will be minor because the amplifier is designed so that the output transistors cannot saturate when the amplifier clips. This prevents power supply ripple from being coupled into the loudspeaker load through saturated output transistors. Instead, when the amplifier clips, either Q9 or Q10 becomes saturated. Because these transistors are isolated from the power supply by low-pass filters, the ripple on the power supply lines cannot be coupled through Q9 and Q10 and into the loudspeaker.

Specifications and Measurements

The average sine wave power rating of the amplifier is 250 watts into an 8-ohm load, corresponding to a load voltage of 45 volts rms or 63 volts peak. Continuous sine wave power measurements load down the power supply more than audio signals because audio signals of the same peak level have a much lower average power level. Thus, a meaningful specification is the peak voltage output of the amplifier into an open circuit, i.e. the maximum transient peak that the amplifier could supply to any load impedance before the voltage on the power supply filter capacitors drops. This peak voltage for the amplifier is 78 volts, and it follows that, if the power supply were perfectly regulated, the average sine wave power rating into 8 ohms would be 380 watts. This is 1.8 dB higher than the average sine wave power rating and corresponds to the dynamic headroom of the amplifier. (Dynamic headroom can be a misleading specification. An amplifier with a perfectly regulated power supply will have a dynamic headroom of 0 dB. Therefore, the smaller this number, the better the power supply but the larger this number, the higher the transient peak power capability.)

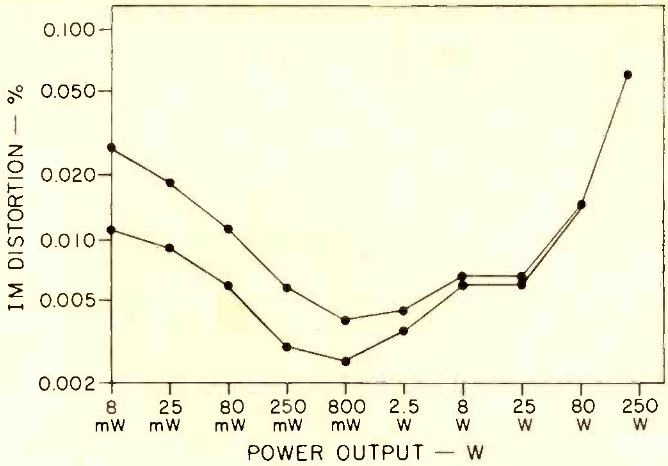

Fig. 3 — SMPTE IM distortion of the amplifier when driving an 8-ohm load. Points are connected by straight lines for plotting. The two curves show uncertainty in the low-level measurements caused by noise in the measurement system.

To test the amplifier for distortion, it was decided to abandon conventional total harmonic distortion (THD) measurements and investigate only the intermodulation distortion (IM) characteristics of the circuit. This is because THD measurements only identify distortion components which are harmonically related to the test frequency, and these components often lie outside the audible frequency band. Thus, some THD specifications can be meaningless, particularly those made above 10 kHz. The most audible and annoying distortion is not harmonically related to the signal frequency. This type is called IM distortion, and it is generated when two or more signals with different frequencies interact inside the amplifier to produce what are called intermodulation products. The ear is most sensitive to IM distortion because, by definition, it is non-harmonically related to the signal, whereas THD is.

Two types of IM measurements were made on the amplifier. These were the SMPTE IM measurement and the DIM-100 measurement. The SMPTE IM standard, written by the Society of Motion Picture and Television Engineers, is a measurement technique that identifies static distortion mechanisms, i.e. those that are dependent only on the amplitude characteristics of the signal. Crossover distortion is an example of static distortion, and the SMPTE IM test is extremely sensitive to it. A good discussion of this test and its implementation is provided in [12]. The SMPTE IM distortion of the amplifier was measured with a Crown IMA intermodulation analyzer which uses two simultaneous sinusoidal test tones, one at 60 Hz and one at 7 kHz with an amplitude ratio of 4 to 1. The IM distortion is determined by measuring the percentage amplitude modulation on the 7-kHz tone caused by the larger amplitude 60-Hz tone. The measurement results are shown in Fig. 3. At 250 watts into 8 ohms, the IM level of the amplifier was 0.054 percent. At lower levels, it decreased to 0.004 percent at 800 milliwatts, increasing below that level. Noise in the measurement system had a strong affect on the low-level distortion measurements, and the data in Fig. 3 have been corrected for it. The upper curve in this figure is the rms difference between the distortion and the residual noise, and the lower curve is the algebraic difference between these; the actual distortion should lie somewhere between the two curves. The residual noise was determined by turning the level of the output signal on the IMA analyzer to

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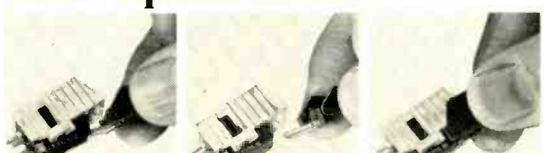

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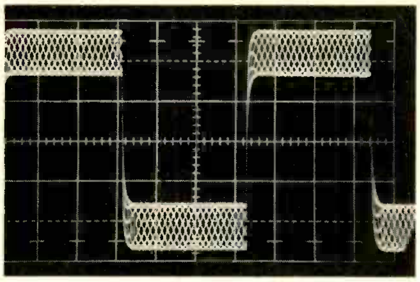


Fig. 4 — DIM-100 input test signal consisting of a 3.18-kHz square wave and a 15-kHz sine wave added with the ratio of 4 to 1. Vertical scale is 1 V per division; horizontal scale is 50 μS per division.

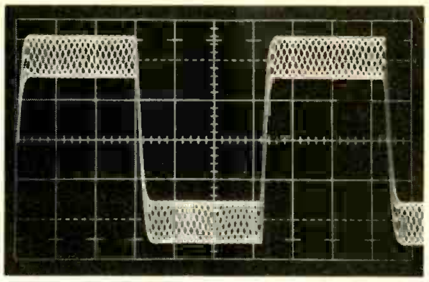


Fig. 5 — Output signal of the amplifier when driving an 8-ohm load with the DIM-100 input test signal. Vertical scale is 25 V per division; horizontal scale is 50 μS per division.

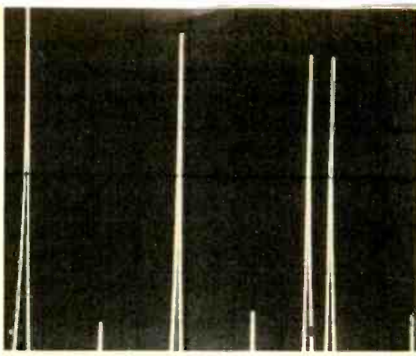


Fig. 6 — Spectral analysis of the amplifier output signal when driving an 8-ohm load with the DIM-100 input test signal. Vertical scale is 10 dB per division; horizontal scale is 2-kHz per division from 0 to 20 kHz.

zero and recording the percentage distortion reading on the analyzer meter. It was determined that the source of this noise was the analyzer, for the percentage distortion dropped to zero when the phono input jack on the amplifier was short circuited, indicating the noise was not being generated by the amplifier. There is no evidence of crossover distortion in the IM measurement data. This would have shown up as a large peak in the IM level in the critical power range from 10 milliwatts to 1 watt. (Author's Note: The noise was later traced to improper grounding of the IMA analyzer.)

The DIM-100 test is one that can be used to identify IM distortion components that fall in the audible range which are caused by distortion mechanisms dependent on both the amplitude and frequency characteristics of the signal. Examples of such distortions are TIM and SID, and this test is extremely sensitive to them. The DIM-100 measurement technique uses a spectrum analyzer to identify and measure the IM components when a square wave and a sine wave are simultaneously applied to the amplifier. Such a measurement technique was originally described by Schrock [13], although no method was given to quantify the measurements. In a later paper by Leinonen, et. al. [14], a method to do this was presented, and the test was called a dynamic intermodulation (DIM) test. It specifies a 3.18-kHz square wave and a 15-kHz sine waved added with the amplitude ratio of 4 to 1 for the amplifier test signal. The square wave is specified to be low-pass filtered with a single-pole filter. The upper -3 dB frequency of this filter is specified to be 30 kHz (DIM-30) for normal testing and 100 kHz (DIM-100) for measurements on the highest class of equipment. This latter test was the one chosen for the amplifier. The percentage of DIM-100 is specified as 100 percent times the ratio of the rms sum of the IM distortion components at the 9 IM frequencies which lie in the audio band to the rms amplitude of the 15-kHz sine wave. These 9 IM frequencies are 0.90, 2.28, 4.08, 5.46, 7.26, 8.64, 10.44, 11.82, and 13.62 kHz. A spectrum analyzer or frequency-selective voltmeter must be used to measure these.

It has been shown that high-frequency THD measurements can be used to identify dynamic distortion mechanisms in operational amplifiers [15]. These tests are also valid in testing power amplifiers but were not used for several reasons, the main one being that the THD must be measured with the amplifier operating near its slew-rate limit. A slew rate of 80 volts per microsecond would require full power THD measurements at 200 kHz and higher, which could damage the output transistors, and the accuracy of distortion analyzers above 200 kHz may not be good. Second, the measurements do not identify IM products that could fall back into the audio range, and these are the distortion components we hear. Finally, THD measurements above the 40-kHz cutoff frequency of the Bessel input filter would require unrealistically large input signals. For example, it would take 56 volts rms at the amplifier input for it to put out a full power sine wave of 45 volts rms at 200 kHz.

Two Hewlett Packard 3310A function generators were used to generate the DIM-100 test signal, and a Hewlett Packard 5381A frequency counter was used to adjust the frequency of each generator to correspond to those specified for the DIM-100 test. An oscillogram of this signal is shown in Fig. 4. Because there is no harmonic relationship between the frequencies of the sine wave and the square wave, the oscillogram shows several cycles of the sine wave superimposed on the square wave. The levels were chosen so that the square wave term produced a 100-volt peak-to-peak square wave at the amplifier output while the sine wave term produced a 25-volt peak-to-peak sine wave. The total peak-to-peak signal swing was thus 125 volts, or 1.5 volts less than that of a 250-watt sine wave into 8 ohms. The amplifier output signal when driving an 8-ohm load is shown in Fig. 5. The average power delivered to the load with this signal was 322 watts,

Fig. 7 — Square wave response of the amplifier at 50 Hz measured at 200 watts with an 8-ohm load. Vertical scale is 20 V per division; horizontal scale is 5 m S per division.

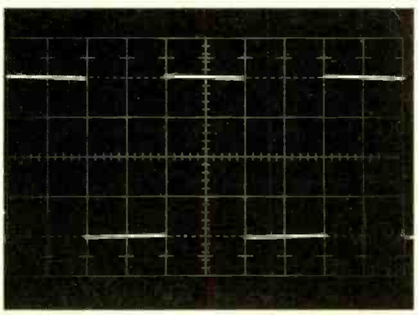


Fig. 8 — Square wave response of the amplifier at 10 kHz measured at 200 watts with an 8-ohm load. Rounded rise and fall portions of waveform are caused by Bessel low-pass input filter which rolls off amplifier response at 12 dB per octave above 40 kHz. Vertical scale is 20 V per division; horizontal scale is 20 μS per division.

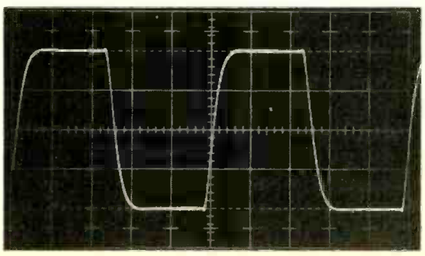
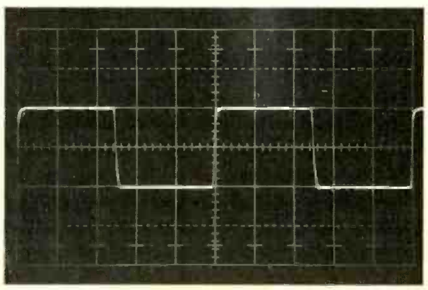


Fig. 9 — Square wave response of the amplifier at 20 kHz with the Bessel input filter bypassed. Measured at 20 V peak-to-peak with an 8-ohm load. Vertical scale is 10 V per division; horizontal scale is 10 μS per division.



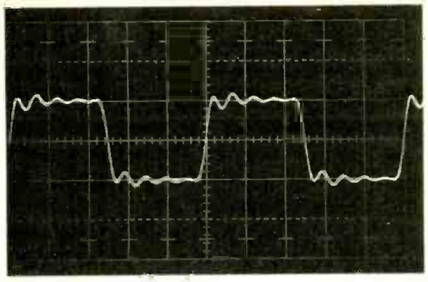
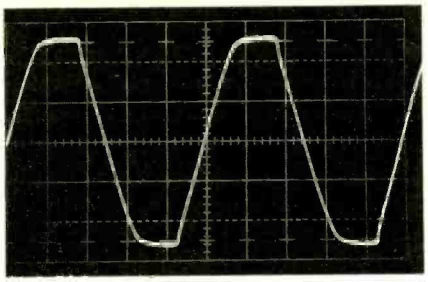


Fig. 10 — Square wave response of the amplifier at 10 kHz measured at 10 V peak-to-peak with a 2-μF capacitor load. Vertical scale is 10 V per division; horizontal scale is 20 μS per division.

Fig. 11 — Sine wave response of the amplifier at 20 kHz with 2 dB of overdrive measured with an 8-ohm load. Vertical scale is 25 V per division; horizontal scale is 10 μS per division.



which was high enough to cause the load resistors to get quite hot during the test. (A sine wave with the same peak-to-peak signal level would correspond to an average power level of 244 watts.) To determine the DIM-100 distortion components in the output signal, the amplifier output was connected through a variable attenuator to the input of a Tektronix 5L4N spectrum analyzer, and its display is shown in Fig. 6.

Figure 6 shows a spectral analysis of the amplifier output signal displayed over a dynamic range of 80 dB from 0 to 20 kHz. There are seven frequency components in the figure, occurring at 3.18, 6.36, 9.54, 12.72, 15.00, 15.90, and 19.08 kHz. With the exception of the 15-kHz sine wave term of the test signal, all are harmonics of the square wave term. (The even-order harmonics were caused by an asymmetry in the 3.18-kHz square wave and would be absent with a perfect square wave.) There are no identifiable IM components at any of the nine specified frequencies for the DIM-100 test. The amplifier thus has no DIM-100 components that are greater than -80 dB below the fundamental frequency component of the 3.18-kHz square wave, and the same was true for tests at lower signal levels. It is important to point out that the DIM-100 test does not measure high-frequency IM products lying outside the audible band, so distortion mechanisms which could affect high-frequency THD measurements are not measured. This is because these mechanisms can only affect the sound quality of an amplifier if the distortion components they produce fall back into the audible frequency band — in which case the DIM-100 test will detect them.

Figures 7 through 11 summarize the waveform responses of the amplifier. The 50-Hz and10-kHz square wave responses at 200 watts into 8 ohms are shown in Figs. 7 and 8. The slight amount of tilt in Fig. 7 is caused by the use of 100 percent feedback at d.c. to stabilize the quiescent bias voltages and currents. The waveform in Fig. 8 exhibits the characteristic response of a second-order Bessel low-pass filter, and the upper -3 dB frequency of this filter is 40 kHz. This is low enough so that the maximum first derivative or time rate-of-change of the output signal can never approach the slew-rate limit of the amplifier when reproducing a worst-case signal, which is a full power square wave. The -3 dB frequency is high enough, however, so that deviations from ideal amplitude and phase response below 20 kHz are negligible [3]. Figure 9 shows the 20-kHz square wave response with the signal applied after the Bessel filter. The absence of overshoots or ringing in the waveform indicate unconditional stability with a phase margin that is close to 90 degrees. Thus, the amplifier is not subject to oscillations because of load effects or if the open-loop gain should decrease with age. The 10-kHz square wave response into a 2- μF capacitor is shown in Fig. 10. This figure reveals only a small amplitude ringing with very little overshoot, indicating outstanding stability of the amplifier into a reactive load. Figure 11 shows the 20-kHz sine wave clipping response into an 8-ohm load. The input signal overload for this test was 2 dB, and the figure shows a symmetrical clipping characteristic with very little evidence of "sticking." The tests reported in Figs. 10 and 11 are torture tests which, in general, should not be performed by the unexperienced unless the tester is aware of the consequences. The author has seen some amplifiers self-destruct during these tests.

The signal-to-noise ratio of the amplifier was measured with a Bruel and Kjaer 2609 measuring amplifier. With the phono input short circuited to ground, the output noise measured 0.67 millivolts unweighted and 0.174 millivolts "A"-weighted. These translate into signal-to-noise ratios referenced to 250 watts into 8 ohms of 96.5-dB unweighted and 108.2 dB "A"-weighted.

The damping factor was measured by driving the amplifier output terminal from the output terminal of a second amplifier, with an 8-ohm resistor connecting the two. The damping factor is one plus the ratio of the voltage at the output of the second amplifier to the voltage at the output of the amplifier under test. A Hewlett Packard 3575A gain phase meter was used to measure this ratio. At 20 Hz, the damping factor was found to be in the range of 300 to 500, the uncertainty caused by the effects of noise on the measurements. At 20 kHz, the damping factor was 60. It follows that the output impedance of the amplifier at 20 Hz is between 0.016 and 0.027 ohms, and at 20 kHz it is 0.13 ohms. The increase in the high-frequency output impedance is primarily caused by the inductor L1.

Construction details of the amplifier will be provided next issue in Part II.

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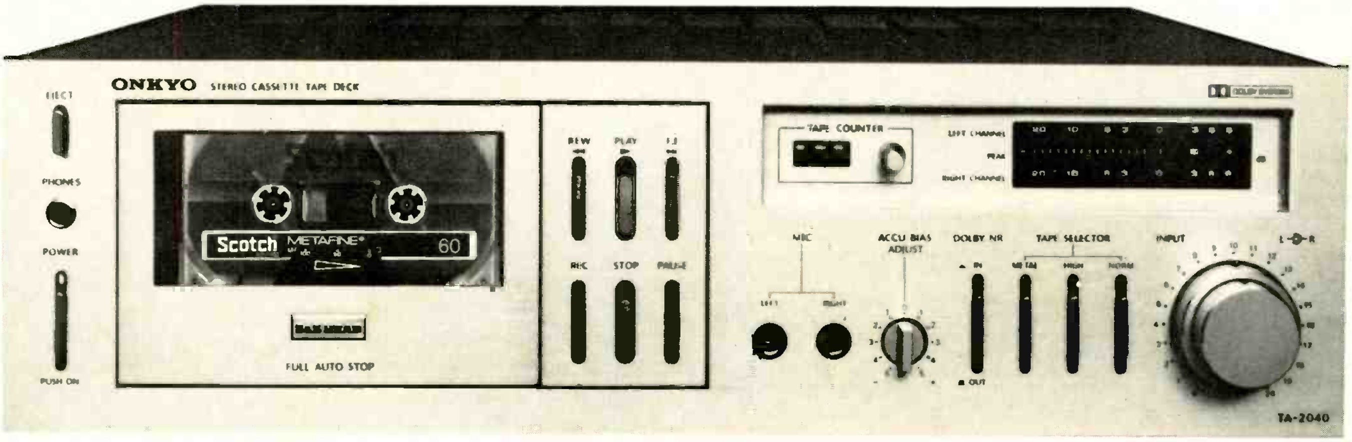
what's new



Onkyo Cassette Deck

Model TA-2040 is a compact cassette deck with metal-particle tape capability. Frequency response with this tape is from 20 Hz to 19 kHz. The two-head deck uses a d.c. servo motor, and wow and flutter is stated to be 0.055 percent W rms. The "Accu-Bias" control allows bias adjustment to a tape's exact requirements, while a fluorescent level meter has separate scales for each channel. Other features include electronic push-button controls, Dolby N-R, and input level control. Price: $370.00.

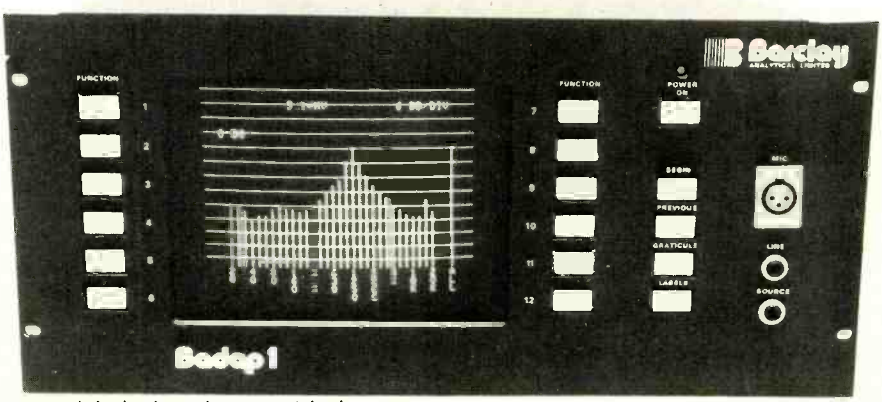
Enter No. 100 on Reader Service Card

Hartke Systems Loudspeaker

Custom made to order, the Hartke Monitor is a two-way system with an infinite baffle mirror-image enclosure. It features an 8-in. full-range aluminum cone driver and a 1⅞-in. dome tweeter. Frequency response is from 35 Hz to 25 kHz, ±2.5 dB, crossover frequency is at 3.5 kHz, and a tweeter level control is included. The speaker measures 19¾x12¾x10¾ inches, weighs 40 lbs., and may be optionally wired for bi-amplification. Price: $850.00 per pair.

Enter No. 101 on Reader Service Card

Barclay Analytical Audio Micro Computer



The Badap I is a programmable audio test instrument that provides measurements of third-octave response, reverberation time, wow and flutter, critical distance, and other functions. It is applicable to room equalizing, spectrum analysis, disc/tape monitoring, sound-system design, multichannel monitoring, and cartridge and tonearm alignment. The computer features a color display for ease in interpretation and comparison of data, and multiple memories for data storage and recall. All controls are touch-sensitive, with corresponding video screen labels that change with the program selected for use. Price: $5,495.00.

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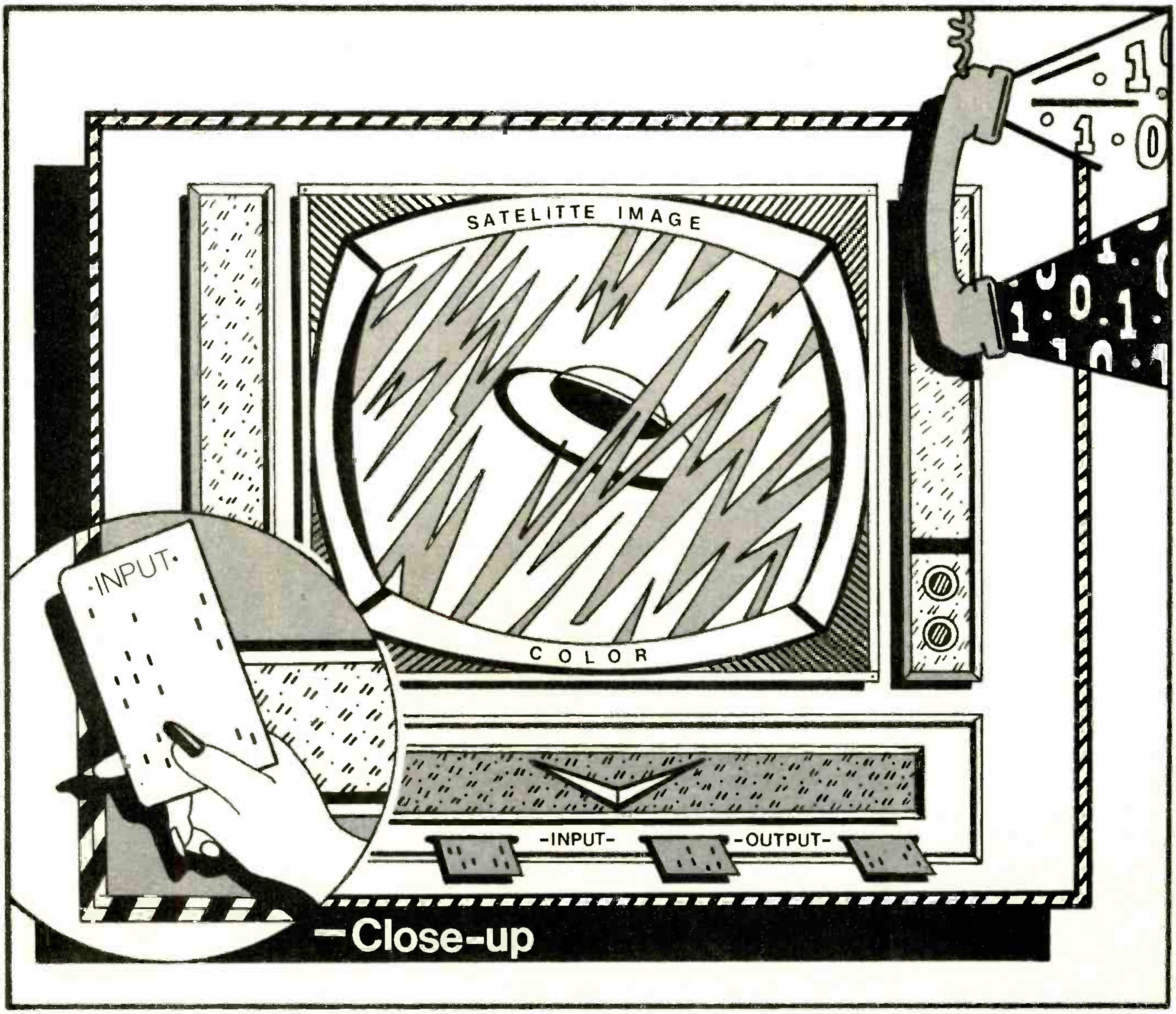


Part I

Digital Techniques In Sound Reproduction

Daniel Minoli

Digital techniques are revolutionizing the high-fidelity industry [1]; this trend is in fact part of a wider phenomenon which is making a marked impact on all signal processing industries (telecommunications, satellite image analysis, pattern recognition, seismic and radar data analysis, and automatic voice generation, to mention a few).

Digital systems are becoming more and more widespread since the introduction of cheap, reliable, and compact logic (microcomputer) at the turn of the last decade, since this allows storage of the data in a way which can be easily and rapidly accessed, processed and restored. In addition, sophisticated error control techniques allow integrity of the data (and, hence, immunity from noise, crosstalk, fading, and other types of errors).

This series is aimed at explaining the fundamental principles of digital techniques so that the audiophile can have an appreciation of the issues involved. A discussion of the basic architecture of a typical computer is followed by a description of the binary representation of numbers. The key aspects of signal processing in general and PCM in particular also are presented, along with issues in error correction/detection, storage media, editing, and digital and analog-digital-analog

International Telephone and Telegraph
Domestic Transmission Systems, Inc.
New York, N.Y.

discs. Some interesting results are also listed from the mother discipline of digital sound reproduction, namely voice codification, so much used by the telecommunications industry (when one makes a long distance call the voice is actually PCM encoded/decoded on the long-haul network).

Architecture and Operation of a Computer

The operation of a computer is not as mysterious as many people think; we furnish some key facts here, with the goal of setting the ground for the digital data formats to be discussed below. A complete understanding, however, is not required to be able to follow the rest of the article.

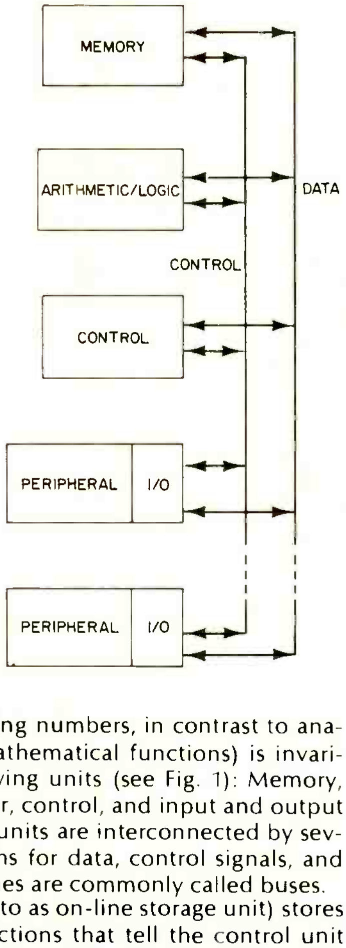


Fig. 1 — Computer architecture.

A digital computer (i.e. using numbers, in contrast to analog computers which use mathematical functions) is invariably composed of the following units (see Fig. 1): Memory, arithmetic and logic processor, control, and input and output mechanism (I/O). These subunits are interconnected by several lines which provide paths for data, control signals, and computer instructions; the lines are commonly called buses.

The memory (also referred to as on-line storage unit) stores actual data as well as instructions that tell the control unit what to do with the data. The arithmetic/logic processor temporarily stores data received from the memory and performs calculations and logic operations on this data. The arithmetic/logic processor contains one or more registers which, in turn, contain the data being operated on as defined by the instruction.

The control unit, as its name implies, controls the flow of data in the system, fetches instructions from memory, and decodes the instructions. The control unit executes instructions by enabling the appropriate electronic signal paths and controlling the proper sequences of operations performed by the arithmetic/logic and input/output units. Finally, it changes the state of the computer to that required by the next operation.

The input/output unit provides the interface and, in some systems, buffering to peripherals connected to the computer, transferring data to and receiving data from the outside world. The control unit and the arithmetic/logic processor units with registers are referred to as the central processing unit (CPU) [2]. For now we can think of the memory as a city, where each dwelling (memory location) has an address or telephone number; by specifying the address we are able to focus uniquely into one of these cells and read out the current content or store a new item of data.

Let's look at the CPU in closer detail to obtain insight in the computation process. The basic elements in the CPU are the instruction register, the decoder, the control unit, the program counter, the adder and comparer, the accumulator, and the status register. The block diagram in Fig. 2 illustrates how these elements are interconnected.

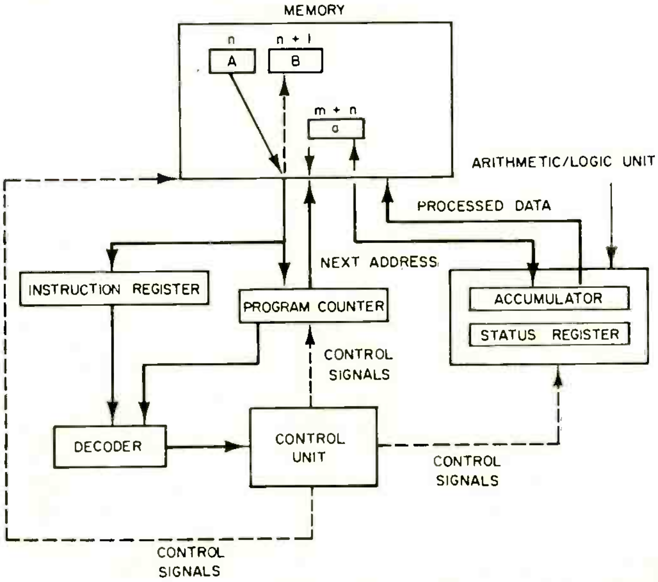
A typical processing cycle can be divided into two subcycles: Instruction or fetch cycle and execution cycle.

The following chain of events takes place during the fetch cycle: (1) The control unit fetches memory address n from the program counter; (2) the decoder decodes this address; (3) the control unit logic fetches the contents A of memory word n addressed; (4) the control unit logic interprets memory word n as an instruction (not data) and loads instruction A into the instruction register; (5) the control unit logic increments the program counter by 1 for the next cycle (the counter therefore acts as a memory address pointer), and (6) the control unit fetches the contents of instruction register A and decodes the instruction.

The control unit is now ready to implement the second subcycle, the execution cycle. The steps followed in the execution cycle depend on the type of instruction to be executed. One of the common instructions is addition or ADD. A typical ADD instruction is based on the following sequence of steps: (1) A piece of data arbitrarily designated "a" stored in memory location m+n is added to the contents of the accumulator. Assuming that the previously stored quantity in the accumulator is "b," the new amount after addition will be a+b, and (2) the new contents of the accumulator are stored in location m+n, which will now contain a+b [2].

One of the greatest steps forward in computer evolution was not explicitly distinguishing the format of the data from that of an instruction. Let us clarify this with an example. Assume that we have a computer with 15 memory locations (1, 2,...15). When we are talking about instructions, let 01XX mean add (01) what is in memory location XX to the current value in the register; 02XX is multiply, 03XX divide, 04XX subtract, 05XX read memory location XX and put it into the accumulator, 06XX copy the accumulator into memory location XX, and 07XX print the memory location XX on a piece of paper. For example 0513 means read memory slot 13 and

Fig. 2 — The central processing unit (CPU).



bring it into the register. On the other hand, when we talk about data, 0513 is the number 513. Assume also that each memory location allowed room for four decimal digits (i.e. 00 to 9999), and you've got yourself a fancy calculator.

The program loaded in the memory in Fig. 3 brings the content of location 11 (4444) into the register (working area, scratch pad), adds the content of location 12 (112), stores the results into location 13 (which must be empty otherwise what is there is over-written), brings such result back into the register, divides by 2 (content of memory location 14) and then, after storing the final result in location 15, prints it out. Note that at the top (program storage area) 112 means add to content of location 12, while at location 12 it means the number 112. The control here does basically two things; it directs the data in the right spot like a policeman directing traffic, and it augments the instruction counter, which in effect provides the continuity of activity. Thus, in a subcycle the next "instruction" is fetched, as soon as the old one is executed, and put into the control, which then decides what to do (which doors to open); the ALU actually performs the required computations.

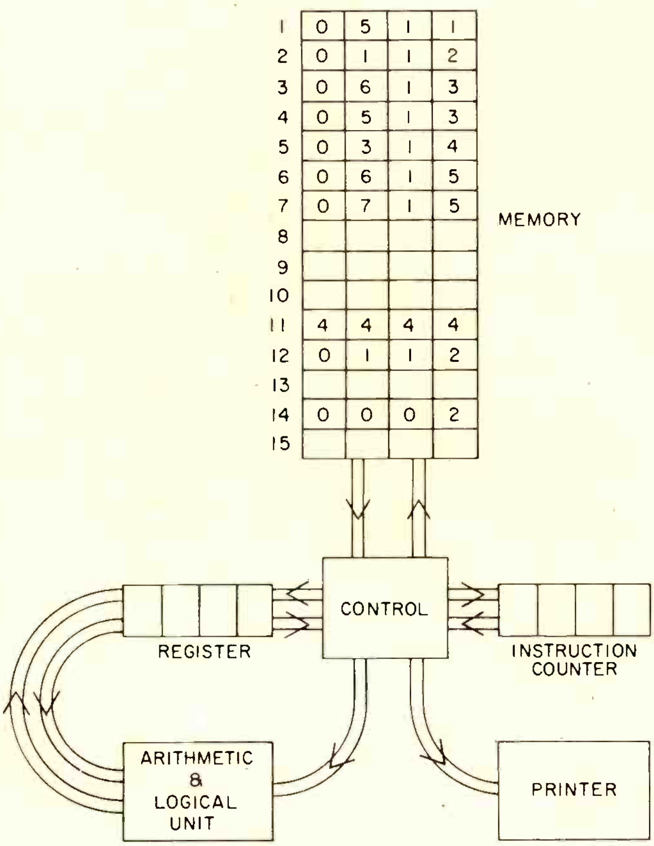


Fig. 3 — Example of a computer.

And so you've got yourself a computer. You have memory addresses, instructions (the collection of instructions is called the instruction set), I/O instructions (e.g. "print"), register, and all the other key components of a real computer.

Memory Architecture

Now that we know how a computer works (or roughly), let's take a closer look at the memory. There are two functionally different types of on-line (always directly and quickly accessible) memory: Read Only Memory (ROM) and Random Access Memory (RAM) by which one means that all cells are equally well (randomly) accessible; their functional

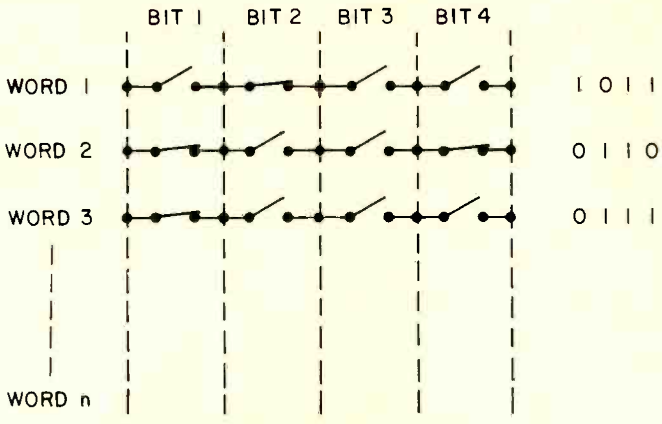


Fig. 4 — A relay-based memory.

purpose should be evident from the nomenclature. These memories are usually accessible in nano-seconds, or at worst microseconds, and can store (in a typical minicomputer) 120,000 or 500,000 words (instructions or data items).

In addition to this easily available memory (the computer can perform one instruction, that is fetch plus execution, usually in nanoseconds or microseconds), one has bulk storage — say up to 120 million items of data. However fetch from bulk storage takes in the millisecond range (fixed head disk) to seconds (tape); this interval is a very long time for the computer (it could have performed a million operations while it was idling waiting for the data). Fortunately once the data header is found, the transfer rate is very high so a large block of data can be brought in virtually in no additional time.

But how does a memory work? From an engineering point of view, the simplest (and hence most efficient) way to store data is to use a dichotomous or binary approach (Boolean algebra and related disciplines can then be used directly). In other words, we want our system to be able to recognize (read) and create (write) two symbols, say an "A" and a "Z," or a "WHITE" and "BLACK," or more conventionally a "0" and a "1," or also a "presence" and "absence" of something, or finally "+5" volts and "0" volts. It's like asking a legally blind person just to distinguish between light and darkness rather than expecting him to see every detail of the world around. Our computer is the legally blind individual; it can only see a 0 or a 1. After all, a computer is only a machine and we can't expect it to understand the details (many symbols). Everything it sees is by inference, not actual sight. While some computers are based on an octal (8) or hexadecimal (16) system, the fundamental logic is still binary (0, 1).

The dichotomous nature of the storage is easily implementable via elementary physical processes. For example, a magnetized pellet (or bubble or core) (1) vs. a non-magnetized pellet (0); this is the principle of core memory. A charge on a device (1) versus no charge (0) is the principle of charge-coupled devices; a saturized magnetic strip on a tape (1) versus a zero magnetization field (0) is the principle of magnetic tape; a hole on a paper tape (1) vs. no hole (0) — paper tape; a closed relay contact (1) vs. an open contact (0) — first computer — see Fig. 4. All these storage techniques are robust in the sense that it is very improbable that the data become corrupted. It is very improbable that a hole would be punched in the right spot on a piece of paper; it is very improbable that a saturation on the tape would develop, even if a mild (stray) magnetic field nearby influences the tape.

The robustness is implemented via a threshold technique. Consider a set of capacitors, where we assume that 0 V represents 0 and +5 V represents 1. Then the usual technique is to

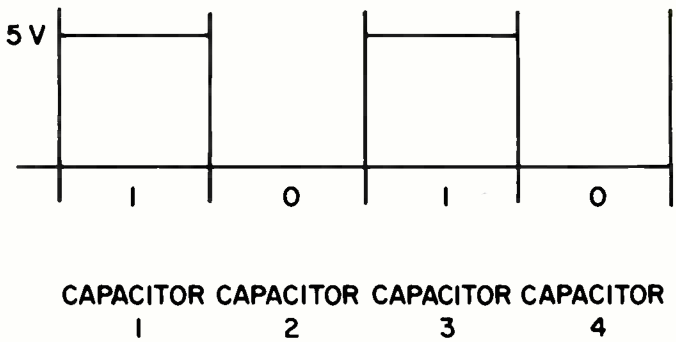


Fig. 5 — Example of a memory.

say that if the charge is between +2.5 V and (say) 20 V, we have a 1; if the charge is between +2.5 V and (say) -10 V, it is a 0. Imagine that the computer writes in a memory, as in the example above, the number 1010 by storing +5 volts in capacitor 1, 0 volts in capacitor 2, +5 volts in capacitor 3, and 0 volts in capacitor 4. See Fig. 5. Assume now that some noise and leakage occurs, so that after 10 minutes the actual readings are 6 V, 1.3 V, 4.2 V, -0.5 V; the threshold approach shaves off or reshapes the signal, on reading, to interpret this combination as 1010. In a real memory such "refreshment" (i.e. reading and resetting the memory to the precise nominal value) is done automatically and constantly (say 10,000 times a second); this refreshment is one of the responsibilities of the memory, and circuitry is built in to take care of itself. In addition to this intrinsic robustness, we also have, right on the memory, error detection/correction algorithms (hardware) to further insure integrity (see below).

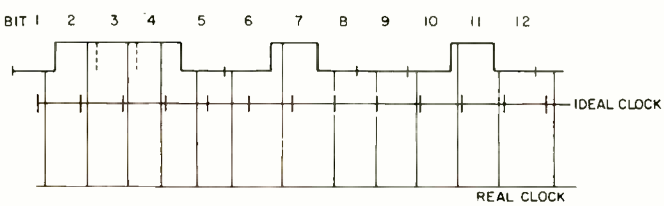


Fig. 6 — Robustness to fluctuations in time/speed.

The robustness is also intrinsic in the way the data are read, say off a magnetic disk. Assume that the disk is spinning and at some clock time the material is tested for the bit content (say saturated vs. non-magnetized). Equivalently one can think of a stationary data stream, but with a clock which initiates the read. See Fig. 6. If the disk were spinning at the precisely engineered specification, the bits would be read correctly at the center of the signal, and even if the speed varied or fluctuated somewhat (or if the read clock/crystal was not perfect), *the correct bit pattern would still be read* as the lower part of the figure clearly indicates.

A few final facts about computer memories before we go on. To have access to the memory, an address must be supplied (practically a memory is a one-dimensional string of values, i.e. a long *list* of numbers; see Fig. 7). One must specify the offset (location) from the head (position D) where the item of interest is to be found or written. Magnetic on-line memory (remember tape is not considered on-line memory) was common a few years ago; today semiconductor memories are catching on very rapidly because of their excellent density. On a 1/2-inch by 1/2-inch chip you can store up to 120,000 0s or 1s — equivalent of 16,000 numbers as we will see below; two chips can store this entire article.

These are memories for which read or write is equally possible (read and write instruction time is equal and small); other memories such as optical microphotograph techniques have extremely high densities but the writing is impossible (consider microfilm) and/or access is limited to sequential, rather than random in which you go directly to any address you want to. In other words, for a sequential memory to get to location n, you must first read location 1,2,...n-1. While this is a stringent limitation for computer applications, it is actually ideal for video discs or PCM discs operating on the same principle.

Binary Representation

We have seen that the best way to store data is to use 0s and 1s. The question is: How do we translate everything we are familiar with to 0s and 1s? Well, think of the Morse code, dash = 1, dot = 0, and you have got it. Since for this article we are interested only in coding numbers, we avoid dwelling on the issue of how to code alphabet letters (for those who are interested, research the ASCII code).

Here is the technique. First assume that the largest integer you are ever interested in is M. (For example: Don't worry if a form asking for your net worth has only 6 boxes to the left of the decimal; if you had more then $10 million you would have other things to worry about). Then you will need S "bits" to code that number (a bit is a 0 or a 1) with

$$S = \lceil \mathrm{Log}_2 M \rceil$$

and ⌈⌉ the ceiling function, or for those who don't know what this is, get S as follows: Divide M by 2; divide what you get by 2, divide what you get by 2, and so on until you get the first number less than 1; S is the number of divisions you performed. Example: If M = 33, then S = 6; 33/2 = 16.5, 16.5/2 = 8.25, 8.25/2 = 4.125, 4.125/2 = 2.0625, 2.0625/2 = 1.03, 1.03/2 = 0.50. A code based on six bits would represent 33 (actually would be good up to 63); now that we know the length of each "word" needed to perform operations on numbers of size up to 33, we need to know how to assign all the codes we get, 100000, 000001, 101010, 011101, 111111, etc., to the numbers.

Fig. 7 — Serial bits on a tape (idealized).

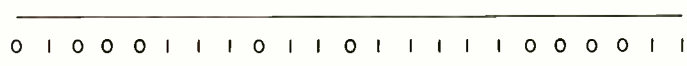
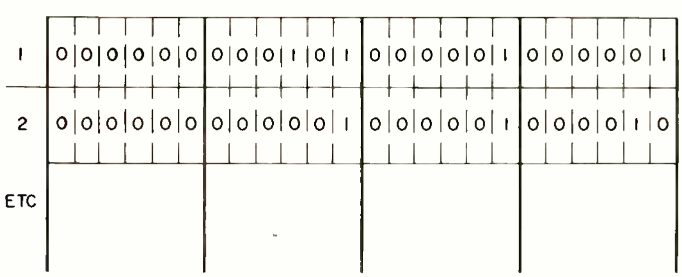
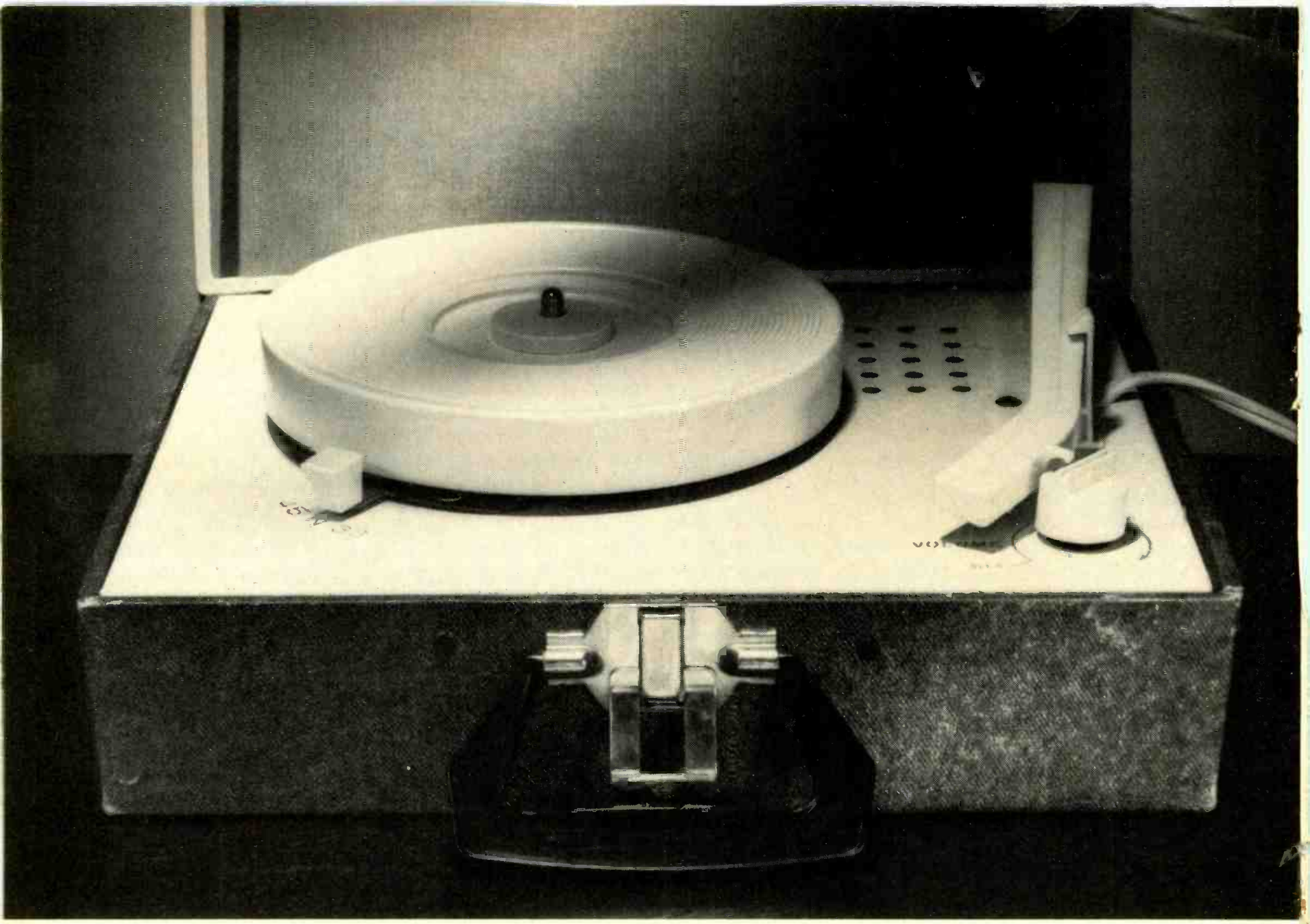


Fig. 8 — Bit map for memory of Fig. 3.





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Here is the technique: When we speak about numbers in the usual or "decimal" representation (1,2,3,...) and say 4732, we really mean

$$4732 = 4 \times 1000 + 7 \times 100 + 3 \times 10 + 2$$

or, how they taught us in elementary school, we have thousands, hundreds, tens and units. More precisely, we have

$$4732 = 4 \times (10 \times 10 \times 10) + 7 \times (10 \times 10) + 3 \times (10) + 2 \times (1).$$

Note that the 10 keeps popping up; that's why we call it decimal. Finally if we let $10^n = 10 \times 10 \ldots \times 10$, n times, a mathematically precise representation is

$$4732 = 4 \times 10^3 + 7 \times 10^2 + 3 \times 10^1 + 2 \times 10^0.$$

Now when we want to code a number in binary code we use the same (unique) procedure; we set

$$M = C_1 x 2^{S-1} + C_2 x 2^{S-2} + C_3\, x 2^{S-3} + \ldots + C_{S+1} x 2^0.$$

For example, consider 33

$$33 = 1x2^5 + 0x2^4 + 0x2^3 + 0x2^2 + 0x2^1 + 1x2^0$$

or 100001 (remember $2^0 = 1$).
Another example:
$63 = 1x2^5 + 1x2^4 + 1x2^3 + 1x2^2 + 1x2^1 + 1x2^0$
or 111111.

Table I — 4-bit code for numbers up to 16.

Decimal	Binary	Decimal	Binary
0	0000	9	1001
1	0001	10	1010
2	0010	11	1011
3	0011	12	1100
4	0100	13	1101
5	0101	14	1110
6	0110	15	1111
7	0111	16	10000
8	1000		

And now you've got binary coding. Precise techniques exist for obtaining the constants Cs directly but we shall not discuss these here. Table 1 depicts the code up to 16. The memory of Fig. 3 would now really look like that of Fig. 8.

But how do we perform operations in this coded environment? We must answer: Extremely simply. We consider only multiplication. Remember the multiplication table from elementary school, 100 items to be remembered? 1x1, 1x2, 2x1, 2x2,..., 9x9, 10x1, 10x2. Well, here (remember the computer is legally blind — how much can we expect from it?) we must teach the computer the following simple multiplication table.

x	0	1
0	0	0
1	0	1

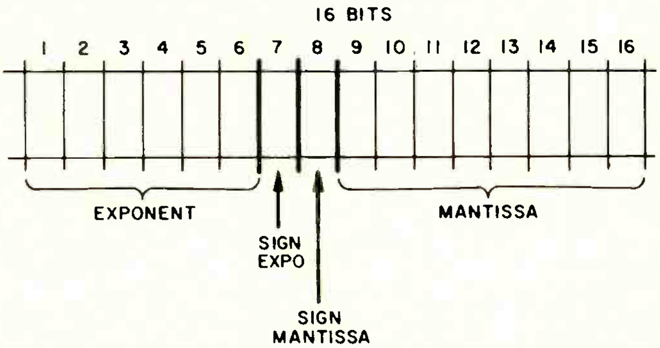


Fig. 9 — Floating point notation.

Yes, that is all. (Well, except that before you can multiply you must also know how to add to take care of the carry. Take it for granted: 0+1=1, 1+0=1, 0+0=0, 1+1=10.) Now consider the following:

```
12        1100
 3        0011
36        1100
         1100
        0000
       0000
       0100100 = 36.
```

Thus, you do your multiplication the usual way, but when it comes to adding 1+1 you get 10; write 0 and carry 1.

Floating Point Numbers

There is a clear need to work not only with integers, but also with fractional and/or negative quantities. A representation technique for these numbers is referred to as floating point representation. Many variations on a basic theme exist; the key approach is to represent all numbers with a standard template consisting of four parts as in Fig. 9. Here we have a mantissa, the sign of the mantissa, the exponent, and the sign of the exponent. For example, 3/512 and the template of Fig. 9 (which is actually a statement of how powerful the computer in question is) give

001001|0|1|00000011

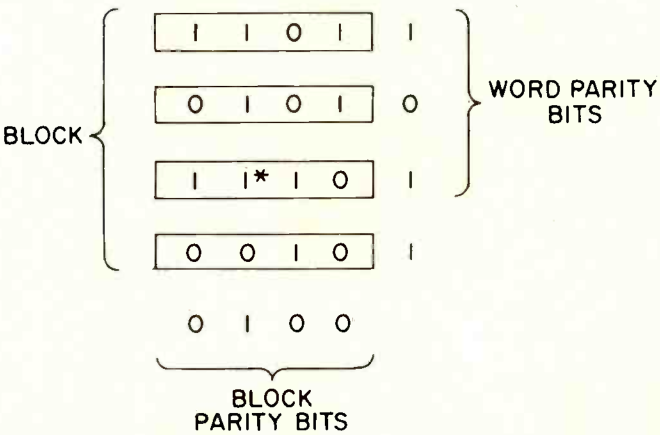
since $1/512 = 1x2^{-9}$ and 9=001001, −=0, +=1, 3=00000011. With this template, we can represent numbers between 2^{-59} to 2^{59} (or 5.7×10^{17} to 1.7×10^{-18}).
Note also that we have 8 binary significant digits (this implies truncation for such things as 1/3=0.333333... . With this system, integers between 0 and 2^8 can be represented exactly; beyond that one gets truncation or the so-called "scientific notation" in the base 2.

Error Correction

Various techniques for error detection/correction at various degrees of reliability and overhead exist. We illustrate only two such error detection schemes; correction is more difficult in the audio context we have in mind. In general, correction is done by asking the computer to re-read a block of data or retransmit such block; hence the computer industry has stressed the detection issue (to achieve specific "undetectable error rates") and usually relied on a retransmission protocol (hand shake) to achieve the correction.

The simplest schemes are word and block parity. (Refer to Fig. 10). In this case one counts all the 1s in a word of real data, and (say we are in an even parity scheme) if this number is odd, a 1 is placed in the parity bit so that the total number of 1s is even. If the number of 1s is already even, a 0

Fig. 10 — Block parity.



is placed in the parity bit (similarly for odd parity). One thus must add one extra bit to the code (this means using up more space, getting less out of the space you have); for our earlier example of a six-bit code to represent 33, we would have to accept 7-bit code.

For example, suppose the data were 111001, then the code with detection capabilities is 1110010; if the data were 111000, then we have 1110001. (Note that the parity bit is the last bit; this bit must not be considered when we use the 2^n expansion described above). The detection would work as follows. Assume that the stylus of a fully digital audio system (as the one to be introduced by Philips) picked up the sequence 1110000 and passed it along to a CPU for conversion, etc. But the computer, on checking the parity bit (adding up all the 1s in the word) would have noticed that an intrinsic error existed since in even parity the sum of 1s must always be even. Thus the CPU could instruct a re-read, etc.

The 1-bit parity approach allows the detection of only 1-bit flip, or 3-bit flips, etc., but could not guard against 2-bit flips. Assume that the original word was 1100110, then if the CPU sees 0100110, it knows we have an error (1 flip). If it sees 0010110, it reaches the same conclusion (3 flips). But if it sees 0000110, it can't tell. This is not a flaw in the system, it is only the degree of checking you get for the price (of adding a single bit). If we assume statistical independence among the bits (this is not always a good assumption), the probability that this technique will fail to detect an error is better than one in 10 million. For its simplicity, this scheme produces remarkably good results, and this is why it is frequently used.

Figure 10 also depicts block parity bits; this is obtained by calling n words a block (n = 4 in this case) and then counting the number of 1s vertically and horizontally; this is why these schemes are also called horizontal and vertical parity checks.

This scheme also allows the correction part (if only one bit becomes corrupted). Assume that the bit marked * had flipped but we didn't know it yet. The third horizontal check indicates an error somewhere in the third word; the second vertical check indicates an error in the second column; it is now possible to achieve the correction.

In general, one can obtain any degree of protection by paying the appropriate price in bits. For example, we can leave two bits of the end of each word and obtain the sum of 1s modulo 3; this is either 0, 1, or 2 (thus two bits since 2 = 10). Here we have more protection.

Next month we'll start with a look at signal processing techniques and how they have been applied to speech for telephone transmission.

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Equipment profiles

Lirpa Model 5 Kg Tonearm and Cartridge

Manufacturer's Specifications

Tonearm

Length: 15 in.
Mass: 11 lbs.
Resonance: -20 Hz (hill-and-dale recording, nonexistent on others).
Tracking Force Range: 500 to 2000 g, 501 to 2001 with anti-skating compensator (simplistically known as a penny).
Cueing: If the spirit moves you.
Damping: One Gabriel shock.

Cartridge

Type: Moving mica.
Frequency Response: Some.
S/N: Infinite.
THD: Do bees buzz?
How Much: Enough.
CD-4: No.
Stereo: No.
Mono: Only up to five playings.
Stylus Shape: Quite pointy.
Price: Best offer.

At a point when most cartridge and tonearm manufacturers are trying to cut down on tracking weight, Lirpa Labs (made famous by its fight for the mono reproduction) has taken a radically different approach and introduced a combo that tracks between 0.5 and 2 kilo (that's right, kilo) grams.

Prof. I. Lirpa's thinking (questionable thinking, I might add) behind this is that recording velocities will eventually exceed the vertical tracking force of today's super-light tracking tonearms and cartridges. To prevent such a catastrophe the Lirpa engineers have designed a tonearm and cartridge combination that tracks at a level far greater than the velocities of even the most heavily modulated direct-to-disc recordings.

Aside from being a radical departure from the usual tracking force settings, the Lirpa Model 5 Kg is unlike any other modern tonearm (that we know of) in appearance. The tonearm itself is basically a long, bending, tapering cylinder. At its base it is slightly more than two inches in diameter. About one-and-a-half inches up it bends at a sharp 90-degree angle to form the actual "arm." This horizontal section of the tonearm continues for approximately five inches, bends to a 45-degree angle, and then continues for another one-and-a-half inches. By this point the arm has tapered to less than one inch in diameter.

The cartridge fitting is one of the most fascinating aspects of the unit. Instead of the almost ubiquitous sockets and electrical contacts, the Lirpa Model 5 Kg merely has a hole (honest). No contacts, no nothing.

The unusual cartridge fitting could be for two reasons. First, the Lirpa engineers may have discovered a more accurate way of transmitting the output of the cartridge, although this reviewer has doubts about this possibility. When one considers the track record of Lirpa Labs (none whatsoever) and the unusual exploits of Prof. I. Lirpa (i.e. returning to mono), one can begin to understand my conviction. I believe that the Lirpa engineers simply wanted to make the Model 5 Kg incompatible with all present systems. Needless to say, they succeeded.

Probably far more unusual than any of the above mentioned peculiarities is what seems to have grown out of the back of this tonearm. It closely resembles the proverbial horn-of-plenty except it has a hole at the base. When we opened the carton in which the tonearm was shipped, we were tempted to discard the horn thinking it was a promo-

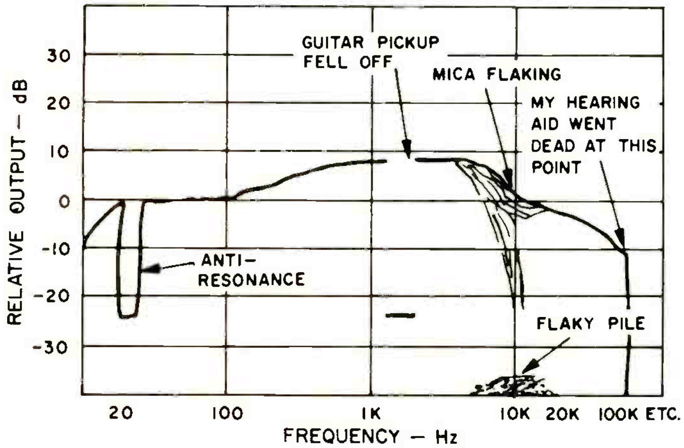


Fig. 1—Derived frequency response.

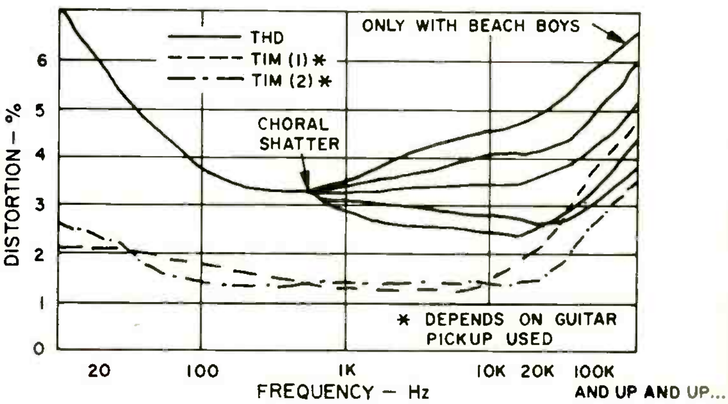


Fig. 2—Distortion vs. frequency.

tional gimmick for that new line of restaurants, Lirpa Lunches, but upon consulting the instruction manual we discovered it was an amplifying device for the cartridge. After close examination we decided it was to be used in place of a more conventional electronic cartridge preamp.

In keeping with the unusual design approaches used in the Model 5 Kg tonearm, the accompanying cartridge is totally unlike any other modern cartridge we have ever tested. Basically it is circular in shape, about 2¾ inches in diameter and approximately half an inch thick. On the circumference, 25 degrees from being perfectly vertical, is the stylus assembly which is among the most rugged that this reviewer has ever tested. This is obvious by simply looking at it, since it's over half an inch long, is 3/64 inch in diameter, and is solid metal. Apparently the Lirpa designer was not overly concerned with the problem of stylus mass. The cantilever is secured to the cartridge by what appears to be your basic, run-of-the-mill set-screw.

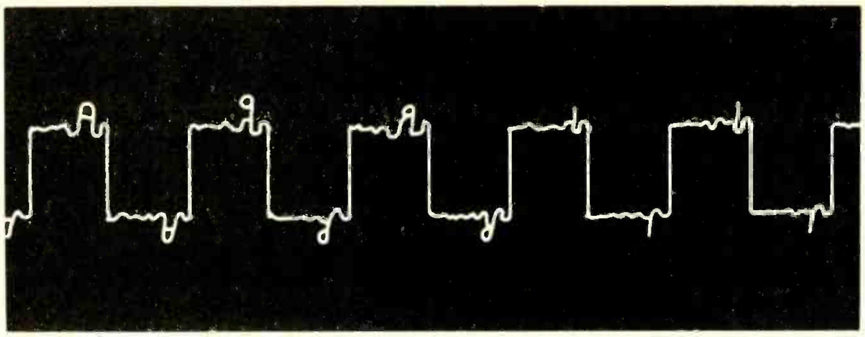
If one were to view the cartridge from either side, one would notice some highly unusual design features. On the side not facing the record is a circular piece of mica film about 2¼ inches in diameter (more than likely the mica referring to "moving mica" in the manufacturer's specs). This is the first cartridge that this reviewer has encountered incorporating such a transducer. On the side of the cartridge facing the center of the record is a bent piece of metal tubing obviously designed to mate with the connecting section of the tonearm. The mounting seemed very positive though no locking scheme was provided. Just ahead of the cartridge assembly is a dust bug type brush; Prof. Lirpa is obviously concerned about record hygiene. Also, on the very top of the cartridge is a slot which, I discovered after much puzzlement, is the anti-skating device holder. Evidently, in an attempt to reduce costs, the usual weight or spring-type compensators have been foregone in favor of the dubiously effective penny-on-cartridge arrangement.

Measurements

We installed the Lirpa Model 5 Kg tonearm and cartridge on a Technics SP-10 MkII, the only turntable we know of that can rotate with two kilograms of pressure. In testing this rather unorthodox tonearm and cartridge, we were required to use some rather unorthodox testing procedures. One method consisted of affixing (with Scotch Magic Tape) a ceramic guitar pickup to the interior of the amplification horn. This was necessitated by the fact that the Lirpa cartridge lacked any facility for connecting an amplifier (in the conventional sense) to it via an electrical conductor (a wire, you clod).

In our preliminary setup we set the vertical tracking pressure at the recommended 1.75 kg. A suggestion in regard to one human engineering aspect of the Lirpa tonearm might be in order at this point. This is one of the few tonearms that lacks the facility of a calibrated tracking force scale. Though not an insurmountable inconvenience, it is just a might tricky slipping a bathroom scale (as recommended in the instruc-

Fig. 3—Response to a 1-kHz square wave.



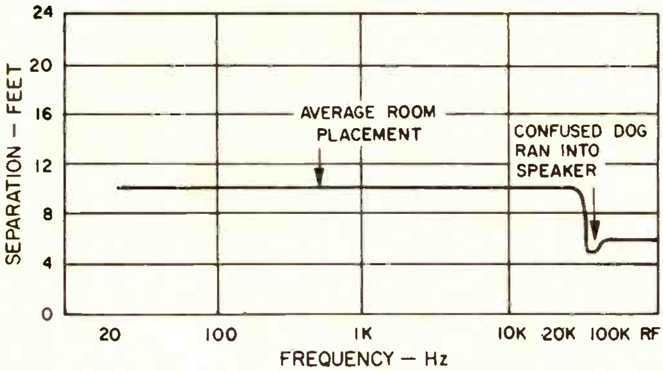


Fig. 4—Separation and frequency response of the Lirpa Model 5 Kg tonearm and cartridge combination.

tion manual) between the tonearm and the turntable while trying to adjust the tracking force. Even trickier is the prospect of holding the scale vertically and setting the tonearm against it while setting the anti-skating (calibrating in pennyweights for some inexplicable reason).

When checking the suggested anti-skating bias with the blank track of our test record, we encountered a somewhat disturbing problem. While lowering the tonearm onto the blank section of the record, we were taken aback in awe as we watched the stylus literally dig a gouge into the whimpering disc of vinyl and, in fact, carve its way through completely. We therefore considered it a sound proposition to simply go by the book and follow the anti-skating setting suggested in the instruction manual (though we know as well as you do that the Lirpa manual is undoubtedly not a book to be trusted).

Considering our lack of vertically cut test records, we are hereby forced to accept the Lirpa claim that their cartridge resonates at a frequency of -20 Hz. If it is any consolation to prospective buyers (regardless of how token their number may be), we did notice a prominent dip in the frequency response around 20 Hz (positive, mind you). We also noted that there was a somewhat disturbing amount of flaked lacquer (there is the outside chance that we used a 78) left on the record after being used with the Lirpa Model 5 Kg tonearm. Though not confirmed, several members of our listening panel claim they heard the record in question whimper while being played with this (savage?) tonearm.

Nonetheless, we were not able to measure its resonance while playing a laterally cut disc. We must say (painfully) that Prof. Lirpa has in fact licked the problem of arm resonance. It was obviously below the sensitivity threshold of our test equipment. But one must consider that, with few exceptions, lead "pigs" are not known for resonating excessively.

The arm fell well above what we consider the acceptable limit in regard to bearing friction (question: what bearings?). Both the vertical and horizontal pivot friction were in the region of 500 g. Needless to say, the vertical friction is just a shade too high to safely track warped records without increased distortion. The mass of the tonearm also sets a record for our test lab. The model designation, 5 Kg, is not simply a catchy number but is also the mass of the tonearm (with cartridge installed). The mass without the cartridge in place was around 4.5 kg.

As for the cartridge, our first job was to determine the frequency response. After weighting our test results for the frequency response of the guitar pickup that we used for our mechanical-to-electrical transducer, we achieved the following result: One very well-erased test record. After three attempts we decided it was a futile effort to find a test record that could withstand the abnormally high tracking weight of the Lirpa tonearm. We considered mounting the cartridge in an alternate arm but the cartridge fittings were unlike those on either our SME or our Audio-Technica. In addition, the aluminum alloy tubes of both of these tonearms were too flexible to withstand the weight of the Lirpa cartridge, and we were left with two bent, totally unusable tonearms.

The hum and noise of the cartridge was generally pretty good, but it can vary depending on the positioning of the guitar pickup on the horn and if a wind is blowing on it. In attempting to measure the distortion we were faced with the same problem we encountered while trying to determine the frequency response. If listening tests are any indication, the IM and THD figures were quite high in that many a solo sounded very much like an entire choir singing consistently out of key.

Among other things, the Lirpa cartridge will never be noted for being a compliant cartridge. It isn't so much that it won't stay in the groove as that it won't yield to the modulation of the groove. It is one of the few cartridges that will not mistrack the fifth level on our Shure ERA-IV test record and is one of the few, if not the only, cartridges in existence that will totally erase this passage.

What can one say after seeing four perfectly good test records go to waste while being played with a totally unyielding cartridge and tonearm combination? This is not to mention the Health Queen bathroom scale that was so brutally destroyed while we attempted to set the tracking pressure.

The instruction manual calls it "the advent of a totally different technology." I'm not one to argue the point, as a moving-mica cartridge certainly is something new to me — but the manufacturer never reveals what is so great about this new technology. The manual also states that the Model 5 Kg has a sound totally unlike any other cartridge on the market today. This point, too, I won't argue since up to the first three playings it is quite different, and after that the difference in sound becomes even more apparent. In some circles it is known as total silence, and I don't mean aside from the music (good); I mean instead of the music (bad).

I won't go any further into the details of what this tonearm and cartridge combo sounds like or what it does to records, as I am afraid I might break out in tears. Suffice it to say that the Lirpa Model 5 Kg combination is completely different from any other I have heard or seen. *Thomas J. Motz*

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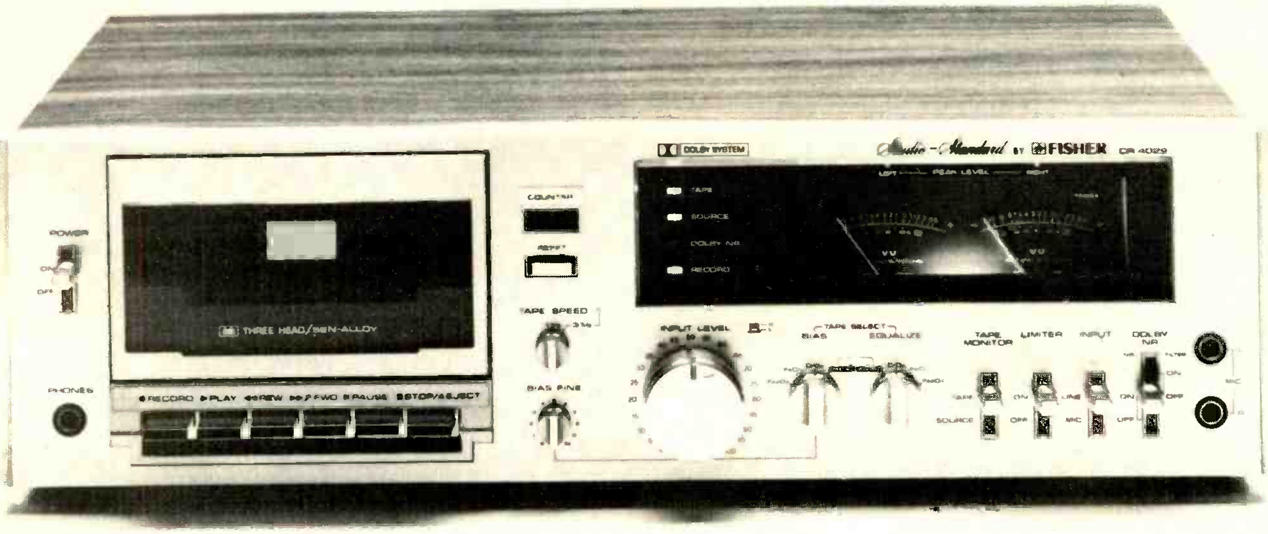
HOME STEREO '81 ENERGY EFFICIENT ENTERTAINMENT

YAMAHA

Fisher CR-4029 Stereo Cassette Deck



Manufacturer's Specifications

Frequency Response: 30 Hz to 14 kHz, to 20 kHz at 3¾ ips; 30 Hz to 16 kHz for FeCr and CrO_2 tapes, to 22 kHz at 3¾ ips; 30 Hz to 18 kHz with metal tape, to 25 kHz at 3¾ ips.
Harmonic Distortion: 1.5 percent; 1.2 percent at 3¾ ips.
S/N: 52 dB, CCIR/ARM; 62 dB with Dolby NR.
Separation: 45 dB.
Crosstalk: Down 70 dB.
Erasure: 70 dB.
Flutter: 0.06 percent W rms; 0.05 percent at 3¾ ips.
Fast Forward and Rewind Times: 120 S for C-60 cassette.
Dimensions: 17⅓ in. (440 mm) W x 12¼ in. (310 mm) D x 4¾ in. (120 mm) H.
Weight: 17 lbs. (7.7 kg).
Price: $499.95.

The Fisher CR-4029 cassette deck is one of the new breed that incorporates a tape speed of 3¾ ips, as well as the standard 1⅞ ips. The unit also offers metal-tape compatibility and has three heads for full monitoring capability. The attractive front panel is brushed aluminum with black designations, which are easily read. The tape-motion lever switches do not match the sophistication of logic-controlled systems, but the force required for actuation is low, much better than most. *Eject* causes the cassette carrier to swing out gently, and the clear-window door is a snap to take out (pun intended), facilitating maintenance tasks. The counter does have a reset but lacks the desirable memory function. A status light shows when the tape-speed selector is set for 3¾ ips.

The good-sized VU-type level meters have white needles and scales with a medium gray background, and are quite easy to read. Just above each meter is a peak-level indicator, which was a bit more difficult to see when looking at the deck from above. To the left of the meters are status lights to show *Tape* or *Source* monitoring, *Dolby NR*, and *Record*. The dual-concentric input level control has large, easily turned knobs, though some fine knurling would aid in setting one channel relative to the other. The bias and EQ switches rotate in opposite directions, sort of pointing at each other for *Metal*. The EQ switch causes a status light to go on in this position. There is a very helpful bias trim pot which can be essential in matching tape and machine, and the incorporated detent should prevent inadvertent bias changes.

Four spring-loaded, snap-action lever switches select *Tape* or *Source* monitoring, limiter on or off, *Line* or *Mic* input,

Fig. 1—Frequency responses in Dolby mode at 1⅞ and 3¾ (---) ips with TDK AD tape.

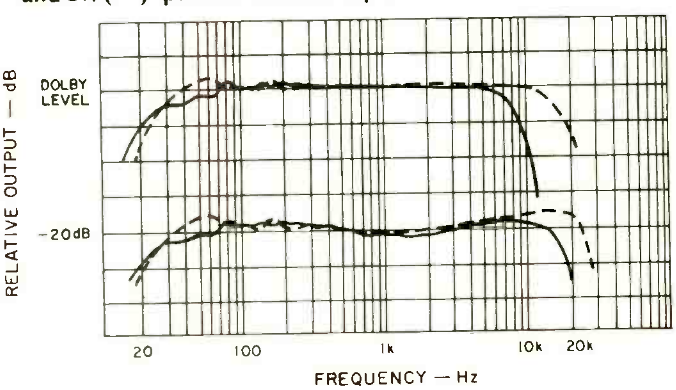
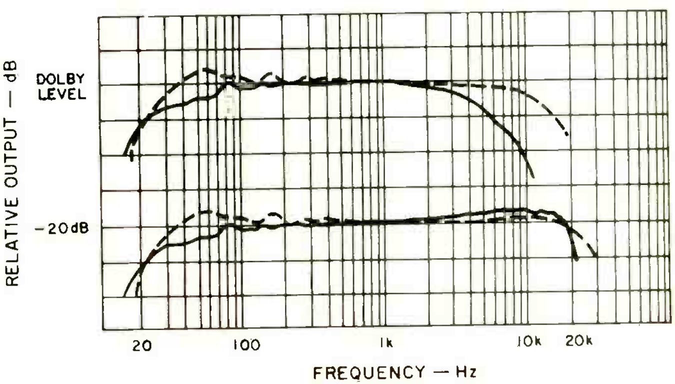
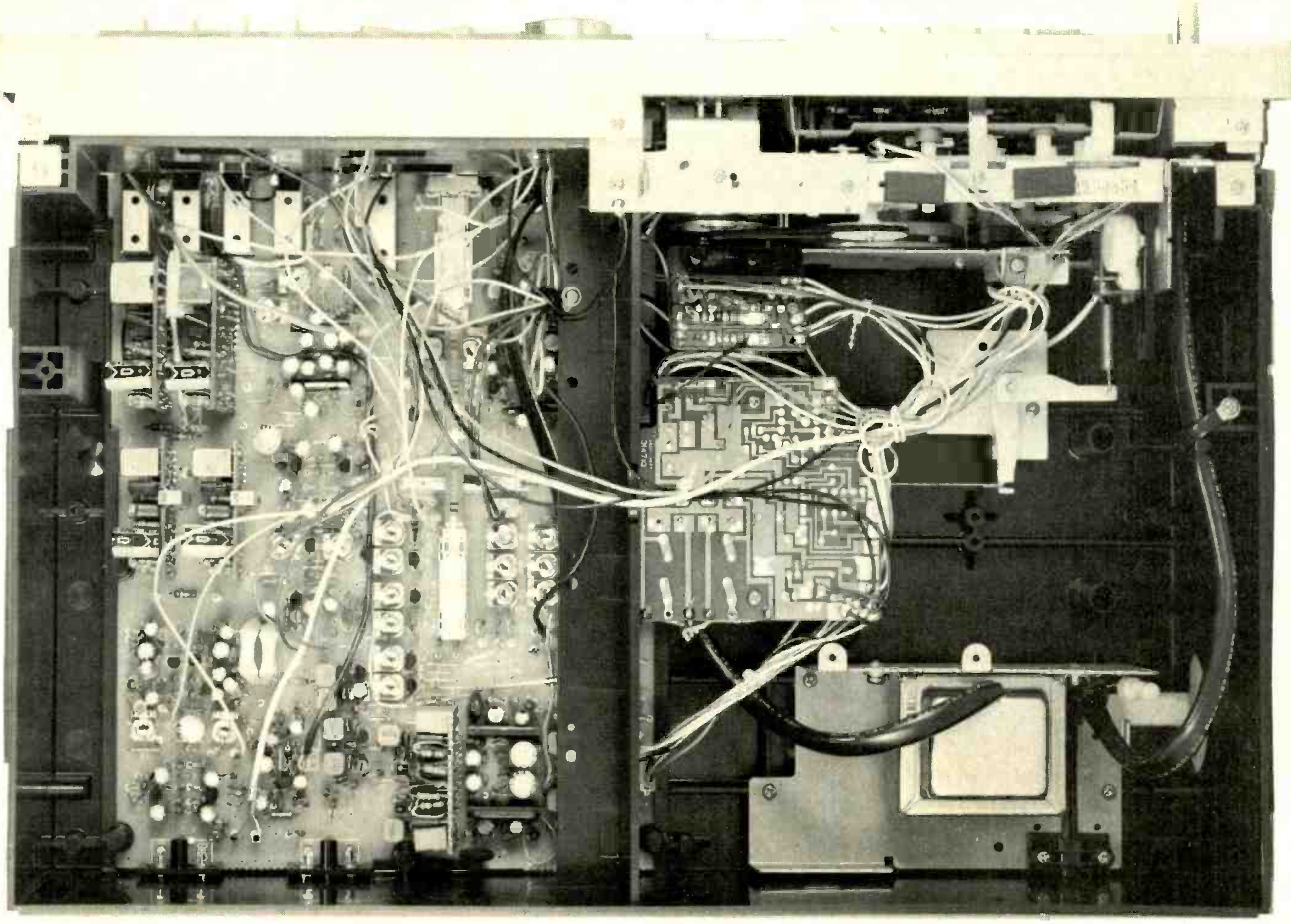


Fig. 2—Frequency responses without Dolby NR at 1⅞ and 3¾ (---) ips with Sony FeCr tape.





and Dolby NR *Off, On/Filter Off,* or *On/Filter On.* It was nice to see the limiter included, since this feature can be very useful if unattended recordings are to be made. The phone jacks for mike input are at the right end of the panel, and the jack for headphones and the power switch are at the left end.

The line-in/line-out phono jacks are on the back panel. The labels are molded into black plastic, so they are difficult to read at an angle in dim light. The metal top and side cover was removed for examination of the interior. The majority of the frame and chassis was ribbed black plastic. Attempts to bend and twist the frame did not reveal any lack of rigidity. Most of the circuitry was on one large p.c.b., and there were a number of small cards plugged into it. The soldering was excellent with very little flux residue. Interconnections were made with multi-pin plugs, in general. Parts were not identified, but most of the adjustments were clearly marked and were very accessible.

Performance

The playback response of the CR-4029 with TDK and BASF test tapes was very good for the low and mid frequencies, but there was a roll-off of close to 5 dB at the extreme high frequencies with both equalizations. With the choice of four settings for bias and EQ in combination with the bias trim, it was possible to match all of the formulations checked with the ⅓-octave RTA. The record/playback responses were plotted for TDK AD, Sony FeCr, TDK SA, and Scotch Metafine tapes, as shown in Figs. 1 to 4. Most of the figures include results for both 1⅞ and 3¾ ips tape speed. There *are* obvious extensions in response at -20 dB with the higher speed, but

Fig. 3—Frequency responses with and without (---) Dolby NR at 1⅞ ips with TDK SA tape.

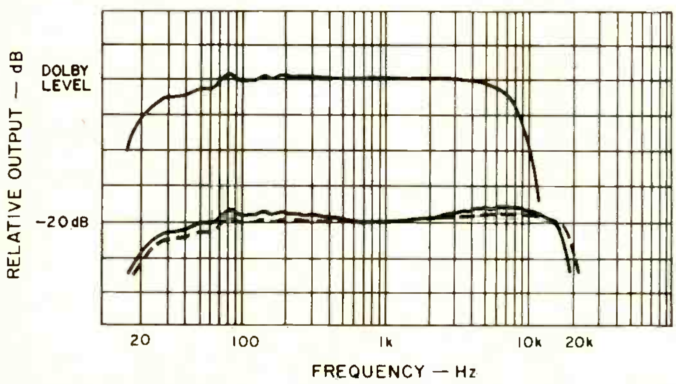
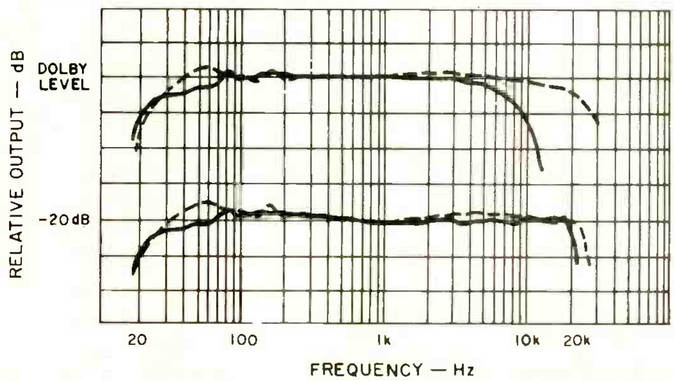
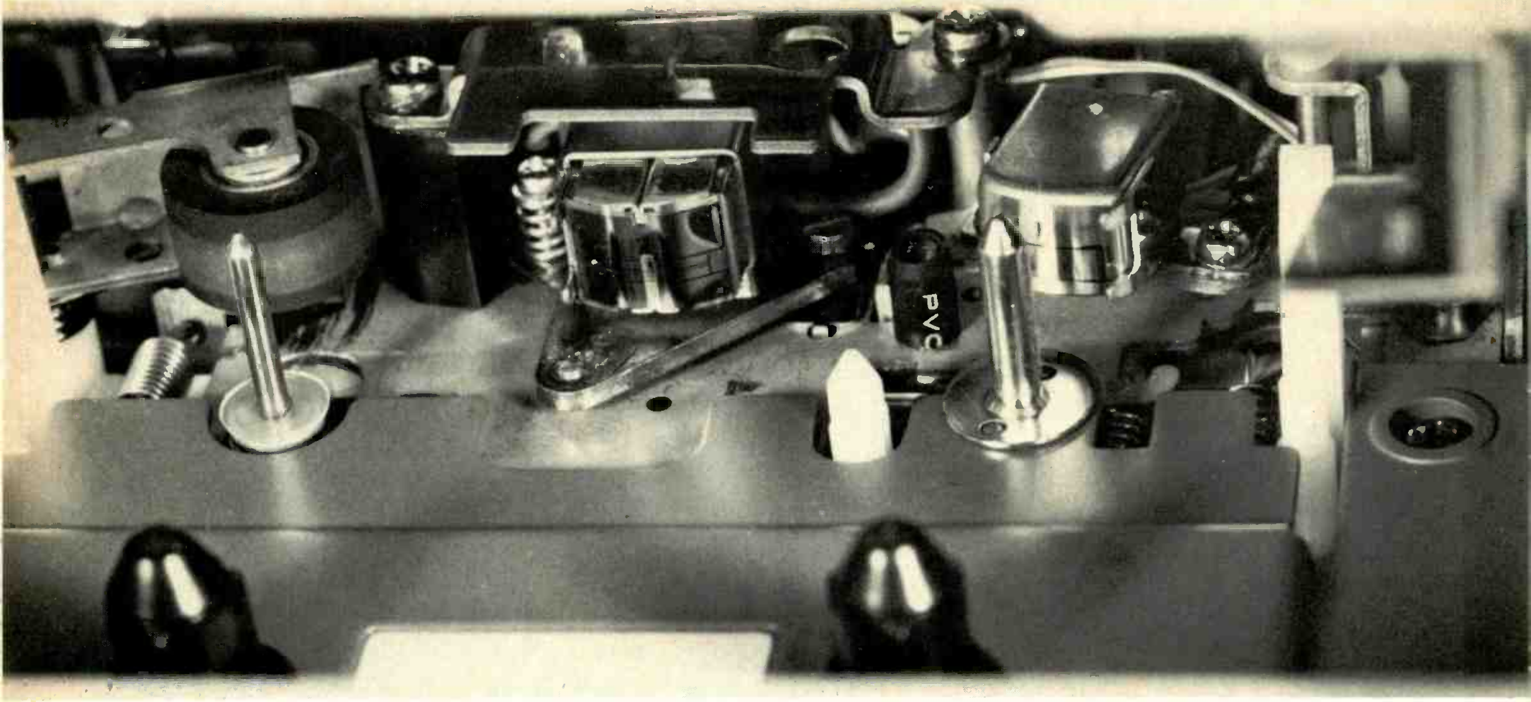


Fig. 4—Frequency responses with Dolby NR at 1⅞ and 3¾ (---) ips with Scotch Metafine tape.





the changes in the headroom at Dolby level are great indeed, particularly with Sony FeCr. Table I gives the measured response limits for all the combinations tried. The use of Dolby NR caused some shift from the very flat responses without it, but a little bias trimming minimized the deviations. The actual range of bias trim was about ±4 dB at 10 kHz with TDK SA tape. Playback of a Dolby-level tape was indicated correctly, at +2.5 VU on the meters.

Close attention was given to a check on the alignment of the playback head with the record head, both mounted within the same assembly. In the past, other recorders had shown phase errors of 70 degrees or more at 10 kHz. Well, Fisher is really doing it right: The phase discrepancy was close to zero degrees at both tape speeds, the best ever seen with this type of head construction — in fact, the best of any type. Phase jitter was about 30 degrees at 1⅞ ips, better than most decks, and was just 5 degrees at 3¾ ips. The multiplex filter was 3 dB down at 15.7 kHz and was an excellent 39 dB down at 19 kHz. The bias in the output during recording was very low.

With its two speeds, this recorder had twice as many test possibilities for checking distortion. A few fast tests showed that all tape types had lower distortion at the higher speed; the largest reduction was with Sony FeCr. TDK AD and Scotch Metafine were also used for taking detailed data. The levels of HDL_3 in Dolby mode were determined with a spectrum analyzer for each tape from the three-percent distortion point down to 10 dB below Dolby level. TDK AD had much the lowest distortion at 1⅞ ips, as shown in Fig. 5, and Sony FeCr was much better when it was at 3¾ ips at all record levels. Measurements of HDL_3 from 30 Hz to 7 kHz were made with Scotch Metafine in Dolby mode at 10 dB below Dolby level at both tape speeds. Figure 6 shows that for Metafine the minimum distortion was about the same at 1⅞ and 3¾ ips but that there was a noticeable improvement at the frequency extremes with the higher tape speed. In all of the distortion tests, the level of other harmonics was very low, much better than most other decks. Without Dolby NR, there was an increase in distortion of about 30 percent.

Signal-to-noise ratios were measured with TDK AD, Sony FeCr, and Scotch Metafine at both tape speeds with and without Dolby NR with both IEC "A" and CCIR/ARM weighting. The results provided in Table II are certainly very good at both speeds. The increase in the ratio for Sony FeCr with 3¾ ips occurred because the much lower distortion gained a much higher maximum record level, as shown in Fig. 5. The separation between channels was 48 dB at 1 kHz, very good performance. Crosstalk was down at least 80 dB at 1 kHz, and erasure of Metafine at the same frequency was 76 dB. At the more challenging 100 Hz, erasure was 60 dB, quite good for the metal tape.

The input sensitivity for mike was 0.16 mV, and the overload point was at 36 mV — quite good. The line sensitivity was 77 mV, and the input overload was at 5.8 V, which is high enough for any normal conditions, albeit lower than most current decks. Output clipping was at a level equivalent to +14.5 VU on the meter. The input pot sections tracked within a dB from maximum down 45 dB. The action of the limiter started at +2 VU, and higher levels caused very little increase

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

	Tape	With Dolby NR				Without Dolby NR			
	Speed	Dolby Lvl		-20 dB		Dolby Lvl		-20 dB	
Tape Type	Ips	Hz	kHz	Hz	kHz	Hz	kHz	Hz	kHz
TDK AD	1⅞	25	7.5	23	17.1				
	3¾	25	14.2	24	24.3				
Sony FeCr	1⅞					30	4.5	27	20.0
	3¾					25	11.8	24	24.6
TDK SA	1⅞	27	7.7	23	17.2	27	7.8	25	19.8
Scotch Metafine	1⅞	27	7.5	23	21.2				
	3¾	27	24.1	24	24.9				

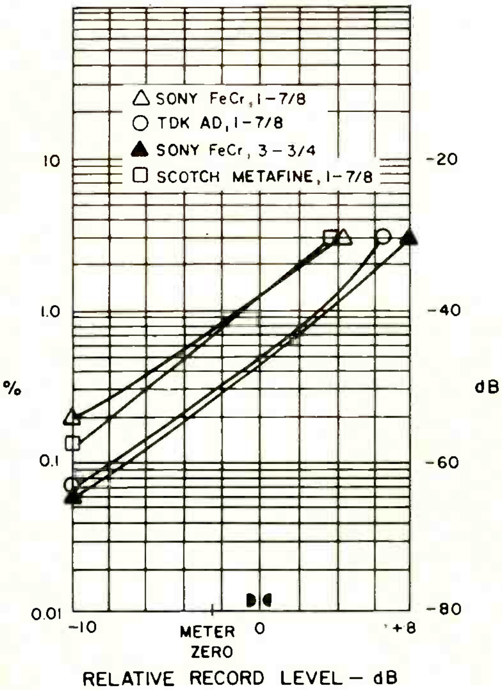
Table II—Signal/noise ratios with IEC "A" and CCIR/ARM weightings.

	Tape	IEC "A" Wtd. (dBA)				CCIR/ARM (dB)			
	Speed	W/Dolby NR		Without NR		W/Dolby NR		Without NR	
Tape Type	Ips	@ DL	HD=3%	@ DL	HD=3%	@ DL	HD=3%	@ DL	HD=3%
TDK AD	1⅞	58.8	65.1	53.0	58.5	59.2	65.5	50.9	56.4
	3¾		64.3				64.7		
Sony FeCr	1⅞	61.0	65.0	56.3	59.3	63.0	67.0	55.3	58.3
	3¾		69.0				71.0		
Scotch Metafine	1⅞	62.3	66.0	57.3	60.6	65.7	69.4	56.4	59.7
	3¾		66.3				69.7		

above this indication. The response time was about 10 mS for a tone burst at 10 dB above meter zero. The line outputs were 0.9 V, slightly below spec, but higher than quite a few decks. The level at the headphone jack with 8-ohm loading was 25 mV, which was a good volume for most of the headphones tried. The VU meter response was down 3 dB at 21 Hz and 20.1 kHz. The dynamic response to the 300-mS test burst was close to VU meter standards, but there was about 0.5 dB extra overshoot. The scale calibration was accurate in most cases, but was about a dB high at levels below -10 VU. The peak indicators fired at +3 VU with a continuous signal, and they gave a good indication with a single-cycle burst of 1 kHz at +4 VU.

The flutter was the same as specified at 1⅞ ips, but was about half the specified figure at the higher tape speed. Tape play speed was about one percent slow and did not vary with changes in line voltage. Fluctuations with time were very low. The wind time for a C-60 cassette was 110 seconds, better than the spec. This is slower than many decks, but the wind was quite smooth.

Fig. 5—Third harmonic distortion vs. level in Dolby mode at 1 kHz with TDK AD, Sony FeCr, and Scotch Metafine tapes.



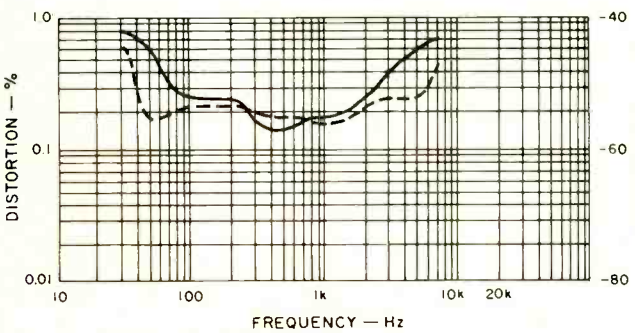


Fig. 6—Third harmonic distortion vs. frequency in Dolby mode, at 10 dB below Dolby level, at 1⅞ and 3¾ (---) ips with Scotch Metafine tape.

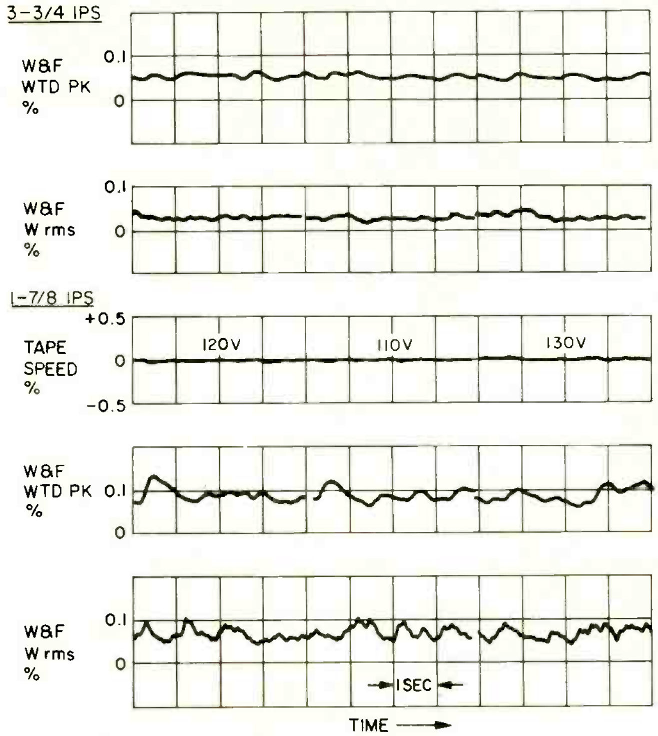


Fig. 7—Wow and flutter (three trials) at 1⅞ and 3¾ ips and tape play speed vs. line voltage at 1⅞ ips.

In-Use Tests

All tape loading and unloading and head maintenance were easy tasks. Controls worked smoothly, and the lever switches snapped positively into position. The long, white needles of the level meters and the meter scales stood out well from the gray background over a range of room illumination. The peak indicators were definitely helpful in setting for the highest possible levels. The owner's manual has an open format with simple, but very clear, illustrations. The instructions on setting bias with FM noise as a test source would be improved by adding a note on the need to make the recordings perhaps 20 dB down from 0 VU.

Various sources were recorded, both for simultaneous monitoring and for playback later. Some material from FM was used, and discs included *A Cut Above* with the Brubeck Quartet, Strauss' *Also Sprach Zarathustra*, and recordings by Virgil Fox and Buddy Spicher. Shifts in response when switching Dolby NR in and out were at most very minor, generally not detected at all. The biggest change noted was that recordings at higher levels were definitely improved with the higher tape speed. The results with the limiter were fairly good, much better than what would have happened without its use, but there was some muffling of the sound at the very highest levels. Record, pause and stop clicks were all very low, not even detected in some cases.

The Fisher CR-4029 is a very well performing deck with excellent capabilities in a number of areas. The higher tape speed improved the results, especially with lower flutter and the significantly extended headroom at the highest recording levels. The deck does not have the sophisticated logic control of tape motion, but the lever switches do most of the same things, with a gentle push. The lack of mike/line mixing might be important to some; I missed the memory function more. All in all, the deck is *very* worthy of consideration in this price range. *Howard A. Roberson*

Enter No. 90 on Reader Service Card

Alpine FM/AM Cassette Car Stereo Model 7307 and Model 3002 Main Amplifier

Manufacturer's Specifications

Model 7307 FM/AM Cassette Unit

Tape Player

Frequency Response: Normal tape, 40 Hz to 16 kHz; CrO_2 tape, 40 Hz to 18 kHz.

Wow and Flutter: 0.09 percent W rms.

FM Tuner Section

Usable Sensitivity: 1.4 μV.

50-dB Quieting Sensitivity: 2.5 μV.

FM Selectivity: 75 dB.

Capture Ratio: 1.5 dB.

Stereo Separation: 35 dB.

S/N: 72 dB, with Dolby.

AM Tuner Section

Sensitivity: 15 μV.

General Specifications

Output Voltage Level: 500 mV.

Bass Control Range: ±10 dB at 100 Hz.

Treble Control Range: ±10 dB at 10 kHz.

Dimensions: Chassis, 7-1/16 in. (176.56 mm) W x 5-25/32 in. (144.53 mm) D x 2 in. (50 mm) H; nosepiece, 4-1/8 in. (103.125 mm) W x 1-3/8 in. (34.375 mm) D x 1-3/4 in. (43.75 mm) H.

Power Requirement: 13.2 V d.c. (11- to 16-V range).

Weight: 5-5/16 lbs. (2.43 kg).

Price: $379.95.

Model 3002 Main Power Amplifier

Power Output: 50 W continuous per channel, 4-ohm loads, with 0.2 percent THD.

Maximum Power Output: 65 W continuous per channel.

Frequency Response: 10 Hz to 60 kHz, ±1.0 dB.

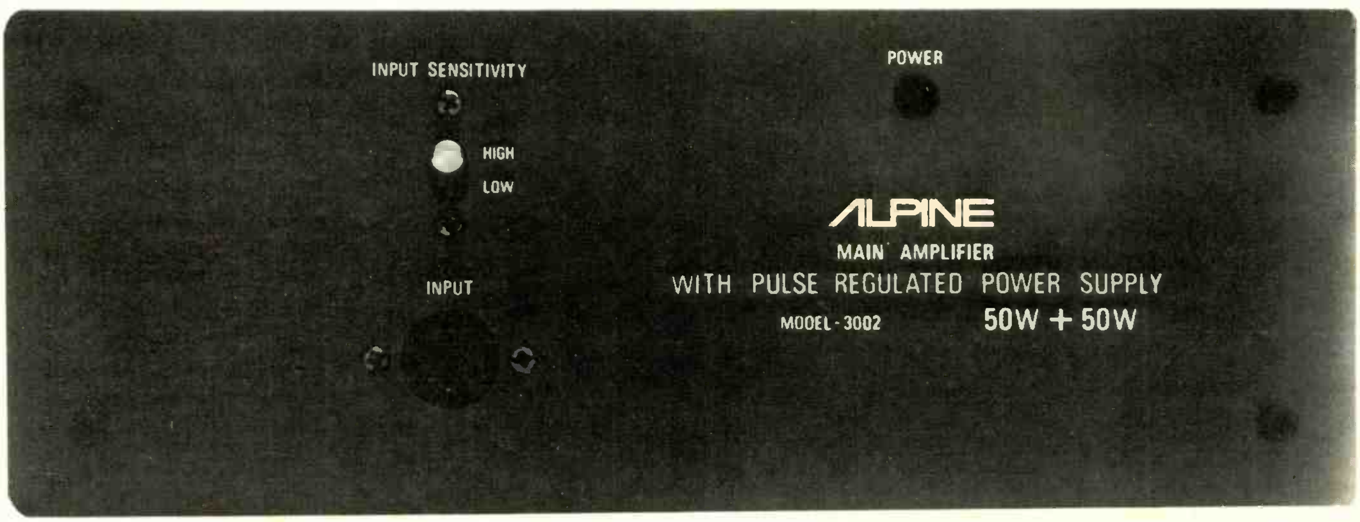
Load Impedance: 4 to 8 ohms.

Input Sensitivity: Line (high/low), 350 mV/800 mV; "speaker" (when used as booster, high/low), 1.5 V/3.0 V.

Dimensions: 7-15/16 in. (198.44 mm) W x 7-25/32 in. (194.53 mm) D x 2-27/32 in. (71.09 mm) H.

Weight: 5.9 lbs. (2.68 kg).

Price: $239.95.



Alpine Electronics of America, Inc. and, for that matter, its parent organization, Alpine Electronics Inc. of Japan, may be unfamiliar names to American purchasers of audio equipment or, more specifically, car stereo equipment, but chances are that such buyers have used equipment either wholly or partly made by this company's parent, known as Alps Electric Co., Ltd., which was founded in 1948.

Parts manufactured by Alps over the years include a variety of resistors, keyboard switches, magnetic heads, TV and FM tuners, cassette recorder mechanisms, r.f. modulators for the video industry, and high-frequency selector switches. The parent company is also a major supplier of parts for the television and computer industries. Alpine Electronics of America was formed in November, 1978, and its car stereo products are generally available through high-end audio and car stereo dealers. The firm was one of the first manufacturers to support and endorse the new standards recently promulgated by the Ad Hoc Committee on Car Stereo Standards, and its engineering personnel served on this committee.

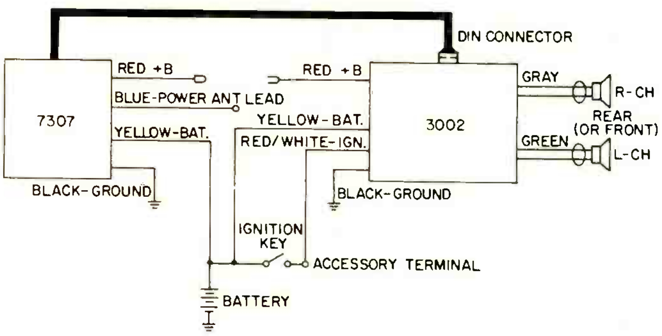
As of this writing, the car stereo products distributed by Alpine in the United States include five models of speaker systems, five separate amplifiers, a digital time-delay unit, and 18 assorted units of FM/AM cassette and cassette-only units for in-dash and under-dash applications. For this report, we have selected their next-to-the-top FM/AM/cassette player combination and mated it with their most powerful stereo main amplifier. Interconnection of the two models is shown in the wiring diagram of Fig. 1. Note that in addition to direct battery connection of each of the units for powering, there is also a post-ignition key connection. The double power-source connection is necessary in order for some of the special features of the combination to work. For example, when the ignition key is turned off in the vehicle, any cassette in the cassette compartment will be automatically ejected, thanks to the power ejection system which still has battery voltage applied to it even when the ignition switch is off.

Model 7307 FM/AM Tuner/Cassette Player

This element of the Alpine system which we tested might best be described as a tuner/preamp/cassette unit, since it has no power amplifier section of its own but is intended for connection to any of Alpine's amplifier or equalizer/amplifier units. The unit is mounted in-dash by means of the left and right control shafts. The left shaft has three concentrically mounted controls: On/off *Volume*, *Bass*, and *Treble*, while the right-most shaft has two knobs affixed to it: *Tuning* and *Balance*. Cassette insertion is via a recess at the upper center of the front panel. *Fast Forward* and *Rewind* buttons are located to the left of the cassette slot, while to its right is a music sensor switch which detects pauses in programs during fast forward or rewind and stops tape motion, causing the transport to go into the play mode from either of the fast wind modes. When this sensor switch is depressed, a light indicator is illuminated to register that fact. A noise elimination switch, also augmented by an indicator light, acts as a pulse noise filter for electrical ignition interference and is located below the sensor switch. To the right of these switches are a tape selector switch (with positions for normal and CrO_2 tape equalization) and a Dolby-on switch. Dolby noise reduction can be used both for cassette playback and for decoding Dolby FM programs received on the tuner section.

The FM and AM frequency scales are located in an illuminated area below the cassette compartment. This area also houses the usual stereo indicator light as well as FM and AM indicator lights and a tiny hole which provides access to the AM antenna trimmer. Below the dial scale area are push buttons for loudness compensation and FM interstation muting, as well as five buttons to pre-set stations. The leftmost and rightmost of these five buttons select AM or FM reception in addition to choosing one of the appropriate pre-set frequencies. The second button from the left does double duty as an eject button for the cassette section and as a pre-set station button when in either the AM or FM listening modes. This button and all remaining ones can be set for favorite AM or FM stations, but a total of only five pre-set frequencies (AM plus FM) can be selected.

Fig. 1—Power supply (battery voltage) wiring to combination of Alpine Models 7307 and 3002.



FM Performance Measurements

Bear in mind that with 75-ohm antenna inputs, microvolt readings, with which we are familiar in terms of 300-ohm antenna impedances, really represent twice the power (in dBf) than they do for the more common home tuner antenna impedance. This, in fact, is the primary reason why the dBf notation is preferable to the microvolt notation and why it was adopted by both the IHF tuner standards and the new Ad Hoc Committee on Car Stereo Standards. In Fig. 2, for example, you will note that 20 dBf, which for a 300-ohm antenna impedance would have corresponded to 5.5 μV, is equivalent to 2.8 μV when referenced to a 75-ohm antenna input impedance.

Usable sensitivity measured 19.8 dBf or 1.7 μV in the mono mode, while 50 dB of quieting was obtained with signal strengths of 2.7 μV (19.8 dBf) in mono and 32 μV (41.3 dBf) in stereo. Best signal-to-noise ratios obtained in mono with a strong input signal were 70 dB, while in stereo ultimate S/N measured 62 dB. Using a 1-kHz modulating signal at 100 percent modulation, harmonic distortion in mono

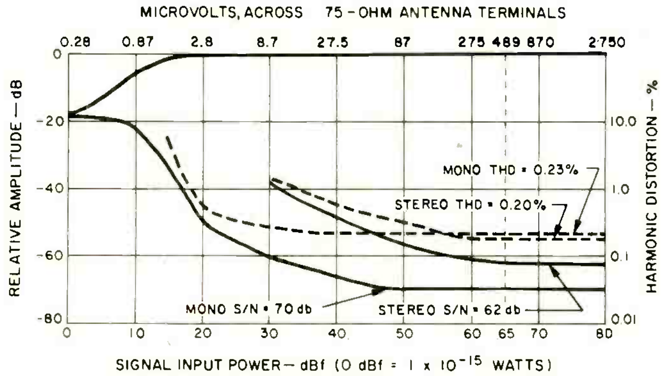


Fig. 2—Mono and stereo quieting and distortion characteristics, FM section, Alpine 7307.

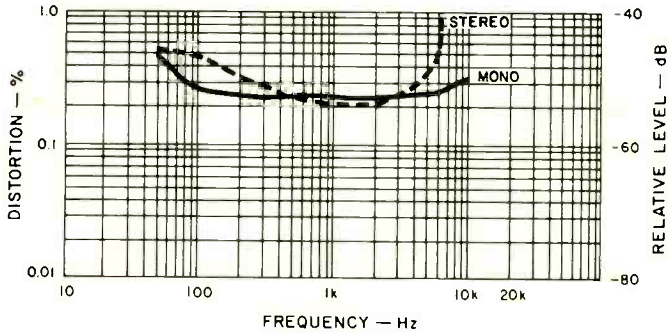


Fig. 3—THD vs. frequency, FM tuner section.

measured 0.23 percent, decreasing slightly to 0.2 percent in stereo. Automatic switchover to stereo in the presence of a received stereo signal occurs at a signal strength of 8.0 μV (29.2 dBf), a level which necessarily determines usable sensitivity in stereo as well.

Figure 3 is a plot of distortion versus modulating frequency in mono and stereo FM. At mid-frequencies, harmonic distortion is almost the same for mono and stereo, while at the frequency extremes stereo THD tends to rise somewhat, as is usually the case. Capture ratio measured 1.5 dB, as claimed by Alpine, while alternate channel selectivity measured 77 dB, just a bit better than claimed.

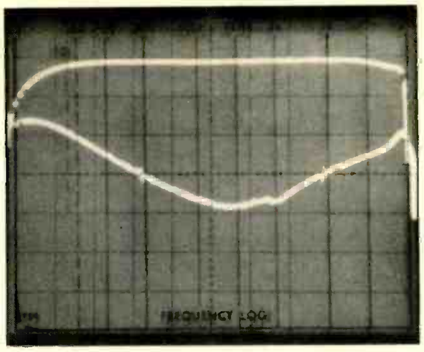


Fig. 4—Frequency response and stereo separation, FM tuner section.

Figure 4 is a spectrum analyzer plot (from 20 Hz to 20 kHz, logarithmically plotted) of stereo FM frequency response and stereo FM separation. We measured a separation of exactly 35 dB at 1 kHz, while at the other test frequencies of 100 Hz and 10 kHz, separation decreased to 21 dB. The dual spectrum analysis display of Fig. 5 shows a reference 5-kHz signal (tall spike at left) as measured from the modulated stereo channel. In a second sweep, we see the crosstalk components appearing at the opposite channel's output terminal, including the 5-kHz crosstalk component (contained within the reference spike) and its harmonics as well as a 19-kHz sub-carrier product, 38-kHz output product, and sidebands surrounding the 38-kHz output. In this display, sweep is linear, and range is increased to cover from 0 Hz to 50 kHz in increments of 5 kHz per horizontal division. Vertical scale in both Figs. 4 and 5 is 10 dB per division.

Cassette Player Measurements

Wow and flutter of the cassette tape transport mechanism measured 0.12 percent W rms and 0.2 percent unweighted. Frequency response was among the best we have measured for a car stereo cassette deck. We used TDK's AC-337 test tape to obtain the plot shown in Fig. 6. The spot frequencies on this tape extend only from 40 Hz to 12.5 kHz and if one sets a ±3 dB tolerance on frequency response, the response could be specified as extending beyond the extreme test frequencies supplied on our test tape.

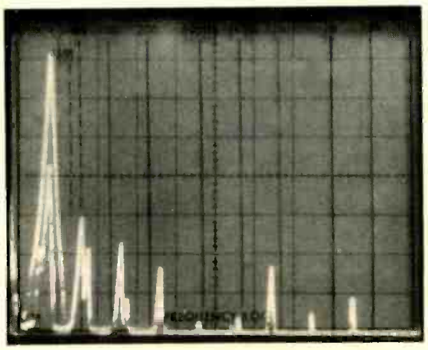
The separate bass and treble controls of the Alpine 7307 unit operate for both cassette playback and for the AM-FM tuner functions of the unit. Range of control is depicted in the 'scope photo of Fig. 7, where the sweep is again logarithmic from 20 Hz to 20 kHz. Note, too, the extremely flat response obtained when the controls are set to their flat position. This kind of response in a car stereo unit has been a rarity until recently. There's also a tone-bypass switch for use with an external equalizer.

Model 3002 Main Amplifier

The Alpine Model 3002 amplifier may be used either as a main amplifier, when hooked up with a tuner-cassette unit, such as the 7307, or as a booster for use with car stereo receivers having an output of 4 to 5 watts. In our tests, connection was made very simply between the tuner-cassette unit and the amplifier using a 5-pin cable DIN connector which emanates from the tuner unit and terminates in a receptacle on the Model 3002. For booster use there are separate individual right and left input terminals which can be connected to the associated car stereo receiver's speaker output leads. As in the case of the Model 7307 tuner cassette, separate power leads must be wired to the battery of the automobile and to the ignition switch when the amplifier is used with other complete car stereo receivers as a booster, so that turning on the associated receiver will also automatically turn on the booster. In our test setup, however, this automatic turn-on via the 7307 was accomplished by one of the connections made via the DIN connector, and the separate B+ lead didn't need to be connected. The B+ would be connected in a normal installation, of course. The only control available on the front panel of the 3002 is an input sensitivity switch. Since this can be set during installation (depending upon output level of the associated tuner or receiver), the amplifier can be installed permanently either under the dashboard, out of sight, or on the floor of the vehicle. A power indicator light illuminates when the associated tuner or receiver has been turned on if the two units have been correctly wired. Since the amplifier is fairly powerful, some attention to air flow and proper ventilation should be given when deciding upon its final location.

The 3002 amplifier's high power output is achieved through the use of a pulse-switching power source. While this poses no particular problems in actual use, it makes things a bit difficult in trying to measure the amplifier's specifications on the test bench, where everything is ultimately

Fig. 5—Crosstalk components for a 5-kHz modulating signal in stereo, FM tuner section.



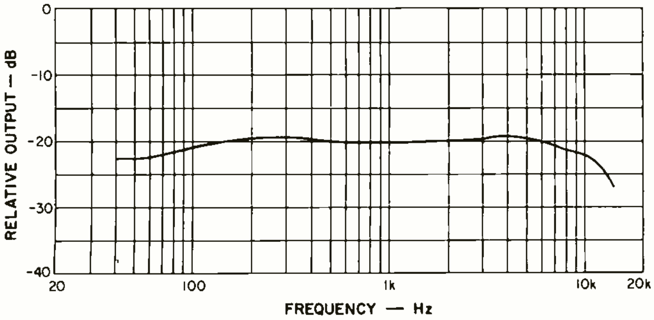


Fig. 6—Playback response, normal tape setting, cassette section.

referenced to ground through test equipment leads connected across loads where we are trying to measure output levels. After a great deal of isolating and use of floating connections, we were finally able to get the amplifier to do what it would customarily do when hooked up properly in an automobile: Deliver in excess of 50 watts per channel into 4-ohm loads. At mid-frequencies, in fact, the amplifier delivered 54 watts per channel into resistive loads before the rated total harmonic distortion level of 0.2 percent was reached, as plotted in Fig. 8. Frequency response at a nominal 1-watt level extended from 8 Hz to 60 kHz for a -1.0 db roll-off. Clipping, or maximum power output, was 65 watts per channel, as claimed. All of these measurements were made with the power supply fixed at 14.4 volts, the new standard reference value adopted by the Ad Hoc Committee on Car Stereo Standards. This may have given a slight advantage to the 3002 as compared with measuring it at the nominal 13.2 volts of supply voltage specified by Alpine.

Incidentally, manufacturers who subscribe to the new Car Stereo Standards have until June of 1980 to alter their brochures and advertising literature to conform to the new methods of measurement. Since these tests were conducted well before that date, we would not have expected to find the new data printed in Alpine's owner's manuals. Nonetheless, it is clear from even these cursory measurements that Alpine is not one of the companies that need fear the adoption of the new Standards. Their units (if these two are any indication) should stand up well under the new tests and measurement methods.

Use Tests

There is, of course, no substitute for listening tests in evaluating any audio equipment. And, in the case of car stereo equipment, ideally that equipment should be judged by listening to it in a car. Unfortunately, that is not always practical or possible when subjecting this type of equipment to lab tests. For one thing, overall performance would still be severely limited by the quality of the loudspeakers used. Then, too, if we were trying to judge radio reception, we would have no ready frame of reference, since FM reception in a moving (or even a stationary) vehicle is so highly variable. Accordingly, we decided long ago that we would have to listen to car stereo equipment right in the lab, as if it were equipment intended for home use. This enables us to couple the amplifier to full-sized speaker enclosures and to judge FM reception using an outdoor antenna whose characteristics are well known to us in terms of signal strengths received.

Under those constraints, the FM section of the 7307 performed extremely well. There was virtually no drift, even as the tuner/cassette unit began to warm up, and tuning was fairly easy. Repeatability of accurate tuning via the five preset buttons was excellent. One of the most elegant features of the 7307 unit, in our opinion, is the ejection system employed to free cassettes either after they have been played or at the direction of the user. Instead of a mechanical system (which often tends to eject cassettes more like missiles than tape packages), a gentle sequence of events, controlled electronically, opens a door slowly, raises the cassette away from its play position, and even more gently ejects it partially out of the recessed opening on the front panel, where the user can then retract it safely. The whole operation takes but a few seconds and has to be seen to be fully appreciated.

Dolby playback circuitry seemed properly calibrated, but the circuitry associated with the Noise Elimination Switch seems to act as a low-pass filter with a cut-off at around 6 to 8 kHz. With muting level adjusted as it was to 9 μV (30.3

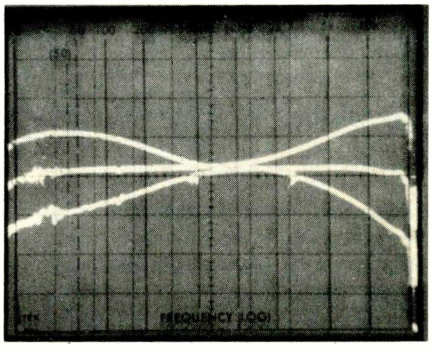


Fig. 7—Tone control range, Alpine 7307.

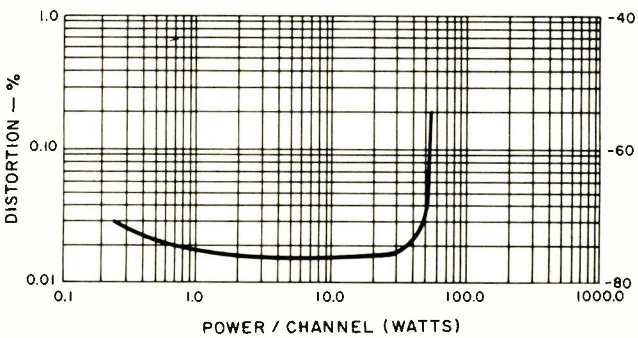


Fig. 8—Power output vs. distortion at 1 kHz into 4-ohm loads, Alpine 3002 amplifier.

dBf), there was perfect interstation silence when tuning across the FM band. However, to receive some of the weaker stations in our area, albeit in mono, we had to defeat the mute setting though that meant tolerating interstation noise.

The 3002 amplifier packed plenty of power and our only caveat for potential users is that they had better make certain that the speaker selected for use with this amplifier can take the kind of power levels possible with this honestly rated unit.

If the 7307 tuner cassette and the 3002 amplifier are any indication of the type of car stereo equipment that Alpine intends to promote and sell in this country, I would venture to say that they will be an unqualified success. It is heartening to run into a new guy on the block who has not abandoned quality and performance in the rush to capture a piece of the car stereo market. *Leonard Feldman*

Luxman Model K-12 Cassette Deck

Manufacturer's Specifications
Frequency Response: Normal tape, 30 Hz to 16 kHz; CrO_2 tape, 30 Hz to 20 kHz; metal tape, 30 Hz to 21 kHz.
Harmonic Distortion: 1.2 percent overall, 0.3 percent HDL_3.
S/N: 56 dB; with Dolby NR, 65 dB; with NR and metal tape, 69 dB.
Input Sensitivity: Mike, 0.25 mV; line, 100 mV; DIN, 30 mV.
Output Level: Line, 580 mV; headphone, 1 mW at 8 ohms.
Flutter: 0.04 percent W rms.
Dimensions: 17¼ in. (438 mm) W x 14 9/16 in. (370 mm) D x 5 in. (126 mm) H.
Weight: 23.1 lbs. (10.5 kg).
Price: $995.00.

Lux has shown with many products that it offers high quality for a premium price. The K-12 cassette deck is no exception, though a prospective buyer may be reluctant to spend this sum for a two-head deck. However, this unit provides performance and features that are quite worthy of attention. The front panel is a very attractive one, and the black designations are most easy to read against the brushed aluminum. The cassette compartment almost seems to dominate, probably because the removable door (for cleaning, etc.) is all clear plastic, without any overlying plates. It is easily lifted out, and then the solid, rugged head-support base can be examined. It was judged superior to substantially all other cassette-deck head supports, more solid than many open-reel head assemblies. This is one of the extra-high-quality items that increases the cost, and the value, of the K-12.

To the right of the tape compartment are the very light-touch tape-motion plate switches. Everything is logic controlled, and all combinations of switching are possible, including the desirable flying-start recording. The arrangement of the rectangular switch plates is not a standard one, but it seemed quite sensible in use, aided by the status lights with *Rec*, *Play*, and *Pause*. The optional AK-1 remote control, which was supplied with the deck, repeats the layout of the main unit exactly, although it does not have status lights for *Play* or *Pause*. It does add facilities, with *Auto Play* and *Rewind* buttons, for all combinations of rewind and play, play and rewind, singly or continuously, and sometimes in conjunction with use of the counter memory button on the deck.

Also on the right side of the front panel are the two dual-concentric mike and line level pots, with mixing capability. The left-section knob is of medium diameter, and the right one consists of a recessed ring with a tab index which extends a short distance out from the panel — a design which might make fine adjustment a bit difficult. The fluorescent peak indicating bar graphs are the most obvious feature of

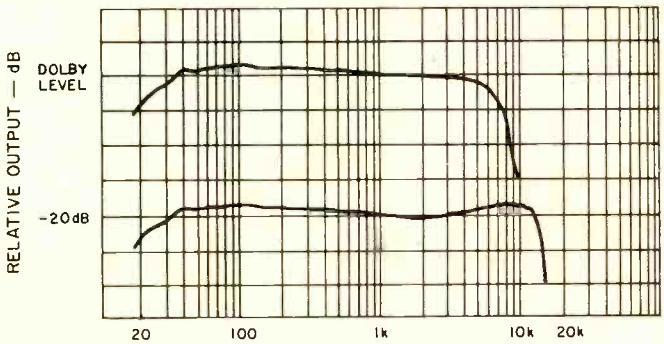


Fig. 1 — Frequency responses in Dolby mode with TDK AD tape.

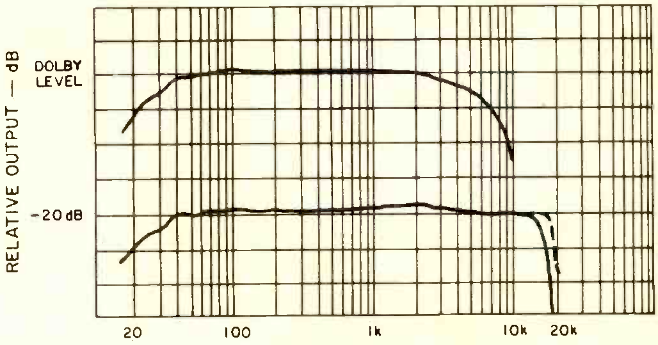


Fig. 2 — Frequency responses in Dolby mode with Luxman XM-II tape; response without Dolby NR is shown by dashed line.

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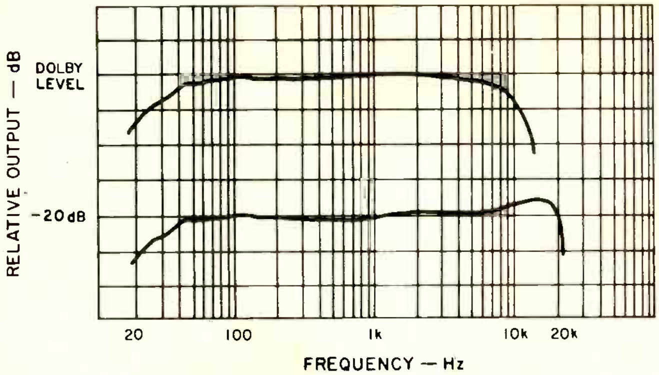


Fig. 3 — Frequency responses in Dolby mode with Luxman XM-IV tape.

the left side, particularly when on and responding to music. They are scaled from -40 to +6, and there's a lower scale that's shifted 4 dB to show up to +10 dB for metal tapes. The display has 24 bars per channel, giving much better resolution than many others of this type. There are single-dB steps from -6 to +6 dB, or from -2 to +10 dB for metal tapes, and a peak hold switch for retaining the highest record (or play) level during any desired period. The counter display is unusual in that it has four 7-segment digits. With most cassettes, it offers the advantage of a high count with more accurate positioning than other decks. When Lux cassettes are used, the counter becomes a tape timer (unless cancelled by a back-panel switch), and it shows tape position in minutes and seconds. This is another higher cost function which could be of great value to users.

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

	With Dolby NR				Without Dolby NR			
	Dolby Lvl		-20 dB		Dolby Lvl		-20 dB	
Tape Type	Hz	kHz	Hz	kHz	Hz	kHz	Hz	kHz
TDK AD	25	6.9	22	15.0	25	7.2	22	16.1
Luxman XM-II	30	5.0	25	16.0	30	5.6	25	19.3
Luxman XM-IV	35	9.0	26	21.0	35	9.3	26	22.2

Four three-position rotary switches with easy-turn bar knobs provide selection for *High*, *Low* or *EX* (metal) bias; CrO_2, *Normal* or EX EQ; timer *Rec*, *Off* or *Play* and Dolby NR *On*, *Off* and *On with Filter*. The output pot has the same type of knob. The counter reset and memory on/off are small push buttons. In this same section of the front panel are the jacks for headphones and left and right microphone inputs. The eject button is next to the tape compartment. The stereo line-in and line-out phono jacks are on the rear panel, along with a DIN socket, a ground post, and a multi-pin remote-control socket.

Removal of the wraparound top and side cover revealed many examples of attention by the manufacturer to quality materials and construction. Soldering on the p.c.b.s was excellent, with very little flux residue. Interconnections were made with wire-wrap, and some wires were bundled a little loosely with many cases of slack evident. It appeared to be purposeful, and such slack can be a great aid to some service tasks. (There was no evidence in later tests of crosstalk or noise pickup.) All parts were of excellent quality, and the adjustment pots were quite superior to those usually used. All parts and a number of functions were clearly identified. The two-motor drive and the solenoid positioner were of solid construction, and steel was used for a good part of the chassis. The power transformer was much larger than many seen in the past; there was a power line fuse in a clip.

Performance

The play responses were checked with TDK and BASF test tapes. The results were excellent, in general, with just a bit of droop with 70-μS EQ at the highest frequencies. Level indications with the standard tapes were about a dB low for left and very close for right. Record/playback performance was very good with the Maxell UD-XL I, Lux XM-II, and Lux XM-IV supplied with the deck. Results were comparable with TDK AD, Sony SHF, Memorex MRX_3, Realistic Supertape Gold, Maxell UD-XL II, and TDK MA-R. Testing was continued with the supplied tapes with the exception that TDK AD was used in place of the Maxell because its response was a little flatter. Figures 1 to 3 show the responses with the three tapes used at Dolby level and 20 dB below, both in Dolby mode. This is a demanding way to conduct these tests, as specifications are for performance without Dolby NR. As Table I shows, the biggest discrepancy was with XM-II tape and Dolby NR. Without NR, it was very close to spec, as listed in the table and shown in Fig. 2. Phase jitter was very low, less than 20 degrees with a 10-kHz test tone. Bias in the output during recording was also very low. The multiplex filter response was down 1 dB at 15 kHz and over 33 dB at 19 kHz.

Other tests were run with the Lux cassettes as they incorporate two special features. The first of these is a precision roller with a reflection plate which, in conjunction with a light source and detector, provides a means of measuring tape speed and, thereby, time. The K-12 display showed "10:00" in "10:02" actual, which was exactly consistent with the results of the tape speed test, indicating the deck to run about 0.3 percent slow. The scheme worked very well with no apparent slip, or missed counts, from fast winds. This feature has great potential and should find favor with those who need to time recordings. The Lux cassettes also have skew adjusters for both play and record and for both sides of the cassette. The play skew would be adjusted for best results with a tape that had been recorded on another deck. Record skew would be adjusted on a three-head machine, rather than adjusting the record head itself. Play skew could be adjusted ±270 degrees with a 10-kHz tone. Record skew had a range of ±100 degrees. There was interaction between sides of the cassette if the adjustments were more than minor. There is a *possible* advantage to having skew adjustments in a cassette, but misadjustment could lower performance. My own hopes are for better tape production, head alignment, and tape guiding so that there will be minimal variations in tape skew without cassette adjustments. Some tapes are very

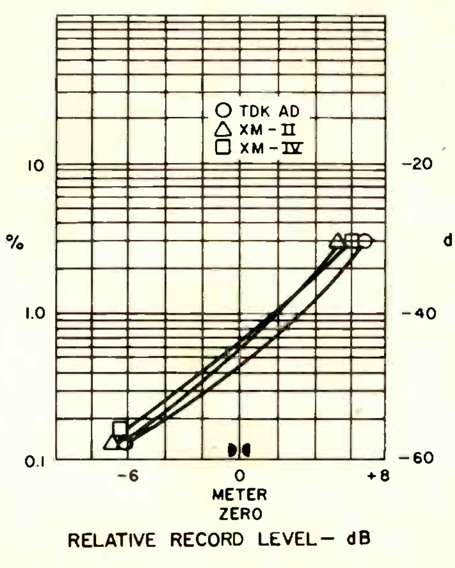


Fig. 4 — Third harmonic distortion vs. level in Dolby mode at 1 kHz with TDK AD, Luxman XM-II, and Luxman XM-IV tapes.

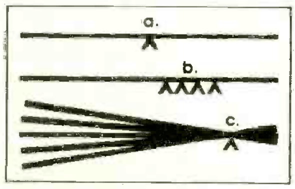
We found the optimum pivot point before the others even knew it was missing.

Most manufacturers are content to determine tonearm pivot points by trial-and-error. And many tonearms are so susceptible to external vibrations that you have to tiptoe around the turntable.

With Sansui's Dyna-Optimum Balanced (DOB) tonearms, based on our Optimum Pivot Point principle, the transmission of vibrations is dramatically reduced to give you more freedom to enjoy your music. It's used in our new, fully automatic direct-drive FR-D4 and FR-Q5.

Here's how the DOB works: Put a pencil on a table. Wiggle one end back-and-forth. The other end will move; but a certain point will not. This is the Optimum Pivot Point.

In our new DOB tonearm the arm is pivoted at this highly stable point. With no relative motion between the point and the arm support, effects from external forces are minimized. Friction is almost non-existent, so the stylus is free to trace every part of the groove. We also added a special decoupling device and a unique counterweight for optimum tracking.



a. Center of Mass. Starting point for conventional tonearm designs.

b. Typical trial-and-error pivot points, usually placed close to a. so that counterweight is not too heavy, tonearm not too long.

c. Sansui's Optimum Pivot Point. Calculated mathematically as a function of length and mass. The most stable point.

A patent is pending on Sansui's brushless DC motor used in the FR-D4 and FR-Q5. And with the Quartz-PLL system of the FR-Q5 and the special speed-error detection/correction system of the FR-D4, wow and flutter, speed accuracy and signal-to-noise specifications are outstanding. All operations are computer-controlled using the latest LSIC technology. The computer even knows to shut off the motor if you forget to unlock the tonearm clip.

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good in that respect now. I find nothing to fault in the tape-time scheme; it should be used by others.

Figure 4 shows the results from measuring HDL_3 at 1 kHz over a range of record levels in Dolby mode for the three tapes. The distortion levels are quite low, with high record levels to reach the three-percent distortion limit. At the lowest levels, there was some flattening of the curves, indicating the possibility of some distortion in the electronics appearing at about 0.1 percent. HDL_3 over the frequency band at a level of -10 dB with XM-IV metal tape is plotted in Fig. 5. The results are quite good, though the distortion is higher than what has been measured with metal tape on three-head machines. With the high maximum record levels and the low machine noise, excellent signal-to-noise ratios were obtained with all three tapes. As shown in Table II, the chrome-type XM-II matches the metal tape, and TDK AD isn't far behind. Erasure of the XM-IV metal tape at both 100 and 1000 Hz was at least 75 dB, excellent performance for the erase head. Separation between tracks was a very good 44 dB, and crosstalk was way down, 75 dB or more.

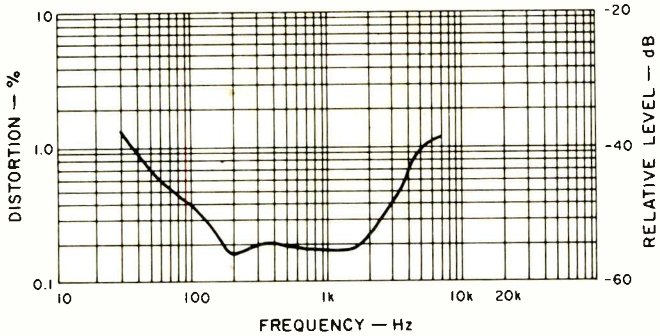


Fig. 5 — Third harmonic distortion vs. frequency in Dolby mode at 10 dB below Dolby level with Luxman XM-IV tape.

The input sensitivity was 0.29 mV for mike and 97 mV for line. Input overloads were 18 mV for mike and 28 V for line. The output clipped at a level equivalent to +10.1 dB on the meter. The mike and line input pot sections tracked within a dB from maximum down at least 65 dB, outstanding performance. The line output was 570 mV at meter zero, just slightly under spec. The pot sections tracked within a dB down from maximum for 65 dB, great again. Drive for headphones with an 8-ohm load was 300 mV (11 mW) which drove all phones used to high levels. The peak-responding displays were very fast and were only a dB down with a 1-mS tone burst. They were down about 5 dB with a 0.5-mS burst. Response to 0 dB and a peak-hold required a 2-mS burst. Even without the peak-hold being used, the individual peaks automatically held for about 2 seconds. This was of definite aid as the 0.7-S decay would have been too fast without the short hold. The calibration of the scales was very accurate from -10 to +6 dB, but there were errors at the lowest levels, with "-40" actually 30 dB down. The displays were easy to read and had a high intensity level. When switched to EX (metal) tape, there was

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

	IEC "A"Wtd. (dBA)				CCIR/ARM			
	W/Dolby NR		Without NR		W/Dolby NR		Without NR	
Tape Type	At DL	HD=3%	At DL	HD=3%	At DL	HD=3%	At DL	HD=3%
TDK AD	60.8	67.8	52.4	59.4	57.6	64.6	50.3	57.3
Luxman XM-II	62.8	68.3	55.8	61.3	60.5	66.0	53.0	58.5
Luxman XM-IV	62.2	68.4	54.2	60.4	59.1	65.3	52.6	58.8

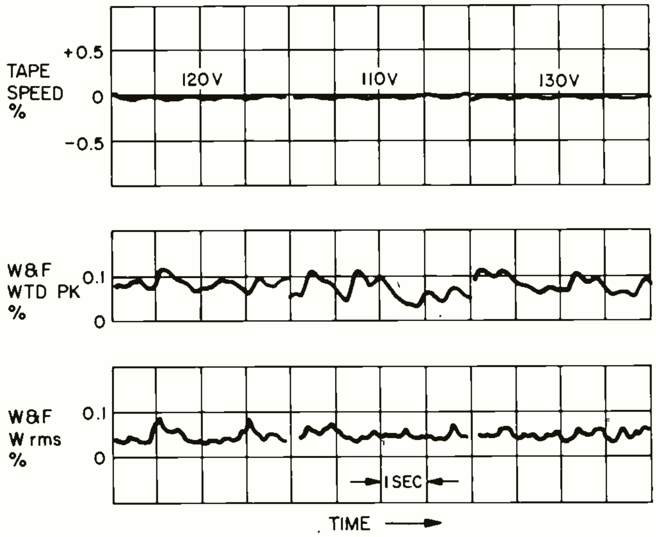


Fig. 6 — Wow and flutter (three trials) and tape play speed vs. time and line voltage.

an automatic switch in displayed level to match the second scale.

Typical flutter values were 0.045 percent W rms and 0.08 percent weighted peak. This is slightly over spec, but very good just the same. There were minor variations in tape speed with steady line voltage, and there was substantially no change in speed with changes in line voltage as shown in Fig. 6. Fast wind time for a C-60 cassette was about 64 seconds. There was a 3-second delay from tape run-out in play or wind to mechanism shut-off. The time required to change wind directions or to switch from fast wind to play was noticeably less than a second.

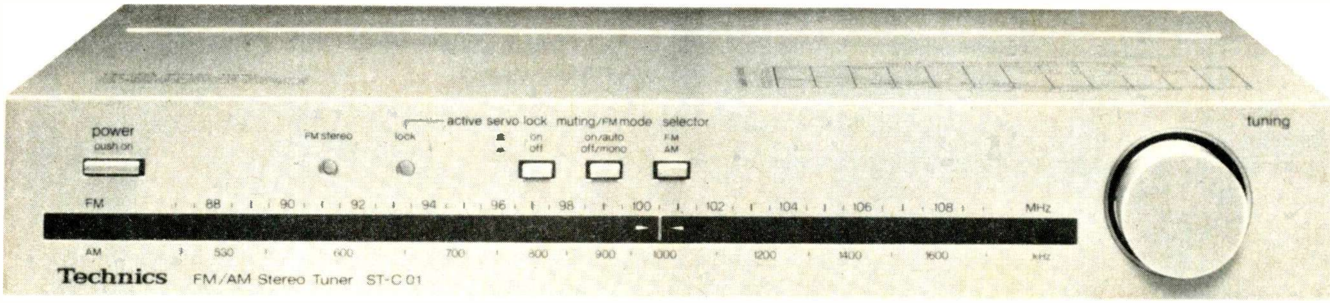
In-Use Tests

The tasks of cassette insertion and removal, cleaning, and demagnetization were all easily done. The counter reset to zero automatically upon removal of the cassette, although I would have occasionally preferred having the option of keeping the reference. The real-time display with the Lux cassettes was very useful a number of times. All controls worked very well, and there was no malfunction of any type. It took but a short time to feel quite at home with the K-12's arrangement of tape motion switches. I did work out a way of holding the tab of the right-channel input pot section for fine balancing, but for me it remained a fussy operation. The peak hold feature was used a number of times to check an entire piece of music for the maximum levels without having to watch continuously.

The instruction book has very good illustrations, and the text covers everything well, although there were a few examples of translation oddities. Various sources were recorded, including a broadcast of the works of Finnish composers and recordings of a few different orchestrations of Moussorgsky's *Pictures at an Exhibition*. It was quite easy to set levels as high as possible without noticeable distortion with the aid of the peak-responding display. Clicks or other noises from record, pause or stop were very low, with changes in tape noise almost undetectable with ear or meter.

The Luxman K-12 provides a level of performance that should appeal to most audiophiles. There would be some improvements, of course, in a three-head design. For the prospective buyer looking at high-quality decks, the K-12 has a number of worthwhile and interesting features and offers solid, premium-quality construction with the look of long-term reliability. *Howard A. Roberson*

Technics Model ST-C01 Stereo FM-AM Tuner



Manufacturer's Specifications

FM Tuner Section

Usable Sensitivity: Mono, 10.8 dBf (1.8 μV).

50-dB Quieting Sensitivity: Mono, 17.0 dBf (3.9 μV); stereo, 38.3 dBf (45 μV).

S/N: Mono, 75 dB; stereo, 70 dB.

Total Harmonic Distortion: Mono, 0.1 percent at 100 Hz and 1 kHz, 0.15 percent at 6 kHz; stereo, 0.25 percent at 100 Hz and 6 kHz, 0.15 percent at 1 kHz.

Frequency Response: 20 Hz to 15 kHz, +0.5, -1.5 dB.

Selectivity: 75 dB.

Capture Ratio: 1.0 dB.

Image Rejection: 50 dB.

I.f. Rejection: 85 dB.

Spurious Rejection: 75 dB.

AM Suppression: 55 dB.

Stereo Separation: 45 dB at 1 kHz, 35 dB at 10 kHz.

Sub-Carrier Rejection: 40 dB.

AM Tuner Section

Sensitivity: 30 μV (250 μV/M, internal antenna).

Selectivity: 30 dB.

Image Rejection: 50 dB.

I.f. Rejection: 40 dB.

General Specifications

Output Voltage Level: 0.5 V.

Power Requirements: 120 V, 60 Hz, 8 W.

Dimensions: 11-$^{11}/_{16}$ in. (29.69 cm) W x 1-$^{15}/_{16}$ in. (4.92 cm) H x 10 in. (25.4 cm) D.

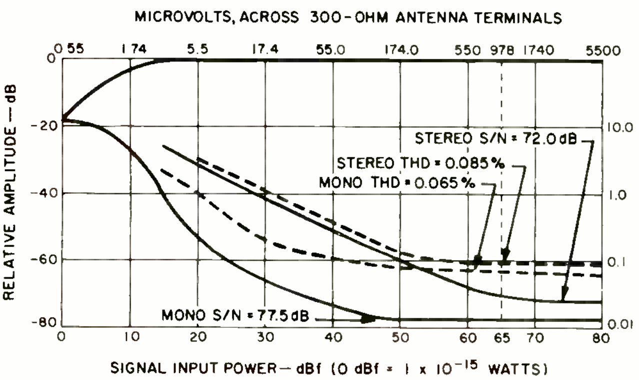
Weight: 6.4 lbs. (2.91 kg).

Price: $260.00.

If ever there was a single high-fidelity component that lends itself to the "mini" or "micro-component" approach, it is the separate tuner. FM-AM tuners, by their very nature and function, generate virtually no heat and no great effort is involved in compressing tuner circuitry into the small cubic volume as is called for in the "mini component" format. Indeed, if one examines the internal layout of most conventionally sized FM-AM tuners (with the exception of those fancy digital-readout, frequency synthesizing types), one will generally find that there is a good deal of empty space inside. So, while this reviewer has not exactly been captivated (so far) by the proliferation of minis and micros in general, I have no quarrel with manufacturers who elect to package their tuner products in tiny boxes. So long as the price/performance ratio is not compromised and ease of use is retained, I don't care if they want to put AM-FM tuners in a matchbox.

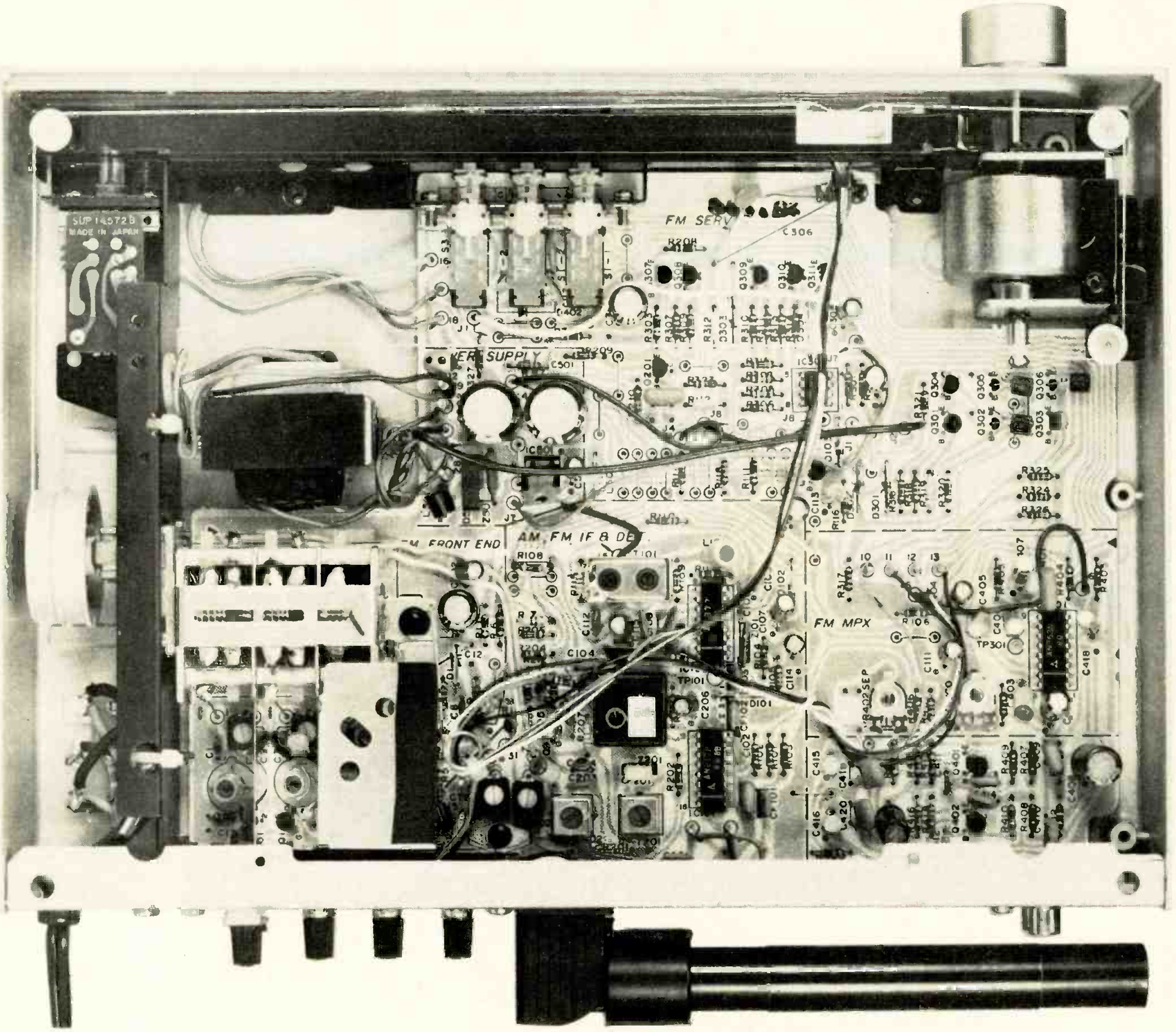
Happily, the Technics ST-C01 is an example of good, basic tuner design which has not in any way suffered because of its miniaturization. The minuscule chassis of this unit has even been equipped with tiny swing-out feet which tilt up the front panel for easier viewing and tuning. Front panel layout is simple and clean, devoid of any unnecessary frills. At the right is a large (relatively speaking) tuning knob which manages to retain a fairly effective flywheel action for smooth, effortless dial spinning. Both AM and FM frequency notations are etched on the panel proper, with FM numerals linearly spaced above a narrow, long cut-out slit, behind which rides an illuminated dial pointer, and with AM frequency numerals etched below this slit. There are no conventional meters on the ST-C01. When tuning to FM frequencies, a pair of tiny illuminated arrows flanking the dial pointer illuminate between stations. As a signal frequency is approached, first one of these arrows is extinguished, with the remaining illuminated arrow telling the user in which direction to fine-tune the dial. When center-of-channel tuning has been achieved, the other arrow is extinguished, indicating that proper tuning has been achieved. In the case of AM tuning, both arrows are extinguished simultaneously when accurate center-tuning has been accomplished.

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



Push buttons atop the frequency dial area include a *Power* switch, an AM/FM *Selector* button, a *Muting/FM Mode* selector button, and a servo-lock switch. The servo-lock circuit is a sensitive form of automatic frequency control which "locks onto" the tuned-to frequency. It should be noted that the previously described arrows function whether or not the servo-lock circuit is activated. When this tuning-assist circuit is employed, a tiny light flashes near the *Active Servo Lock* switch whenever precise tuning has been achieved. There is a delay in the "grab" action of the servo lock to allow the user more time to tune to the center of the FM channel. An *FM Stereo* indicator light is located adjacent to this servo-lock indicator light.

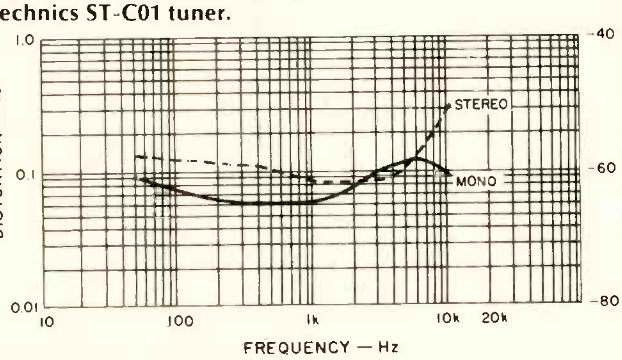
The rear panel of the ST-C01 is equipped with a pair of output jacks at the left and the usual antenna input terminals at the right. Included are terminals for an external AM antenna and for 300-ohm or 75-ohm FM antenna transmission lines, the latter including a grounding clamp for the outer shield of coaxial cable, if that type of transmission line is employed. A pivotable AM ferrite bar antenna is folded down against the chassis for shipment but should be rotated away from the rear surface of the chassis for best reception. Rotating the ferrite bar so that it is perpendicular to the rear



surface of the chassis adds about six inches to the shelf depth required for this micro component, but in most cases it should not be necessary to rotate the AM antenna that much.

While no schematic diagram or circuit details concerning the ST-C01 were provided with the tuner, an examination of the inside of this small chassis discloses a neatly laid out circuit board onto which all parts are mounted, including the front end but with the exception of the small power transformer, a.c. switch, and a.c. line bypass components. As we suspected, parts density is no greater than might be expected in a conventionally sized tuner. The main p.c. board is adequately labelled as to parts locations to facilitate servicing, if required. A three-gang tuning capacitor is used for FM, while the AM tuning function is accomplished by means of a two-section variable capacitor.

Fig. 2 — Distortion vs. frequency response in the Technics ST-C01 tuner.



Performance Measurements

Usable FM sensitivity in mono measured 14.1 dBf (2.8 μV) as opposed to 10.8 dBf (1.8 μV) claimed by Technics. 50-dB quieting, in mono, was 3.9 μV (17.0 dBf), exactly as claimed. In stereo, usable sensitivity measured 6.0 μV (20.8 dBf), while 50-dB quieting required input signal strengths of 50 μV (39.2 dBf) as against 45 μV (38.3 dBf) claimed by the manufacturer. In all probability, a minor bit of FM front-end alignment might have brought all of these sensitivity measurements into spec. With strong signals, signal-to-noise ratio in both mono and stereo exceeded the manufacturer's claims, with readings of 77.5 dB in mono and 72 dB in stereo—both very good figures for a tuner in this price category. Distortion readings (at 1 kHz) were also much better than claimed, measuring 0.065 percent in mono and 0.085 percent in stereo. Quieting and distortion characteristics of the FM tuner section are shown in the graphs of Fig. 1. It was interesting to find similar noise-quieting curves actually screened onto the metal top cover of the tuner itself. Recently, manufacturers of separates have taken to presenting performance graphs, block diagrams, and the like right on the metal top

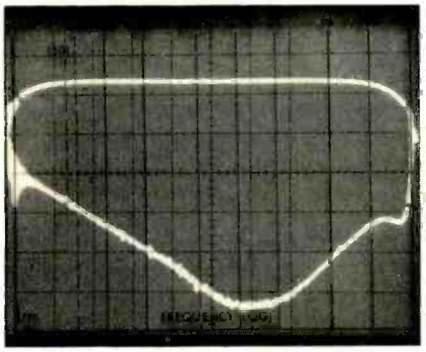


Fig. 3 — Stereo FM frequency response and separation.

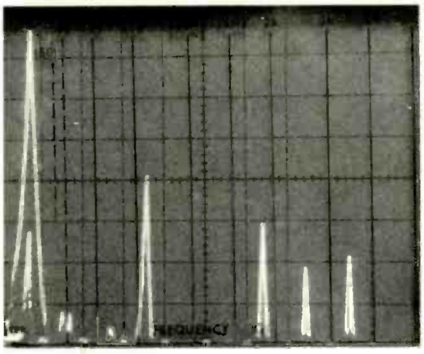


Fig. 4 — 5-kHz crosstalk components.

covers of their products and Technics has gone along with the trend. I suppose that for the serious audiophile these graphic presentations provide some useful information; for the public at large they make the product look very "technical . . . ."

We plotted distortion versus frequency for both mono and stereo reception, and the results are shown in Fig. 2. At the other IHF-required test frequencies, distortion measured 0.075 percent at 100 Hz and 0.14 percent at 6 kHz for mono, while in stereo the THD figures were 0.13 percent at 100 Hz and 0.15 percent at 6 kHz, all very acceptable for a tuner in this category. Selectivity measured exactly 75 dB as claimed, and capture ratio was close enough to the claimed figure of 1.0 dB with observed readings of 1.1 dB. AM suppression measured 57 dB while image, i.f., and spurious rejection all exceeded published figures with readings of 53 dB, 86 dB, and 80 dB respectively.

We must mention the fact that the ultra-low distortion figures we read were obtained with the active-servo-lock feature defeated. With these variations on automatic frequency control, unless the set is absolutely perfectly aligned they can de-tune the unit by minute amounts instead of pulling it in to perfect center tuning. In the case of the sample Technics ST-C01 we tested, the error (with the automatic servo circuit on) was minimal, but did exist. For example, using that convenience circuit, THD at 1 kHz in mono rose from its excellent value of 0.065 percent to 0.1 percent—just at published specification.

With the aid of our spectrum analyzer, we plotted frequency response in the stereo mode, as well as stereo separation. Results are shown in the 'scope photo of Fig. 3. Response was well within specified limits from 30 Hz to 10 kHz but was down some 3 dB at 15 kHz. Stereo separation (represented by the lower trace in Fig. 3) measured 33 dB at 100 Hz, 52.5 dB at 1 kHz, and 35 db at 10 kHz. Crosstalk was measured in accordance with the technique which we have developed and used during the past year or so. In Fig. 4, a 5-kHz "left-only" signal, at 100 percent modulation, is represented by the tall spike at the left of the screen, obtained by sweeping the spectrum analyzer while its input was connected to the left output jack. A second trace, obtained with the analyzer's input connected to the right-channel output, shows actual separation at 5 kHz (the lower-amplitude spike contained within the tall 5-kHz spike at left) to be around 45 dB. Additional spikes to the right clearly depict some crosstalk harmonic distortion components at 10 kHz and 15 kHz (sweep is linear, at 5 kHz per division, while vertical sensitivity is 10 dB per box), an unusually large 19-kHz pilot-carrier output (down approximately 40 dB compared to 100 percent modulation level), and, to the right of the screen, 33-kHz and 43-kHz sideband components, as well as a 38-kHz sub-carrier component nestled between them at a level of around 58 dB below 100 percent modulation level. The rather high sub-carrier output products, though not included in our earlier harmonic distortion readings (we use a bandpass filter with a cut-off at 15 kHz, as prescribed in the IHF Tuner Measurement Standards for THD, might have audible consequences when trying to record FM programs onto a cassette recorder that utilizes relatively low bias frequencies or is not equipped with an MPX filter.

Frequency response of the AM tuner section was also plotted by means of the spectrum analyzer, swept logarithmically this time from 20 Hz to 20 kHz; results are reproduced in the 'scope photo of Fig. 5. As is true of most minimum-circuitry AM tuners found in high-fidelity tuners and receivers, response begins to roll off above 2 kHz.

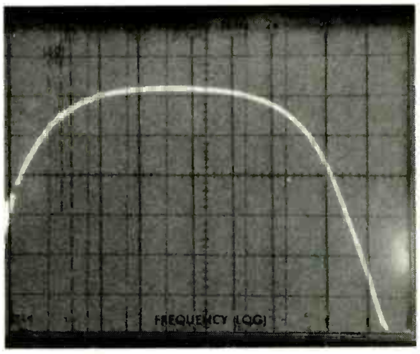


Fig. 5 — Frequency response in the AM section.

Summary and Listening Tests

Technics has managed to come up with a small tuner package which provides basic and adequate FM and stereo FM reception at a cost that does not penalize purchasers who crave the miniaturized format for their components. Reception using a directional outdoor FM antenna was more than adequate in our listening area, with quality of received programs limited primarily by program material being broadcast. Even 72 dB of signal-to-noise ratio is more effective dynamic range than is usually needed when tuning into current FM radio fare. I have only two minor criticisms of the ST-C01. First, I feel that some sort of signal-strength indicating device (be it a meter or even a series of LEDs) would have been helpful. Second (and this is my pet peeve with lower cost tuners and receivers), I do not care for the coupling of the muting function on the same switch with the mono/stereo selection function. I feel one should be able to enjoy (or defeat) the muting circuitry whether one is listening to stereo or mono. In the case of the ST-C01, I must admit that this last objection is not serious, since muting threshold was set at a nice low level (3.0 μV, or 14.7 dBf), while stereo switching threshold occurs at approximately 6 μV (20.8 dBf). Thus, in this case, my criticism is not related to inability to receive usable stereo signals while employing the muting feature, but rather the inability to utilize the muting feature when tuning for weak (or strong) mono FM signals.

In summary, the Technics ST-C01 is a quite competently designed tuner which offers good value for its price. Its performance compares favorably with standard-sized tuners costing as much — a characteristic which does not necessarily apply to all micro component categories that I have seen thus far. *Leonard Feldman*

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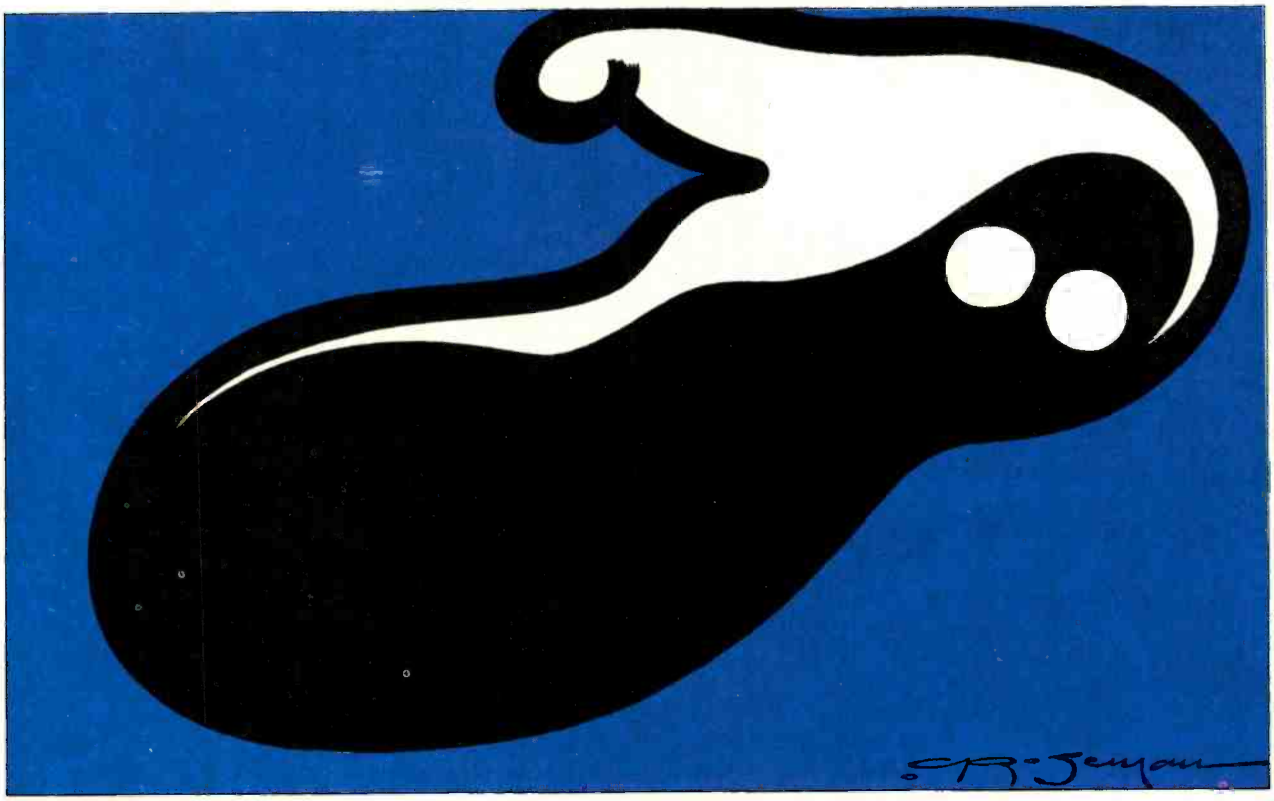
Michael Tearson

The Column



Live Rust: Neil Young and Crazy Horse
Reprise 2RX 2296, 2 discs, stereo, $13.98.

Live Rust is a two-record live set recorded during the same tour that yielded the album and film entitled **Rust Never Sleeps.** That previous album was mostly live tracks enhanced in the studio, and the several songs repeated from it are all presented in different versions, usually more impassioned ones. From the even rougher sound of **Live Rust,** I would guess that this time there has been relatively little studio prettification performed.

Even more than **Rust, Live Rust** is cut rough, warts brightly exposed. The performances are fascinating, often recasting into a new image some of Neil's best songs from throughout his decade-plus career. The album's sequencing follows what was done in concert and is intentional. There is an implied theme of youth growing/maturing/aging. Side one is acoustically performed solo. Very early songs like *Sugar Mountain* and *I Am a Child* take on a new poignance. *After the Gold Rush* played on piano is almost a lullaby. At the end of that song Neil is heard to say, "When I grow up big, I'm gonna get an electric guitar. I mean *real* big," and then he slides into the acoustic *My, My, Hey, Hey.*

The other three sides are electric as Crazy Horse, a real raw-nerves band, joins Neil. They cook like crazy on *The Loner,* originally on Neil's very first solo album, and on *Powderfinger* (a different take than the one on **Rust**). *Cortez the Killer* is completely redrawn from the **Zuma** version into a Caribbean nightmare to which *Like a Hurricane* is a necessary follow-up. After an electric *Hey, Hey, My, My* the album closes on a furious *Tonight's the Night.*

Inspired, bold performances and *intentionally* sloppy recording techniques create a dark ambience throughout the set, making it a fascinating document. The recordings are so raw that a carefully tuned ear wants to be repelled, but that is not what happens. A grisly fascination is set up instead, vindicating Neil's recording philosophy.

Over the years Neil Young has over and over again courted commercial suicide by releasing albums that specifically run against the grain of what the public might expect from him. Thus came albums like the resolutely doomed **Tonight's the Night** and the impenetrable **On the Beach.** Time continues to recast those albums in the light of later achievements. Now they seem like Pre Wave records, punk before punk happened in its late '70s incarnation. **Comes a Time,** the Nashville album and logical successor to the inordinately successful **Harvest,** seems almost a perverse joke in the light of the no-holds-barred rock and roll of the two **Rust** albums that followed it. Pretty as it is, it sounds nearly embalmed next to the **Rusts.**

From the shadows of disgrace Neil Young has re-emerged stage center with perhaps his most thrill-packed records ever, essential stuff you skip at your own risk. Few other survivors of the '60s can match that. **Live Rust** is a look backwards utterly without nostalgia and a look forward utterly without fear. *M.T.*

Sound: D+ Performance: A+

The Fabulous Thunderbirds
Takoma TAK 7068, stereo, $7.98.

Here's a band perfect for touring with George Thorogood—an authentic Texas blues quartet that sounds like

Freddie King reborn as a cracker. There's no great virtuosity here—lead guitarist Jimmy Vaughan isn't exactly the kind of guitarist who inspires young axemen to learn his licks note for note, and lead singer Kim Wilson tends to underplay his role—but they sound positively bona fide. They exude charm and dapperness, never come on flash, but their original compositions don't project much in the way of personality. Occasionally, on tracks like *She's Tuff* and *Rich Woman* they display a persona and a quality unlike anything else going on at the moment, and once they capture this in their own songs they will be absolutely unstoppable. *J.T.*

Sound: B+ Performance: B

John Fahey Visits Washington, D.C.: John Fahey
Takoma TAK-7069, stereo, $7.98.

When Chrysalis bought out the Takoma label, I had to wonder how it would affect the legendary guitar stylings of John Fahey. With his first album since the takeover, I am happy to deliver an answer of "Not at all." **John Fahey Visits Washington, D.C.** is one of his better, more coherent albums. It

is entirely a solo guitar album save for *Silver Bell*, where Richard Ruskin joins in on a second guitar part. The variety of ideas is most striking and pleasing.

Both sides have the feel of an odyssey, culminating in an explosive celebration of Americana as each side's final section is a clever medley of traditional and near-traditional American melodies and themes like *Railroad Bill* and *Camptown Races*. I wouldn't want to list excerpts too fully for two reasons: Fear of missing some and fear of destroying your potential fun in picking them out.

It has always been difficult to describe Fahey's playing in print. Suffice to say that this album is a good one to use as an introduction to the peculiar world in John Fahey's head if you have not yet experienced it. If you are a fan, I suspect you will welcome this latest installment in his ongoing musical epic novel.

By the way, the liner notes Fahey has written tell about a journey through the past in and around Washington; they may be of some help in understanding the music although they make no mention of the album's contents. But then again, that's typical for the enigmatic Mr. Fahey. *M.T.*

Sound: B- Performance: B

Deguello: Z.Z. Top
Warner Bros. HS 3361, stereo, $8.98.

It may not be the hippest thing in the world to like Z. Z. Top, but these Texans know how to rock their blues off! What other band in their position has actually become *hotter* players over the years, gotten weirder in a funny sort of way, and still managed to bring out the animal in every teenage audience they encounter? Not many, and on their new LP — their first in about four years or so — these guys seem to be as fiery and farcical as when they first started to catch the public eye.

Of course, they cut their teeth playing in Texas bar bands and covering Zombies tunes so they know if they let go of what they've got for a minute, they've had it. Still, Billy Gibbons plays perhaps his best solos ever on **Deguello,** even if they're in the midst of the most ludicrous tunes they've ever written *(Manic Mechanic)*. The group picks seemingly silly topics for tunes — song titles like *She Loves My Automobile, Hi Fi Mama,* and *I'm Bad, I'm Nationwide* for instance — but with their sense of humor and Texas charm they bring it off with nary a trace of self-consciousness. And although their cover of *I Thank You* isn't a killer, *Dust My Broom* is in every sense of the word. **Deguello** is truly an album to make you want to see the show. *J.T.*

Sound: B — Performance: A

Night in the Ruts: Aerosmith
Columbia FC 36050, stereo, $8.98.

Aerosmith is the kind of group that releases product, not records — the guy at their record company says, "Tyler, it's time for the next Aerosmith to make another elpee" so maybe Steve wakes up and writes a few songs that sound just like his last one or two original ideas and gets his (then) companion in crime Joe Perry to do the rest. It's not like songwriting is a natural process with these guys, they just crank 'em out when it's time to pay the taxes on the farm in New Hampshire or stock up on whatever.

Of course, it wasn't always this way — when they were fighting for hits, they'd do a good job at covertly stealing Rolling Stones tunes (*We Love You* became *Sweet Emotion*), Yardbirds licks, and Mick Jagger's lips. Unfortunately, once success struck there wasn't far for them to go — there's no real good instrumental virtuoso in Aerosmith, no active creative intelligence, and no visionary philosophy to defend — and the net result was a succession of mediocre albums without a single song worth remembering.

Night in the Ruts features a new producer, the departing guitarist Joe Perry plus a few mediocre guest axemen, and two cover tunes: *Remember (Walking in the Sand)*, which might have been noteworthy except that Louise Goffin did a version of it only a few months ago that isn't much different from this, and an old Yardbirds gem called *Think About It*, in which the guitarist quotes note for note from the book of Jimmy Page, and Tyler sings in the whiniest high range he's ever set to disc.

It seems this group is determined to make themselves nothing more than a minor footnote in the book of rock 'n' roll, an afterthought to heavy metal, and the cornerstone that true mediocrity is judged by. It's a shame that they don't spend their money on guitar lessons from Jeff Beck or energy lessons from The Sex Pistols. *J.T.*

Sound: B- Performance: C

Stay with Me Till Dawn: Judy Tzuke
Rocket/MCA PIG-27001, stereo, $7.98.

Judy Tzuke's debut album *feels* like Elton John's records did back when he was really interesting and still pretty new, back around the **Madman Across the Water** period. Tzuke's album has a wide diversity that it displays very well from cut to cut, never flaunting. The album is one of the best examples of good sequencing I've heard in a while.

Side one, for instance, goes from the slightly ominous sounding but hopeful *Welcome to the Cruise*, to the gliding *Sukarita*, to the mostly a cappella *For You* (three Judy Tzukes dubbed one over the other), to a very danceable *These Are the Laws*, to a ballad/torch song *Bring the Rain*. The other side has an equally wide range, equally tasty.

With the way musical tastes are running more to rocking out than they have for a while, Judy's appearance might be ill-timed. If so, 'tis a pity. Her songs written with Mike Paxman are very strong with a sure sense of what makes a song work. The album's production is thoughtful and caring and graceful. **Stay With Me Till Dawn** is what the record industry calls a sleeper. I call it a find. *M.T.*

Sound: B Performance: A

Greatest Hits: Rod Stewart
Warner Bros. HS 3373, stereo, $8.98.
Greatest: Bee Gees
RSO RS-2-4200, 2 discs, stereo, $13.98.

To think that our culture may someday be judged by the best-selling albums of the Seventies scares this observer in the light of these two "best of" packages by America's most popular artists. Based on what's to be heard here, rock 'n' roll died sometime late in the Sixties and was replaced by a combination of slush and bass drum-dominated tunes. Obviously we know better, but 50 years from now the Seventies may well be looked upon as the bleakest period popular music has had since before the invention of the phonograph.

Rod Stewart, once a prime exponent of Who/Stones style of rock music, deserted whatever roots he had for the sake of ultimate stardom. He's this generation's Frank Sinatra, but he sounds like he's got as much visceral energy as Petula Clark on this greatest hits album. Only on *Hot Legs* does he even attempt to dig in and punch out a song; the rest of the time he's just exploiting his voice for the sake of the sappiest tunes this decade's produced. Granted, he's made his money (at least 30 million) but for a once-respected artist to be doing such lame shtick is wholly disheartening.

The Bee Gees were never really ballsy, except for maybe on the Lennonesque *Lonely Days, Lonely Nights*, but in the Sixties they lived in the

shadow of The Beatles and had some pleasant hits, similar to, say, The Hollies. Unfortunately, they managed to wimp out totally in the Seventies and combined that style with disco for an occasionally inspired *(Jive Talkin')* but more often mundane *(Fanny)* sound. Very little on their two-record anthology can be considered either an aesthetic success or a great pop record, merely "the hits." For some, that may be enough — unfortunately. *J.T.*

Sound: A- Performance: D-

Down on the Farm: Little Feat
Warner Bros. HS 3345, stereo, $8.98.

The final Little Feat album was something past 80 percent complete when the group's center, Lowell George, died suddenly last summer. The rest of the band, already in the advanced stages of breaking up, rallied around and finished up the project in real style, for **Down on the Farm** is one of the best Little Feat albums ever.

The first time through, as with most Feat albums, it kind of slipped past me, but each listen unfolds something more. Lowell's songs range from the goofy country sounds of *Six Feet of Snow* to the sly, sexy wordplay and jumping tune of *Kokomo* to the downright touching *Be One Now.* Two more Lowell wrote with Mr. Keyboards, Bill Payne: *Straight from the Heart* cooks behind an updated Stax/Volt groove, while *Front Page News* tips the hat more in the direction of Mr. Allen Toussaint of New Orleans. *Wake Up Dreaming,* which Bill wrote with his wife Fran, bubbles like recent Mike McDonald/Doobie Brothers stuff. Even Sam Clayton, the conga man, donates a song, *Feel the Groove,* which closes the last Little Feat album. It is wonderfully offbeat, perfect for the most consistently offbeat band of the decade.

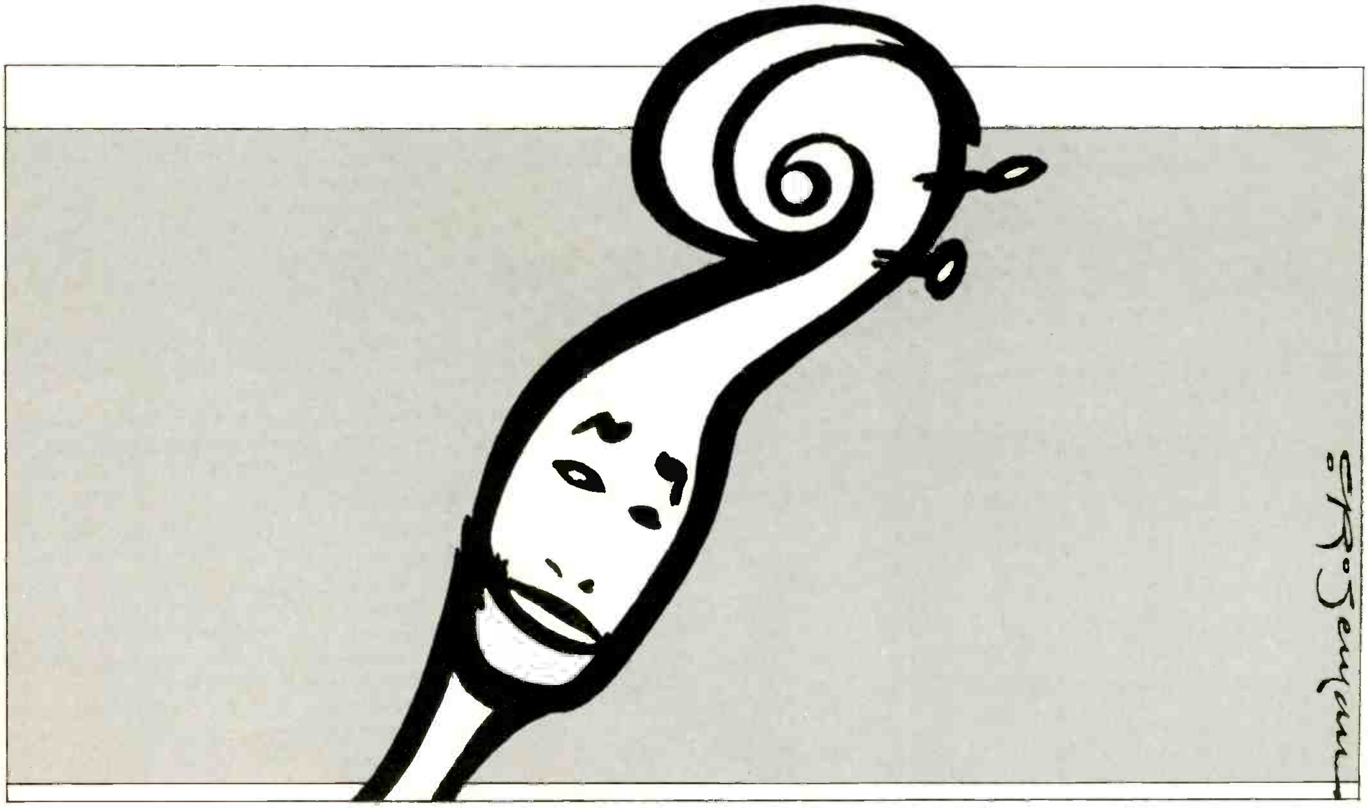
In the long run I suspect that the prime purveyor of the kind of wacky, off-center writing that was Lowell George's trademark will be Paul Barrere. He has two songs on the album, the title song and *Perfect Imperfection,* a title that by itself — the rhythm of the words — hints at how dandy a wordslinger Barrere is getting to be.

The album's production is standard for Little Feat, fitting, not flashy. The performances by the band and their guests/friends are flawless, inspired even. What characterized Little Feat's work most is that they always knew what notes not to play. What to leave out is as important as what to play, and you could never accuse Little Feat of over-playing. Certain combinations are just magical. Little Feat was magic of the first order. *M.T.*

Sound: B- Performance: A

Folk bag

Tom Bingham



Tartans & Sagebrush: Marie Rhines
Biscuit City BC 1323, stereo, $7.98.

Marie Rhines is hardly your everyday, garden-variety, old-time fiddler.

One can hardly refute her knowledge of, and talent for, both traditional Scots/Shetland fiddle styles and American contest fiddling as *The Cow That Ate the Blanket* and *Tom & Jerry* respectively demonstrate. But her highly developed technique, impressive as it is, strikes me as secondary to her innovative arranging concepts. Rhines fearlessly harmonizes time-honored fiddle tunes in a manner akin to chamber music, partly through an advanced variational sense, partly through the overdubbing of classically influenced multiple-violin textures. This aspect of her art was introduced on her debut album (**The Reconciliation,** Fretless 118) and is taken to even greater heights on side two of **Tartans & Sagebrush.** Note, in particular, *Mary Walker* with its harp-like pizzicatos, and *Jon Anderson*, in which Rhine also multi-tracks her singing into a small choir. On the last cut, though, she falls prey to the temptation to carry her ideas too far. Not that *Loch Earn* is poorly done by any stretch of the imagination, but at 7:26, it's woefully overlong.

Rhines also tries her hand at jazz on one track, a soulfully moody adaptation of Coltrane's *Lonnie's Lament*, backed by the superb jazz/classical bassist Charlie Burrell and Dick Weissman on electric guitar (who plays skillful acoustic guitar and banjo elsewhere on the album).

No doubt closed-minded purists will object to Rhines' tampering with tradition, but the results are without question successful enough artistically to withstand such carping. It would have been helpful if the titles of the tunes had been listed on the back cover; certainly there was room for them. (Biscuit City Records, 4027 East 50th St., Minneapolis, Minn. 55417.)

Tom Bingham

Sound: B- Performance: A-

John Herald and The John Herald Band
Bay 213, stereo, $7.98.

John Herald is best known as lead singer and guitarist for the Greenbriar Boys, who probably contributed as much as Bill Monroe, Flatt and Scruggs, or anyone else to the spread of bluegrass to urban audiences during the Hootenanny Era. Since then, he's worked most often in a contemporary vein, but this debut album by The John Herald Band suggests that Herald now realizes where his true talents lie.

Herald may not have a "pure" bluegrass voice, but pure bluegrass is what suits him best. This is not to imply that his contemporary-folk originals — in particular, the thought-provoking *Slightly Blind,* the Cajun-flavored *With Every Month* (with sturdy fiddle overdubs by Caroline Dutton), and the newgrass-tinged *Cowboy, You Ain't Plowing Now* — are without merit. Quite the contrary; the songs are striking, well-written, and insightful, while his singing is heartfelt and communicative. But when he lets his high-pitched nasal voice open up on bluegrass tunes like Bill Monroe's *Goodbye Old Pal* and Jim Eanes' *Wiggle Worm Wiggle*, Herald's infectious enthusiasm is absolutely stimulating. He's no less cogent on the more low-keyed *Shine Hallelujah Shine* and *Happy Sunny Side Of Life*. Never mind that his intonation, especially his crack-voiced, semi-yodelled embellishments, is of questionable accuracy; the man obviously feels his music, and that's what counts in the long run.

The John Herald Band provides fitting support for their leader's various moods. Fiddler Dutton has good ear for texture and appropriate licks. Banjoist Wanamaker Lewis is a tasteful accompanist whose breaks benefit from precise spacing of notes. Gordon Titcomb plays mandolin with a bouncing snap and a jazz-inflected syncopation that adds considerable rhythmic interest to the music. Roly Sally is a capable bass player, but only a so-so lead singer on two cuts. Guest appearances are made by fellow Bay artists Larry Hanks and Jody Stecher, a fine harmony vocalist named Willow, and Bernie Leadon, who plays second banjo on *Cowboy*.

In all, a welcome return for the best Armenian bluegrass singer ever to emerge from the hills of Greenwich Village. (Bay Records, 1516 Oak St., Alameda, Calif. 94501.) *Tom Bingham*

Sound: B Performance: B

Wish You Were Here: The Boys of the Lough
Flying Fish FF-070, stereo, $7.98.

Fulfilling a dream, The Boys of the Lough recorded their new album, the second live one they've made, during a tour of village halls in Scotland and the Highlands, the geographical source of the music The Boys play.

The recording is lively, capturing The Boys playing with exuberance and fluidity. The result is far more satisfying than their previous live album recorded at Passim's in Boston some years back (Philo 1026), and that was a fine album, too.

If you're not familiar with the reels, jigs, airs and songs that make up the repertoire of The Boys of the Lough, who both individually and collectively are one of the most amazing aggregations playing British and Irish traditional music, then **Wish You Were Here** is a superb introduction. For the fans it is a delightful addition to an ever-growing legacy. *Michael Tearson*

Sound: B+ Performance: A

Folk Music: LaDonna Smith, Davey Williams, Theodore Bowen
Trans Museq 2, stereo, $7.98.

Why would anyone entitle an album **Folk Music** when it has absolutely nothing to do with what we normally conceive of as "folk music?" Of course, the very asking of that question casts doubt on our entire conception of what is or is not folk music, which in turn renews the perennial debate over the validity, wisdom, and desirability of categorizing any musical expression.

Smith, Williams, and Bowen (known collectively as Trans, formerly a quintet called Transcendprovisation) employ "jazz" instruments (piano, electric guitar, string bass, tenor sax) as well as instruments which, though normally associated with other fields, also have well-established jazz credentials (violin, banjo). The trio's musical language, collective improvisation, is an outgrowth of "free jazz," combining still-recognizable roots with a good deal of their own developing originality (compare the greatly increased maturity of this record with their more derivative first album, **Trans**). So if they wanted to entitle this album after a musical idiom, shouldn't it have been more legitimately called **Jazz?** Or, since the trio's instrumental methods derive in goodly measure from techniques first evolved not in jazz, but by the academic avant-garde, why not classify it as "art music," the direct antithesis (or so some observers feel) of "folk music?"

What we're left with is a lot of questions for which the easy answers are superficial. After all, the answers lie in the music, not in words about the music. The music is by its very nature an attempt to define *itself*, which is more than I intend to do for it here.

If all this seems rather cryptic, you'll probably find the music no less so. Let's just say that if you buy this album because of its title, you're in for a big surprise! (Trans Museq, 1505 4th Ave., Tuscaloosa, Ala. 35401.) *Tom Bingham*

Sound: B- Performance: A

One Time Friend: Jay Round
TurneRound TR 5003, stereo, $6.98.

When last we met Jay Round, the adventurous young hammered dulcimerist was introducing his instrument to bluegrass. On **One Time Friend,** he goes another step further, applying his talents to modern country-folk as well as to a number of old-time favorites.

Tunes like *St. Anne's Reel* and *Devil's Dream,* of course, show the hammered dulcimer in its most familiar light. But it is a testimony to Round's clearheaded experimentalism and his highly evolved knowledge of his instrument's capabilities that the resonant chime of his dulcimer sounds equally at home on contemporary songs. Among the album's highlights are such unexpected contexts for the dulcimer as Lyle Mayfield's *The Longest Road Is Going Back Home*, Billy Joe Shaver's *Bottom Dollar*, and Round's own *One Time Friend* and *Jamestown Homestead* (the latter an impressionistic instrumental).

Also worthy of note are a novel arrangement of *Dixie* inspired by Mickey Newbury's *American Trilogy; Tribute to Chet Parker*, dedicated to the memory of Round's friend and mentor who was almost single-handedly responsible for the renascence of the hammered dulcimer in America, and *I'm an Old Cowhand*, which is close enough to a mild form of jazz to warrant further investigation into the improvisatory possibilities of the dulcimer.

Although I objected to Round's weak singing in my review of **Columbus Stockade Blues**, his quiet, nasal voice has matured considerably and is quite well suited to the folk-oriented songs on this album (though he still needs more work). Round competently overdubbed the bulk of the vocal and instrumental backing himself. The mix, however, could have been more judiciously balanced, with more dulcimer upfront in the instrumentals and less crowding of the middle channel. The amateurish delegation of the lead dulcimer to the right channel at the start of the duet section of *Redwing* is downright laughable.

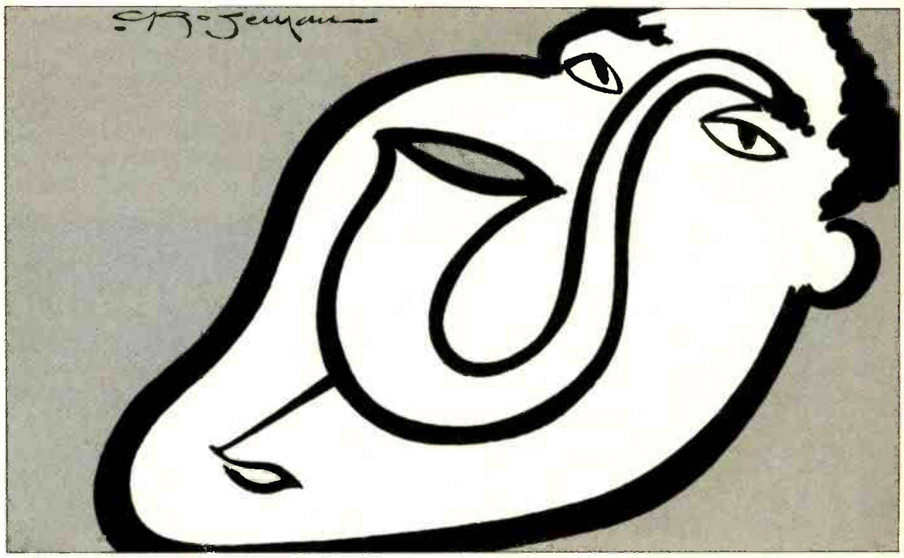
The last I heard, Jay Round had left Michigan for Hawaii. I keep wondering whether he and his hammered dulcimer have hooked up with any equally intrepid steel and slack-key guitarists. Don't laugh—if anybody could make it work, Jay Round would be the one! (Available from Donald A. Round, 6470 8th Ave., Grandville, Mich. 49418.) *Tom Bingham*

Sound: C+ Performance: B+

John Diliberto

John Lissner

Jazz & blues



Charlie Parker Reissues
The Very Best of The Bird
Warner Bros. 2WB 3198, 2 discs, mono, $5.98.
The Complete Savoy Studio Sessions
Savoy SJL 5500, 5 discs, mono, $6.98 each.
Bird: The Savoy Recordings (Master Takes)
Savoy SJL 2201, 2 discs, mono, $9.98.
Encores: The Savoy Sessions
Savoy SJL 1107, mono, $7.98.
Bird at The Roost: Savoy Sessions
Savoy SJL 1108, mono, $7.98.
One Night in Birdland
Columbia JG 34808, 2 discs, mono, $7.98.
Summit Meeting at Birdland
Columbia JC 34831, mono, $11.98.
Bird with Strings
Columbia JC 34832, mono, $7.98.

The incredible virtuosity, artistry, and musical genius of the alto saxist Charlie Parker has been extolled in so many jazz critiques and analyses that it is only necessary to say that there have been few more influential figures in jazz than Parker. During the past year, the stream of Parker reissues has reached flood tide; eight releases are reviewed here and put in perspective.

The splendid and sonically excellent Warner Bros. double-set offers us some of the most famous of the Parker Dial recording sessions made between 1946 and 1947. Here we are offered bop classics such as *Moose the Mooche, Bird's Nest, Yardbird Suite, Ornothology, Cool Blues, Scrapple from the Apple*, and *Relaxin' at Camerillo*. Accompanyists include a very young Miles Davis, pianist Erroll Garner, trumpeter Howard McGhee, tenor man Lucky Thompson, pianist Dodo Marmarosa, guitarist Barney Kessel, and bassist Red Callender. The music is indispensable for any modern jazz collection. On these tracks we have Bird reaching a maturity of style, sweeping through his identifying trademarks — the long complicated phrases contrasted with simple, sharply contrasted staccato and legato notes, the oblique, devious approach to the harmonic patterns of a tune, the bitter, caustic yet beautiful tone.

Parker's Savoy recordings more or less parallelled the time period of the Dial sessions. The remarkably comprehensive five-record set includes every released master, partial recording, and alternate take that Parker recorded for Savoy between 1944 and 1948. The set is a necessity for the jazz historian and the Parker scholar. It offers us not only the genius of the man, but also parades his foibles and mistakes. Here Parker's reed can be heard squeaking, popping false notes, and also creating pure musical magic. Since Parker never repeated the same solo the same way, listening to these alternate takes may be a fascinating experience for the *aficionado*.

The more casual jazz fan may be satisfied with **Bird: The Savoy Recordings**

(**Master Takes**). This two-LP set includes such essential Parker material as *Koko*, *Now's the Time*, and *Billie's Bounce*, and it is the album that people unfamiliar with Parker should begin with. **Charlie Parker Encores** is a single LP made up of alternate takes of the most important numbers from the double-set. It is an album recommended only for the Parker buff. **Bird at the Roost** is material culled from 16 broadcasts made from The Royal Roost, a Manhattan nightspot famous in the late '40s. Parker's work here is sometimes less precise than the earlier recordings, but his solos have dash and fire and are, as always, idea-packed. Trumpeter Kenny Dorham and pianist Duke Jordan helped to provide a cohesive group feeling. All of the Savoys retain the messy, muddy sonic characteristics of the original 78-rpm discs.

The Columbia recordings — **One Night in Birdland, Summit Meeting at Birdland,** and **Bird With Strings** — are just as low-fi as the Savoys, but the CBS engineers have made a valiant effort to give us the best sound possible from the extremely variable original material. The three albums are part of Columbia's current Contemporary Masters series, and cover some magnificent Parker taken off the air by engineer Boris Rose from live broadcasts from Birdland, Carnegie Hall, the Band Box, and The Royal Roost. **One Night in Birdland** is a particularly exciting two-record set that costars trumpeter Fats Navarro and pianist Bud Powell. The three principals are in dazzling form here. **Summit Meeting at Birdland** is also rewarding, as it features Parker supported by many of his bop contemporaries including Dizzy Gillespie, Kenny Clarke, Milt Jackson, and Bud Powell. **Bird with Strings** is a bit schmaltzy, but it offers two extraordinary solos on *April in Paris* and *Just Friends*, with Parker playing dazzling improvisations over five strings, harp, oboe, and rhythm. *John Lissner*

Very Best

Sound: B+ Performance: A+

Complete Savoy Sessions

Sound: C+ Performance: A

Savoy Recordings (Master Takes)

Sound: C Performance: A+

Bird at The Roost

Sound: C- Performance: A-

One Night in Birdland

Sound: B- Performance: A+

Summit Meeting at Birdland

Sound: B- Performance: A+

Bird with Strings

Sound: B- Performance: A+

Space Minds, New Worlds, Survival of America: Leroy Jenkins
Tomato Tom-8001, stereo, $7.98

Space Minds, New Worlds, Survival of America is the latest exploration by the adventurous violinist, Leroy Jenkins. When he is plundering old concepts for hidden ideas or creating new vehicles of sound travel, his music is never less than exhilarating. On this album he does both. The title composition exhibits a myriad of new colors with its odd instrumentation and the flexibility of its improvisors. The musicians are used as independent modular units who can plug into the superstructure, step out on their own, or recombine with other units. With a group consisting of Jenkins, percussionist Andrew Cyrille, Anthony Davis on electric and acoustic piano, George Lewis on natural and electronically altered trombone, and Richard Teitelbaum on Moogs, the textures and colors are wide and varied.

Space Minds . . . shifts through the timeless free-falls of Jenkins' and Teitelbaum's eerie sustained lines only to be caught in the turbulent rumbling of Cyrille's percussive washes across sheets of low-frequency electronic rocket blasts. Musicians shift between segments of quirky counterpoint round-abouts and collective plunges of swirling improvisation. The group consciousness of these musicians allows them to follow and support each other in the wildest and most spontaneous changes. The interface between electric and acoustic instruments comes together so well because these are players of sound and not merely notes.

On the flip side, Jenkins jettisons the electronics and Teitelbaum in a set of four quartet pieces. *Dancing on a Melody* features a romantic melody played by Jenkins and Anthony Davis between Cyrille's punchy percussion and an extended jaunty solo by George Lewis. *The Clowns* is a frenzied collective improvisation. *Kick Back Stomp* is also largely collective but with a flowing continuity that brings each individual soloist to the fore. The album closes with *Through the Ages of Jehovah*, a low-key, wistful reminiscence.

Among all the intellectual concepts and virtuoso muscianship, there are powerful emotions and an ability by these players to express themselves directly. The recording enhances this directness with a precision mix giving each instrument space while at the same time allowing them to blend in textural harmonics. **Space Minds, New Worlds, Survival of America** lives up to its ostentatious title. This is music of open minds, of new physical and mental territories, and of a place where this music is still allowed to thrive and be brought to the public. *John Diliberto*

Sound: B Performance: A

The Rise of Atlantis: Carter Jefferson
Timeless Muse TI 309, stereo, $7.98.

The saxophones of Carter Jefferson should be no stranger to anyone familiar with the straight-ahead drive of the Woody Shaw Quintet. As a member of that unit, Jefferson has served as both foil and focal point. With **The Rise of Atlantis,** he makes his recording debut as a somewhat tentative leader. Jefferson uses two different groups with two very different sides of music.

The first side is oriented towards melody and mood, with two tunes embracing Latin modes and a third establishing a swinging groove. *Why is a* lush samba that has Jefferson's sweet soprano intertwined amidst breathy cries from vocalist Lani Groves. The rhythm section of Victor Lewis (drums), Steve Thornton (congas, percussion) and Harry Whitaker maintains a steady pulse, but the whole thing is held together by the supple bass work of Clint Houston. His supple tone and flexibility provide the album with all its warmth. *Wind Chimes* alternates between a snappy Latin canter and an easy shuffle. The title piece is an arid but brisk caravan with a fiery Jefferson tenor and a flighty and weightless solo from trumpeter Teramasa Hino.

The problem with this first side is that spontaneity and free-wheeling playing have been sacrificed in an attempt to generate a specific mood. On side two, uninhibited by preconceived moods, emotions are free-flowing. The difference is immediately evident on *Changing Trains*. The Victor Lewis-Clint Houston team is supercharged and fast. John Hicks, replacing Harry Whitaker on piano, is fluent in his comping and riveting when he steps out to solo. Jefferson simply smokes on top of this in an explosive flurry of tenor statements. *Blues for Wood*, written by Woody Shaw, is another straight-ahead tune with bristling solos from Shunzo Ono on trumpet and from Houston. Jefferson plays the head on tenor but switches to soprano for a swirling run. The final piece is a dark, starlit ramble called *Song for Gwen*. Jefferson settles in on some smoky tenor while the rhythm section lays down a subtly caressing pulse.

When Carter Jefferson allows the tunes to work for him, he is an able leader who allows his musicians to generate their own excitement. When he stays within the confines of a tune and trys to create a mood to suit it, he plays competent but uninspired music. The recording is clean and unadorned, but the dry sound does no justice to the warmth or power these musicians extract from their instruments. *John Diliberto*

Sound: B– Performance: B–

The Individualism of Wild Bill Davison
Savoy 2229, 2 discs, mono, $8.98.

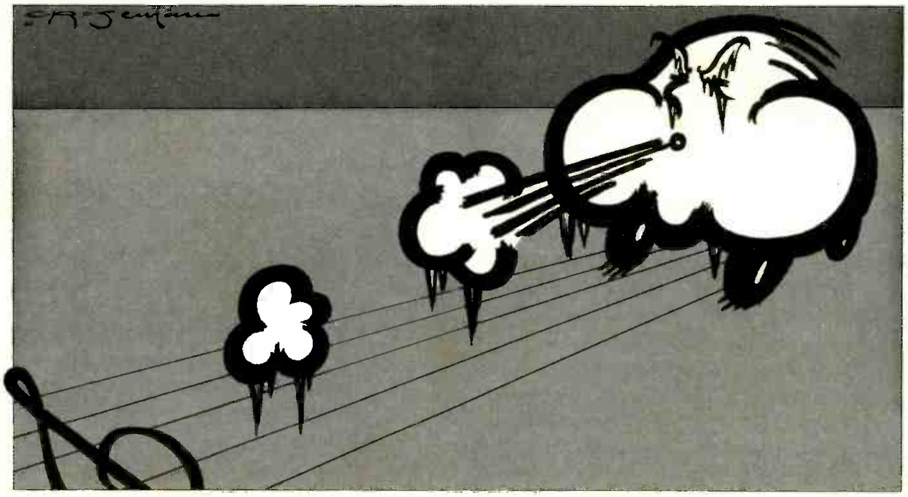
Well into his seventies, the Dixieland veteran Wild Bill Davison still blows some of the cockiest, sassiest, most rambunctious trumpet in jazz. This two-record set is a repackaging of two Savoy LPs originally released in 1951, **Ringside at Condon's** and **Jazz at Storyville.** Wild Bill's playing here on standards like *Blues My Naughty Sweetie Gave Me, Wrap Your Troubles in Dreams, The Original Dixieland One-Step, Squeeze Me, Dippermouth Blues, Sweet Georgia Brown, Struttin' with Some Barbecue, Keepin' Out of Mischief Now*, and *If I Could Be With You* is typically brash, tart, and edgy; his driving choruses can only be described as joyously swinging.

The 10 **Jazz at Storyville** sides are taken from a November 7, 1951, broadcast and they offer, at best, moderate fidelity. Davison is backed by a sizzling rhythm section (George Wein on piano, John Field on bass, and Johnny Vine on drums) which sustains and supports his barking, staccato comments. On the "at home" at Condon's sides, the support by traditional jazz veterans like Ed Hall on clarinet, Cutty Cutshall on trombone, Gene Schroeder on piano, Condon on guitar, and Cliff Leeman on drums is vibrant and kicking but somewhat obscured by the muffled, shrill sonics of the original Savoy recordings. Engineer Rudy Van Gelder deserves our thanks for managing to clean up the sound on the repackage to where it is at least listenable. *John Lissner*

Sound: C Performance: A

Classical reviews

Edward Tatnall Canby



To Drive the Cold Winter Away. (A Fireside presentation of music). St. George's Canzona, dir. John Sothcott. **Vanguard VSD 71261,** stereo, $7.98.

There are now hundreds of recordings of the typical "pro musica" or "collegium musicum" groups of old-instrument performers, often with voices as well, to give us a prolific idea of the sound of music back in the Renaissance and Middle Ages. The problem, both in concert and in recordings, is how to present the vast quantities of very short little items (by later standards, that is) which make up the ever burgeoning restored repertory for these groups.

This item from Vanguard, licensed out of England (1975) gives us a new and probably unique slant. The music is very largely *composed* — or at least arranged, harmonized, set, whatever — by the leader of the group, John Sothcott, a man who is definitely not a Renaissance man, chronologically speaking. Quite an idea and I like the result.

For instance, you will hear a batch of very familiar old English tunes, the kind every child learns, including *God Rest You Merry Gentlemen* and *I Saw Three Ships,* sung to an accompaniment of ancient instruments, just like for real — but the settings are modern, written out by Mr. Sothcott from his own fertile musical imagination. Odd, but nice. Even stranger for an old country dancer like me is a group of the well-known Playford dances, English "country" dances (actually city dances) which to this day are danced to by thousands of fans all over the Anglo world under the leadership of the Country Dance and Song Society, both here and in England. The original tunes were published just as tunes — no harmonization. But some of the dances, the earlier ones, were set by contemporary composers like William Byrd in Elizabethan times. The dancing arrangements now used are modern, with modern instruments plus an occasional pipe or wheeze box and drums. So what do we have here? Braces of Medieval-Renaissance instruments playing the tunes, but again in arrangements composed today. Strange and lovely! But definitely not for dancing. It just happens that I actually was involved in dancing one of these tunes only a month or so back. It is a "long dance," like a Virginia reel, and the version on this record would be just fine for a herd of giraffes.

No matter. The best thing about this excellent record, danceable or no, is the high musicianship of all concerned, following after the prolific John Sothcott. These people play with spirit, intelligence, humanity. Their instrumental techniques are good but the careful shaping and phrasing are even better. And I like the deliberately "pop" style of singing, a big thing in England now for old music and a lot better than the operatic vocal sounds too often heard in our own old-music performances in America.

Sound: B Recording: B+ Surfaces: B+

Hummel: Septet in D Minor, Op. 74. Berwald: Grand Septet in B Flat. The Nash Ensemble. **Vanguard VSD 71260,** stereo, $7.98.

There is no nicer musical period to rediscover today than the early 19th century. It has a freshness and a romantic exuberance that somehow just fits our needs in this ominous, sour age we live in.

Here are two Septets by able composers of that time, if not so well known at this moment, Hummel around 1817 (he was a student of Mozart, successor to Haydn at the Esterhazy establishment in the Austrian Empire) and Berwald, 1828, a mildly eccentric Swede of enormous talent who was not well recognized in his homeland — like Charles Ives, he went into business to make ends meet. Both men echo the "greats" of their day and before, from Beethoven to Weber and Chopin and Berlioz, but both of them had immense musical abilities, if not on the super-genius plane, and we can enjoy their outgoing and joyous music today as it must have been by the favored few in their own times.

On records, in the living room, a Septet is as big as an orchestra and a lot clearer in detail. Tremendous sound! The Hummel Septet features the piano as solo (Hummel was a celebrated pianist, as you can immediately hear) with strings and woodwinds around it. Berwald's Septet has no piano and accentuates the three wind instruments. Hummel has much that reminds of Beethoven and Schubert with a touch of Weber; Berwald, a year older than Schubert, writes an individualistic music, full of quirky rhythms, short, twisty themes, sudden changes, a style even here in his youth (he was just over 30 and lived a lot longer) already very much his own.

The Nash Ensemble is superb. Such perfect musicianship, such verve, such enthusiasm! And particularly, the pianist Clifford Benson, in the Hummel, is unbelievably fleet and skittish, a pianistic faun. Lovely.

Sound: B+ Recording: B+ Surfaces: B

Rameau: Suites for Harpsichord in A Minor, E Minor. Trevor Pinnock. **Vanguard VSD 71256,** stereo, $7.98.

Trevor Pinnock began his musical life as a "chorister" — a choirboy — in, of all places, Canterbury Cathedral. That surely was an experience to affect a person's whole life in music and it could account for the very smooth articulation and phrasing of these works by Rameau for the harpsichord, in spite of the well-known and enormously elaborate ornamentation that is a part of the Rameau style. Here, it flows like oil, and the underlying melodies are effortlessly projected.

The French had a habit of writing instructions on how to play their music more or less integral with the actual published notations. As a theorist and writer about music, Rameau was particularly fluent in his directions — just as well, considering how much of the music is not literally contained in the notation. In addition, many of the pieces in these suites were also used as part of Rameau's opera music — in which case he wrote out for the orchestral musicians some of the ornamentation and "unequal notes" (like jazz/pop playing of eighth notes today) which are left to the judgment of the solo keyboard player in the suites. One more aid to a reconstruction of this extremely complex keyboard art. All of which, as I say, leaves Trevor Pinnock unfazed. Rarely has this French composer sounded forth with such fluent ease.

Sound: A- Recording: A- Surfaces: B+

P. D. Q. Bach — Black Forest Bluegrass. (Cantata "Blaues Gras," No-No Nonette, Hear Me Through. John Ferrante, bargain counter tenor; The New York Pick-Up Ensemble. **Vanguard VSD 79427,** stereo, $7.98.

How does this man go on! That is, P.D.Q.'s alter ego, Peter Schickele, who has been turning out these musical spoofs, right on the dot around Christmas time each year, forever, almost. And each year Vanguard takes up the live performance and shoots it out to us in hi-fi. This one is as good as any of 'em — Mr. Schickele's peculiar genius is not failing.

Of course, this sort of corn would be no more than that, with all the crudity of an endless series of brutal puns, if it were not for the really splendid, subtle, and beautifully tailored pseudo-music that goes with it. As I've had to say many a time before, Schickele's P.D.Q. has a marvelous sense of parody in the original meaning, that is, going-along-parallel-to — whether serious or otherwise. This little "Blue Grass" Cantata is just delightful, a gentle and absolutely totally musical take-off of a good mid-eighteenth century cantata in German. Bach, of course, neatly mixed up with bits of Kentucky Blue Grass. Mr. Schickele himself is the first soloist we hear — he can barely sing in tune, but he knows whereof he sings. The other solo is by the ever-determined Mr. Ferrante, a real bargain tenor all right — and the pair of them even sings duets.

'Nuff said! Find out for yourself what the rest of it is all about. You will not be disappointed. Especially if you hate Bach. (But even more if you just love that Baroque sound.) And if you enjoy — well, say no more.

Sound: B+ Recording: B Surfaces: B+

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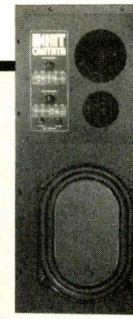

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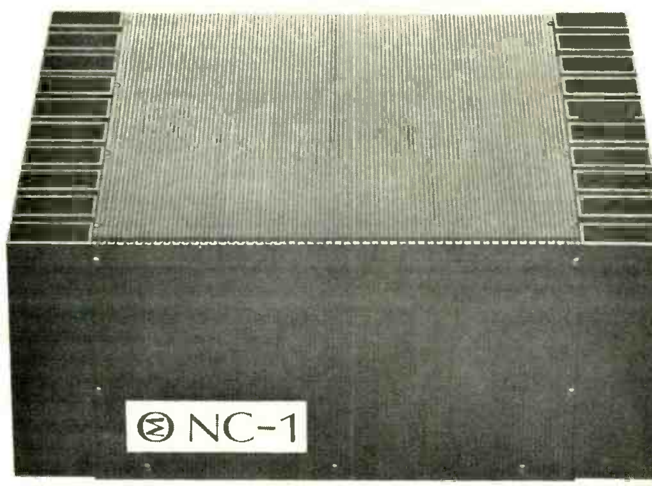

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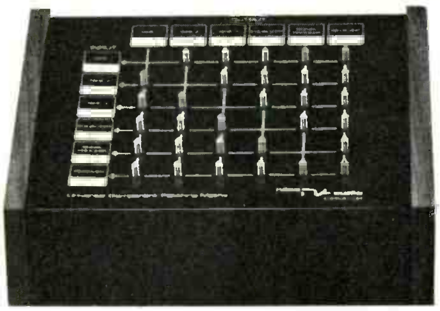

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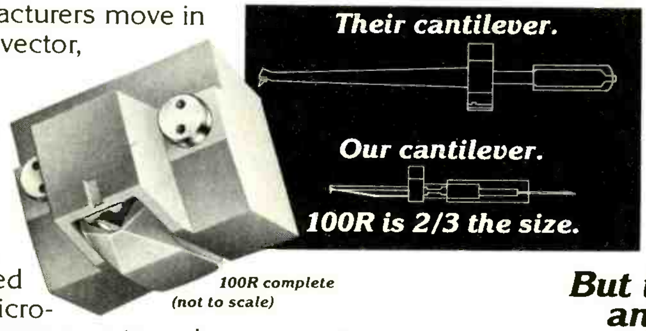

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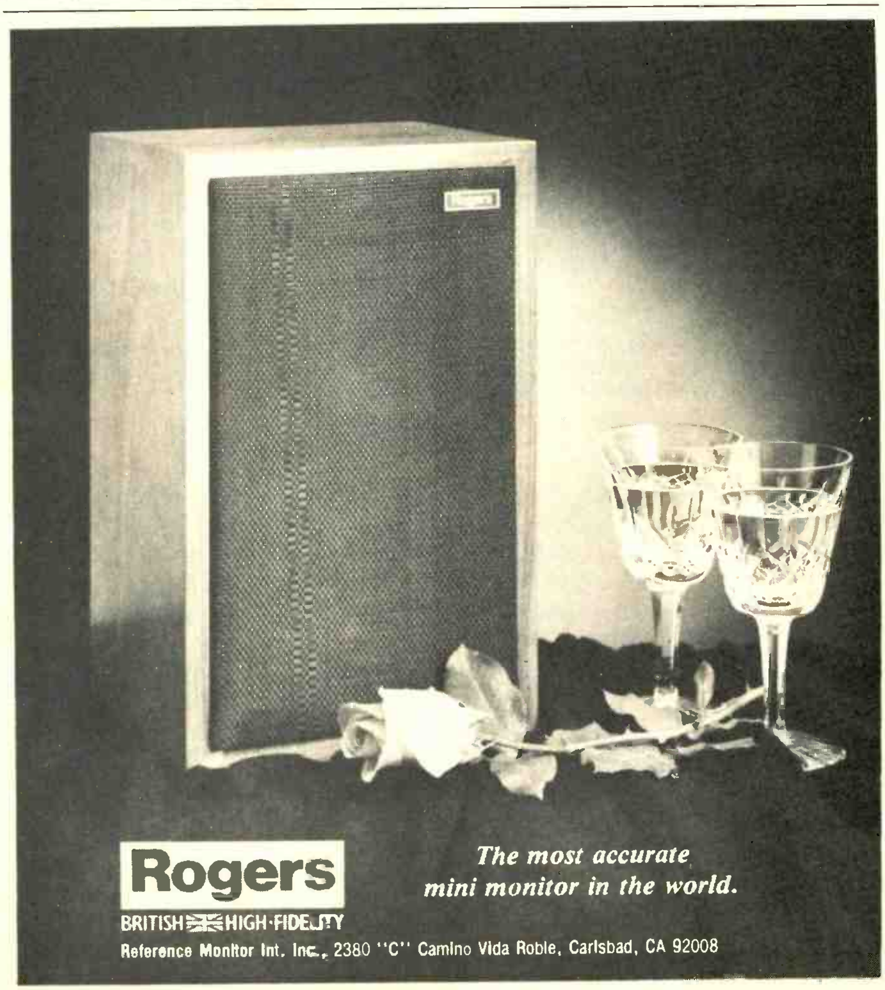

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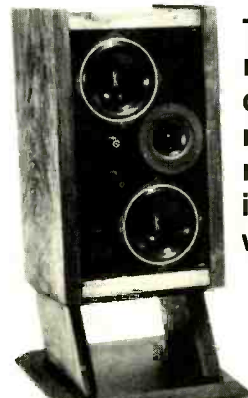

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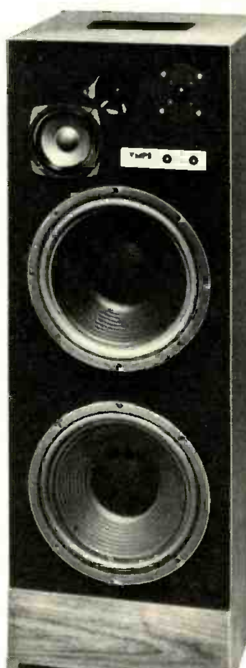

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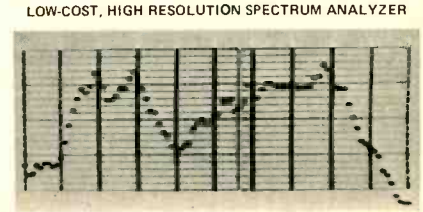

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