Audio

The Authoritative Magazine About High Fidelity

JANUARY 1982 • $1.50 • Ⓕ06030

HANDS-ON REPORT: TECHNICOLOR VTR

ANTENNAS:
- Ultra-Directional Rhombic FM
- AM Superloop

YOU BUILD THEM!

REVIEWS:
Nakamichi 700ZXL

dbx Auto Equalizer

NAD 6050 Cassette Deck

Adcom XC Phono Cartridge

0 27100 06030 01

A WHOLE NEW
OP OF ALL THESE FEATURES.

have won Pioneer acclaim throughout the high fidelity industry.

Pioneer's engineers have designed an exclusive ID MOS FET transistor for the front end of the SX-7's tuner. It allows you to tune in stations with weaker signals without worrying about stronger stations causing distortion due to front end overload. That's what keeps the SX-7 virtually free of RF intermodulation.

But no matter how free a receiver is from all forms of distortion, it must be able to keep the station you select perfectly tuned for hours. Pioneer's quartz-PLL digital synthesized tuning does this by making drift virtually impossible.

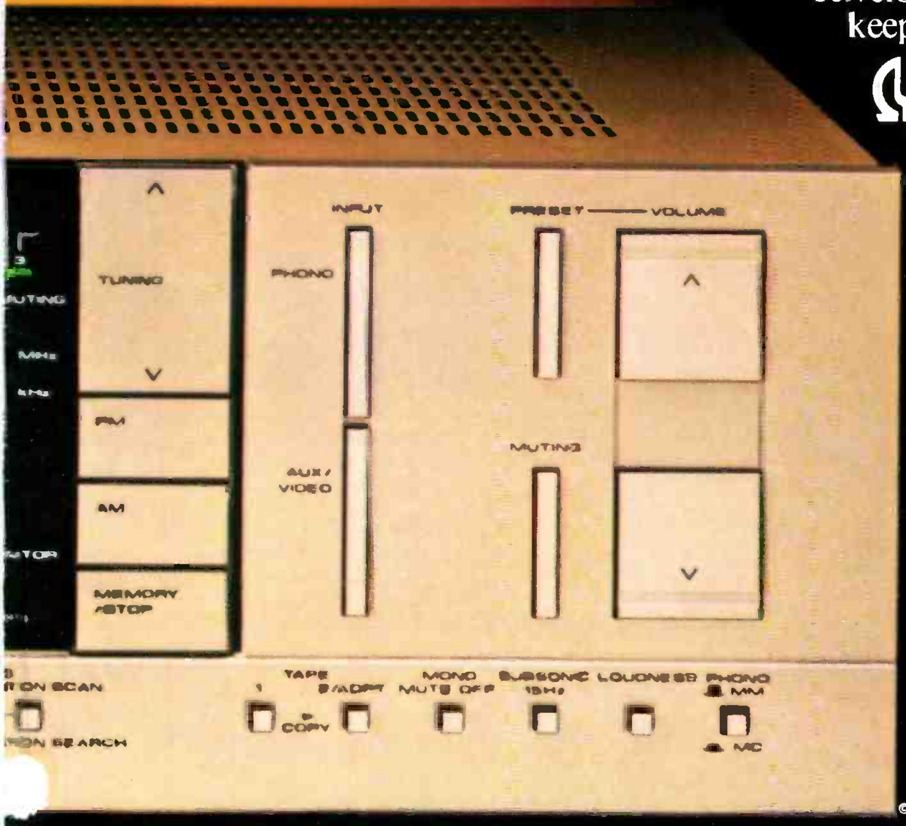
Pioneer's exclusive Non-switching™ amp also eliminates distortion caused by output transistors switching on and off thousands of times a second in response to music signals. This is one of the reasons that the total harmonic distortion of the SX-7 is no more than 0.009% (continuous average power output of 60 watts per channel minimum at 8 ohms, from 20Hz to 20,000Hz).

And Pioneer's high-gain phono preamp section allows the use of either MM or low-output MC cartridges selectable by a front panel switch. There's even a Subsonic filter you can use to do away with very low frequency interference caused by record warps.

Now if you think all these features sound great in print, listen to them in person at your nearby Pioneer dealer. He'll demonstrate the SX-7 and an entire new line of Pioneer receivers. And you'll quickly see that we've done everything humanly possible to give you more music for your money.

That's what made Pioneer No. 1 in receivers. And that's what's going to keep us there.

SX-7 RECEIVER.



PIONEER®
We bring it back alive.

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AND ONLY PIONEER OFFERS A
ENGINEERING CONCEPT ON T

You'd expect a new receiver from the leading manufacturer of stereo receivers to be packed with exciting features. As you can see, it is. But Pioneer didn't get to be No. 1 in receivers by doing the expected and stopping.

So we developed the SX-7 using a unique engineering concept we call High Fidelity for Humans. It makes the SX-7 as superb to live with as it is to listen to.

At the heart of the receiver is a microcomputer that's been programmed to operate controls electronically. It affords the owner of the SX-7 operating convenience unlike any previously available in conventional receiver designs.

For example, the microcomputer's prodigious memory allows you to preset up to eight FM and eight AM stations and recall them instantly. Once set, all stations are directly accessible via "Station Call" buttons. And you can even recall them at the preprogrammed volume level because the microcomputer electronically controls volume setting.

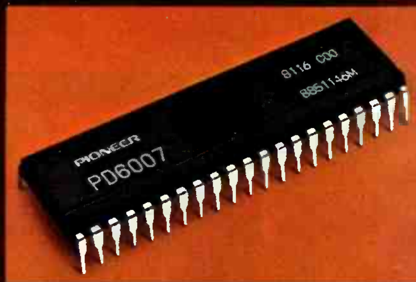
What's more, with just the touch of a button you can search out the next station up (or down) the AM or FM tuning band. Stations are brought in perfectly tuned every time. And you can select any station by tuning it manually or scanning the entire band automatically sampling five seconds of each station.

But these human engineering features aren't all that make the SX-7 such an extraordinary receiver. It also offers features that

INTRODUCING THE PIONEER

NO OTHER RECEIVER OFFERS ALL THESE FEATURES.

Computerized Push Button Controls:



Pioneer has programmed a microcomputer to operate controls electronically for improved accuracy, reliability and convenience.

Quartz PLL Digital Synthesized Tuning:

FM "Drift" is eliminated by this incredibly accurate tuner.

Station Scan:

Touch this control and you'll hear five seconds of every station strong enough to meet the mute threshold.

Station Search:

Touch this control and move to the next station up, or down, the band.

Subsonic Filter:

This control lets you do away with ultra low frequency distortion caused by record warps and such.

Touch Volume:

The SX-7 will digitally display and recall any of 32 volume levels at the touch of a button.

Eight AM presets, eight FM presets:

The SX-7 will memorize eight of your favorite FM and eight of your favorite AM stations and retrieve them instantly.

Non-Switching Amp:

Pioneer's patented amp design gets rid of transistor switching distortion once and for all.

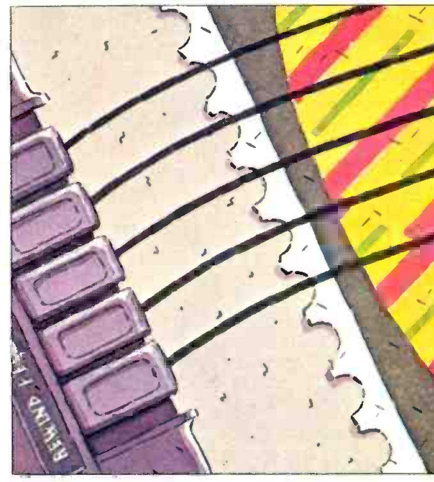
High-Gain Phono Preamp:

Allows the use of either MM or low-output MC cartridges.

ID MOS FET Front End:

This exclusive transistor circuitry tunes in weak stations as clearly and quickly as strong stations.

Audio JANUARY 1982 VOL. 66, No. 1



FEATURE ARTICLES

EQUIPMENT PROFILES

RECORD REVIEWS

AUDIO IN GENERAL

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The newest addition to our world-renowned line of graphic equalizers is the **AS1000,** the most accurate Real-Time Analyzer you can buy, thanks to Soundcraftsmen's revolutionary Differential-Comparator circuitry. It complements any high-quality octave equalizer and it's fast and simple to use. Truly the professional's choice . . . $499.

See your participating Soundcraftsmen Dealer before JANUARY 31, 1982 and ask about a VERY SPECIAL OFFER on the Soundcraftsmen SOUND MODULE!

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Sansui.
The story of high fidelity.

High fidelity was born just a generation ago. So was Sansui. In 1947, when the transistor was invented, we began as a manufacturer of high-quality audio transformers. Since then, Sansui's dedication to the sound of music and our extensive R & D have led to countless technological breakthroughs and products that have continually advanced the art and science of high fidelity. Some highlights:

1958: The year of the first stereo recordings also brings the release of our first stereo amplifier.

1965: As hi-fi widens its appeal, we introduce our first stereo receiver, the TR 707A.

1966: Sansui's U.S. subsidiary, destined to be outgrown in little more than a decade by our new headquarters in Lyndhurst, N.J., begins operation.

1970: QS, Sansui's patented 4-channel system, gains worldwide recognition.

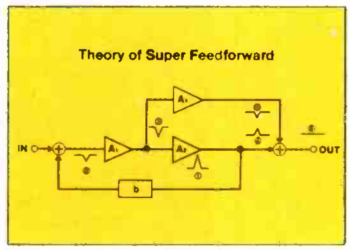
1976: No less a leader in broadcast than in consumer audio technology, Sansui introduces two stereo AM systems at the Audio Engineering Society convention.

1978: Psychoacoustic research into the subtle but very real deficiencies in bass and in transient response in music reproduction results in Sansui's introduction of DC amplifiers, the renowned G-series receivers, and our patented DD/DC circuitry. These advanced technologies reduce distortions whose very existence had been questioned until we developed a straightforward measurement technique to verify on a meter what listeners' ears had long told them.

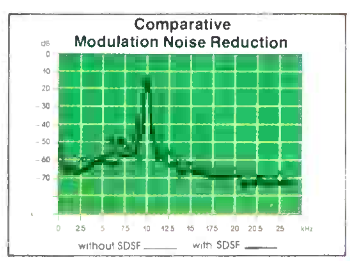
7900Z RECEIVER

1979: Sansui's patent-pending D-O-B (Dynaoptimum Balanced) method of optimally locating the pivot point results in significantly lower tonearm susceptibility to unwanted vibrations. The same year Sansui introduces the first member of our trend-setting system approach to hi-fi componentry, the Super Compo series.

1980: Developing a theory first suggested in 1928, Sansui presents the first Super Feedforward amplifiers, the realization of a design that eliminates even the last vestiges of distortion that not even negative feedback could combat. This development inaugurates a new era in the reduction of amplifier distortion and firmly establishes Sansui as a world leader in this important work. Eager to maintain its technological leadership, now also in video, in the same year Sansui develops an ultra-compact gas laser-optical pickup, some 40 times smaller than conventional detector systems, that promises to play a vital role in future compact digital audio disc players.



1981: Modulation noise, long a problem in cassette recorders, is reduced to virtual inaudibility by Sansui's patent-pending Dyna-Scrape Filter. Equalization that's simple enough for practical home use is realized with Sansui's computerized SE-9 equalizer, which not only achieves professional results in record or playback, but also permits storing up to four instantly-selectable equalization curves.



At the 1981 NY AES, we presented four major papers outlining breakthroughs in both audio and video engineering, each of which will lead to products to enrich all our lives.

Sansui's story and the story of high fidelity. They are really one ongoing story, and the future is bright for both.

TU-S9 TUNER

AU-D11 AMPLIFIER

1982
NEW TECHNOLOGIES TO COME.

1981
DYNA-SCRAPE FILTER.
DIGITAL EQUALIZER.

1980
SUPER FEEDFORWARD.
LASERDISC PICK-UP.

1979
D-O-B TONEARMS.
SUPER COMPO.

1978
G-RECEIVERS.
DD/DC AMPLIFIERS.

1976
AM STEREO.

1970
QS 4-CHANNEL.

1966
U.S. OPERATION BEGINS.

1965
STEREO RECEIVER.

1958
STEREO AMPLIFIER.

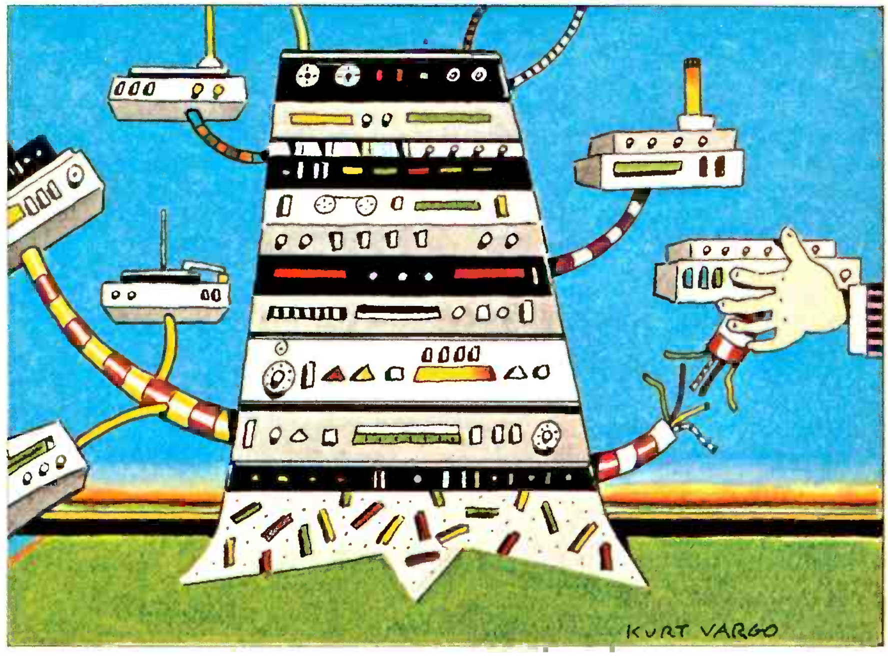
1947
SANSUI FOUNDED

Sansui

SANSUI ELECTRONICS CORPORATION
Lyndhurst, New Jersey 07071, Gardena, CA 90248
Sansui Electric Co., Ltd., Tokyo, Japan

AUDIO ETC

EDWARD TATNALL CANBY



What seemed at first to be no more than a cosmetic development in recent top-level hi-fi, I'm beginning to think, can turn itself into a significant change in our long-time system of componentry, separate, semi-interchangeable equipment units from many manufacturers, assembled to choice in individualized home systems. It has taken us some 30 years to work out the multiple standardizations which this demands — are we now turning a corner back in the other direction?

Not really. But we are indeed creating a new option. Here's how it came home to me, figuratively and literally.

Phone call from the Editor in New York, a bad connection. He had some sort of equipment he wanted me to try. A Clmlzztxn? I didn't get it. A what —? A COLLECTION, he replied, ever so distinctly. I started to ask again but thought better. Oh sure, I said casually, just send it right on. Glad to oblige. And hung up, mystified. A collection of what —?

Five minutes later I got the idea. I was looking at a hi-fi ad. It featured, not components, but something called "Separates," amplifier, record player and so on. Ladies' wear? "A pink blouse and a blue skirt," said a lady who was with me at the moment.

No dear, not any more. This is hi-fi. And so in a flash I saw what a Collection just had to be. *Haute couture!* In hi-fi terms, of course. Like something out of Christian Dior or maybe Bill Blass. Ensembles of the fanciest, all from one glamorous designer. Separates, but going harmoniously together, with panache. That would be a Collection.

In this case the glamorous designer turned out to be Technics, a name, as they say, to conjure with. And the mail soon brought me the promotion, in four-color glossies. There it was: The Technics Studio Collection. Top of the line. After a suitable pause for shipping, the Collection itself began to appear *chez moi.* What a spectacular entrance! First came four big boxes via UPS and I tried to help the driver in with them, which was a *faux pas* because she was a lady. Then, while I was out, another UPS truck delivered more boxes to the local grocery store, where I had to retrieve them. I began to catch on to the awesome scope of this Collection.

You can, of course, buy these units one by one if you so desire. These are still compon —, I mean Separates, and they will operate in the traditional fashion, connected to items from elsewhere all over. But the impetus is clearly and impressively on a one-ness, a Whole. *E pluribus unum.* That's the idea.

Now if you think I could get through all that marvelous pile of goods in time for this writing, you do even the packages a grave injustice. After all, it takes a good half-hour just to undo one of those foxy shipping boxes and get its parts all stowed away for future reference. At this moment I have worked extensively with only one of the Separates, the linear tracking turntable, which got me so interested I put all the rest aside. More in a moment.

My eyes are already fixed on the enticing box that contains what must be one of the most fabulous cassette decks around, among numerous other fabulous machines. And then there are the speakers, with the new Technics honeycomb flat piston radiators replacing cones and domes. I'll insert these into my present system for a bit, to see what they can do.

In the end, given time, I'll put the whole Collection together, but that will be in another room, another place, away from all present hi-fi. I need a whole new start for this Collection on its own.

For your info, here are items sent to me as part of the Technics Studio Collection. Two SB-6 speakers (there is a larger and a smaller model); three matching units, in identical slim and stylish cases, the SE-A7 stereo/mono d.c. power amp, the SU-A8 control amp and the ST-S8 quartz synthesizer FM/AM digital tuner. And finally, the second-generation SL-QL1 quartz linear tracking table, astonishingly compact, styled to match the rest. I assume that when you mount these in a rack there must be a bit of ventilation in between each; even so, the economy of space is impressive and the *haute couture* definitely new and unusual. Technics provides its own home-style rack for all this, optionally, and you'll probably want it. That's the clincher that makes the many into one, the *pluribus* into *unum*.

I must add hastily that, whereas at the moment I am overwhelmed with Technics, other manufacturers are clearly onto the same trend, if with different nomenclature. Also from Japan, for instance, came Nakamichi's early and widely admired line of matching black components, though these weren't officially billed as a Collection or such. The idea was there, nevertheless, and still is. And you have seen the ads for Technics' simpler blood relatives, the Panasonic SoundScape systems, ready mounted in another handsome rack. These go fur-

Illustration: Kurt A. Vargo

...and then came the SE-9.

35 years ago, to satisfy listening preferences, serious music lovers had to redesign their listening rooms. Remove the drapes. Add a rug here. Rearrange the upholstered sofa there. Get rid of that crystal chandelier!

Bass and treble tone controls came later, and they helped—but only a little. When you needed a boost in that lowest bass region, you had to accept boosted upper bass and mid-range tones as well—whether you needed them or not.

By 1958, the first equalizers appeared. They allowed you to alter specific bands of tones to suit the needs of the listening room—and the music program. With special mics, a pink noise generator, and a real-time analyzer, you could electronically adjust your system to your listening preference. If—that is—you didn't mind spending several thousand dollars and a half hour adjusting and readjusting controls to enjoy a half hour of listening.

Then came Sansui's remarkable SE-9 Compu-Equalizer. It takes the guesswork and the frustration out of equalization. At the touch of a button the SE-9's built-in pink noise generator feeds its signals first to one speaker, then the other. Sounds picked up by the SE-9's calibrated microphone are then analyzed by its microprocessor. Sit back and watch in amazement, as the SE-9's motorized system moves each of its 16 fader controls (8 per channel) to create the curve that yields precisely flat response at your preferred listening location.

Touch another button, and the curve is memorized for future, instant recall. Move to another location—even another room—and the SE-9 can create and store a new curve—up to four of them.

At last, after 35 years, a perfect equalization system without errors or frustration. And, at a price that makes perfect equalization affordable for all serious music lovers.

See the SE-9 and Sansui's truly complete line of high quality components and systems at your Sansui dealer today. Or write to us for details.

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Sansui Electric Co., Ltd., Tokyo, Japan

Sansui

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ther; they even feature collective model names, the P-9, for instance, and it is pointedly suggested that you "escape from the world of technical intimidation." Does that smack of anti-component propaganda? And yet in that rack you see five genuine, uncompromised components, Separates, including another linear tracking turntable, all matched in size and looks in the same way as the higher-up Technics Studio Collection. You can have your hi-fi cake and eat it.

Good. Because all these units match electronically as well as visually, and they are newly compact — good, good! And, above all, they forcibly avoid the hideous compromises of a million older unified hi-fis and stereos that have tried to bridge the gap between the old single-piece radio or phonograph and the multiple systems that have made our business what it is. This time, it's for real; none of these new systems, whatever they are called, are compromised merely to get them into one piece or onto one rack. That's a big positive. I find it indeed wise, and appropriate, to start this new, uncompromised, centralized one-maker equipment at the top level. Even a hint of corner cutting, today, could kill the idea dead for all of us. We've seen enough of that. In due time, quality for quality, price by price, the Collection idea can surely move downwards towards simpler but still valid formulations.

That is, until we reach the bottom, where those cheaper monstrosities that now call themselves hi-fi manage to look extremely pro, replete with shiny knobs and switches and readouts, but boast monster 3-watt power amps inside and a cheapo turntable on top, plus little outrider speakers in cardboard boxes. Not that! There, friends, I hope we will stop. Let those who will. Not us. That's no Collection.

Fortunately, the Technics turntable, the only part of the Collection that I have really got to know well by this time, was reviewed in an "Equipment Profile" here (November 1981). What remains is for me to communicate my deep musical enthusiasm for this remarkable little player with its motor-driven arm that moves directly sidewise across the disc, with no pivot at all in the rear. It is, frankly, the easiest, most effective turntable I have ever used and, so far, there are no reservations except maybe that I'd prefer to have my own cartridge, rather than the fixed "house model" that came built into my player. (You can, as an option.)

This machine is so SMALL! It is a pleasure just to look at it. It is 17 inches wide (to match the other Collection items) but stands only 3½ inches high with a depth of under 14 inches. It fits beautifully into my equipment cabinet. The top dust cover — which, remarka-

It has taken us 30 years to work out the standardizations demanded by separate components. Are we now turning a corner back in the other direction?

bly, carries with it the entire arm and cartridge system — is only an inch tall above the motor board; I can really open it wide, in contrast to the bulky plastic covers on other tables.

The thing just plays. Astonishing. From the very first try it worked to perfection. It lowers its little arm precisely and quickly, plays anything, even a violently warped disc I had around, and tidily winds itself back to the start after each play in short order. Always starts right, always stops right. And no swinging arm here! The cartridge is so far in the back it is well out of the way of most danger.

If the top is open, nothing happens. Won't play. Close it and the machine goes. All so casually. No complications, no problems. The mark of good design, good ergonomics, a machine modelled for the human being who uses it.

But what has capped my joy is that the necessary remote cueing system, for an arm that cannot be moved by hand, works better than a charm. On this table, I hit a chosen LP band by remote control right on the nose four out of the first five times I tried. I couldn't believe it; I got an outsider to try. On the nose, too, every time. It can be done! No space to describe the compact two-speed action, but I'll stand on my statement: This machine cues up via buttons with as great accuracy as any hand cueing I have ever performed, and maybe better. Also minus danger. All you need is a proper light, which is nothing new.

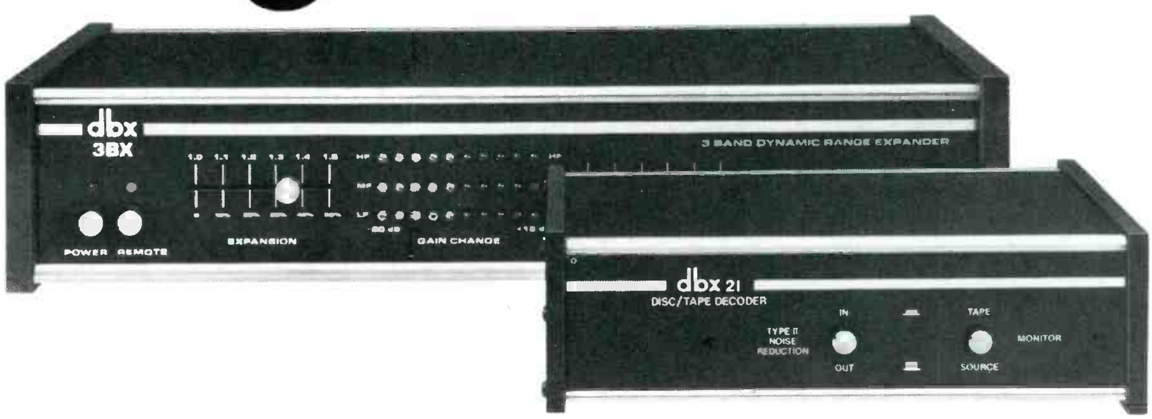
I think what really fascinates me in this type of player (there are others, past and present, including, for example, the current Bang & Olufsen line from Denmark) is the sheer fact that the things work at all. Until we had our present microprocessors and their relatives, plus tiny d.c. motors, super-correction via light beams, and so on, the sidewise-drive arm was mechanically impractical and often dangerous. It could cut its own grooves right on top of yours, or shave off hundreds of feet of signal. You just can't track a groove sidewise the way you track it out at the end of a pivoted tonearm.

True, Edison's original phonograph played this way and so did a million later cylinders. But in those days the signal modulation was all vertical and, more important, the pitch of the record spiral was fixed. You could screw an overhead player across with a reasonable chance that it would match. No more! Today, with both vertical and lateral excursion, our LP grooves are variably spaced, according to the musical amplitude. No fixed mechanical screw drive could cope with that. The drive has to be adjustable and there must be a way to tell the thing when to go faster or slower, controlled by the grooves themselves. All in all, a seemingly horrendous problem, you'd think. So you see what I mean. It is now as though the problem never existed. No wonder I marvel. That's your new linear tracking table.

Go out, then, and gander at the new hi-fi *haute couture*. It's well worth the trouble. And be sure you look at that turntable. A

Add truth to your system.

Offer extended thru January 9, 1982 at participating dbx retailers



A live performance has 90 or more decibels of dynamic range.

But you don't hear anywhere near that from your stereo. Because your records and tapes don't have it in the first place. In fact, you're lucky if you hear 40 or 50 decibels. Which means you're losing half the impact of your music.

The only answer is to add a dbx Dynamic Range Expander. It works on the same principle as the dbx noise reduction technology now built into 1981 tape decks. Only it takes your existing records and tapes, and increases the dynamic range by up to 50%.

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Now, if you're wondering just how dramatic that sounds, there's an easy way to find out.

Buy a 3BX Dynamic Range Expander and get a dbx Disc Decoder free.

Just visit your participating dbx retailer between October 1 and December 5, and ask to listen to the 3BX Dynamic Range Expander, our top of the line model. As soon as you catch your breath, offer to buy the 3BX. And you'll get a dbx Model 21 Disc Decoder absolutely free. Or you can buy the 1BX or 2BX Dynamic Range Expander, and get the Model 21 for half the regular price.

The Model 21 decodes the revolutionary dbx Discs and Digital dbx Discs, the world's first Full Dynamic Range Recordings. And soon, we'll be introducing dbx cassettes. More than 150 titles are now available to choose from. Including new releases by Joan Baez, The Police, Neil Diamond, J. Geils, Moody Blues, Styx, Pablo Cruise, Rita Coolidge, and Eric Clapton.

So with a dbx Dynamic Range Expander, you can improve your existing library. And with the Model 21, you can start building a new library of almost flawless recordings.

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And discover the truth about your stereo system.

For the names of participating retailers near you, write dbx, Incorporated, 71 Chapel Street, Newton, Mass. 02195 U.S.A. Tel. 617-964-3210

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TAPE GUIDE

HERMAN BURSTEIN

Slip Sliding Away

Q. After having the record head of my open-reel tape deck replaced, I tried to make recordings with good tape, but could not due to an excessive amount of wow and flutter. I returned the deck to the service center and was told it needed a new pinch roller. After having the pinch roller replaced, the problem remained. The odd thing is that I can record on cheap tape without any problem with wow and flutter. Is there a lubricant of some kind on the better tape that allows it to slip as it passes the capstan and pinch roller? — James Fellwock, Santee, Cal.

A. Yes, a good tape often contains a fair amount of lubricant (silicone or such), as it should in order to permit passage of the tape past the heads, guides, etc. with a minimum of friction. But, as you suggest, the lubricant may be permitting slippage of the tape with respect to the capstan and pinch roller.

Possibly the audio shop put in a defective pinch roller (with glazed rubber), or it may have improperly adjusted the tension exerted by the roller against the tape and capstan. I think that you are entitled to a free return trip to that shop. Before doing so, carefully clean the capstan and pinch roller, as well as the heads, guides, and other parts contacted by the tape. Ordinarily, unless your manual recommends another substance, isopropyl alcohol will do a satisfactory job, and it's important to check this. If you still have slippage, take the deck back to the shop. Another alternative would be the use of back-coated tape, which aims to eliminate slippage.

Leftist Leanings

Q. I have noticed that my cassette deck records a stronger signal in the left channel. To balance the left and right channels while recording, I have to cut back the left-channel input. I am using the deck with a new receiver, whose left output meter always shows a stronger signal than the right output meter. Balancing of the channels helps to solve the amplifier problem. Does this affect the problem with my tape deck? — Gary Guarneri, Danville, Cal.

A. Tape deck imbalance between the left and right channels may arise from (1) imbalance in the record amplifiers; (2) imbalance in the circuit that feeds the record level meters; (3) imbalance in the bias circuit (at the same time, reduced bias in the right channel will produce over-bright sound there); (4) imbalance in the playback amplifiers; (5) a defective record head; (6) a defective playback head, or (7) imbalance in the preamp or receiver that feeds the tape deck.

From your description, it appears the fault lies in your receiver, which is feeding a stronger signal to the left channel than to the right. Even though you say that you balance your receiver, such balancing apparently occurs at a point after the signal is fed to the tape deck.

Ups and Downs

Q. Some of the new cars have vertically mounted radios instead of the standard horizontal mount. This poses a problem when installing an aftermarket cassette unit because the standard horizontal in-dash unit is said to be manufactured to only play at a maximum 30° off horizontal without causing unusual wear of the unit. What can the owner of one of these new cars do? — Phil Miltenberger, Wabash, Ind.

A. Some tape decks are designed so that they can be operated in virtually any position, while others are limited in this respect. If the unit you want to use has a tuner section with a vertical scale, then you'll be okay. The only other answer I can give you is to consult the manufacturer of the deck you intend to use as to the effect of vertical mounting.

Off the Track

Q. I recently purchased a cassette deck with Dolby calibration and no external bias adjustment. My problem is that when listening to A-B playback between source and tape, there is noticeable lack of highs with Dolby NR on. Without Dolby NR, the source and the tape are almost indistinguishable. The Dolby calibration controls don't help — they appear to be just a gimmick. I wonder if I could alleviate my problem by making an internal adjustment of bias. — Andy Ulloa, Red Bluff, Cal.

A. I recommend against any adjustment of bias inasmuch as you are getting good performance with the present bias and with Dolby NR off.

Your problem seems to lie in the Dolby calibration, or rather miscalibration, which can result in what is called mistracking; the effect is to either accentuate or depress the treble frequencies. The degree of mistracking that occurs can vary with the output level of the tape, and hence the proper Dolby calibration can vary from one type or brand of tape to another.

Your best course is to take your deck and a cassette of your preferred brand to an authorized service shop for proper Dolby calibration. Have the shop record with the deck while you are present so that there is agreement as to the specific problem.

Dolby calibration controls are not a gimmick. It is possible that one of these controls, or the Dolby circuitry, may be defective. If your deck is still under warranty, the service should be free. After the deck is serviced and you come to pick it up, ask for a bench check, which will demonstrate to you in the shop that the deck is working correctly.

Playing Percentages

Q. While I was recording an album with my cassette deck, I left the machine for a minute. When I returned, the meters were bouncing far into the red, +5 dB. I thought my recording was ruined, but when I played it back it sounded good. Why didn't I hear a lot of distortion? How much distortion is audible in tape machines? By the way, my deck is supposed to have less than 1.5% distortion at 0 dB. At the time of the recording I was using a high-quality ferrichrome tape. — Carl Smith, Mt. Home A.F.B., Idaho

A. I assume that the meters of your deck are a peak-reading type. If distortion is 1.5% (harmonic) at 0 dB, it is probably about 3% at +5 dB. Harmonic distortion reaching about 3% on peaks is generally considered acceptable in tape recording. This may vary somewhat with the nature of the music and with the acuity of the individual. The briefer the peaks, the less likely that distortion will be unacceptable.

Further, tapes vary somewhat, roughly on the order of 3 to 5 dB, as to the amount of signal they can accept before distortion becomes noticeable. It may be that the tape you used can accept sub-

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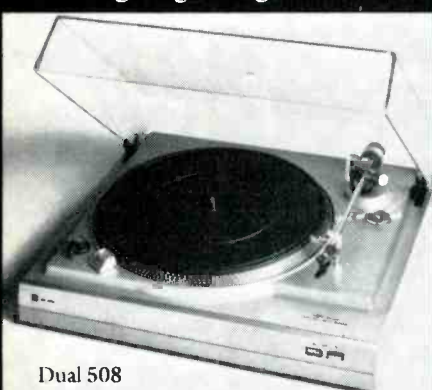

Dual 508

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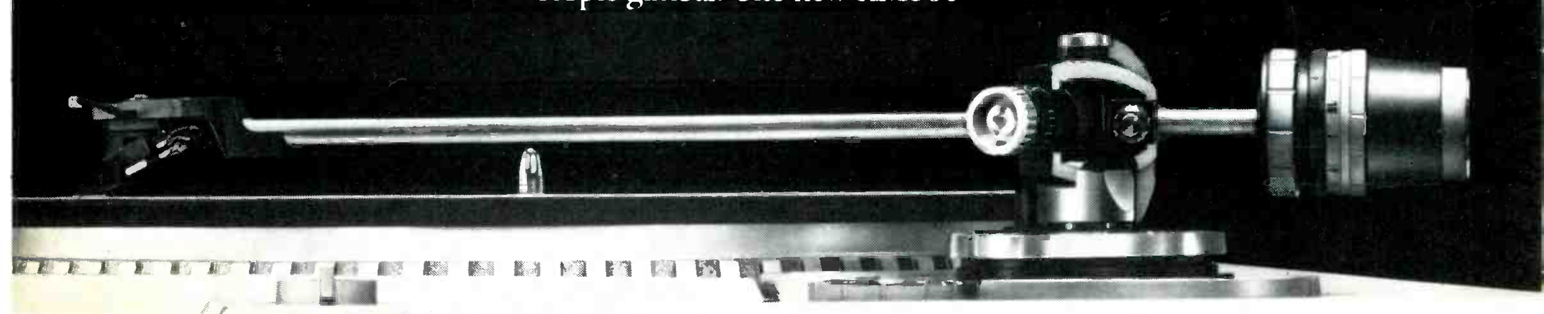


stantially more signal than the average tape without going into distortion.

On single steady tones, few persons can detect distortion below approximately 0.5%, although some exceptional individuals, it is claimed, can detect distortion as low as 0.1%. But on mixed tones — program material — it appears that distortion can rise as high as 5%, and perhaps even as high as 10%, yet escape notice by most listeners.

First and Format

Q. I'm in a quandary. I want to tape my record collection and FM broadcasts. For this purpose, would it be to my advantage to buy a cassette or an open-reel deck? — Joseph Banks, Jamaica, N.Y.

A. For live recordings, an open-reel deck operating at 7½ ips should give you distinctly better recordings than a cassette deck operating at 1⅞ ips. If the open-reel deck is operated at 3¾ ips, its margin of superiority may be marginal. But if your principal purpose is to copy phono discs and FM programs, you may be hard pressed to detect the difference between the performance of an open-reel deck and a cassette deck of good quality.

Another factor is cost. Generally, the better open-reel decks tend to cost from $700 upward. On the other hand, there are very good cassette decks available for under $400. With improvements in cassette decks and cassette tapes, the cassette format gets better and better.

Off-Speed Pitches

Q. I have a problem with one of my three open-reel decks. When I record a tape on it and play the tape on the other decks, the pitch drops. When I record on the other decks and play it on the problem deck, the pitch rises. I lubricated this deck, but without success. I ordered a new idler wheel, but after it was installed the deck still ran fast. — Alfred Hernandez, Santa Juanita, Bayamon, P.R.

A. First, there is a slight possibility that the other two decks are at fault, that is, they may be running slow.

Assuming that the deck you question is at fault, the trouble could be in the diameter of either the idler wheel or the capstan. The fact that a new idler wheel did not cure the problem does not eliminate this component as the culprit. Some manufacturers have several slightly differing sizes of idler wheels, and they use the one which brings a given deck closest to nominal speed. I don't know whether this is the case with your deck, but I know the practice exists.

It seems that your best course is to have the deck checked out by an authorized service shop which is capable of checking tape speed as you watch. *A*

JAZZ & BLUES

JOHN DILIBERTO
JOHN LISSNER

Stone Crazy!: Buddy Guy
Alligator AL 4723, stereo, $8.98.

Sound: B Performance: A–

Buddy Guy is back! No, not the clowning blues guitarist whose showmanship came to swallow his best musical instincts. *Stone Crazy!* marks the return to disc of the once-promising newcomer touted as the heir-apparent to B. B. King.

For the first time in years, Buddy Guy sounds as though he's playing for himself rather than slavishly adoring crowds. These tracks don't radiate the celebratory exuberance of Guy's early Chess sides, but presumably those days can no more be recaptured than this 45-year-old bluesman's heady youth. There are even moments when Guy's heated picking lapses into self-indulgence reminiscent of his "much sound and fury yet signifying nothing" days. Nonetheless, *Stone Crazy!* shows Guy to have developed into an exciting, unique stylist. He's harnessed the brute force of amplification to increase the dramatic range of tense solos nursed to crescendo in the style of B. B. King. In short, an unmistakably *electric* bluesman. It's no surprise that Jimi Hendrix was among his greatest fans.

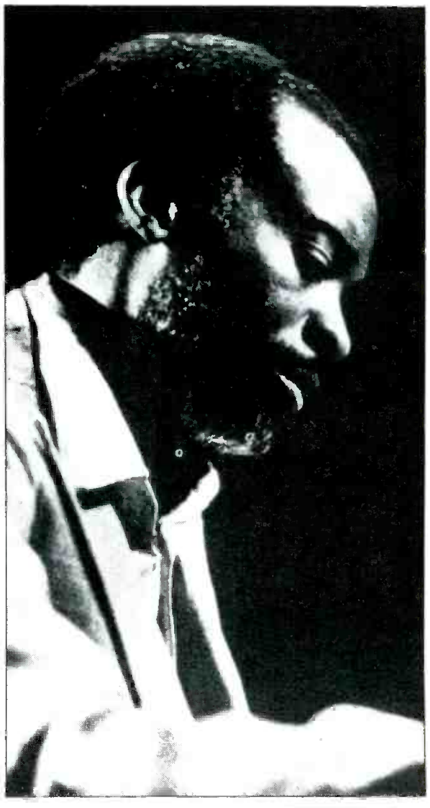
Stone Crazy! was cut in one day overseas, which might explain why the six lengthy tracks often struggle for the emotional impact that came naturally to Guy's tightly crafted 45s. The material is new but isn't strong enough to be much more than an opportunity for Guy to showcase his talent. Backed only by a three-piece band, he dominates every cut. If he's now a cautious, stylized singer when once he was an uninhibited shouter, this set proves that his vocals are no less effective.

Stone Crazy! is a milestone in Guy's career and one of the year's best blues guitar albums. Maybe the name of Buddy Guy can finally be removed from the "I Could Have Been a Contender" list of Chicago bluesmen. Cross your fingers and let's see what he does for an encore. *Roy Greenberg*

Intervals: Ahmad Jamal
20th Century-Fox T 622, stereo, $7.98.

In the late '50s, pianist Ahmad Jamal developed an enormous following with his spare, highly abbreviated keyboard style that was backed by the pulsing bass and drum team of Israel Crosby and Vernell Fournier. The Ahmad Jamal Trio is long gone, and for most of the past 10 years Jamal has been content to play a straightforward, melodious kind of contemporary jazz that offers a great deal of rhythmic drive.

His latest release on 20th Century-Fox is a schizophrenic affair — half of it cleanly articulated, sensitively played balladry, the other half a banal mishmash of heavily synthesized "fusion." I would have to give the four straight-ahead jazz sides an A rating and the Fuzak stuff, D. Skillful engineers collaborated on the excellent recorded sound — the mixing is by Barney Perkins at Golden Sound, LA; mastering by Mike Reese at Mastering Lab, and the tapes were edited at Sierra Pacific Studios in Los Angeles. *John Lissner*



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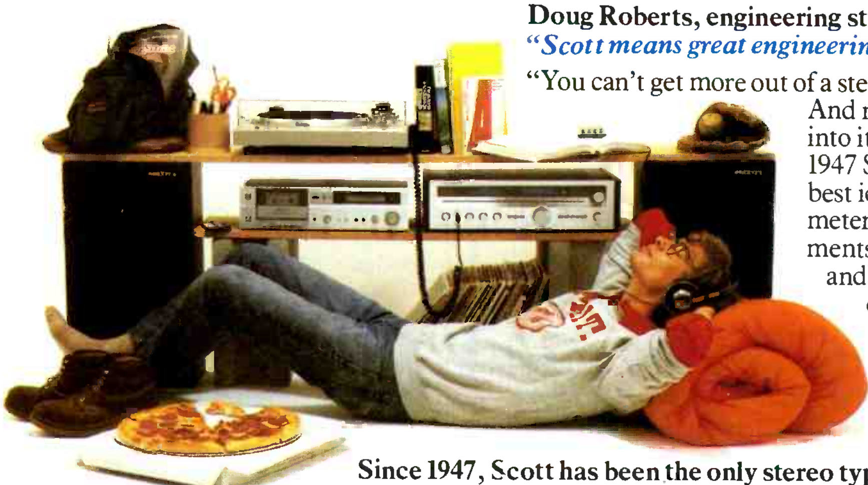

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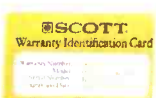

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Coming to You Live: Charles Earland
Columbia JC 36449, stereo, $8.98.

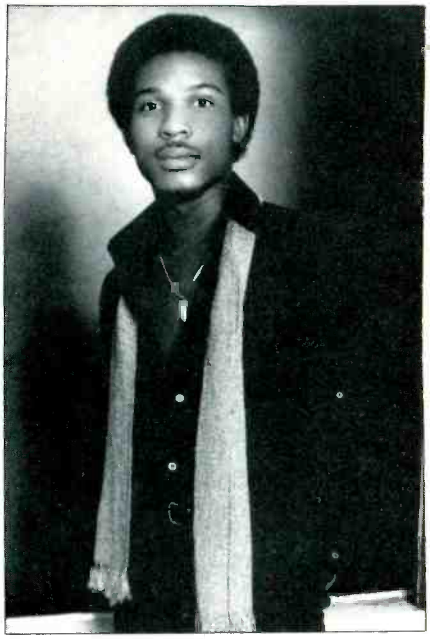
Sound: B	Performance: D–

Mr. Hands: Herbie Hancock
Columbia JC 36578, stereo, $8.98.

Sound: B	Performance: C+

Rodney Franklin
Columbia JC 36747, stereo, $8.98.

Sound: B	Performance: C–



Rodney Franklin

Electric jazz and funk has gone a long way from its beginnings with Miles Davis. It's even pretty far from those first commercial breakthroughs of Herbie Hancock *(Headhunters)* and Donald Byrd *(Blackbyrd)*. The three records here present an interesting cross-section of the current state of the art. Charles Earland is the older veteran who even in the '60s was on the funkier side of jazz, playing his Jimmy Smith-inspired organ. Rodney Franklin is the relative newcomer (this is his third LP) who actually grew up listening to the crossover and fusion music of the '70s. Hancock, of course, is the outrageously successful architect of crossover music who was in on it from the beginning with Miles.

There is a standard criticism that all funk-jazz albums sound alike, which is somewhat justified when you consider the incestuous nature of the studio session scene from which most of these albums derive their personnel. Earland's *Coming to You Live*, which is not a live album, is no exception. Daryl Thompson, Jeff Mironov of the Brecker Bros., Urbie Green, and Wade Marcus should be familiar names to anyone who listens to this music. They provide the heavy backbeat and silk-swathed strings that make these albums such a marketable commodity. The question is, with all

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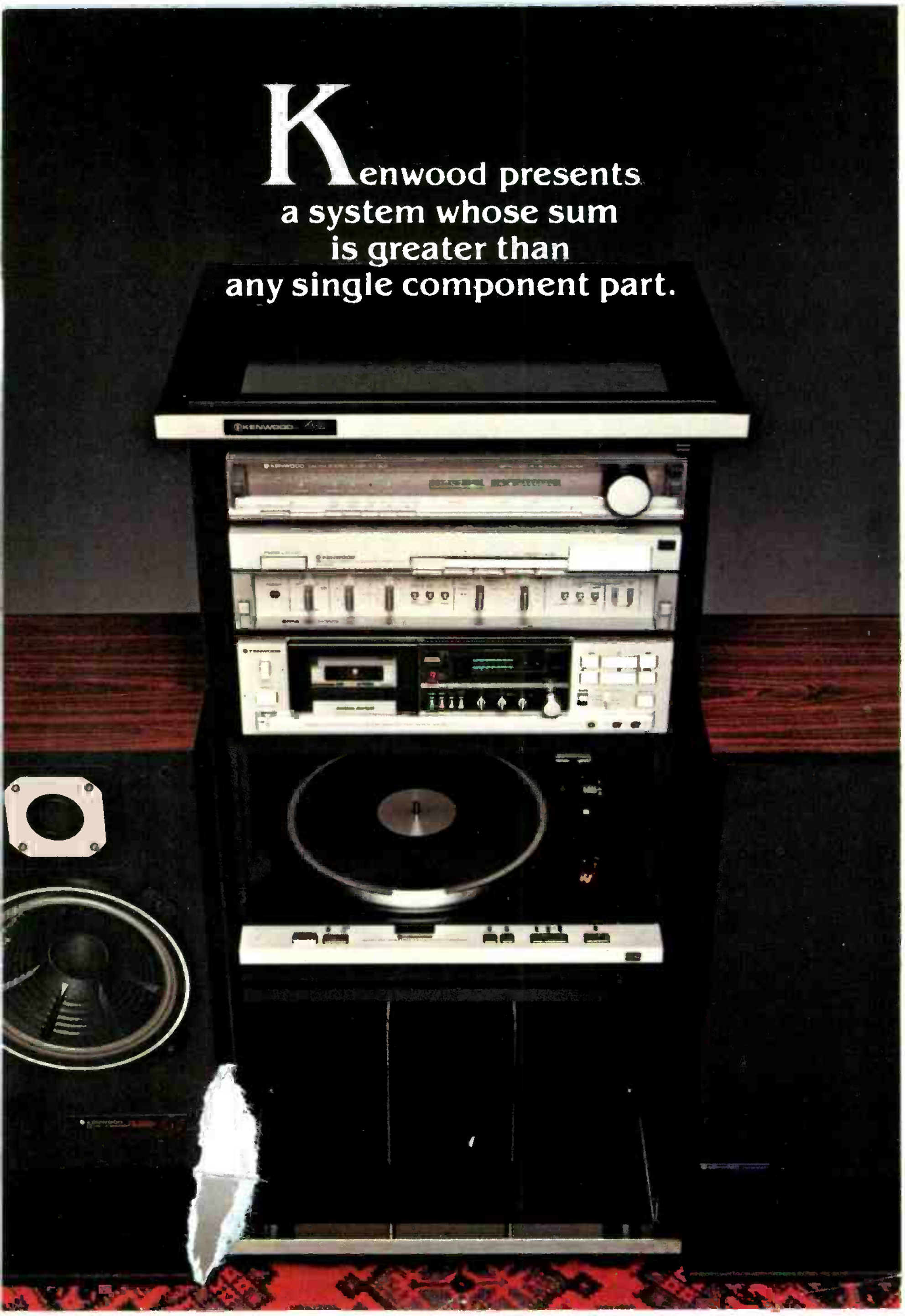

these artists and a formula format, who needs Earland? Not his producer George Butler apparently, because I'll be damned if I can find the organ that Earland is credited with playing on at least one cut on the album, "It's the Woman in You." On other cuts there's usually less of Earland than anyone else. He gets in a few licks on dance numbers like "Cornbread" and "Zee Funkin' Space," but these are just passing moments in an album dominated by vocalists, chicken-scratch guitars, and ponderous strings.

Pianist Rodney Franklin shares the same producer as Earland on most of the tracks from his self-titled LP. The same formula is used, funky tunes and Muzak ballads with chanting female choruses. It's also dominated by session musicians including Phil Upchurch, Victor Feldman, and Jeff Porcaro. Yet Franklin manages to find some solo space on acoustic piano amidst the mass production, especially on the opener "Windy City." But he is quickly overcome by the hyperactive production work.

Surprisingly, Herbie Hancock has made his most listenable electric album in years. While musicians like Earland and Franklin have become fodder for the industry and are without any real artistic control, Hancock has always seemed to be the master of his recorded output even if he has used this freedom to play the corporate game. But in playing the game, Herbie has lost a lot of trust. His forays outside of the disco machine with VSOP and the Chick Corea duets were tainted and informed by the fact that he had put out works which were less than honest.

Mr. Hands doesn't remedy all that, but at least he's exploring some new sounds and rhythms. This is essentially a solo electric keyboard album with Hancock backed by different all-star rhythm sections on all but one cut. He stacks up solos and synthesized textures on top of understated rhythms on "Spiraling Prism." "Calypso" is the most driving piece, with Ron Carter's pulsing ostinato bass line and Tony Williams pushing and rushing the beat forward on drums. "Shiftless Shuffle" is Hancock's most unencumbered moment as he launches into a jaunty electric piano solo. The only piece without a rhythm section, "Texture," still has a strong backbeat, one created by Hancock's synthesizers. He gets some beautiful hammered dulcimer tones that offset his languid solo lines. Overall, an entertaining album that combines some of Hancock's jazz legacy with his electric sound in a lighthearted endeavor.

Hancock shows that disco-funk-jazz is not intrinsically bankrupt. It's just that almost everyone associated with it, including Franklin, Earland and their hordes of session musicians, are.

John Diliberto

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ANTENNAS

FM

RICHARD KAUFMAN

TRY A RHOMBIC FM ANTENNA

A good antenna will make an inexpensive receiver outperform all but the very most expensive state-of-the-art models, but most owners of FM stereo equipment continue to use a 50¢ "folded dipole." The best tuner will give only mediocre performance with the piece of wire the manufacturer supplied. Some of the money spent on electronics would be better spent on the most neglected component of a stereo system, the antenna. This would increase signal strength to the tuner and eliminate multipath distortion. (Multipath distortion is the FM equivalent of television's ghosts, caused by reflected signals reaching the antenna after the direct signal. A directional antenna — one with a good front-to-back ratio — eliminates this source of distortion.) Many readers of this magazine are aware of this, but still use a wire dipole. Antenna installation may be too inconvenient. Apartment dwellers may not have access to their roofs. Perhaps a TV antenna serves double duty; some TV antennas are designed for FM reception, but most have poor FM performance. What's needed is something effective, but easy to build.

The antenna I will describe can be built without special tools or skills. Its performance is at least as good as commercial FM antennas, with high sensitivity and a good front-to-back ratio. One form of this antenna can be mounted indoors, solving the apartment installation problem. An outdoor version will provide as much as 27 dB of gain for deep fringe reception. (This could pull in European stations in New England, when the troposphere is cooperating.)

The rhombic antenna is made of wire and shaped like a diamond. All four sides are equal, as are the opposite angles (see Fig. 1). The sides, or legs, should be at least one wavelength long at the lowest frequency of interest. One end is connected to the tuner. One-half the angle formed by the legs at this end is called the "apex angle." The other end points toward the signal source and usually terminates in a resistor. The resistor makes reception unidirectional (in theory an infinite front-to-back ratio is possible); it also makes the antenna non-resonant, so that it has a wide bandwidth and is relatively insensitive to impedance mismatch with the feedline.

There are some disadvantages to the rhombic antenna: A small one is difficult to rotate, a large one is impossible, some people may find the large size and unusual appearance an aesthetic objection, and the characteristic impedance is about 600 ohms, which is difficult to match. These problems can be overcome: Material costs are so low that building several antennas costs less than buying one rotator, the antenna can be camouflaged and made unobtrusive, and two rhombics can be run in parallel to match the standard 300-ohm impedance.

HOW IT WORKS

An antenna one-half wavelength long is most sensitive in a direction 90° to its axis (see Fig. 2). If the antenna is lengthened until it is one wavelength long, the sensitive area splits into four "lobes" each at a 45° angle to the antenna. The directivity pattern looks like a four-leaf clover. If it is further lengthened, a number of minor lobes, or areas of some sensitivity, appear between the major lobes. The longer, the antenna, the smaller the angle formed by the major lobes to the antenna axis, and the greater the number of minor lobes.

Figure 3 shows the effect of combining two long antennas to form a vee. Two of the major lobes cancel; the others reinforce each other. The antenna has a figure-eight sensitivity pattern.

A rhombic is a combination of two vees. Signals that would be in the back lobe are burned up in the resistor, making the sensitivity pattern unidirectional. There are several design criteria, which will be described later, for aligning and shaping the sensitive lobe for optimum performance. An ad hoc design procedure will produce an indoor antenna with good performance, more than adequate for most people's needs.

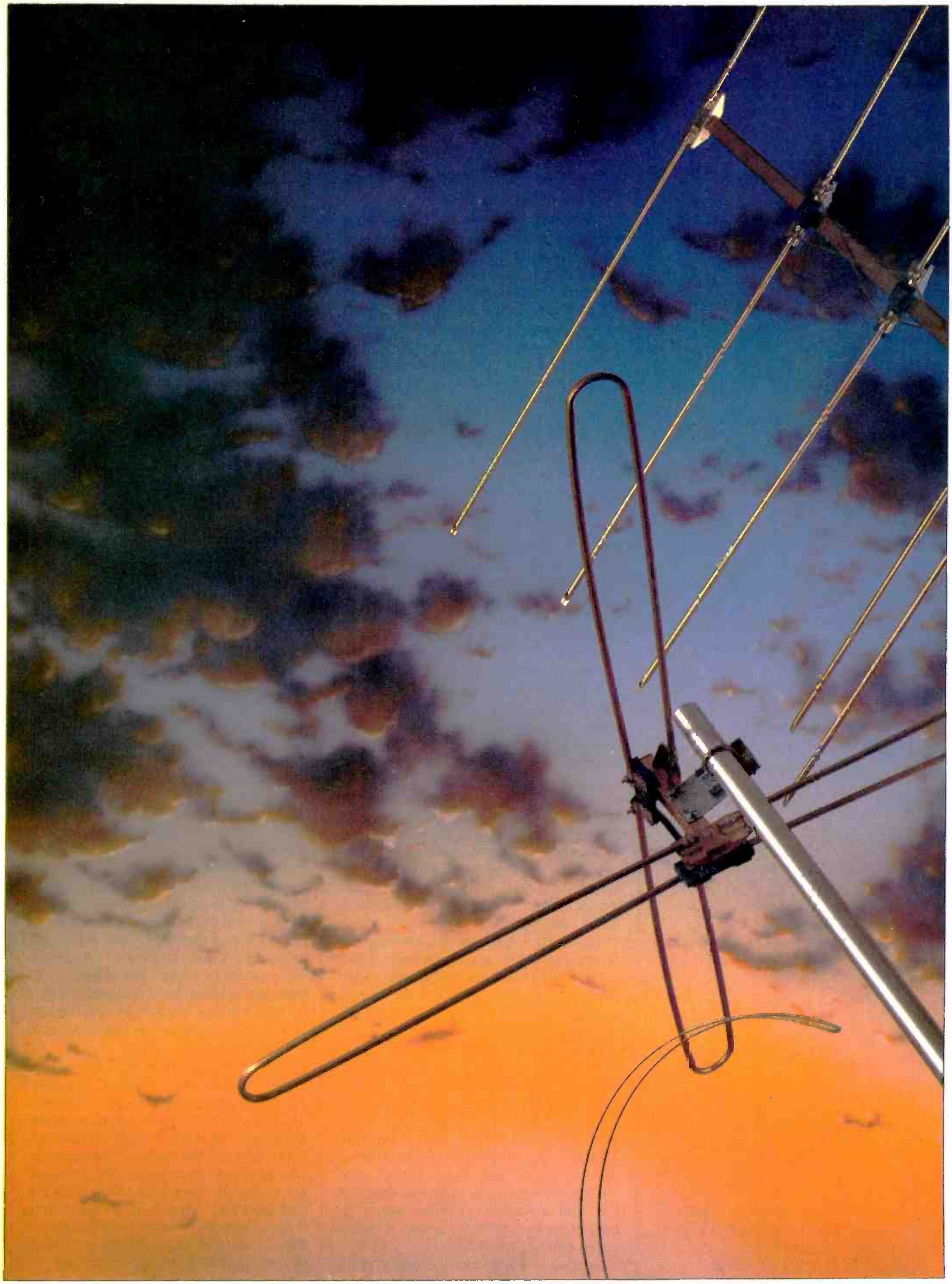


Photo: Robert Lewis

ANTENNAS FM

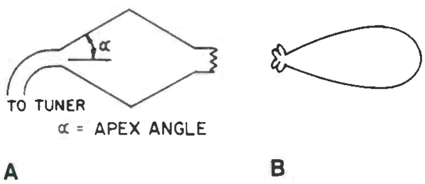


Fig. 1A—Rhombic antenna, and B, its sensitivity pattern.

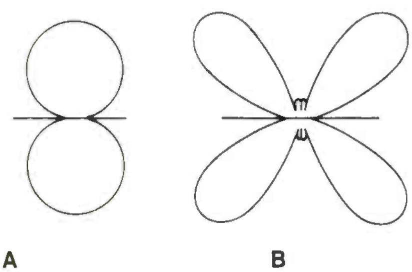


Fig. 2A—Half-wave antenna sensitivity pattern, and B, full-wave antenna sensitivity pattern.

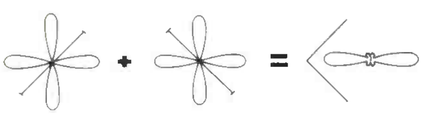


Fig. 3—Combining two long antennas for a vee.

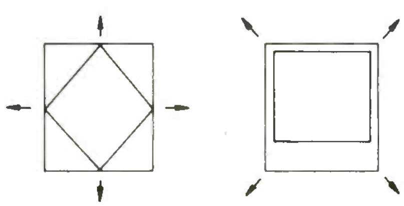


Fig. 4—Installing a rhombic in a room when the signal is in the direction of one of the arrows.

AN AD HOC RHOMBIC ANTENNA

There are two ways to fit a rhombic antenna into a rectilinear room, inscribe the rhombus as in Fig. 4A or overlay a square portion of the room as in Fig. 4B — which method you use depends on the direction to the transmitter. Use a map to determine the direction in relation to the room even if you are confident of the right direction. I once installed an antenna before looking at a map; after reinstallation, reception was much better. An alternative is to check the direction in which the rooftop antennas in your area point.

Following this procedure will result in an antenna whose dimensions give good results. Eight feet is about the shortest leg length that is likely to be usable. (The wavelength of 88 MHz is 11.1 feet; 108 MHz is about 9 feet. A leg length of slightly less than one wavelength will work, though not as well as one wavelength or greater.) It is a fortuitous coincidence, but residential room dimensions fall in a range that gives suitable leg length and apex angles.

Antennas built following this design procedure have given good results in Manhattan, where multipath distortion had made stereo reception of several stations too noisy to be listenable when using either a folded dipole or a rabbit-ear antenna. Not only did reception improve on these stations, but many low-powered transmitters in the metropolitan area, whose existence was hitherto unsuspected, can now be received. The results are impressive, especially considering that these antennas are inside steel-frame buildings.

Camarillo, California, is 50 miles from downtown Los Angeles. Between them is a mountain range 1,800 feet high. Multipath is not a problem; signal strength is. A square rhombic with a leg length of 18 feet has been installed in the living room of a wood-frame house in Camarillo. The wire is stapled to the wall near the ceiling and is barely visible. Even though the ceiling is tilted, so that the antenna is not in a horizontal plane, reception is much better than with a folded dipole. A log-periodic TV-FM antenna doesn't do as well, even though roof mounted. High-fidelity mono reception of L.A. stations wasn't possible with a dipole. With the rhombic, stereo is undistorted and noise-free.

A square rhombic with a leg length of 11 feet will show a gain of approximately 6 dB or more over a half-wave dipole throughout the FM band. (This is about 8 dB over isotropic.) This is as good as or better than any commercially available FM antenna I am aware of, with the exception of some large, expensive deep-fringe models. Smaller rhombics will have less gain, big ones more. This figure includes a 3-dB allowance for signal loss in the antenna due to its length and the thin wire used. The actual signal loss is probably somewhat less than this, yielding slightly higher gain.

CONSTRUCTION

The rhombic antenna's impedance is nominally between 600 and 800 ohms. Although a nonresonant rhombic is relatively insensitive to impedance mismatch at the feedline, this is too far from 300 ohms to work well with standard twin lead. Standard impedance-matching techniques would limit the bandwidth. Running two antennas in parallel provides a good match to 300-ohm line; the easiest way to do this is to use twin lead.

Two sets of terminating resistors will be required. The value of these resistors has been arbitrarily chosen as 660 ohms; the exact value is not critical. (Changing the value of the resistors has the effect of steering the minor lobes in back of the antenna. Experimenting with the value of the resistors will make it possible to tune out a source of interference behind the antenna. I have never yet found this to be necessary.) Noninductive carbon or metal film resistors, ¼-watt, are suitable, but the capacitance of a single resistor is too high. Use two or, better, three resistors in series to total 660 ohms.

The other materials required will be tacks or staples, possibly insulated standoffs, and terminal strips. The resistors should be soldered together unless extra terminal strips are used. There is a great deal of flexibility in construction. Use whatever techniques and materials work for you. Take care not to twist the twin lead that forms the antenna. Figure 5 shows my construction details. About the only thing to watch out for is shorting between antenna wires or to ground.

There's More to Noise Reduction Than Silence.

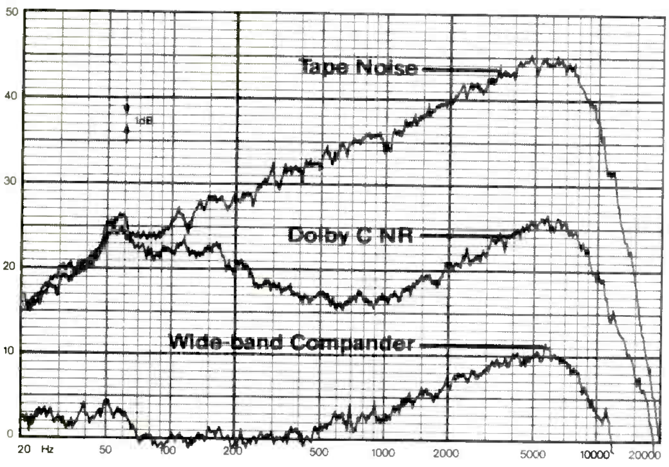


FIGURE 1: NOISE AND NOISE REDUCTION IN THE ABSENCE OF MUSIC.
Noise from biased cassette tape without noise reduction, the effects of Dolby C-type noise reduction, and the effects of a wide-band compander are shown in the *absence* of any signal.* Dolby C's noise reduction effect results in an overall perceived noise level below the ambient noise of many listening rooms, even at high playback levels. In the absence of signals, the conventional wide-band compander provides still more electrical noise reduction (but usually no more audible noise reduction).

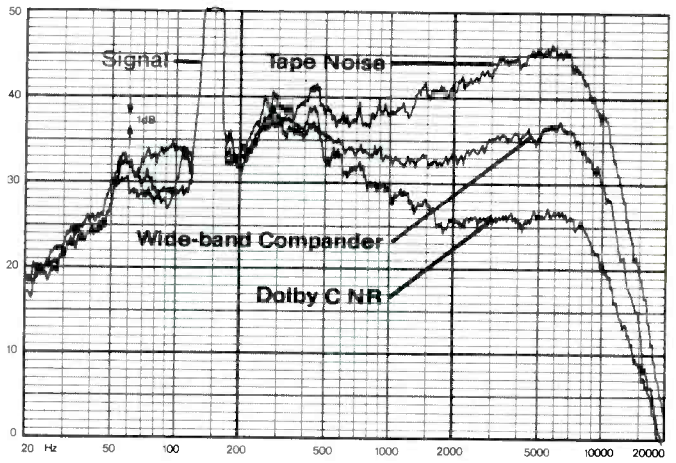


FIGURE 2: NOISE AND NOISE REDUCTION IN THE PRESENCE OF MUSIC.
In the *presence* of a signal (148 Hz, D below middle C on the piano, recorded at Dolby level), in all cases noise in the region of the signal will be masked by it. However, at higher frequencies, especially between 2 kHz and 10 kHz where tape hiss is clearly audible, Dolby noise reduction provides almost as much noise reduction as if the signal weren't there, while the compander allows the noise to increase to a considerably higher level than with Dolby C.

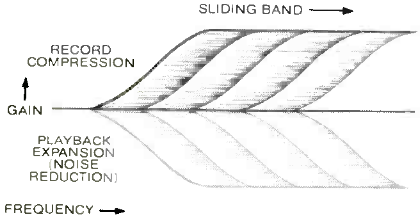


FIGURE 3: THE SLIDING BAND PRINCIPLE.
Dolby noise reduction operates over a band of frequencies which slides up out of the way of the music, resulting in noise reduction just where there is no musical signal to hide the noise. Thus the perceived noise level is consistently low at all times.

Providing noise reduction on silence is not all that difficult. For years, conventional wide-band companders have been available which dramatically reduce noise — between selections on a tape or record.

Yet it is just as important to have noise reduction when there is music playing. While music will mask noise part of the time, there are times when it won't. A bass drum note, for example, cannot hide tape hiss, no matter how loud the drum is: the ear can detect both simultaneously.

Conventional noise reduction systems effect noise reduction at the time of playback by turning down the volume when there is little or no music present. This turns down the noise as well. But they also turn the volume back up again on louder music, and so turn the noise back up at the same time. Thus the bass drum note is accompanied by a burst of tape hiss — hiss which is audible if there is no music at higher frequencies to hide it.

This problem is called noise modulation. It means that with a conventional NR system, the noise level is constantly shifting up and down with changes in the level of the music. But Dolby noise reduction, on the other hand, is free of noise modulation on virtually any type of music (Figures 1 and 2).

Unlike conventional companders, Dolby noise reduction operates over a constantly changing, or sliding band of frequencies (Figure 3). The band extends low enough to provide very effective noise reduction on silence. But in the presence of music, the band slides up just out of the way of the music, so that noise at frequencies above the music is almost as effectively reduced as if the music weren't there.

Both Dolby B-type and Dolby C-type noise reduction are sliding-band systems. With the standard B-type system, noise reduction begins at 500 Hz and increases to 10 dB at 4 kHz and above, while with the new C-type system, noise reduction begins at 100 Hz and increases to 20 dB at 1 kHz and above. With either system, the presence of music does not prevent noise reduction from occurring where it is still needed.

*70μs equalization, measured with a constant-bandwidth wave analyzer, and weighted (CCIR/ARM) to reflect the ear's sensitivity to noise and noise reduction effects.

FM

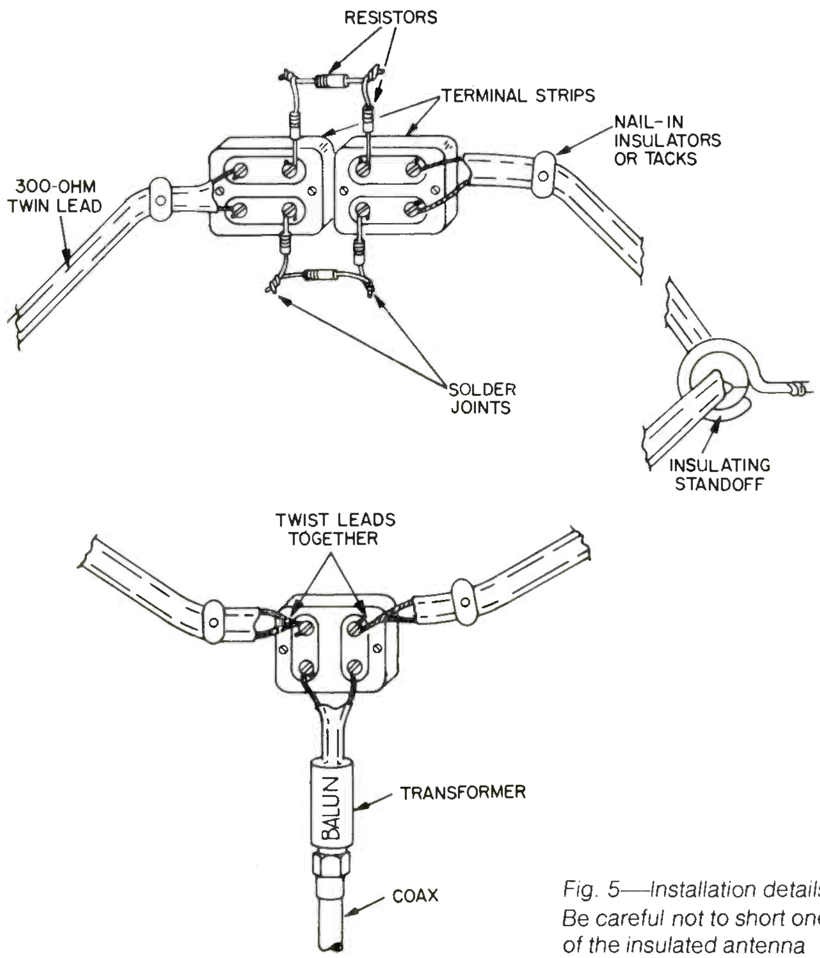


Fig. 5—Installation details. Be careful not to short one of the insulated antenna wires to another or to ground.

The higher the antenna, the better. An exception is in steel frame buildings. When a ceiling is of steel, the antenna works better if it is at least a foot lower.

In a city, shielded coaxial cable makes the best lead-in wire since it is least sensitive to interfering signals. Use a balun transformer to match the antenna to 75-ohm coaxial cable. Another balun will be needed at your receiver if it does not have a 75-ohm input; 300-ohm twin lead can be used if interference is not a problem. In fringe reception areas, twin lead will give a stronger signal since it has a lower signal loss. To prevent unbalanced currents on the shielding from causing interference, when using coax, coil the cable for two or three turns, about 3 inches in diameter, near the receiver.

The perfectionist will not be satisfied with an antenna that gives merely acceptably good results. There will also be cases when a better antenna than the ad hoc model is needed; deep fringe reception will require greater sensitivity, and severe multipath problems will need a sharper area of sensitivity (better front-to-side ratio) than an ad hoc rhombic is likely to provide in such a location. Determining the optimum apex angle for the leg length chosen will realize the rhombic's full potential.

Figure 6 is a graph relating apex angle to leg length in wavelengths. As the leg length increases, the apex angle gets smaller. The frequency range from 88 to 108 MHz includes wavelengths of 9 to 11.1 feet. Consequently, an 18-foot leg length is 1.8 wavelengths at 88 MHz and 2 wavelengths at 108. Which wavelength should be used in designing the antenna? Under most conditions, the longer one. So, for an 18-foot leg length, the apex angle should equal 38°. Actually, the range of angles in this example is 35° to 38°, which is not terribly significant.

Part of the reason for favoring the longer wavelength is evident in Fig. 7. As the leg length increases, so does gain. Too great an apex angle will decrease gain at the higher frequencies, but the greater leg length in terms of wavelength increases the gain. The effects tend to cancel out.

The formula, 980 divided by frequency in MHz equals wavelength in feet, can be used to calculate wavelength if there is a station or a frequency of interest.

The most practical method of designing an antenna for a particular space is to lay out a scale drawing on graph paper. A ruler and a protractor are the only tools needed. Use successive approximations to find the largest antenna that will fit. A table of trigonometric functions, or a scientific calculator, will speed up the process but aren't absolutely necessary for this.

OUTDOOR CONSTRUCTION TECHNIQUES

The reader interested in constructing a large outdoor rhombic should read the section on wire antenna construction in The ARRL Antenna Book. Smaller antennas (leg length under 30 feet) do not require special construction techniques.

An outdoor antenna should be mounted at least one wavelength high, the higher the better, and should be well clear of power lines. Enamel-coated or plastic-insulated wire is preferable to bare wire. Soft-drawn copper has a tendency to sag. With thin wire, up to 30 feet between supports, or with TV twin lead, sag should be no problem. Hard-drawn copper or copper-clad steel should be used for longer spans.

9'
115' 13'9"
4
50'

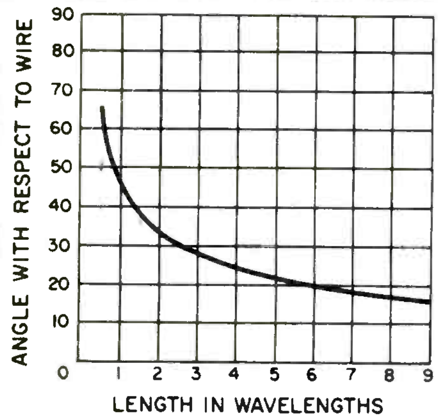


Fig. 6—Angle with respect to wire axis at which sensitivity of the rhombic is maximum.

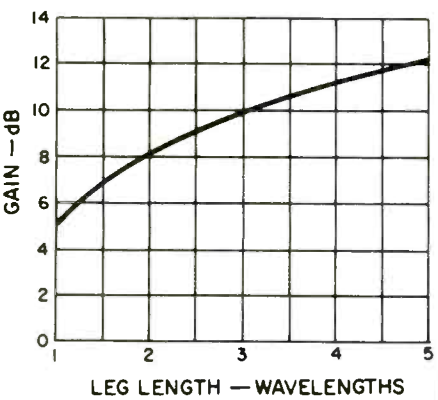


Fig. 7—Theoretical gain of a nonresonant rhombic antenna over a half-wave dipole in free space. This curve allows 3 dB for loss.

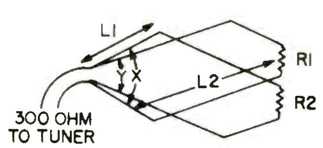


Fig. 8—Double parallelogram rhombic designed for 88 MHz. The wires are in the same horizontal plane with the crossing points insulated. L1 = 4.3 wavelengths = 48.3 feet; L2 = 7.5 wavelengths = 83 feet; X = 52.2 degrees; Y = 37.7 degrees; R1 = R2 = 660 ohms, and the gain = 27 dB.

Glass or porcelain antenna insulators should be used at the antenna's corners. Twin-lead stand-off insulators are also possible. The resistors should be protected from the weather; enclosing them in a plastic box, sealing them in silicone bathtub sealer, or spraying them with acrylic lacquer are all possiblities. Lightning arresters should be used. Where wires are joined, they should be soldered or fastened with screws. The sides of buildings and poles are good supports, but trees tend to sway in the wind and the stress can break wire. A pulley and counterweight can provide strain relief if you must use any but the sturdiest tree.

If you're working with a length of wire more than 50-feet long, keep it grounded until you're done working on it. Long wires can pick up enough static charge to knock one unconscious. This was well-known in the early days of radio but seems to be largely forgotten.

AN IMPROVED RHOMBIC

An improved version of the rhombic has been developed by E. A. LaPort and A. C. Veldhuis. A descriptive name for their antenna would be a "double parallelogram." The antenna in Fig. 8 was originally designed by Mike Staal from their specifications for use on 144 MHz. Gain is estimated to be 27 dB; the theoretical Standing Wave Ratio (SWR) into 300-ohm line is 1.3 to 1, with little variation over a frequency range much wider than the FM band. (An SWR of under 2 is very good.) Antennas of this design have been used to bounce signals off the moon; I have adjusted the scale for FM use. The required real estate will only be available in the country, which is where high gain will be required. This may be the ultimate VHF deep-fringe antenna. The beamwidth is only 8.5°, so extreme care is required in aiming the antenna. This design is too large to be practical, but one can design smaller antennas of this type. Gain will be lower, but still higher than for a simple rhombic that would fit in the same space.

The double parallelogram antenna in Fig. 8 has legs of two different lengths. L1 is 4.3 wavelengths; L2 is 7.5 wavelengths. The leg lengths can be changed, and the apex angles adjusted accordingly. The two apex angles, ½ X and ½ Y, can be found from the graph in Fig. 6. Shorter leg lengths increase the beamwidth. Gain can be found using Fig. 7; the gain for a leg length of L1 is added to that for L2. The figure so obtained will be too high when the leg lengths are nearly the same. The design is worth the extra calculation required where multipath problems are severe or signals are very weak.

A double parallelogram is really two rhombics combined. The trick to designing a very efficient one is to have the nulls in one rhombic's pattern overlay the minor lobes in the others, while both major lobes coincide. I've written a short computer program in BASIC to calculate the angles of nulls and lobes and will send a copy to anyone who sends a stamped, self-addressed envelope and $1 for handling to RK Systems, 482 Broome St., New York, N.Y. 10013.

I have built an indoor "double parallelogram" rhombic with L1 = 13 feet, L2 = 16.3 feet, X = 90° and Y = 60°. The design is a compromise for convenience of construction. The apex angles are not perfect for the leg lengths. Still, performance is better than an ad hoc rhombic in the same location, as multipath distortion is measurably lower. The gain, in comparison to a reference dipole, is between 8 and 9 dB across the FM band. In free space, the figure would be better, but the directivity pattern is distorted by the building's steel frame. An ad hoc rhombic in the same location had a gain of 6 dB. The antenna was made of white plastic-coated "bell wire" from a hardware store; otherwise, construction was similar to the ad hoc rhombic. The finished antenna is nearly invisible. Many more stations can be received than with a wire dipole, and sound quality is much improved on all stations.

I have been experimenting with indoor rhombics for about a year and am convinced that this is the most cost effective option for serious FM listeners, and perhaps the only option for most Manhattanites.

REFERENCES

1. *The ARRL Antenna Book*, 1974, The American Radio Relay League, Inc., Newington, Conn. 06111.
2. Laport and Veldhuis, "Improved Antennas of the Rhombic Class," *RCA Review*, March, 1960.

ANTENNAS

AM

RICHARD MODAFFERI

BUILD THE AM SUPERLOOP ANTENNA

Usable long- and medium-wave radio signals travel further than you would believe. Cheap transistor radios and the poor AM sections of modern hi-fi tuners have conditioned us to accept only local reception. In the early days of AM radio, people happily listened to radio sets which would offer reliable daytime reception of signals as far away as 500 miles from the transmitter! Large, powerful console radios by Scott, RCA, Zenith, Philco, and others brought good and varied programming from surrounding metropolitan stations to the distant listener.

Today, fine AM radio programming still exists. Every large city and even some lucky smaller ones have at least one worthwhile AM radio station. If some of these stations exist within 500 miles from you, the powerful antenna I'll discuss here can be used with any AM radio to make possible a choice from a variety of interesting and listenable programming.

The Superloop tunes continuously from 140 to 1800 kHz, which covers both the long- and medium-wave bands. North American low-frequency radio broadcasting is confined to the medium-wave band only, 540 to 1600 kHz, but in Europe the long-wave band (150 to 350 kHz) is also used for radio broadcasts.

Large loop antennas make long-distance low-frequency reception easy. Big loops provide much greater signal pickup than the tiny ferrite rod antennas used in modern radios. Loops work better than long-wire antennas at long- and medium-wave band frequencies, because loops tend to reject the common types of "electric field" static interference from power lines which often plague long-wire antenna systems. Within reason, the bigger the loop, the better it will work. Some readers may remember the "Wavemagnet" loops hidden inside the large cabinets of the Zenith consoles of the 1930s. The Superloop is bigger and better. Ambitious DXers can even pack the Superloop and a good transistor portable radio to any convenient mountaintop for some superb long-distance reception.

DESCRIPTION

The Superloop is easy to build — I put mine together in an afternoon — with the coil winding being the only tricky part of the construction. I'll cover detailed assembly plans later, but first a description of what the loop antenna is and what it can do is in order.

The Superloop has two large coils, each wound on separate parts of a wood frame which is mounted on a base. Tuning controls and small parts are grouped together at the center of the frame. Terminals are provided near the base for connection to radio sets requiring an external antenna.

Referring to Fig. 1, the Superloop schematic, L1, the tunable primary, is the larger outer winding. The smaller inner winding, L2, is the secondary coupling coil which connects to output terminals T1, T2 and T3.

C1(a) and C1(b) is a two-section radio variable capacitor of the "TRF" type, having two identical 365-pF sections. See Fig. 2, a closeup photo of the central control section of the Superloop, showing C1, C3, L3, S1, and S2. Switches S1 and S2 are used in various combinations for control of the frequency tuning range of the Superloop. This action is summarized in Table I. The other possible switch combination, with S1 and S2 both open, is not useful since it yields a tuning range already covered.

The capacitor C2, connected between output terminals T2 and T3, is

Table I—Frequency tuning ranges with various positions of the two Superloop switches.

S1	S2	Tuning Range
Open	Closed	600 to 1800 kHz
Closed	Closed	380 to 600 kHz
Closed	Open	140 to 380 kHz

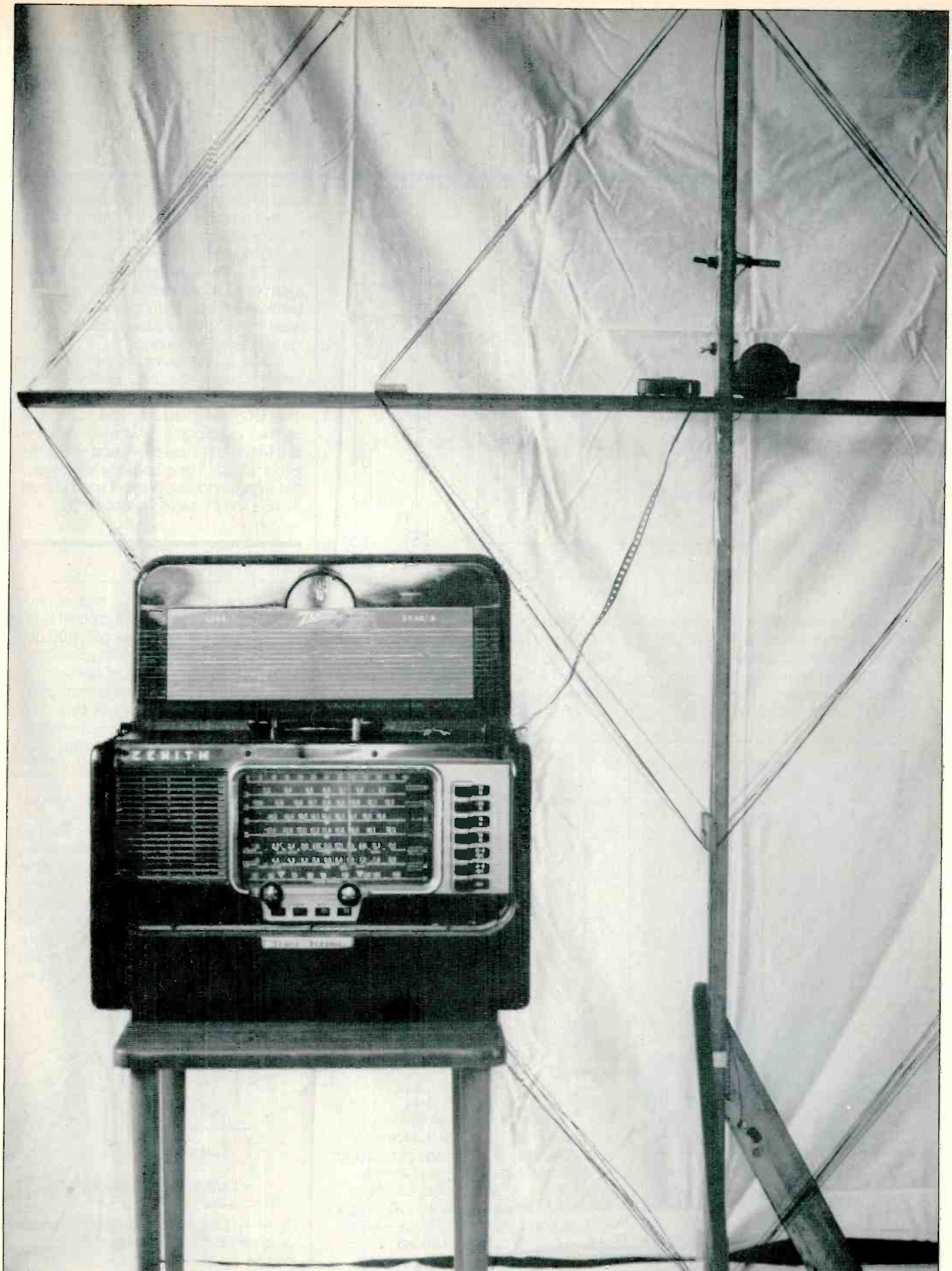


Photo: Richard Modafferi

part of an impedance matching circuit on the output terminals. Radios having high-impedance external antenna inputs are connected between terminals T1 and T2; radios having low-impedance external antenna inputs are connected to terminals T1 and T3. You should experiment if you're not certain about your radio's antenna impedance.

C3 is a padder capacitor on C1(b) which causes the two tuning ranges determined by S1 to just barely overlap. The long-wave loading coil, L3, is a common "loopstick" AM radio antenna coil which is switched into and out of the circuit by S2. Hand capacity will detune the loop slightly, so a large knob should be used on the tuning capacitor C1.

Table II—Parts list.

L1	Approx. ¼ lb. No. 18 magnet wire.
L2	Approx. ⅛ lb. No. 22 magnet wire.
L3	Loopstick antenna coil, 600 µH.
C1(a),(b)	Two-gang tuning capacitor, 365 pF per section.
C2	180-pF mica or ceramic capacitor.
C3	390-pF mica or ceramic capacitor.
S1, S2	SPST toggle switches.
T1, T2, T3	Five-way binding posts.
Lumber, screws, glue, paint, a large knob, etc. as needed.	

All the components used in the Superloop came from my well-stocked parts junkbox. A parts list is given in Table II; you may substitute electrical equivalents as necessary. The 600-µH loopstick coil is vintage Radio Shack and may be the only component which would be hard to find new. Any loopstick coil can be brought up to 600-µH by

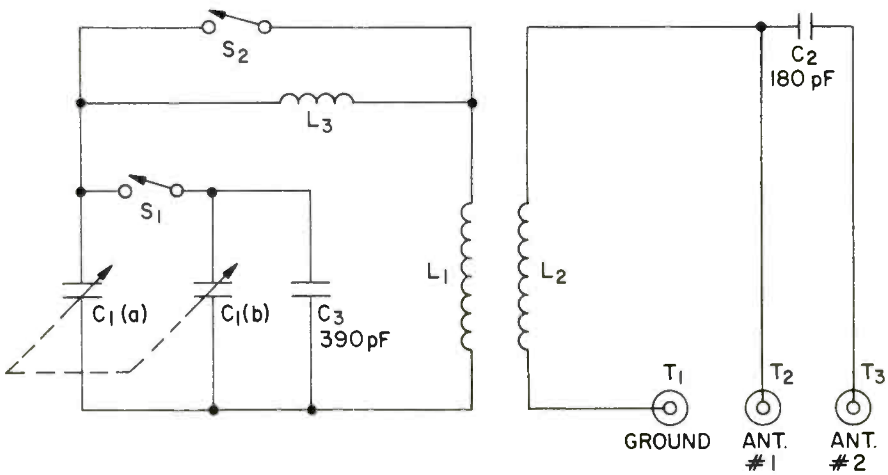


Fig. 1 — Schematic of the Superloop, which has specifications as follows: Outer coil, L1, has an inductance of 180 µH at 1 kHz, self-resonance at 1775 kHz (includes stray capacity in C1), Q = 143 at 550 kHz and 57 at 1300 kHz. The inner coil, L2, has an inductance of 160 µH at 1 kHz, self-resonance at 2300 kHz, while Q = 115 at 790 kHz. Coil L3 is a loopstick radio antenna type with 600-µH inductance and Q of 75 at 790 kHz.

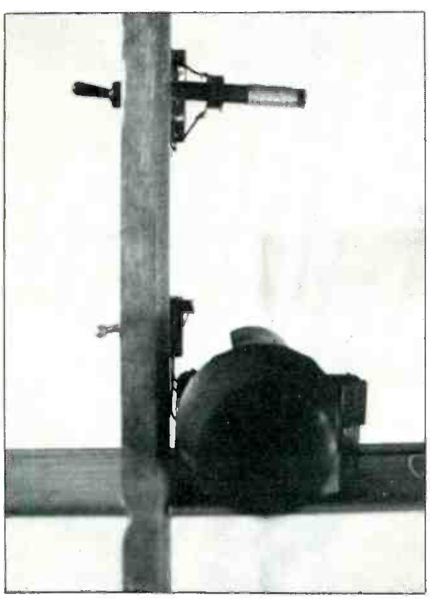


Fig. 2 — Component parts placement at the crossbar of the author's Superloop. Clockwise from 4 o'clock are the large-knobbed C1 beside which is C3, switch S1, switch S2, and finally the loopstick, L3.

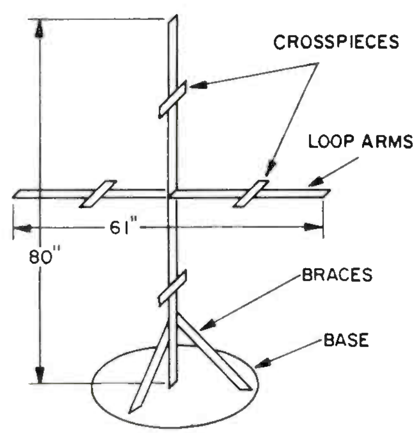


Fig. 3 — Superloop frame and wire supports. Four 4-inch crosspieces are placed halfway from the end of each arm to the frame center. The loop arms are made of 2½ by ½ inch material. The two braces should be set at a 90° angle and attached firmly to the base, which should have at least an 18-inch diameter.

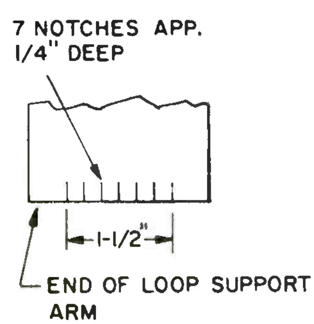
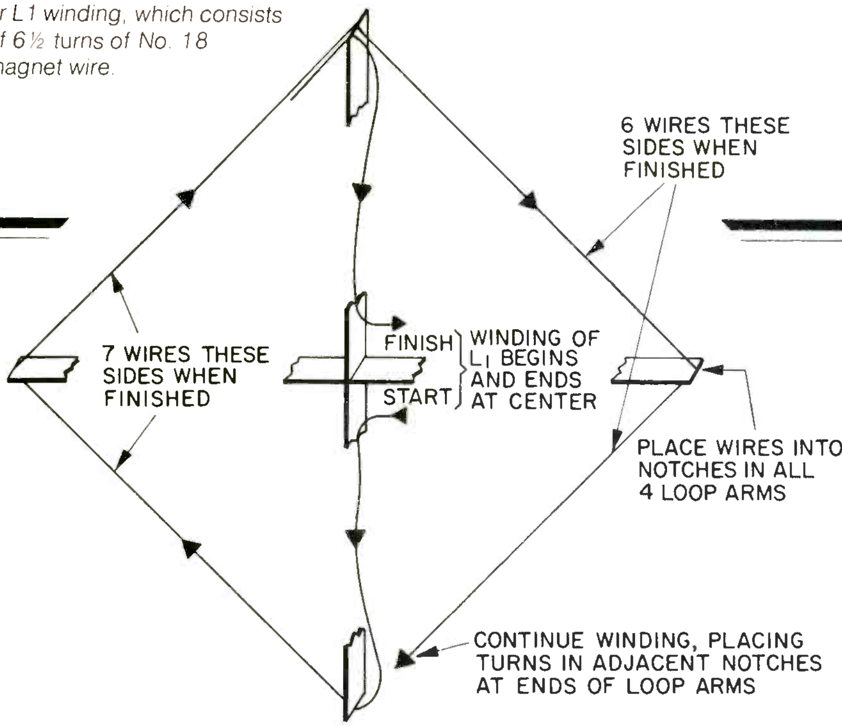


Fig. 4 — Detail of wire support notches which are cut into the ends of the loop arms.

ANTENNAS

AM

Fig. 5 — Schematic of the outer or L1 winding, which consists of 6½ turns of No. 18 magnet wire.



adding turns. Coils of lesser inductance will not tune to the bottom of the long-wave band (140 kHz). Note that if you are not interested in using the Superloop to tune the long waves, then merely omit S2 and L3. You will then have a tuning range of 380 to 1800 kHz.

The secret of the Superloop's high performance lies in the somewhat complex low distributed-capacity coil windings. Radio loops were wound in the same manner back in the 1920s — old technology is merely being reused here!

Assembly Instructions

Building the Superloop is not difficult, but the coil winding is a bit tricky. I made my loop frame and supports from odd bits of scrap lumber. Yours need not look exactly like mine, so use your ingenuity and available materials. The only thing to preserve in building your loop is the physical size and winding schemes for the two loop windings, L1 and L2; follow mine closely.

Begin by making the two loop arms. My vertical one is 80 inches long and the horizontal one 61 inches. Fasten the four crosspieces (for support of the L2 winding) to the loop arms as in Fig. 3. With a saw, cut notches about ¼ inch deep and evenly spaced over 1¼ inches into each end of the two loop arms (Fig. 4). These notches will secure the windings of the large coil, L1, later. Fasten the two loop arms together at their centers, forming a large cross. Use a proper woodworking joint, that is, notch the arms halfway through, so the result will be neat and strong. Refer to Figs. 3 and 4 as you go along, as well as the overall photo, so you get things looking right.

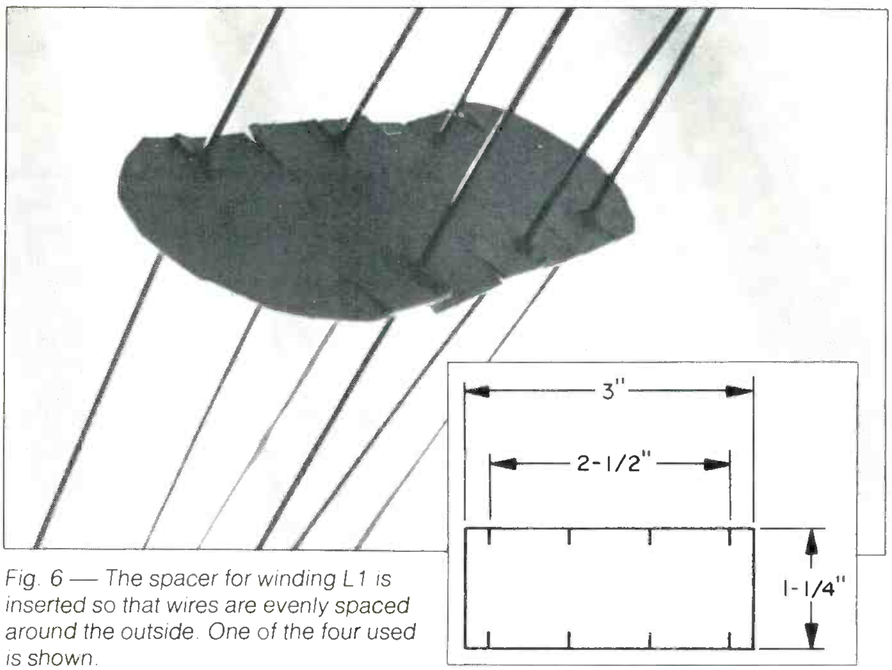
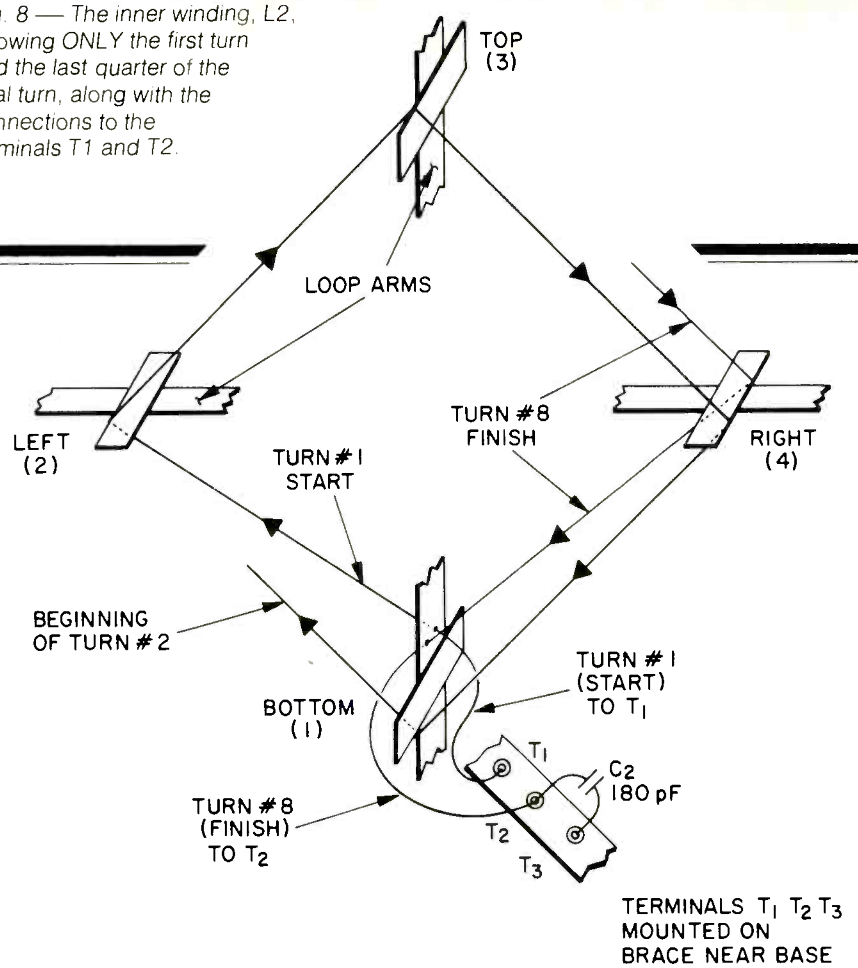


Fig. 6 — The spacer for winding L1 is inserted so that wires are evenly spaced around the outside. One of the four used is shown.

The outer coil, L1, can now be wound. This **MUST** be done **BEFORE** the base is attached! Using #18 magnet wire, begin L1 at the center of the cross formed by the loop arms, leaving several inches slack for connections later. Run the wire along one of the long arms to the notched end, and bend the wire into one of the outside notches. Proceed clockwise around the loop arms, placing the wires into the notches in the ends of the arms until you have wound 6½ turns. As you wind, pull the wires taut but not excessively tight. At the end of 6½ turns, bring the wire down the length of the long arm (you are on the opposite end of the arm on which you started the winding), returning to the center of the cross (see Fig. 5).

A few preparatory steps are required before winding L2, which begins and ends at the loop output terminals that I mounted on one of the base braces. The location of terminals T1, T2, and T3 is not critical but they should be somewhere near the base of the Superloop. After mounting the terminals, drill two small holes (1/32-inch dia.) about 1

Fig. 8 — The inner winding, L2, showing ONLY the first turn and the last quarter of the final turn, along with the connections to the terminals T1 and T2.



inch apart through the loop arm near the base and output terminals.

The loop cross may now be attached to the base. Make something which looks roughly like the scheme in Fig. 7. I used No. 6 wood screws and panel cement to hold everything together, and the result was a sturdy construction. Be careful to make things reasonably square so your Superloop will stand upright on the base.

With the Superloop now standing on its base, construction can now continue. Insert the four spacers into the wires of L1 (Fig. 6). Mine are of stiff cardboard; thin plastic or fiberboard would be more elegant. Slip the spacers into the wires, adjust the wires evenly around both sides of the spacer, and apply a bit of cement to each wire at the spacer to hold things in place.

The inner coil, L2, will be eight turns of No. 22 magnet wire. Begin by passing the wire through one of the holes drilled in the loop arm, and solder the end to

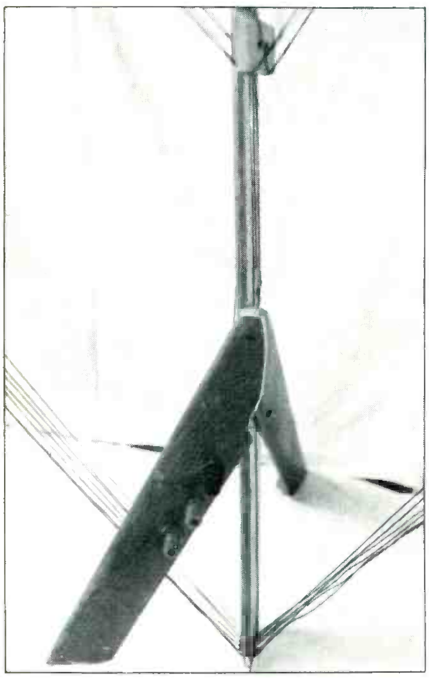


Fig. 7 — Output terminals for the Superloop are mounted on one of the frame supports near the base.

Table III—Winding table for the inner coil, L2. All turns are clockwise, F means put the wire on the front of the crosspiece, and B means put the wire on the back of the crosspiece. The numbering system for the crosspieces refers to Fig. 8.

Turn Number	1 (Bottom)	2 (Left)	3 (Top)	4 (Right)
1 (Start)	F	F	F	F
2	F	F	F	F
3	F	B	F	B
4	F	B	F	B
5	F x B	F	B	F
6	B	F	B	F
7	B	B	B	B
8	B	B	B	B
8 (End)	B			

T1. Pass the wire upwards along the vertical loop arm to the bottom crosspiece (see Fig. 8). You are now ready to begin winding L2. Stand facing the loop, with the plane of the winding L1 at right angles to your line of sight. Refer to Fig. 8 and note that the windings of L2 will pass over the front (nearest to you) or rear (farthest from you) of the crosspieces, as determined in Table III.

Begin winding L2 with two complete clockwise turns passing over the front of all four crosspieces. Begin turn three on the front of the bottom crosspiece, No. 1, but now alternate front and back wind positions on the crosspieces as you go around, following the positions as indicated in Table III. For example, you will be at the back of crosspiece two at 3 ¼ turns, at the front of crosspiece three at 3 ½ turns, and so forth. At the beginning of turn five, you should be at the front of crosspiece one. Begin turn five by first looping the wire from front to back of crosspiece one so that turn five will begin at the BACK of crosspiece one. Continue winding turns five and six, alternating back and front wind positions on the crosspieces as you go around. At the end of turn six, you should be at the back of crosspiece one. Wind turns seven and eight remain on the back of the four crosspieces, as indicated in the table.

Upon completion of turn eight, pass the wire downwards on the vertical loop arm, pass it through the remaining hole in the loop arm, and solder to T2. Keep the wires to T1 and T2 separated by at least 1 inch in order to minimize stray capacity. Attach C2 between T2 and T3, and this completes the inner loop, L2.

Finish your Superloop by mounting C1, S1, S2, L3, and C3. Group these components near the center of the loop frame, making things look roughly like Fig. 2. Connect the components as in the schematic (Fig. 1), and your Superloop is finished and ready for testing. Check the wiring carefully, then go find an AM radio set.

OPERATION

Two modes of operation of the Superloop are possible, each determined by the type of antenna system in the radio set to be used with it. For radios with built-in small loops or ferrite rods, merely place the radio near the Superloop and tune both radio and loop to the same frequency. Be sure that the axis of the radio's loop coil and the Superloop windings are parallel. Rotate radio and loop together for best reception. Radios not having built-in loop antennas are connected to the Superloop secondary-winding output terminals. Tap the radio's antenna lead to T2 or T3 on the Superloop, whichever gives the best results. Connect the ground lead of the radio to T1. Both antenna and ground must be connected for best results. If the radio and the Superloop are located physically far apart, you may use shielded 50- or 75-ohm coax to connect the Superloop to the radio. Ordinary "zip" cord, 300-ohm twin lead, or simple twisted wires will also work to connect the radio to the loop, but may pick up some noise.

All my radios work on the Superloop, with surprising and amazing success. Summer thunderstorm activity will be the only restriction on DX reception with the Superloop, although not as much as you might think. The loop does seem to pick up less static than a long-wire antenna. You will be able to detect the approach of a storm front from great distances. With a bit of practice, you might even try using the Superloop to forecast the weather!

Bigger loops can be built. I am planning a 20-foot tall monster set in concrete and rotatable with remote tuning via varactor diodes. If this thing is built and works, I may report on it. Good DXing!

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Today, only one high bias tape is able to combine outstanding sensitivity in the critical high frequency range with the lowest background noise of any oxide tape in the world.

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Professional II is like no other tape because it's made like no other tape. While ordinary high bias tapes are made from modified particles of ferric oxide, Professional II is made of pure chromium dioxide. These perfectly shaped and uniformly sized particles provide a magnetic medium that not only delivers an absolute minimum of background noise, but outstanding high frequencies as well.

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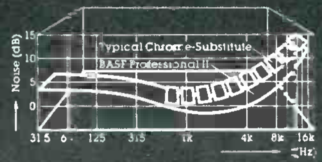

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BASF Professional II is so superior it was chosen by Mobile Fidelity Sound Lab for their Original Master Recording™ High Fidelity Cassettes. These state-of-the-art prerecorded cassettes are duplicated in real time (1:1) from the original recording studio master tapes of some of the most prominent recording artists of our time.

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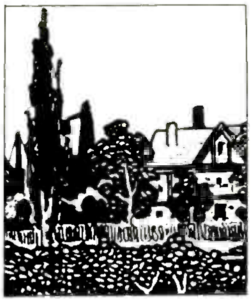
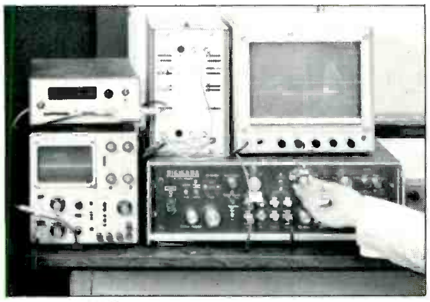
Audio in England

GEORGE W. TILLETT

American hi-fi enthusiasts seem always to have had a special and high regard for audio equipment from England, almost as if the gear were the work of an older, wiser brother whose abilities and intentions were respected, but not quite fully understood. England has also had and continues to have a succession of highly interesting innovators and inventors, whose products are the stuff of myth or legend and whose exploits and foibles bear frequent description. Names such as Alan Blumlein, Percy Wilson, and Gilbert Briggs come to mind. Several such folk are currently active on the British hi-fi scene, so we thought it would be interesting to have Contributing Editor George W. Tillett, a Brit who's been transplanted, tell us about his trip to the Harrogate Festival, England's consumer hi-fi show, and to the facilities of several leading audio equipment manufacturers. — *E.P.*



HARROGATE FESTIVAL



Harrogate, the scene of the August International Festival of Sound, is a delightful spa resort in the north of England renowned for the beautiful gardens and flower displays. Compared to U.S. Shows, the Festival was much smaller with about 125 exhibitors. On the other hand, it was more leisurely and friendly with many of the demonstration rooms in such Dickensian hostelries as The Old Swan, The Crown, and St. George. Unfortunately, most of the demonstrations were too loud and nearly all were of pop music with a heavy bass line. However, there were some notable exceptions, and some excellent sound was heard from KEF, Quad, Castle, Wharfedale, Rogers, and Mission. Both Pioneer and Philips were showing LaserDisc players, although they are not yet available in the U.K. The JVC VHD player, sponsored there by the EMI-Ferguson group, was scheduled to be released this month (January) but I understand it has been postponed until June.

One of the most interesting items on display was a turntable called The Rock from Elite. It uses a pivoted arm with a tiny paddle at the cartridge end which dips into a silicone fluid in an arc-shaped trough. Thus, the arm is really a damped beam instead of a free cantilever. The viscous damping is claimed to reduce the arm resonance by some 15 dB as well as providing extra stability. I can testify to this feature, as the base and platter could be pounded quite hard before tracking was affected. The motor is a servo-controlled d.c. type and the rigid epoxy-concrete platter turns in a viscous fluid bearing.

Garrard broke with tradition by showing a complete range of components — speaker systems, tuners, amplifiers, turntables — the lot. As some are made by their Brazilian affiliate, we may well see some of these items over here later. I didn't get a chance to hear them but I must say that their styling was most impressive.

Tannoy, now under new ownership, also broke with tradition as they were proudly demonstrating a bookshelf loudspeaker measuring only 20 x 14½ x 10 inches using a 10-inch coaxial driver. The model number is the SRM 10B.

Center of attraction at the Wharfedale booth was a computer display programmed to select the best loudspeaker system for any or almost any listener. Details to be punched in include the type of music most often listened to (classical, opera, pop, rock, etc.), amplifier power, room size (length, height and width), and so on. After telling the computer the most important parameter — the maximum amount of money available — the recommended model numbers are flashed on the screen.

Toshiba was showing a new AM/FM tuner with no fewer than 30 presets, and I noted that they now have three cassette decks boasting ADRES noise-reduction circuitry which is an encode-decode system giving 30 dB signal-to-noise improvement.

One of the reasons for this European trip was to visit some of the better known British loudspeaker companies. First on my list was Wharfedale as they are located quite near Harrogate, in a town with the inappropriate name of Idle. As most readers know, the company was founded by the late Gilbert Briggs, famous for his books on audio which were notable for a down-to-earth style and enlivened with a droll Yorkshire humor. The company began operations in 1932, and it has an impressive list of "firsts" which include moving-coil headphones (1947), a two-way speaker with crossover (1945), and a speaker unit with a roll-type surround (1955). They were the first to use laser holography for the study of speaker cone behavior and the first to make planar high-frequency units, at least commercially. I believe they were also the first to stage live-versus-recorded music concerts. In fact, I was privileged to help in one such affair in London's Festival Hall back in 1957 or thereabouts.

After a discussion with Wharfedale's Technical Manager, Ken Russell, and some of the senior engineers, I was taken on an inspection tour of the 400,000-square-foot Idle facility. The Plant Manager was justifiably proud of the large, well-equipped cabinet-making facility, and he pointed out that most cabinets are finished with wood veneers, not vinyl. Great care is taken to match them, and each cabinet's grain is a mirror image of its partner's. In the test department, bass drivers were being checked with 300-watt pulses — a necessary precaution in these days of super power amplifiers. I was told that the biggest problems did not have to do with rock, organ or disco music but with reggae!

As mentioned earlier, Wharfedale pioneered the use of laser holography, and the original technique was to illuminate the speaker cone so the reflected light would fall onto a special photographic plate where it would be combined with the reference beam. When the plate was developed, the photograph could be viewed by laser light to show the interference patterns. Although nodal patterns can easily be seen, frequency aberrations are not that simple to interpret and the photographic process is time-consuming.

One present Wharfedale system is called SCALP, a hair-raising acronym which stands for Scanned Laser Probe. Here's how the system works. Light from the laser is divided into two beams, one is sent to the loudspeaker being tested and the other is sent to a rapidly rotating disc which changes its frequency by 10.7 MHz. Both beams are returned to the beam splitter which then sends a composite beam to a photocell. The two components beat with each other to produce a signal which is amplified and passed to an FM discriminator and an X-Y plotter. When the speaker cone is stationary, a steady d.c. signal is generated, but as the cone moves forwards the light reflected is shifted upwards in frequency. Conversely, when the cone moves back, the reflected frequency will be lower. The beam falling on the speaker cone passes through two mirrors connected to the magnetic coils; one drives the beam across the cone while the other scans vertically so the plotter builds up a three-dimensional picture of the cone's vibration. Using a single frequency, the SCALP process takes 15 minutes to build up a complete picture.

A variation of the system is called FRESP or Frequency Slice Plot, and its inventor, Dr. Peter Fryer, said it was most useful for pinpointing the troublesome regions of a speaker cone's behavior. The equipment is set up in the same way as SCALP, but the vertical scanning mechanism is turned off so each curve plotted is of the same horizontal slice across the middle of the cone. Instead of inching the laser beam from the bottom to the top of the cone for each separate trace, the frequency fed to the speaker is changed between plots starting at the highest frequency desired and going down in small steps. This results in a plot having the same width from top to bottom, the width corresponding to the central slice across the middle of the cone. Thus, each separate curve illustrates the behavior of this slice of cone at a different frequency.

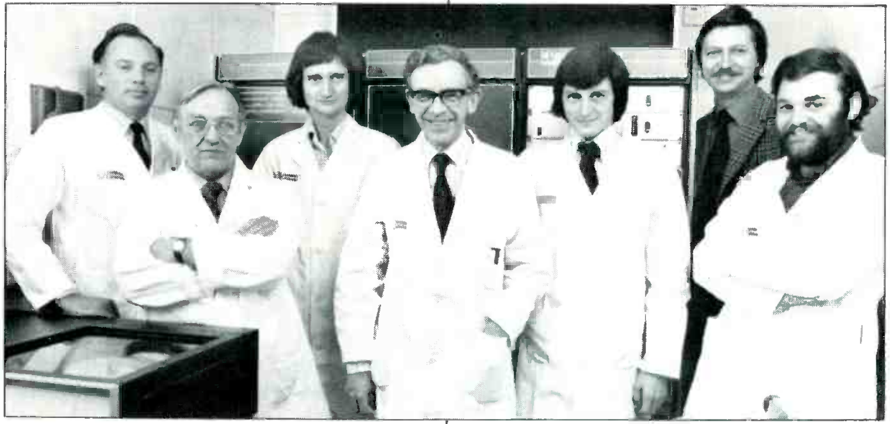
Alternatively, each curve can be made with a frequency sweep so the effect is a change in "vision angle," as each curve represents the behavior of the cone at all frequencies. It is also possible with FRESP to plot the cone behavior in three dimensions when each slice is at the same frequency but at a different phase. In fact, curves at any phase angle can be made and complete vibration cycles can be studied. Finally, both SCALP and FRESP systems have phase reversal capabilities so "holes" in the complex curve mass can be changed into "hills" if desired.

John Bowers

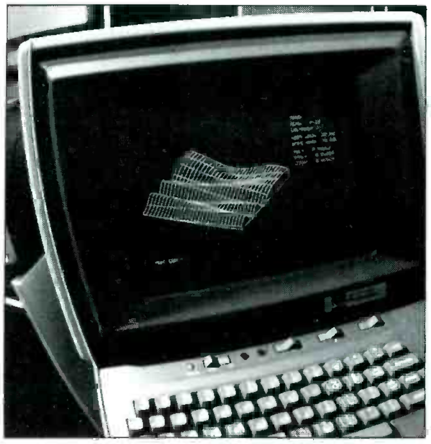
BOWERS & WILKENS

Bowers and Wilkens, or B&W, commenced operations in 1966, and they are based in the attractive seaside town of Worthing on the south coast. The company, headed by the energetic John Bowers, now has three plants with a modern well-equipped laboratory. Computers play a large part in production and design functions, and I noticed that access to a sophisticated PDP 11/40 was available in a number of areas. The B&W laser system as applied to cone technology has been described at some length in these pages (August and September, 1981), and it is sufficient to say here that it is a little different from Wharfedale's system, although both employ a Doppler principle.

But laser techniques can be useful in other areas, and Chief Engineer Dr. Glyn Adams made use of it to improve the enclosure housing the midrange unit in the Series 800 loudspeaker systems. The original cabinet was made of wood



and caused a subtle coloration. As the possible radiating area of the complete enclosure is many times that of the cone area, it is obvious that it must be as acoustically dead as possible. Using a laser system as a "massless accelerometer," B&W tried all kinds of materials as linings — bitumin, lead sheeting, pads — as well as various bracing combinations. Eventually, the answer to the problems was found in a glass-reinforced cement with an outer skin of molded polystyrene. The improvement in the critical 300 Hz to 3 kHz region is over 10 dB, bringing cabinet vibration down to 60 dB below the cone output. The difference was quite audible in listening tests



Peter Walker

ACOUSTICAL MFG. CO.

although it would not be easily discernible in normal frequency response measurements. But pulse tests and non-steady-state analysis tell a far different story!

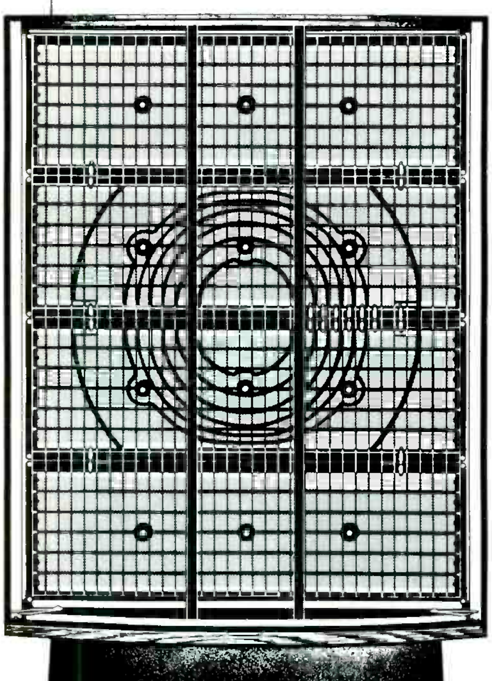
One example of computer use pointed out by Dr. Adams is the solving of a crossover design equation with *13 variables* in a matter of minutes. This facility could save a lot of headaches and man-hours, although it might tend to make the engineers rather lazy! B&W has come a long way in a relatively short time, and one reason for their success has to be the emphasis on up-to-the-minute technology but I was even more impressed by the highly qualified, dedicated staff. Working conditions are excellent and even the employees on the production line are made to feel part of the company. Perhaps that's the essential secret of B&W's success.

My next visit was to Quad, as the Acoustical Manufacturing Co. is often known, which is located about 70 miles northeast of London, in the small country town of Huntingdon. The company was founded way back in 1936 by Peter Walker who is now ably assisted by his son Ross. The name Quad has nothing to do with four; it originated with an amplifier which was called Quality Unit Amplifier Domestic. Incidentally, the Quad amplifier, which was introduced in 1951, was the first to use an ultralinear power stage where the cathodes of the output tubes were taken to taps on the transformer. The Corner Ribbon speaker system also made its appearance about this time, and I note from an advertisement in September 1951 that "Reflections from the back radiation add to the area of sound so now it appears to emanate from an opening of eight to ten feet square." The well-known Quad full-range electrostatic loudspeaker was introduced in 1957, and it was soon accepted by broadcasting authorities, studios, and loudspeaker engineers as a reference standard. It is still being made.

However, in 1963 work commenced on a revised version which is now in production. This is the ESL-63, known among acronym-loving cognoscenti as Fred or Full Range Electrostatic Doublet. I had heard these long-awaited models at the last Chicago CES but I was eager to listen to them under better conditions as well as to see how they are made. Peter Walker explained the basic concept as follows:

"An ideal loudspeaker can be imagined as some form of pulsating or vibrating sphere, neither of which is practicably realizable with precision if any reasonable power output is required. Suppose, however, we were to plot the air-particle velocity components normal to a plane interposed between an imaginary ideal source and the observer. If we now substitute a plane surface with the same distributed velocity pattern, it follows (if the surface is sufficiently large) that a replica of the curved wavefronts would be created and we would have an accurate acoustic 'picture' of our ideal source for any position of the observer." Then, holding up a large sheet of thin, transparent plastic, Peter said, "You will hear no difference to the sound of my voice when I speak through it."

Well, obviously the best way to drive a large, low-mass diaphragm is by electrostatic means but controlling it to produce a spherical waveform posed some problems. The diaphragm in the ESL-63 measures 30 x 24 inches and is suspended between two sets of electrodes made from perforated copper-coated plastic. This diaphragm is only 2 microns thick (or thin), and it is coated with a conductive material. A polarizing voltage of 5 kV is used, but the outside plates are at ground potential. Now, here is where the construction differs from the original model: Each of the copper plates is cut to form circular rings shown in the photo. The audio signal is fed sequentially to each set of rings by a series of inductors and capacitors which form delay lines. The result is a waveform which is coherent in terms of phase and frequency, since this delayed signal application causes a relatively large diaphragm to act as a point source.



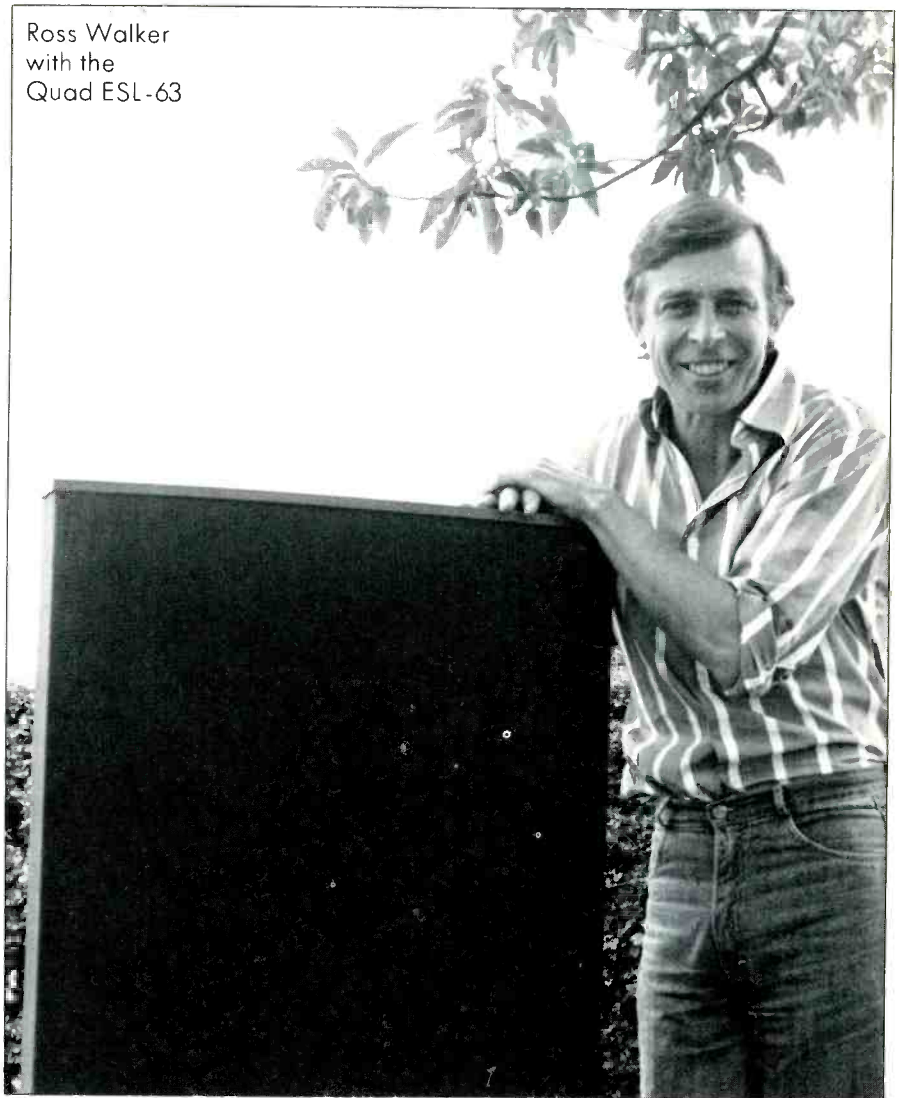
The radiation pattern is arranged to be substantially constant with frequency. In a normal listening room, the excitation of both horizontal modes is 3 dB lower than with an omnidirectional source, resulting in a better stereo image. Each coil consists of 12,000 turns of fine-gauge wire, and the delay per section is 24 μS which is equivalent to a path length in air of just over ⅜ of an inch. It must be emphasized that the circuit is very complex; for example, there are several crossfeed capacitors. The high-voltage generator circuit is a fairly conventional cascade arrangement. A neon lamp is connected in a relaxation circuit so the flashes serve as an indicator. There are two protection circuits, one a "soft clipper" which reacts to peaks over 40 volts, while the other senses ionization which could be a prelude to a "flashover." The high-frequency noise radiation that happens just at the start of ionization is picked up by an antenna which is closely coupled to the high-voltage section, and the signal is amplified and passed to a timer which then fires T1 to short circuit the audio input. Very ingenious....

The units are amazingly constant, and a favorite trick of Peter Walker's is to place a microphone in between a pair fed with a square-wave signal of around 1 kHz. Microphone output is displayed on a 'scope, and when one channel is phase-reversed, a slight touch of the amplifier's balance control and the square wave is nulled out — it just completely disappears!

Each subassembly is thoroughly tested and the electrostatic panels are checked for capacitance, Q factor and other parameters. The final test proved to be quite simple but impressive for all that. After checking the frequency and impedance against a standard 'scope curve, the aforementioned nulling technique is then used with a reference loudspeaker. This kind of test is only possible because of close tolerances at every manufacturing stage.

I noticed that the assemblers work in teams which produce complete units (amplifiers, tuners or speakers), which is obviously more satisfying than mass-production methods where each worker continually solders the same six wires or whatever.

How does the ESL-63 sound? Compared to the original model (one of mine, by the way, is number 51), it has an extended bass response but I think the most spectacular improvement is in the smooth radiation pattern. The vertical angle is much greater, and the stereo image has a sense of spaciousness and depth, while the listener is not so restricted to the "stereo seat." Overall sound is well-balanced and completely neutral. Some years ago, Peter Walker was asked whether he was satisfied with the ELS. He replied, "No, we think our loudspeaker is very poor but we think most of the others are much worse. But you can put a good moving-coil loudspeaker and an ESL side by side and there's much less difference now than there was 20 years ago." I didn't ask him whether he thought the ESL-63 was perfect, but he would probably answer with a roundly diffident, "No, but it does make a nicer noise than any of the others!"



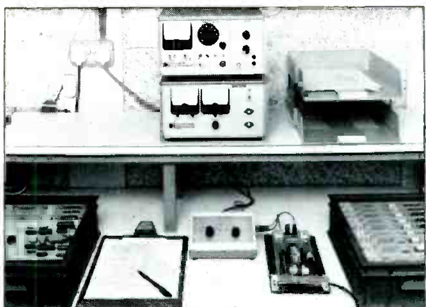
Ross Walker with the Quad ESL-63

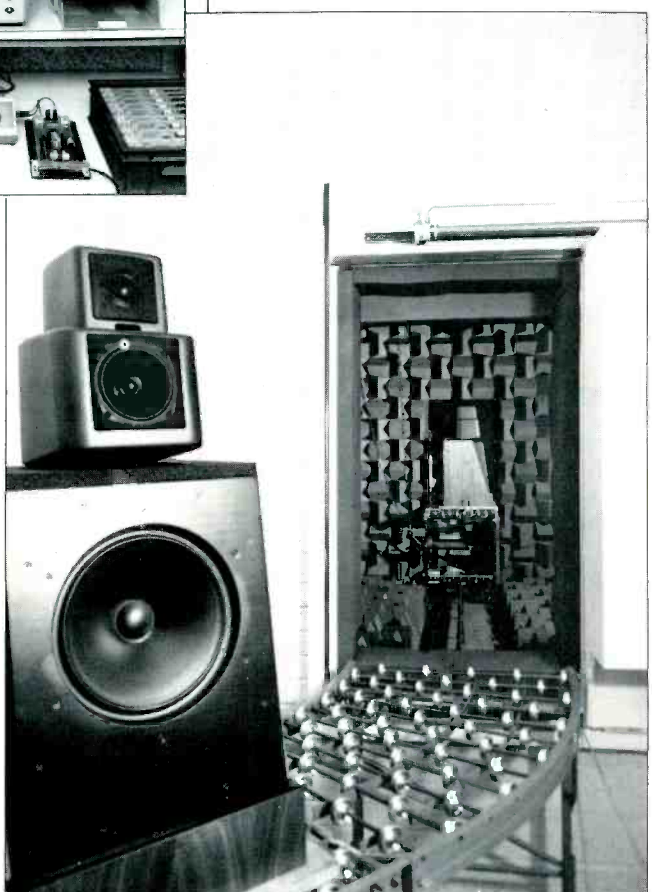
The last plant on my list was KEF, situated near Maidstone in the County of Kent about 40 miles south of London. The company was formed by Raymond Cooke in 1961 and soon acquired a reputation for enterprise with their innovative designs. They were the first to make a bass driver with a flat plastic-foil sand-

Raymond Cooke

KEF ELECTRONICS

wich diaphragm and the first to use Melinex (Mylar) for a low-mass dome tweeter. In 1966, KEF introduced a driver using Bextrene hard plastic cone material, and since then many thousands of these units and the flat diaphragm models have been sold to other speaker manufacturers in many countries. Needless to say, computer techniques play an important role in KEF designs, and some two years ago, a unique computerized production system was installed. Unfortunately, I was unable to see the plant in operation, but I did have discussions with Raymond Cooke and some of his engineers. Basically, the speaker units are not tested with frequency sweeps but by a digital method based on the relationship between the frequency response and impulse response as expressed by the Fast Fourier Transform (FFT). In other words, a loudspeaker's frequency response and other data can be calculated by a computer if the impulse response is known. The advantages are that it is much faster than frequency measurements, less critical of room acoustics and, once the impulse response is obtained, all other parameters including transient behavior can then be analyzed.





The unit under test is placed near the center of the test room and fed with a series of pulses. The resulting waveform is picked up by a microphone and then passed to an analog-to-digital converter and a spectrum analyzer which has a CRT display for monitoring before the data is stored in an HP-7900A magnetic disc memory. To maintain a good signal-to-noise ratio, the pulses are repeated 64 times and the responses averaged by the computer. Drive units are usually measured in batches of 94, and the data is transferred to the computer which then compares the sensitivities and responses at ⅛-octave points before providing a printout listing matching pairs. If, for example, the units are for a three-way system like the 105, the process is repeated for the other two drivers, and finally they are matched in sets of six. Crossovers are matched within 0.2 dB so the complete loudspeaker systems do not differ more than 0.5 dB from its partner in the pair.

The same FFT measurement technique is used by the design engineers. For example, cabinet resonances can be investigated, and optimum phase locations of the driver units can be made. A further development of the system is the production of three-dimensional response curves which are made by simulating delayed response curves. As Laurie Fincham, KEF's Chief Engineer, has pointed out, steady-state response curves do not show a loudspeaker's behavior with transients, such as occur naturally in music.

Like other manufacturers, KEF has broadened their range to include low-priced models. For instance, the Cantor II, a new two-way system, costs only 100 pounds a pair (about $185) in the U.K.! Because of the experience and technology involved, it is safe to say they will outperform systems put together on a "hit or miss" principle and costing a lot more....

I would have liked to visit Celestion as I know they are well advanced in laser analysis, but time was pressing and I had to get back to sunny Florida. Perhaps I'll make it next year!

Technics linear-tracking turntable.
Program it to play any cut. In any order. Even upside down.

Technics direct-drive SL-15. It automatically plays the record selections you want and skips the ones you don't. It completely eliminates tracking error and is so advanced it can even play upside down.

The SL-15's microcomputer and infrared optical sensor let you play up to 10 cuts per side, in any order. Just press the program keys in the order of the selections you want to hear. And with the repeat button, the SL-15 can repeat the entire program or any selection.

The SL-15 performs virtually any function, automatically. It accurately selects the record size and speed, finds the lead-in groove and begins playback at the touch of a button.

More proof of the SL-15's accuracy is its quartz-locked, direct-drive motor and dynamically balanced, linear-tracking tonearm. In addition to tracking perfectly, the SL-15 plays a record as accurately upside down as it does right side up.

Technics also offers other linear-tracking turntables, including our famous SL-10 and SL-7. Audition one and you'll agree when it comes to linear tracking, Technics is a cut above the rest.

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1

NAKAMICHI 700 ZXL CASSETTE DECK

Manufacturer's Specifications

Frequency Response: 20 Hz to 20 kHz, ±1.5 dB; 18 Hz to 24 kHz, ±3 dB.

Harmonic Distortion: 0.8% for 400 Hz at 200 nWb/m.

S/N Ratio: 66 dBA with Dolby B NR.

Separation: 37 dB.

Crosstalk: 60 dB.

Erasure: 60 dB at 100 Hz with metal tape.

Input Sensitivity: Mike, 0.2 mV; line, 50 mV; NR, 100 mV.

Output Level: Line, 1.0 V; headphone, 45 mW; to external NR, 100 mV.

Flutter: 0.04% W rms, 0.08% wtd. pk.

Dimensions: 19-11/16 in. (500 mm) W x 10-5/16 in. (262 mm) H x 9⅞ in. (250 mm) D.

Weight: 30.8 lb. (14 kg).

Price: $3,000.00.

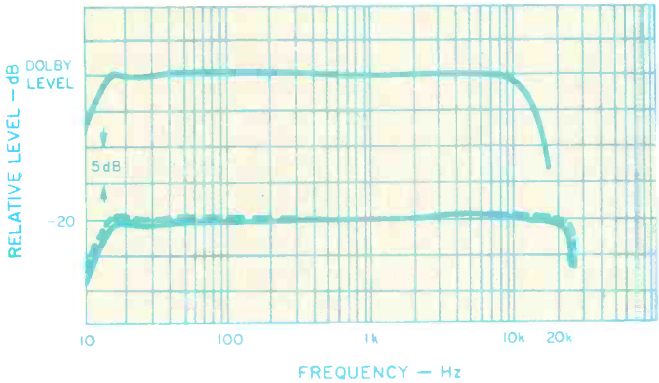

Fig. 1—Frequency responses using Nakamichi EX II tape with and without (dashed line) Dolby B noise reduction.

The Nakamichi 700 ZXL cassette deck can be thought of in different ways: As a very high priced recorder with outstanding performance, or perhaps as the Nakamichi unit which matches the 1000 ZXL in most respects for $800.00 less. (Additional details on some of the features to be described here may be found in the June 1981 "Equipment Profile" of the 1000 ZXL.) The 700 ZXL is immediately impressive because of its size and weight. The top and bottom of the front panel continue the jet black of the rest of the cabinet, while the brushed-aluminum center portion stands in vivid contrast to the black, adding to the overall attractiveness. In the top section are three displays. The one at the left has a series of annunciators that show the status of A.B.L.E. (the auto-calibration processor), tape selection, EQ, noise-reduction mode and RAMM (Random Access Music Memory). Once started with *Auto Cal/Run* in record mode, A.B.L.E. automatically adjusts azimuth, bias, level (record sensitivity) and record equalization for any tape formulation. There are regular bias and EQ switches which act as presets for adjustment ranges, and illogical combinations will be rejected by A.B.L.E. after a few adjustments. For example, it will adjust the deck for SX (Type II) tape for 120-μS EQ, but not for ferric-level bias. Such a rejection is indicated by the A.B.L.E. annunciators, *Bias, Level* and *EQ,* flashing until a correct choice is made — an excellent implementation of this scheme.

When auto calibration is completed, the results can be entered into any one of four memories, including the noise-reduction setting: *Out, Dolby NR* (the built-in Dolby B scheme) or *Ext* (designed for the Nakamichi High-Com II or the NR-100 Dolby C add-ons). A manual setting facilitates changing just the EQ or the NR mode if that is desired. Green indicators show which memory is being used and whether *Manual Set* is active.

Other annunciators in the first (left) top-of-panel display show when RAMM mode is active and what the program condition is. RAMM is similar to a number of other systems in that it allows the playing of a number of selections in any desired order to be programmed. RAMM is unique, however, in that it encodes information on playback EQ and NR status for decoding in subsequent playback — a feature that is certain to be very helpful to some. In the center is the four-digit tape counter, which provides more resolution for exact location.

The right-hand top-of-panel display consists of the two horizontal LED-type bar graph level meters, each with 30 segments. These peak-responding devices cover a 50-dB range from −40 to +10 dB, with momentary holding on any peaks to aid in record-level setting, an excellent combination.

Loading a cassette is a simple drop-in process, and the compartment door closes smoothly with a firm push. *Eject* is below and to the left, and it requires a push to the left for actuation. This seems a little odd, because it is different from most, but it certainly will not be mistaken for tape motion buttons, which are wide, knurled bars which require just light touches for the logic to take over. *Pause, Stop, Play* and the wind buttons all have green indicators; *Record* has red. There is some interlocking in the logic, which prevents adding record to play, but there are other uses for these buttons. For example, record muting is obtained by holding in *Record* while in that mode. Also, if *Pause* is pushed during fast wind, the 700 ZXL goes into a cue mode with wind reduced to one-third speed. Holding in a wind button will reduce speed further to one-fifth that of normal. When a cassette is inserted, there is some automatic take-up to eliminate

The 700 ZXL easily meets its demanding record/playback specifications of ±1.5 dB, and it does so with all three tape formulations.

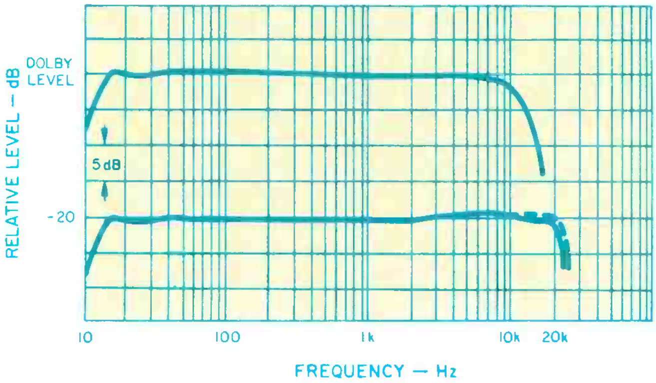

Fig. 2—Frequency responses using Nakamichi SX tape with and without (dashed line) Dolby B noise reduction.

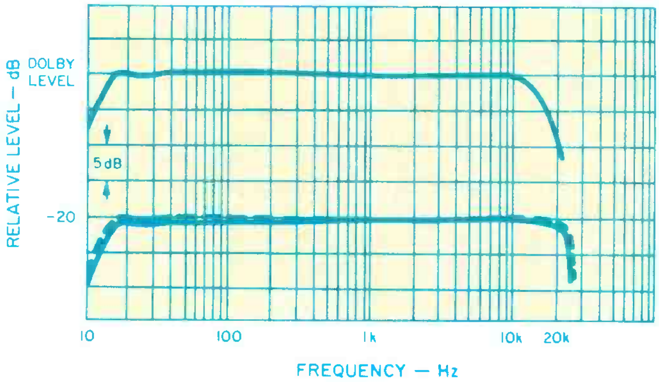

Fig. 3—Frequency responses using Nakamichi ZX tape with and without (dashed line) Dolby B noise reduction.

any slack in the cassette. For a start at the absolute beginning of a cassette, it may be necessary to rewind slightly.

In the right half of the center section is a swing-out panel which covers a number of controls and switches not necessarily needed in day-to-day use. A light touch on the upper-right corner, and it swings up and out of the way. Revealed are the tape bias and EQ selectors; the noise-reduction mode switch; input pots for left, right, and blend microphones; the output level pot; the play speed pitch control (±6%), and switches for timer *(Record/Off/Play)*, memory *(Stop/Off/Play)*, 400-Hz test tone for external NR calibration *(Off/On)* and *Filter (Subsonic/Off/MPX)*. Most of the above are well understood, but comments are in order for two of them. The output of a microphone fed into *Blend* goes into both left and right channels, providing a simple and effective way of getting a centered sound image, such as with a vocal, without the use of a separate mixer. The subsonic filter is useful in two ways: It can be used to reject low-frequency spurious signals such as from record warps, and it is needed with the RAMM to keep its 5-Hz code signals out of the music signal flow.

In the bottom black section on the left are five small buttons for RAMM *(RAMM*, down [arrow], up [arrow], *Set* and *Reset)*. *RAMM*, of course, puts the deck into that mode, and the others control programming for playing up to 15 selections in any sequence up to a total of 30 plays. When recording a series of selections, the encoding and numbering can be automatic or manual. Just to the left are the power on/off switch and the headphones jack. To the right are the two *Auto Cal* buttons, *Azimuth* and *Run*, both with green indicators. Starting *Auto Cal* (from record/pause to *Run*/play) results in automatic record-head azimuth alignment, and *Azimuth* flashes during this process. When it stays off, adjustments in bias, level and EQ are made, with the associated annunciators flashing indications of the steps being taken. If a tape has already been matched, but there is some question on alignment, then just that button is pushed. The detailed information on any set of adjustments for any formulation can be entered into tape memory (positions A to D) with select buttons on the right-hand side of the bottom strip. After an *Auto Cal*, *Standby/Set* indicates that a memory can be selected. Once that is done, the settings for that tape will remain in memory, even with power off, as there are memory back-up batteries just for this purpose. The *Manual Set* button permits making a change in EQ or NR mode as desired. Green status bars remind the user of memory condition. Just to the left in the middle of the bottom strip are the counter reset button and the tape/source monitor switch. At the right end is the dual-section friction-coupled line-input pot with a split-bar knob which allows easy adjustment of levels for the two channels, separately if desired. There is complete mixing capability between the line inputs and those for microphone.

On the back panel are the four line-in/line-out jacks and the eight NR encoder/decoder in/out jacks, all gold plated. There are also DIN-type sockets for the RM200 (transport only) and RM300 (full function including RAMM) remote controls and the NR-100 Dolby C add-on. The memory back-up battery compartment for two AA cells is here too.

The steel top and side cover was removed for an examination of the internal construction. The inside surface of the top was covered with a rubberlike pad, probably to make things more snug and to damp out any panel vibrations. The soldering on the many p.c. boards was excellent, with just occasional flux residue at a couple of the hand-wired points. There were about 10 good-sized cards with several smaller ones, all with high-quality components. Parts were identified on both sides of the cards, but servicing on this deck is best left to the experts. The chassis construction was quite rigid, and the sophisticated, dual-capstan tape drive with the cam system and the auto-azimuth alignment scheme was impressive.

Measurements

The playback responses of this Nakamichi deck were excellent for both equalizations, within a dB except for one single low-frequency point. The play speed was just 0.1% slow, and the meter indications for a standard level was just a fraction of a dB low. Many different tape formulations were tried with the 700 ZXL, and A.B.L.E. achieved excellent results with all of them. All of the subsequent tests, however, were run with three Nakamichi tapes provided with the deck.

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The auto-calibration processor, dubbed A.B.L.E., is the star of the show, making a series of adjustments in seconds.

With a specified 20 Hz to 20 kHz response ±1.5 dB, the recorder called for a critical examination. Record/playback responses were taken at Dolby level and at 20 dB below that, both with Dolby B NR and without it. Figures 1 to 3 show that the deck easily met the demanding ±1.5 dB limitation, both with and without Dolby NR. It should be kept in mind that the results were obtained from computer-derived information for deck settings that were retrieved from memory. The Dolby tracking was generally excellent, including close-to-exact matches at Dolby level. Table I lists all of the 3-dB down points, and all are better than the specifications, particularly at the low end. Note the high-frequency headroom evidenced in the Dolby-level plots and the flatness of all of the responses.

The auto-azimuth alignment scheme was checked by the record/playback of a 10-kHz tone at the completion of the process. There was just 20° phase discrepancy between the tracks, one of the best to date. The phase jitter with the same tone was only 10°, the best seen to date. The multiplex filter was 1 dB down at 15 kHz and 31.4 dB at 19 kHz. The subsonic filter was 1 dB down at 30 Hz, -3 dB at 27 Hz, and -10 dB at 25 Hz. This is more attenuation than would be needed for some purposes, but to ensure proper RAMM encoding and decoding and minimum effect on the music, the 5-Hz code signal must be reduced greatly. The bias in the output during recording was *very* low, much better than most recorders. There was no 15-kHz loss measured with repeated replays using tapes known to be sensitive to certain decks. The 400-Hz (390-Hz actual) oscillator had just 0.22% distortion, plenty low enough for its intended purpose. The separation at 1 kHz was 51 dB, noticeably better than the 37-dB spec. The crosstalk at the same frequency was down more than 85 dB, and erasure was down more than 75 dB at 100 Hz with metal tape, both better than spec and quite excellent.

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

	With Dolby B NR				Without Dolby NR			
	Dolby Lvl		-20 dB		Dolby Lvl		-20 dB	
Tape Type	Hz	kHz	Hz	kHz	Hz	kHz	Hz	kHz
Nakamichi EX II	12	12.4	14	24.3	12	12.4	12	25.7
Nakamichi SX	12	11.7	12	24.5	12	11.9	12	25.2
Nakamichi ZX	12	15.2	14	25.2	12	15.4	12	25.7

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

	IEC A Wtd. (dBA)				CCIR/ARM (dB)			
	W/Dolby NR		Without NR		W/Dolby NR		Without NR	
Tape Type	@DL	HD=3%	@DL	HD=3%	@DL	HD=3%	@DL	HD=3%
Nakamichi EX II	58.5	63.2	49.5	53.8	57.2	61.9	46.4	50.7
Nakamichi SX	61.6	67.6	52.3	57.5	60.8	66.8	50.0	55.2
Nakamichi ZX	61.2	70.4	52.2	60.9	60.1	69.3	49.3	58.0

The third harmonic distortion was measured with a 1-kHz tone from -10 dB to the point where $HDL_3 = 3\%$ for the three tapes with Dolby B NR. Figure 4 illustrates that the distortion was very low for all of the tapes, but especially so for the ZX metal-particle formulation. This is in refreshing contrast to the "metal compatible" decks that actually have poor distortion performance with Type IV tapes. Also note the very high (+10.4 dB

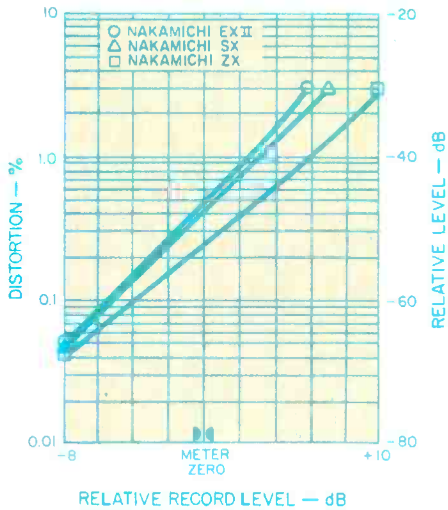

Fig. 4—Third harmonic distortion at 1 kHz vs. record level, using Dolby B noise reduction.

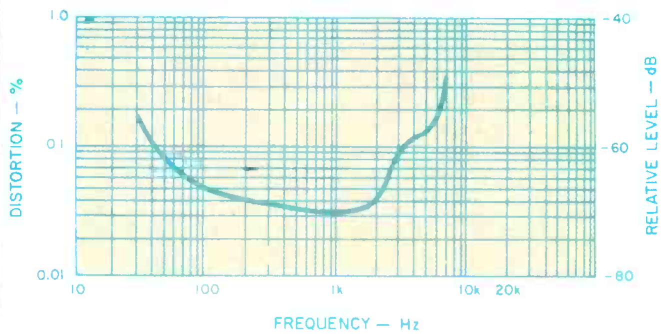

Fig. 5—Third harmonic distortion vs. frequency at 10 dB below Dolby level using Dolby B noise reduction with Nakamichi ZX tape.

exactly) 3% MRL with ZX. Distortion was about 30% higher without Dolby B NR. It was difficult to get precise distortion figures at -8 to -10 dB because of noise effects, but they were very close to 66 dB down from the fundamental or a superbly low 0.05%. HDL_3 vs. frequency was measured from 30 Hz to 7 kHz at -10 dB in Dolby B mode with ZX tape (Fig. 5). Distortion across the band was very low — the best ever seen, with just 0.032% (!) at 1 kHz. The sharp rise to 7 kHz is not very high, and it's not too surprising as the 700 ZXL is one of the few decks that is flat to 21 kHz (third harmonic of 7 kHz).

The input sensitivities were 0.17 mV for mike and 50 mV for line, both good, low voltages. The input overload points were an incredible 2.3 *volts* for mike and over 30 volts for line. Output clipping appeared at a level equivalent to +17.1 dB relative to meter zero, one of the best ever measured. The line input pot sections tracked within a dB from maximum down more than 60 dB, noticeably better than most. There was some variation in the input impedance with rotation of the pot, but the values were 20 kilohms or above, even at 20 kHz, in all cases. The line output

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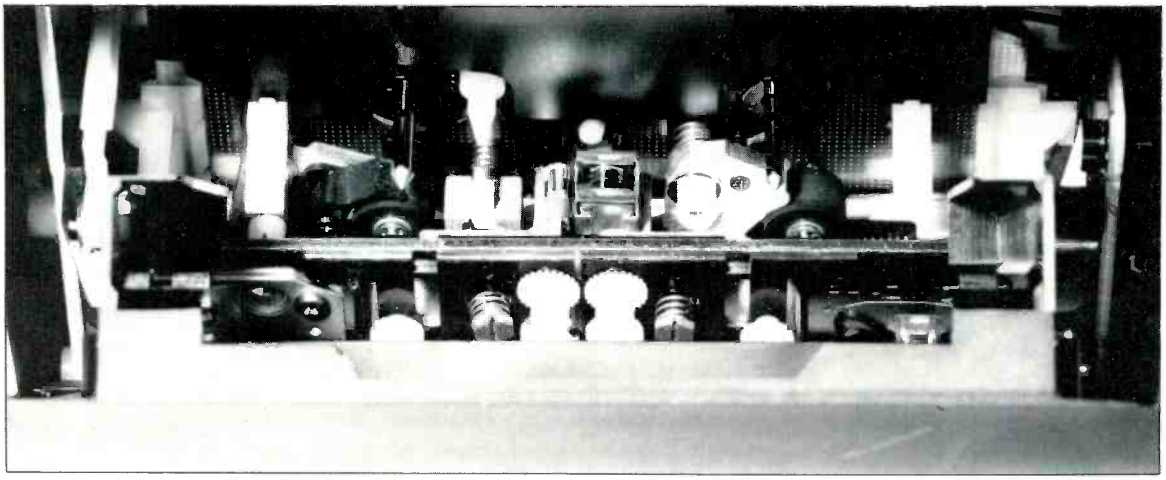
While the Nakamichi 700 ZXL does have a high price, the deck offers performance which is unsurpassed overall.



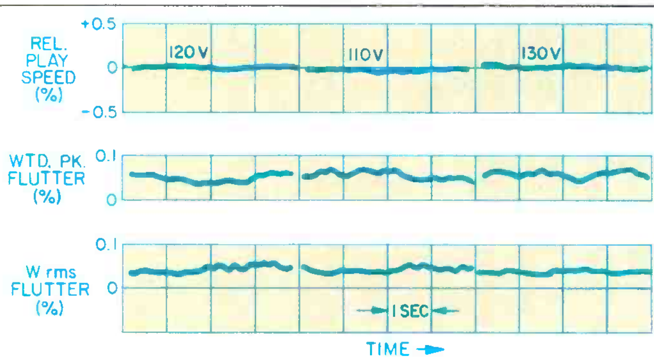


Fig. 6—Tape play speed vs. time and line voltage, and wtd. peak and wtd. rms flutter (three trials each).

was 990 mV, slightly below spec, with high-Z loading. With a 10-kilohm load, this dropped to 817 mV, the expected result with the 2.2-kilohm source impedance.

The headphone output was 554 mV to 8 ohms or 38 mW — lower than the 45 mW specified for an unstated load. A very high level was possible, however, with all of the headphones tried, and the level could be easily set to suit with the output level pot. That control tracked within a dB from maximum down about 45 dB, quite acceptable for this function. The bar graph level meters were 10 dB down with a 10-mS burst and required a 100-mS duration to reach zero. They thus should be described as fast-response meters, rather than peak responding. The decay time was 1.8 S, which is to the IEC standard. Meter indications were 3 dB down at 7 Hz and 21.2 kHz.

Tape play speed wandered very little with time, and the average speed changed just slightly with shifts in line voltage. The flutter was very low, ±0.058% weighted peak and 0.039% W rms, and the values were quite constant with time — much steadier than with most decks. The wind times for a C-60 were 45 seconds, fast and smooth. The 700 ZXL pitch control had a range from -6.7 to +7.8% (semitone = 5.9%) of normal play speed. Run-out to stop from wind or play took less than a second, as did any other mode change.

Use and Listening Tests

Tape loading and unloading were easy and convenient, more so after learning the position of *Eject* below and to the left. Access was quite good with the compartment door open, but some tasks were best done with the window/cover removed, the door closed, and the deck in play. All of the tape motion controls were completely reliable, including use of the cueing scheme and record muting. RAMM performed faultlessly, but some familiarization time was needed for use with minimum fuss. The star of the whole show was A.B.L.E. with its outstanding capability to make in seconds a whole series of adjustments that would be a challenge on anyone's test bench. Tape memory proved to be an essential and valuable adjunct in regular use of the deck. For much of the testing, of course, it was only necessary to use *Azimuth* in addition to selecting the correct memory. The annunciators were of great assistance at times, including cases of incorrect tape-type settings.

I did not have occasion to use the three-mike recording scheme, but since I use "centered" mikes regularly with my mixers, I can attest to the value of the blend microphone. All switches and controls had a good feel to them, especially the line-input pot. The meters gave excellent indications for setting levels, and the temporary peak holds in each channel helped in that regard. They were easy to read under a wide range of lighting conditions. The owner's manual has text that is direct, but quite detailed in 30 plus pages. There are many excellent illustrations, including the seven-page section on RAMM. There are extensive maintenance instructions with worthwhile cautions that should be followed.

Sources for the record/playback listening tests included pink noise and a number of discs, mostly from Mobile Fidelity and dbx. The Dolby matching was obviously excellent, and the sonic results were very fine even with some portions that were recorded at over-normal levels. Record, pause, and stop noises were all quite low — down into tape noise. Timer start went into play or record, as selected, after a five-second delay after power turn-on. The Nakamichi 700 ZXL has a very high price: For that, this deck offers performance that is unsurpassed overall.

Howard A. Roberson

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2

dbx MODEL 20/20 COMPUTERIZED EQ/ANALYZER

Manufacturer's Specifications

Equalizer Section

Filter Center Frequencies: 31.5, 63, 125, 250, 500, 1k, 2k, 4k, 8k, and 16k Hz.
EQ Range, Each Filter: -15 to +14 dB.
Resolution: One-dB steps, ±0.25 dB.
Maximum Input or Output Level: +15 dBV (5.6 V).
S/N Ratio: 80 dBA re 1 V.
THD: 0.01%, 20 Hz to 20 kHz.
Computer EQ: Typically within ±1 dB, 18 iterations within 15 S.
EQ Memory: Stores 10 curves.

RTA Section

Filter Center Frequencies: As above.
Relative Accuracy: ±1 dB.
SPL Calibration: Within 3 dB.
Display: From -15 to +14 dB in each band with 1-dB steps, with horizontal bar LEDs.
Band Detector: Average responding.
SPL Range: From 45 to 124 dB, ±3 dB.
SPL Detector: Rms responding.
Microphone Type: Electret condenser, omnidirectional.

General Specifications

Dimensions: 19 in. (483 mm) W x 5¼ in. (133 mm) H x 12¼ in. (311 mm) D.
Weight: 21 lb. (9.5 kg).
Price: $1,500.00.

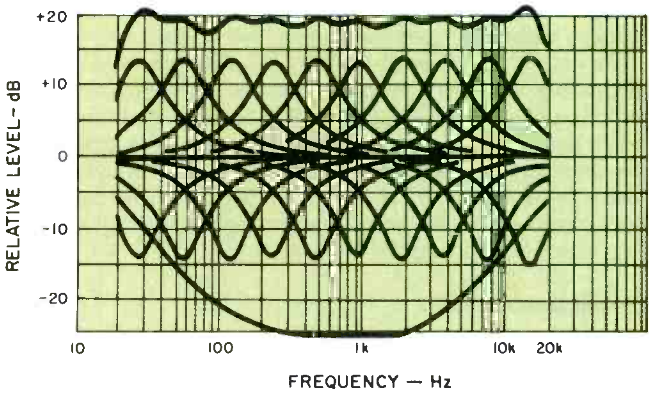
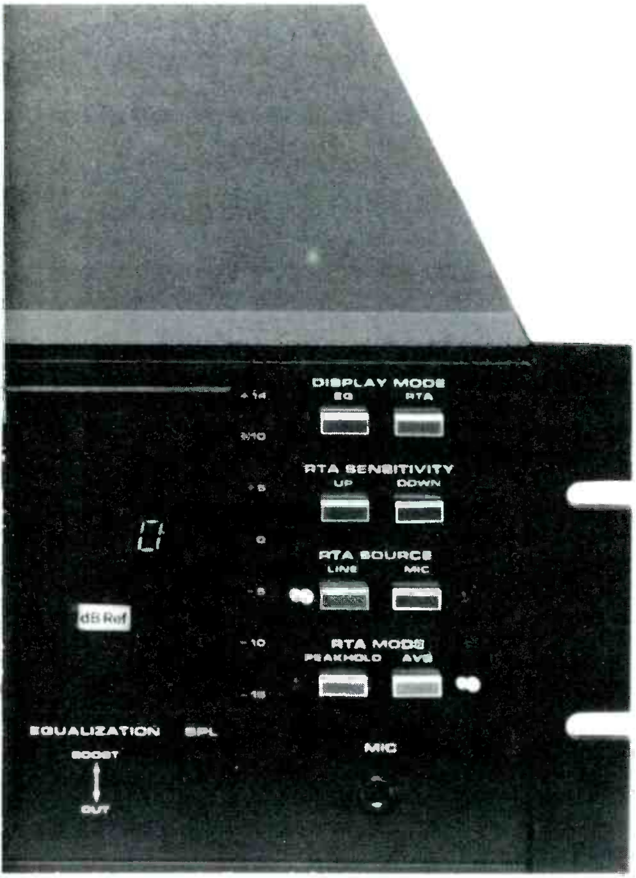


Fig. 1—Frequency responses with filters at 0 dB, each at +14 dB and also at −15 dB individually, all at +14 dB, and all at −15 dB.



The dbx 20/20 equalizer/analyzer is a sophisticated, well-thought-out combination under the control of a built-in microprocessor. The unusual, automatic equalization performed by the 20/20 is a standout achievement, even in this day of complexity and rapid change. The black front panel is quite attractive with silver-colored pushbuttons and toggles and white lettering, which also makes for excellent legibility, even in dim light. Under *Memory* there is a 3x4 array: The 10 memory buttons, *Set Flat*, and *Enter Memory*. Each memory switch has an adjacent status light to indicate if the EQ in that memory is being used. *Set Flat* will reset any EQ being used, and in the display, to zero reference level with a single push of this switch — *much* easier than trying to adjust each band manually. With *Enter Memory*, an EQ obtained manually or with the computer in use can be entered in any of the 10 memories.

Just to the left of the display is a double row of similar pushbuttons: *Auto EQ/HFR Curve*, *Average: Enter/Compute*, *Monitor: Source/Tape* and *Pink Noise: On/Off*. The *Auto EQ* button initiates the process of the computer-controlled equalization using the signal picked up by the system's microphone and with the high-fidelity system driven by the built-in pink-noise source. There is automatic checking to make certain that the pink-noise is turned on and that the level picked up by the microphone is sufficient for the auto EQ. Then, each channel of the digitally controlled equalizer is boosted or cut so that the compensating equalization makes the total system response flat, all the time keeping close to the same average level. The process stops when the response is within ±1 dB or when there have been 18 successive attempts at EQ, with a maximum time of 15 seconds — a marvel to behold. The *HFR Curve* button adds a frequency roll-off of 1 dB per octave starting at 2 kHz to any EQ displayed. This is a handy way of getting one version of a so-called house curve, somewhat corresponding to the effect of the extra absorption of the highest frequencies in a performing hall.

The averaging function of the 20/20 is one of its most interesting and important features. Perceptive listeners know there is a change in high-fidelity system performance from one listening position to another. The requirements for equalization, therefore, change as well. Some sort of average correction might be desired, but that is difficult to do manually, even with quite a few notes. With the 20/20 the corrective EQ can be stored for up to 10 different positions. With *Enter*, the user selects which of these is to be averaged by use of the *Memory* buttons; *Compute* performs the automatic averaging of all those entered. If desired, the result can then be entered into memory. It is thus quite easy to store EQ for particular individual positions as well as averages of any combinations desired. Status lights help keep track of things.

Just to the right of the display is another double row of pushbutton switches. In *EQ*, the display is of the EQ being used, whether from memory or one that has been entered manually. The levels shown in *RTA* are the result of the input selected, either line or mike, and the RTA sensitivity can be shifted in 10-dB steps over a 50-dB range. With the microphone in use, the minimum level is 45 dB (at -15 dB and 60 dB reference), and the maximum level is 124 dB (at +14 dB and 110 dB reference). The *Peakhold* RTA mode holds the maximum level in any band and in the SPL channel while it is on. *Avg* is used for the normal RTA average-responding mode, and the SPL channel is returned to its normal rms response.

The display is a 30 x 10 LED matrix with 1-dB steps from -15

The unusual, automatic equalization performed by the dbx 20/20 is truly a standout achievement.

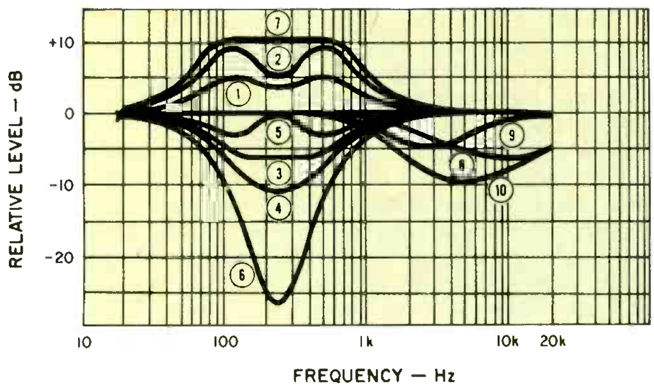


Fig. 2—Swept frequency responses with (1) 125- and 500-Hz filters at +5 dB, (2) at +10 dB, and (3) at −5 dB; (4) with 250-Hz filter also at −5 dB; (5) with 250-Hz filter shifted to +6 dB; (6) with all three filters at −10 dB, and (7) with same filters at +10 dB. Curve (8) shows HFR response, (9) 2- and 4-kHz filters at −3 dB, and (10) with HFR added.

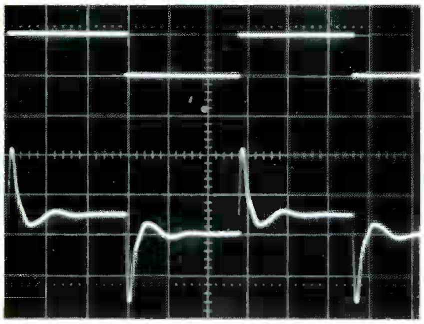


Fig. 3—Input and output waveforms with 350-Hz square wave and 4-, 8-, and 16-kHz filters at +10 dB. Vertical scale, 2 V/division; horizontal, 0.5 mS/division.

to +14 dB for each of the 10 channels, plus a single column of 30 LEDs covering the same range for the SPL channel. There is a *dB Ref* annunciator with a "0" shown for EQ mode and from "60" to "110" shown for RTA mode, depending upon the setting of the sensitivity. Each of the LEDs is a short, red horizontal bar, and all are lined up at 0 dB in EQ if *Set Flat* is pushed. Spring-loaded toggles are below the display, one for each channel. Pushing a toggle up increases the level in that channel in 1-dB steps (down for a decrease in 1-dB steps), at a faster rate if the toggle is held in longer than a few seconds. The LED bars are bright enough to be seen easily under a wide range of lighting conditions.

The power on/off switch and a microphone jack complete the features of the front panel, but it should be noted that the unit is supplied ready for rack mounting. There are stereo in/out phono jacks on the rear panel for connections to a preamp's tape monitor loop and to a separate tape recorder. There is also another mike jack, a pink-noise output jack of fixed level, the memory battery compartment, and a fuse holder.

Removing the cover of the 20/20 gives one pause in contemplating two chassis-size p.c. boards, one above the other. The top board has over 60 ICs, all in sockets, and there was a shield between the two cards. All of the parts were labeled, and the soldering was excellent. Ribbon-type cables were used between cards, including the one for the display on the back of the front panel. There was an inverted chassis with a bottom cover, making for excellent rigidity and shielding.

Circuit Description

Certain portions of this equalizer/analyzer are similar to other units. The similarity stops, however, when we consider the microprocessor system and its interfaces, particularly to the digitally controlled graphic equalizer. For those who would like to dig more deeply into the details of this unit, reference should be made to "An Automatic Equalizer/Analyzer," by Robert W. Adams of dbx, AES Preprint No. 1680 (E-3).

Measurements

The equalizer was the first section to be put under test. The center frequencies of the filters were more accurate than most, within 1% of the ISO standard in most cases. The filter shapes were very consistent from channel to channel as shown in Fig. 1. The boost/bandwidth characteristics were quite comparable to other units with a 1-octave bandwidth (Q = 1.4) obtained with an 11-dB boost; a Q of 1 was secured with a 7-dB boost.

With all of the filter sections put to maximum boost and then to maximum cut, additional swept responses were run (Fig. 1). The results are not typical, and, therefore, some explanation is required. The dbx 20/20 utilizes both series and parallel addition of filter section outputs. When the outputs combine, there is a combination of voltage and gain addition. Thus, the boost obtained with all filters at maximum is more than the 2 or 3 dB increase reported on other units. With all sections at maximum cut, another condition existed: The cut of the combination was about 25 dB in the center of the band, but it fell off greatly at the frequency extremes. A series of tests showed that at 31.5 Hz, the total cut was increased to 23 dB when the 63-Hz filter was at maximum cut along with the 31.5-Hz filter. As additional filters were put to maximum cut, however, the actual cut at 31.5 Hz was reduced. Examination of the filter phase responses showed that the shifts caused by sections more than a band away were great enough (up to 125°) to cause the reduction effect observed. The shifts are *not* as significant as they might seem immediately. It has been common practice to run responses on equalizers with all controls at maximum positions, but that is really a never-do-it condition. In fact, the dbx 20/20 can't create such a situation in its automatic mode, because the adjustments are made to keep the average around the 0-dB reference. These results do show the desirability of keeping the same type of centering for manual adjustments as well. The phase shifts with typical settings were quite acceptable.

With all filters at 0 dB, the response was within 0.3 dB from 20 Hz to 20 kHz, down 3 dB at about 100 kHz. A series of swept responses were made (Fig. 2) with several combinations of filter settings. In general, the figure captions are self-explanatory. Note the difference in curve shapes between boost and cut settings: (1) vs. (3) and (6) vs. (7). Curve (5) shows how consid-

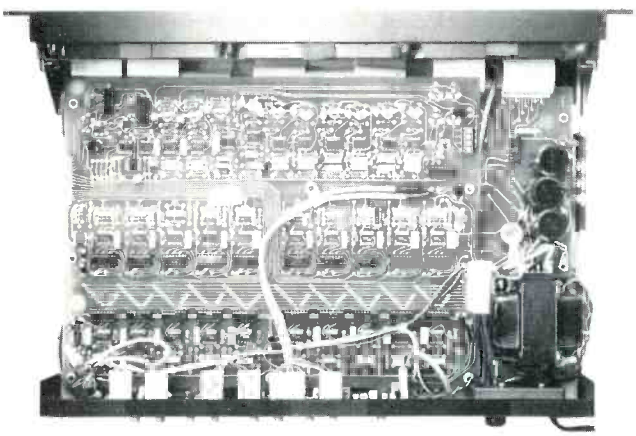
The memory storage feature combined with the averaging function sets this unit apart from all others.

erable boost could be needed to reduce cut between two other bands. Curve (8) shows the high-frequency roll-off that can be added to any EQ with a single touch, somewhat different from the specification and the display because of filter combining. Figure 3 shows the input and output of a 350-Hz square wave with a rather unlikely setting, even in manual. The overshoot and ringing observed is a typical result for octave-band equalizers with such boosts. It is presented here as a reminder to the reader that boosts which are large (Q greater than 1.0) can cause these effects.

The input impedance was exactly to the 47-kilohm specification for most of the audio band, falling somewhat at the highest frequencies. The output impedance was a little less than the specified 470 ohms (very good), rising at the frequency extremes. The gain was within 0.1 dB of 0 dB. With various auto EQs with the pink-noise source, the overall output level was normally within 2 dB, quite good for the automatic level adjustment scheme. The maximum input/output was 7.2 V for the great majority of the band, dropping slightly at 20 Hz, to 7.0 V with a 10-kilohm load. The output polarity matched that of the input.

There was no slew-rate limiting observed with 3-V in with frequencies up to 100 kHz. The harmonic distortion was right at the specified 0.01% for most of the band, although it was slightly higher at 20 Hz. THD and noise was 0.08% with 2-V out at 100 kHz, an excellent figure. The IM distortion was less than 0.003%, rising to 0.01% just below clipping. The signal-to-noise ratio was an excellent 86 dBA with a 1-V reference.

Attention was then turned to the RTA section of the dbx unit. The peaks of the analyzer filters were within 6% of the standard ISO frequencies, and many were much closer. For the same threshold, the channel responses were very close, generally within ±0.5 dB. With pink noise fed in, the indications were within ±1 dB. With 0-dB indications in all 10 channels, the SPL channel read about 2 dB high (+12 dB). Such a discrepancy can be caused by out-of-band energy going to the SPL channel, or the "extra" energy compared to that in a channel with its peaked filter. The RTA filters are fairly peaked with crossovers to adjacent channels at about −12 dB. The thresholds for each of the 1-dB steps were very accurate in each of the channels. A change in input level of 27.3 dB was required to complete the 28 steps, an average of 0.98 dB per step, much more accurate than most such equipment.



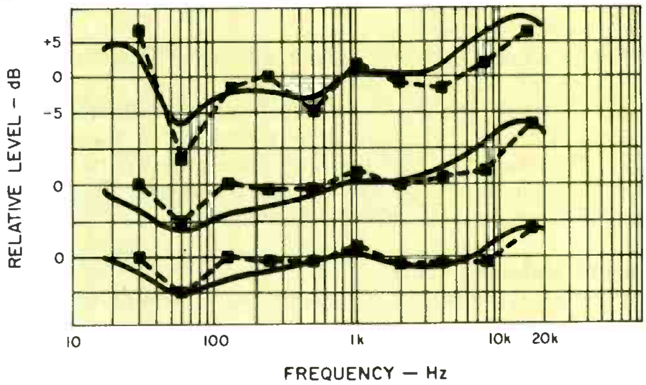


Fig. 4—Swept responses and display with EQ from Memory 1 (top), Memory 5 (middle), and Memory 6 (bottom).

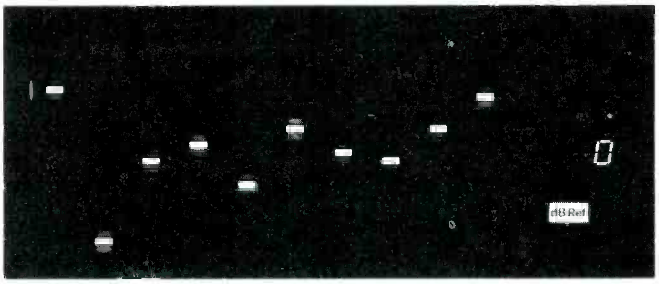


Fig. 5—dbx 20/20 with EQ from Memory 1 displayed.

The line input sensitivity was 1.07 V for a 0-dB indication at 110-dB and 3.3 mV at 60-dB zero reference. Band level was 96 dB, and SPL channel level was 108 dB with 0.9-V rms pink noise input. Each of the 10-dB steps from 60 to 110 dB were substantially exact. The SPL indications using the supplied microphone were within 1 dB of the Ivie IE-30A and Gen Rad 1933 precision-SLM reference units; this is far superior to the great majority of octave-band RTAs. There was a small rise at 16 kHz with the microphone pointed at the speaker source. In a direct field, therefore, the most accurate results would be obtained with the mike angled off to some extent, more toward grazing incidence. The microphone's 0.580-inch diameter prevents easy calibration checks, but as supplied there was no need for adjustment.

Tone-burst tests were utilized to check the dynamic responses. The SPL channel had full charge and discharge times of about 500 mS, satisfactory for most uses. In the main display, the 31.5-Hz filter had 1.5-S charge and discharge times, the 1-kHz filter had 150 mS, and the 16-kHz channel had 100 mS. The response times were the same in peak-hold mode. All of these times are generally satisfactory, although for music moni-

The dbx 20/20 is truly unique in its technology and its useful capability.

toring, faster charge and slower discharge times can be beneficial, as with a tape deck.

The pink-noise generator output was flat across the band within ±1 dB, and the sound was smooth without any recycle clunks observed. The maximum output level was 185 mV (175-mV specification), controllable down to less than a mV with the slider. The fixed output on the back panel was 47 mV, much lower than the 150-mV spec, which dbx is changing. The output impedance was very low, about 90 ohms.

Use and Listening Tests

The 32-page instruction manual includes many excellent figures, although there are some atypical EQ responses shown. The text gets a lot of essential information across very well with very good operating instructions and desirable cautions on avoiding excessive boost. Interconnections are shown for adding EQ to recording or to a pink-noise response test, but it seems that with all its sophistication and complexity, the dbx 20/20 should have included these functions as features with only a few more switches.

With the equalizer/analyzer installed in the tape-monitor loop of my system, the fascinating automatic EQ mode was used at several points in the listening area, and the results entered into the unit's memory. Figure 4 shows the results from two of the positions (Memories 1 and 5) and the application of the HFR curve to Memory 5 (stored in Memory 6). Memory 1 is the result from a location which was not considered good for listening, and the plots show a number of deficiencies. The connected-bar curve shows what appeared in the display, while the continuous-line plots show the actual EQ applied to the system. The reduction in the high-end boost when adding HFR is quite apparent in the figure, as it was to the ear. I preferred a result in between, and a slight manual adjustment achieved that purpose. Figure 5 shows the actual display of Memory 1.

Music monitoring was quite easy with the 20/20, although different time constants would have been better, as mentioned earlier. The peak-hold function was interesting to use, but a faster response time seemed appropriate for such a use. The display was always easy to read under a range of light levels. The annunciators in the display include one which informs the user when the batteries for memory hold (when the unit is off) are running low — a useful and potentially important feature. The auto equalization was always performed quickly, with automatic indications if the level from the speakers was too low or if the noise generator was not on. The memory storage feature in combination with the averaging function further sets this unit apart from all others. The price is considerable, but the dbx 20/20 is truly unique in its technology and its useful capability.

Howard A. Roberson

Enter No. 91 on Reader Service Card

3

NAD 6050C CASSETTE DECK

Manufacturer's Specifications

Frequency Response: 40 Hz to 15 kHz; with metal tape, 40 Hz to 17 kHz.

Harmonic Distortion: One percent at 0 dB.

S/N Ratio: 56 dBA, 65 dBA with Dolby B NR and 70 dBA with Dolby C NR.

Separation: 40 dB.

Erasure: 65 dB.

Input Sensitivity: Mike, 0.6 mV; line, 90 mV.

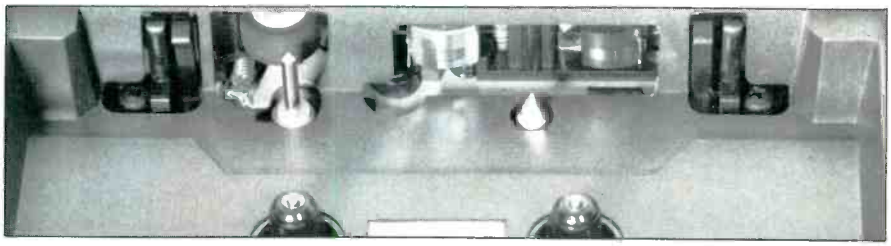
Output Level: Line, 580 mV; headphone, 60 mV at 8 ohms.

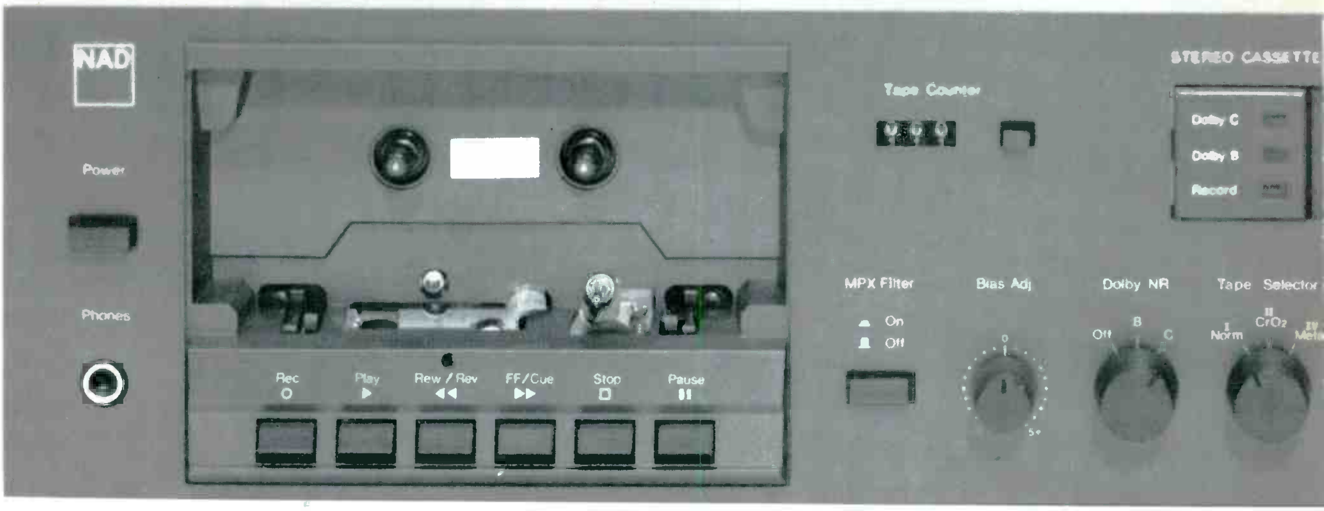
Flutter: 0.06% W rms, 0.15% wtd. pk.

Dimensions: 16½ in. (420 mm) W x 4½ in. (110 mm) H x 9½ in. (230 mm) D.

Weight: 12½ lb. (5.7 kg).

Price: $298.00.





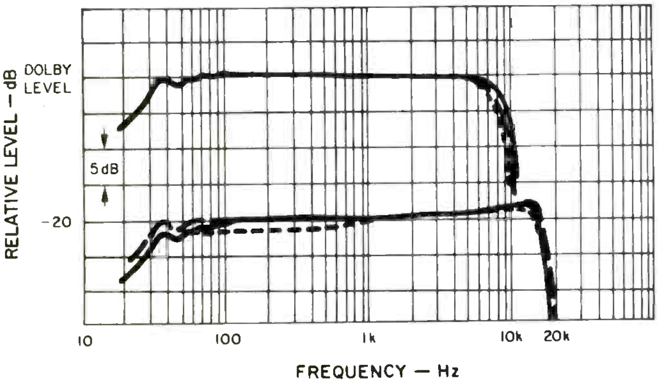


Fig. 1—NAD 6050C frequency responses using Maxell XL I-S tape with Dolby C NR (solid line), Dolby B NR (—), and without NR (— —).

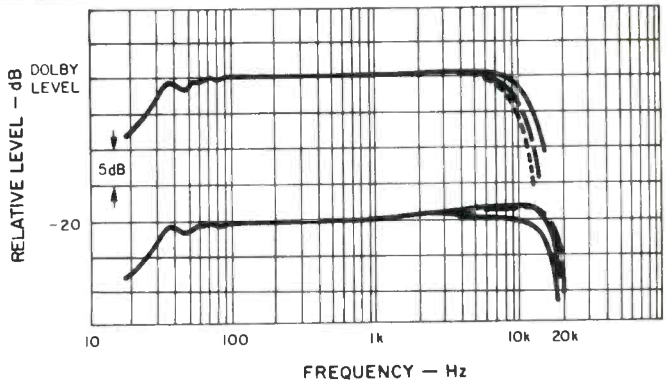


Fig. 2—Frequency responses using Maxell XL II-S tape with Dolby C NR (solid line) with matching bias and maximum bias (see text), also with Dolby B (—) and without NR (— —).

The NAD Model 6050C cassette deck is one of the new breed that include the recently developed Dolby Type C for greater noise reduction. The results given later in this report will amply demonstrate that NAD has made a very successful implementation at an appealing price; their stated philosophy is to put emphasis on products with high performance, but without frills that are high in cost. It is not surprising, then, that the deck is a two-head unit and that the tape-motion controls are not part of a sophisticated logic system. The tape-motion pushbuttons give the impression that there is at least one solenoid being used because such a short push is needed for action. In fact, a cam is used to move heads and pinch roller, which takes about one second before latching occurs. The *Play* or *Rec* button must be held in this long when going into one of these modes or the unit drops back into *Stop*. It is possible to go into record mode with the use of just the one button. When in *Play*, the wind buttons obtain cue/review modes, which can accelerate finding the beginnings and ends of selections. A cassette is inserted very easily with just a slight push upwards and then pushing in the bottom over the spring retainers. Access for maintenance tasks is outstanding as there is no door or guide frame in the way. A snap-in dust cover is provided to minimize dust collection on the heads and moving parts.

The level meters are peak-responding with horizontal LED bar graphs, yellow-green for "−18" to "0" and red for "+2" and "+4." There is a red LED at the bottom (left) of each bar graph, illuminated when the deck is turned on. Just to the left are similar indicators for Dolby B, Dolby C, and record mode. Below are the separate left and right record-level pots with medium-size, easily turned knobs. The Dolby NR rotary switch has positions for *Off*, *B* and *C*; the multiplex filter control has a separate push-button on/off switch. The tape-selector switch changes both bias and EQ and offers: *I/Norm*, *II/CrO*$_2$ and *IV/Metal*. NAD deserves at least a small plaudit for including the IEC tape-type reference designation — more manufacturers should do so. There is a bias-adjust pot with center detent for best tape-to-deck matching, an important feature.

The tape counter has a reset, but there is no memory

The flatness of the response with the 6050C was among the best ever seen for *any* recorder at *any price*.

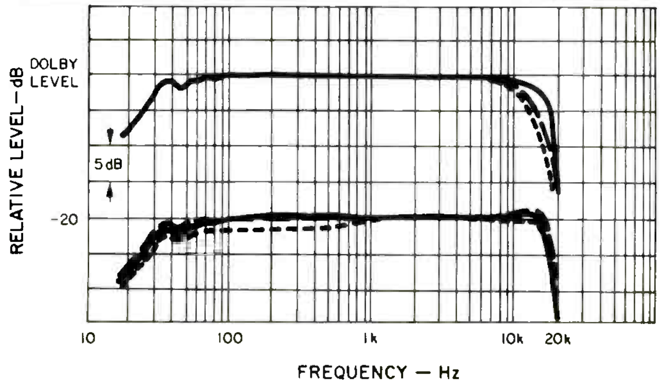


Fig. 3—Frequency responses using Maxell MX tape with Dolby C NR (solid line), with Dolby B (—) and without NR (— —).

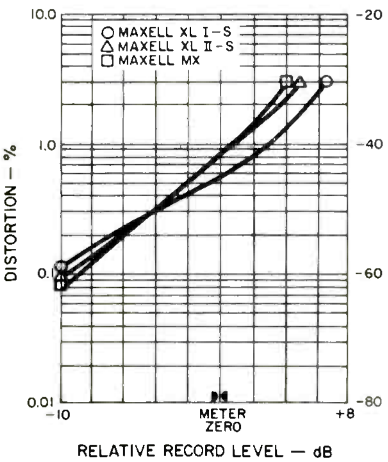


Fig. 4—Third harmonic distortion vs. level in Dolby mode (Dolby B or Dolby C) at 1 kHz using Maxell XL I-S, XL II-S, and MX tapes.

scheme, so rewinding to zero requires watching the countdown. The left and right mike and headphones phone jacks and the pushbutton power switch complete the front panel. Line in/out connections are made on the back panel via phono jacks or a DIN socket. Removal of the steel side and top cover exposed one large p.c. board, with the great majority of the circuitry, installed foil side up. The soldering was excellent with no flux residue except at a few hand-wired points. Most of the adjustments were labeled, and parts were identified on the component side of the card. The transformer seemed small at first, but it was just warm to the touch after several hours of operation, so current drain was obviously low. The single-motor drive had a medium-size flywheel, and it was interesting to observe the rotation of the head-roller positioning cam with a push of either *Play* or *Rec*.

Measurements

The playback responses of this NAD deck with TDK and BASF test tapes were excellent — within a dB for both equalizations, with a few minor exceptions at the low end. Many high-frequency points were within 0.4 dB, much better than many high-priced decks. Tape play speed was just 0.2% fast, a minor discrepancy. The playback level indication was very close, well within the resolution limits of the LED bar graph. The record/playback responses of the 6050C were checked with many different formulations of all types using pink noise as a source with the output on playback fed to a ⅓-octave RTA. The results were very good to excellent for most of the tapes, including Maxell XL I-S, XL II-S and MX which were used for setting up the deck by NAD. Best matching, after the Maxell tapes, was obtained with Ampex MPT, BASF Professional II, Fuji FX-II, Memorex HBII, Osawa MX, Scotch Master I, Sony SHF, and TDK SA, SA-X and MA-R.

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
Maxell XL I-S	B	27	7.0	31	15.8	27	7.4	27	17.0
	C	27	8.6	31	16.0				
Maxell XL II-S	B	29	8.3	29	16.2	29	9.6	29	17.5
	C	29	10.9	29	16.4				
Maxell MX	B	29	10.9	29	16.1	29	12.1	28	17.5
	C	29	15.8	29	16.3				

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

		IEC A Wtd. (dBA)				CCIR/ARM (dB)			
		W/Dolby NR		Without NR		W/Dolby NR		Without NR	
Tape Type		@DL	HD=3%	@DL	HD=3%	@DL	HD=3%	@DL	HD=3%
Maxell XL I-S	B	62.5	67.7	53.0	57.8	60.4	65.6	50.3	
	C	67.0	72.1			68.3	73.4		
Maxell XL II-S	B	64.8	68.9	55.5	58.4	62.9	67.0	51.6	54.5
	C	68.3	72.3			69.4	73.4		
Maxell MX	B	64.5	67.7	56.0	58.4	62.2	65.4	52.4	54.8
	C	69.5	72.8			70.5	73.8		

The record/playback responses were plotted at Dolby level and 20 dB below that for the Maxell tapes (Figs. 1 to 3) with both Dolby B and Dolby C and without any NR. The -3 dB response limits for all of these combinations are given in Table I. It can be seen that the Dolby C tracking was actually better than with Dolby B and that the headroom at the higher level was extended significantly with Dolby C, rather than reduced slightly as with Dolby B. The flatness of the response at Dolby level was among the best ever seen for *any* recorder at *any price!* There was a gentle rise in the higher frequencies at -20 dB with the XL I-S and XL II-S tapes, but not with the metal-particle MX. The relative droop in the lower frequencies (re: 1 kHz) with Dolby B and the Type I and IV tapes was not considered of much importance as the B mode is primarily for playing previously recorded and encoded tapes. Dolby C would and should be the mode to use for normal recording purposes. As readers may note, the high-end responses don't extend to 20 kHz, as with some other decks, but more design emphasis is given here to the overall smoothness of response which many listeners can detect more easily. The response plot with XL II-S (Fig. 2) has one trace at -20 dB which shows the effect of increasing bias from its matching point to the maximum setting. Setting the bias to minimum would have caused a relative rise of similar magnitude.

Signal-to-noise ratios with Dolby C NR must be classified as superb.

Phase discrepancies with the recording and playback of a 10-kHz tone were 20° or less and average phase jitter was 30°, both very good figures. The output polarity matched that of the input, whether during recording or playback of a single-polarity waveform. This characteristic maintains the basic nature of certain transients, provided they are well defined in the original recording. There was no measured high-frequency loss with repeated plays using tapes known to be sensitive to possible deck problems. The multiplex filter response was down 1 dB at 15.6 kHz and a good 30.3 dB at 19 kHz. No bias leak-through was observed in the output during recording. The separation at 1 kHz was 55 dB, and crosstalk was down more than 80 dB—both excellent figures. Erasure at 1 kHz was greater than 80 dB, and about 70 dB at 100 Hz with MX tape—two more excellent figures.

Figure 4 shows the results of measuring the third harmonic distortion (HDL_3) at 1 kHz with record levels from −10 dB re Dolby level to the points at which HDL_3 reached 3%. All of the results were very good, with slight differences between Dolby B and Dolby C figures dependent upon the record level. Distortion without Dolby NR was about 30% higher over most of the level range. The curve shape for XL I-S was unusual, but it was repeatable, and the high-level performance was excellent indeed. Figure 5 shows HDL_3 vs. frequency in Dolby mode at -10 dB with Maxell MX tape. These results are excellent across the band, with superbly low distortion in midband, matching the best decks seen to date. The distortion at the frequency extremes was also very low, matching a number of higher priced decks.

The signal-to-noise ratios were measured for the three tapes without NR and with Dolby B and C, with both IEC A and CCIR/ARM weightings. Table II lists the data secured both at Dolby level and at the points where the distortion reached 3%. The figures include any effects of distortion reduction with Dolby mode and the compression at higher record levels. All of the figures are excellent, and with the current state of cassette recording, the Dolby C results must be classified as superb.

The input sensitivities were 0.58 mV for mike and 82 mV for line. The mike input is thus less sensitive than many units (0.2 to 0.3 mV), but it should be adequate for most users. The input overload points were 15 mV for mike (quite good) and at least 30 V for line (excellent). The input impedance varied with the setting of the level pots, but it was at least 36 kilohms midband for any pot setting. There was some lowering of this figure at 10 kHz and above. The line output was 630 mV open circuit, 585 mV with a 10-kilohm load. The output impedance was about 1.5 kilohms across the audio band. The headphone output was 78 mV (0.8 mW) into 8 ohms, and there was a very good level to all of the headphones tried with meter indications to 0 dB. The level was actually too high for comfort with one set, and there is no output level pot to reduce the level. It should be easy, however, to find a combination to match any personal preference in this regard. Most thresholds for the eight-segment bar graphs were within a dB of the designated levels. The dynamic responses met the requirements of the IEC peak-meter standard for charge time, reaching zero with any burst over 15 mS in duration. The 450-mS decay time, however, was shorter than the standard (1.7 ±0.3 S). The 3-dB down points were at 41 Hz and 23.3 kHz, a bit restricted on the low end. All of the LEDs had a high brightness level which made for easy viewing. My immediate reaction to the display was that it should have more segments

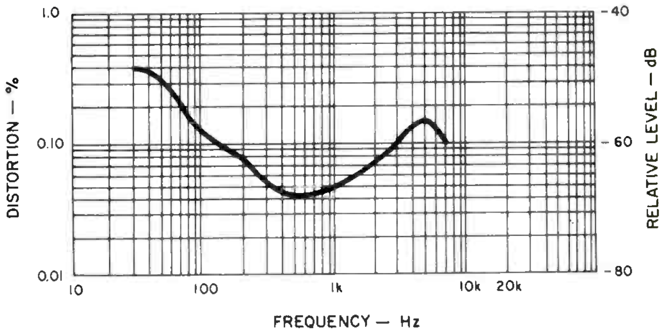


Fig. 5—Third harmonic distortion vs. frequency in Dolby C mode at 10 dB below Dolby level using Maxell MX tape.

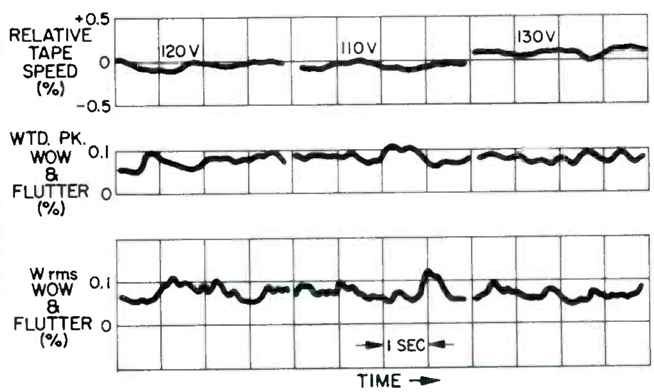
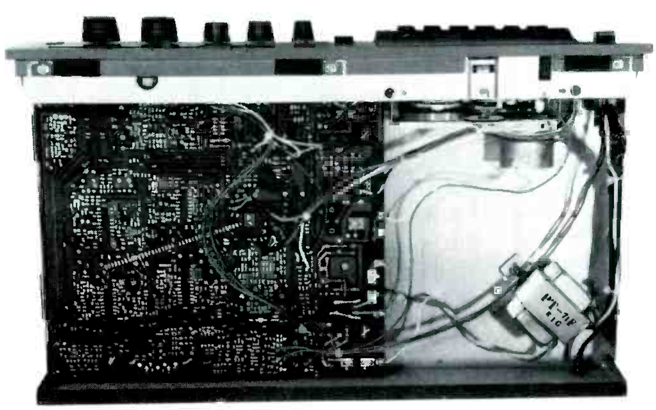


Fig. 6—Relative tape play speed vs. time and line voltage; wtd. pk. and W rms flutter vs. time (three trials each).



NAD has produced a cassette deck with excellent performance for a most attractive price.

for final steps near 0 dB, but final judgment was reserved for the in-use tests.

There was quite a small effect on the average tape play speed with changes in line voltage. With time, the play speed wandered up to 0.05%, which is a small amount, but it might have some significance to critical users. Typical flutter for the 6050C was ±0.08% on a weighted peak basis, which is quite good. The W rms figure was 0.07% which seemed a bit high, mostly because the typical deck has W rms figures that are about one-half the weighted-peak results. The wind times were 93 seconds with a C-60, slower than most decks. Run-out to stop was about two seconds for either wind or play mode.

Use and Listening Tests

A little care was needed to snap cassettes in and out, but it actually was very easy, as were all maintenance tasks because of the excellent access. In general, all controls and switches were completely reliable. Occasionally, however, latching did not occur when using just the record button. Using both record and play buttons, the normal practice on most decks, was always successful. The bias-adjust pot was continually of use for improving tape-to-deck matching. The fast response of the bar-graph meters aided setting levels quickly and accurately. Additional LED segments for finer resolution would have helped but slightly, as the varying intensity of the top-most LED provided good clues on the exact peak level. The review and cue modes worked well and without malfunction, although there were some tape loops generated within the cassette at times. The instruction manual (provided to me in draft form) had excellent text with a number of sections that included tutorial aids for the user. One discussion cross-tied the related factors of the tape itself, bias, and performance with Dolby NR. Overall, one of the best manuals seen to date.

Listening tests were run with each of the Maxell tapes and several others that matched the deck particularly well. Sources included pink noise, the Mobile Fidelity version of Holst's *The Planets* with Solti and the London Philharmonic, and the dbx-encoded *Boy with Goldfish* with Holdridge and the London Symphony Orchestra. It was apparent with a bit of care in listening that there was a relative loss in the low end with Dolby B and the XL I-S and MX tapes. The matches were much closer and without fault with Dolby C, which should be considered the normal mode for this deck. The Dolby C results approached the original dbx-encoded discs with just a slight change in the highest frequencies noted. The deck took a little overloading very well, illustrative of the fine high-level responses of the unit. There were *no* record or pause clicks detected, and stop sounds were well down in tape noise. The 6050C does not have the convenience features of quite a few other decks, but NAD has produced a deck that has excellent performance for a most attractive price.

Howard A. Roberson

Enter No. 92 on Reader Service Card

4

ADCOM CROSSCOIL XC/VAN DEN HUL MOVING-COIL PHONO CARTRIDGE

Manufacturer's Specifications

Type: XC/van den Hul stylus, nude mounted, grain oriented.

Frequency Response: 20 Hz to 20 kHz ± 1 dB.

Channel Separation: 25 dB from 200 Hz to 10 kHz; 20 dB from 10 kHz to 20 kHz.

Channel Balance: Within 1 dB.

Output: 2.5 mV for 5 cm/S, peak velocity.

Tracking Ability: 70 µm at 1.8 g, 300 Hz.

Effective Tip Mass: 0.27 mg.

Tip Dimensions: 3.5 µ x 85 µ.

Cartridge Weight: 4.7 g.

Load Impedance: 47 kilohms (non-critical).

Vertical Tracking Angle: 20°.

Tracking Force: 1.9 g.

Square Wave Rise-Time: 10 µS.

Dynamic Compliance: 13 x 10^{-6} cm/dyne at 400 Hz.

Price: $400.00.

The Adcom Crosscoil phono cartridge reviewed here is the second U.S. cartridge to be fitted with the new stylus tip developed and designed by A.J. van den Hul of Delft, The Netherlands. The shape of this stylus tip resembles that of the cutter, but instead of the cutter's 2-micron radius, the van den Hul stylus tip has a radius of about 4 microns. Because of this small front-to-back contact radius, only a very small part of the record groove is traced at any one time, with only one specific moment of tracking for any portion of the groove. Thus, the tip movement is precisely the same as the groove modulation. The vertical groove contact line is exactly vertical with no curvature, and its radius measures 85 microns. I recently had an opportunity to examine some Scanning Electron Microscope (SEM) *scaled* pic-

This cartridge was able to cleanly reproduce *The Sheffield Drum Record* and the cannon on Tchaikovsky's *1812*.

tures of the van den Hul stylus tip and found the overall vertical groove contact radius measured 143 microns, while the front-to-back contact radius measured 5 microns. (For further discussion of the van den Hul stylus tip see my comments in *Audio* November 1981, page 62.)

The Adcom XC/van den Hul moving-coil phono cartridge is packaged in a well-built case along with a stylus brush, small screwdriver, a headshell weight, gold-plated connectors, and suitable hardware for mounting the cartridge in a headshell. The cartridge has a removable stylus guard. As in almost all moving-coil cartridges, the stylus assembly is not user replaceable. The cartridge is fitted with a unique Crosscoil design that significantly increases its output, thus eliminating the need for a step-up device. The generating coils for the two channels are wound around an "X"-shaped armature instead of the conventional cube form, effecting a very considerable reduction in weight. The "X" shape permits many more turns of wire to be wound on each of the crosspieces without a large increase in weight, thus generating a larger output. The Crosscoil design has enough output to drive the standard magnetic phono input of a preamplifier without the need for a step-up transformer or a pre-preamplifier. It is claimed that the "X" shape insures greater uniformity of output between channels, as well as excellent channel separation. It is further claimed that an important advantage of the Crosscoil design is controlled damping, since the linkage between the "X"-shaped armature and the elastomer damping block permits smoother, less impeded movement of the entire stylus assembly with a consequent improvement in the midrange transient response. The cantilever shank is a high-strength aluminum alloy tube drawn in a thin wall configuration. It is considered to have an exceedingly low mass per unit of cantilever length, and its stiffness is optimized to produce a smooth flat frequency response.

Measurements

The Adcom XC/van den Hul moving-coil phono cartridge was mounted in a Technics headshell and used with the Technics EPA-100 tonearm mounted on a Technics SP-10 MkII turntable. The cartridge was oriented in the headshell and tonearm with the Dennesen Geometric Soundtracktor. Because the stylus requires precise vertical alignment, it is necessary to place a thin, flat mirror on the turntable, place the cartridge on the mirror surface, and observe the vertical white line on the front of the cartridge body with its reflection in the mirror. The white lines should be lined up in a straight vertical line (not canted to one side or the other) for correct vertical alignment. The red dot on either side of the cartridge body indicates the location of the stylus while playing a record.

Laboratory tests were conducted at an ambient temperature of 70° F ± 0° (21° C) and a relative humidity of 66 percent ± 0 percent. The tracking force for all reported tests was 2.1 grams, with an anti-skating force of 2.5 grams. As is our practice, measurements are made on both channels, but only the left channel is reported unless there is a significant difference between the two channels, in which case both channels are reported for a given measurement.

The following test records were used in making the reported measurements: Columbia STR-170, STR-100, STR-112; Shure TTR-103, TTR-109, TTR-110, TTR-115; Deutsches No. 2, Nippon Columbia Audio Technical Record (PCM) XL-7004; JVC TRS-1005, and the Ortofon Pickup Test Records 0001 and 0002.

Frequency response, using the Columbia STR-170 test record, Fig. 1, was −0, +1.25 dB from 40 Hz to 11 kHz, +1 dB at 15 kHz, and +2.25 dB at 20 kHz. Separation was 20.25 dB at 1 kHz, 21 dB at 5 kHz, 22.5 dB at 10 kHz, 20.75 dB at 15 kHz, and 19.75 dB at 20 kHz. Using the JVC TRS-1005 test record, Fig. 2, sweeping from 1 kHz to 50 kHz, the frequency response was −1, +0 dB from 1 kHz through 20 kHz, +0.25 dB at 30 kHz, −0.25 dB at 40 kHz, and +1 dB at 50 kHz. Separation was 28.75 dB at 1 kHz, 27 kHz at 10 kHz, 24 dB at 20 kHz, 21 dB at 30 kHz, 24.75 dB at 40 kHz, and 23.25 dB at 50 kHz. From these data, it is quite evident that this Adcom cartridge has an excellent frequency response and a very satisfactory high-frequency separation.

The 1-kHz square-wave response shows a large overshoot followed by ringing that represents the inherent error in this test record at about 42 to 45 kHz, which was probably generated by the cutterhead when cutting the record. The large overshoot is possibly due to the underdamped high-frequency resonances of the cartridge. The cartridge-arm low-frequency lateral resonance is at 7 Hz at +3 dB amplitude. The vertical resonance is at about 7 Hz. Both the lateral

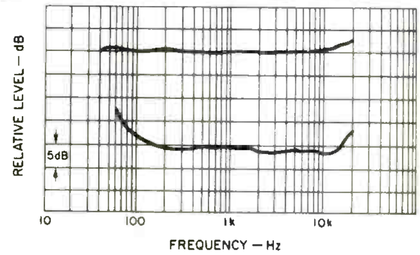


Fig. 1—Frequency response and separation with the CBS STR-170 test disc.

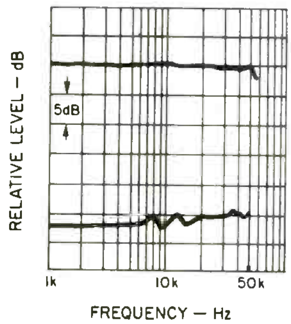


Fig. 2—Response and separation with the JVC TRS-1005 record.

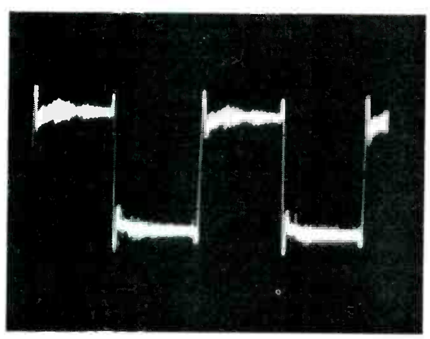


Fig. 3—Response to 1-kHz square wave from CBS STR-112.

The shape of this new stylus tip closely resembles that of the cutter so that groove tracing is very accurate.

and vertical resonances were measured with the Technics EPA-100 tonearm.

Wt., 4.9 g; opt. tracking force, 2.1 g; anti-skating force, 2.5 g; output, left: 0.65, right: 0.71 mV/cm/S; IM distortion: (4:1) +9 dB lateral, 200/4000 Hz, left: 1.2 percent, right: 4.2 percent; +6 dB vertical, 200/4000 Hz, left: 2.6 percent, right: 3.4 percent; crosstalk (using Shure TTR-109), -30 dB; channel balance, within 0.75 dB; trackability: high freq. (10.8 kHz, pulsed), 30 cm/S, mid-freq. (1000 and 1500 Hz, lat. cut), 31.5 cm/S, low freq. (400 and 4000 Hz, lat. cut), 24 cm/S; Deutsches Hi-Fi No. 2, 300-Hz test band was tracked cleanly to 86 microns (0.0086 cm) lateral at 16.2 cm/S at +9 dB and 43.1 microns (0.00431 cm) vertical at 8.12 cm/S at 3.64 dB.

The Adcom XC/van den Hul phono cartridge played all the test bands cleanly on the Shure Obstacle Course — Era III musical test record. On the Shure Obstacle Course — Era IV musical test record, the cartridge experienced some difficulty in playing level 5 of the harp, harp and flute, and flute and bells test bands. Needless to say, the cartridge played very well inasmuch as level 5 peak recorded velocities for the combined instruments exceed 45 cm/S and 50 cm/S, respectively. The peak recorded velocity of commercial records averages about 15 cm/S.

Use and Listening Tests

As usual, I listened to the cartridge both before and after measurement. The cartridge was able to cleanly reproduce *The Sheffield Drum Record* (Lab 14) and all the cannon shots on the Tchaikovsky *1812* recording (Telarc DG-10041), which are remarkable feats. In general, the cartridge acquitted itself very well, particularly in transient response, applause definition, sonic clarity, well-defined bass, transparency of sound, and very good stereo imaging. I did not encounter any apparent coloration or audible distortion that was introduced by the cartridge while playing records. After considerable measurements and listening tests, I am convinced that the van den Hul stylus, though it may be considered radical in some quarters, is a significant contribution to the fine musicality of the Adcom XC/van den Hul moving-coil phono cartridge. *B.V. Pisha*

Enter No. 93 on Reader Service Card

5

ACE AUDIO MODEL 3900 GROUND LLIMINATOR

Manufacturer's Specifications
Dimensions: 3 x 4 x 1½ in. (76 x 105 x 38 mm).
Weight: 0.3 lbs. (0.13 kg).
Price: $16.25, kit; $20.75, wired — ordered direct, sent postpaid.

The Ace Audio Model 3900, which is designed to eliminate ground loops in high-fidelity systems, is actually a very simple device. It is a small box with two phono jacks, input and output. The center, or signal, terminals are bent and soldered together, and the input shield/ground is tied to the metal mounting plate. The output ground, however, is *not* connected to the input ground or the box plate in any way. In this fashion, the ground path is broken; only the signal path is carried through.

It is possible in a stereo system for there to be serious ground-loop problems in the stereo cabling, sometimes because the left and right connections are quite some distance apart on the chassis. *If* this is the cause of a hum problem, the 3900 may gain a great improvement by breaking one of the ground paths. It *cannot* be used where only one cable carries the ground, and it might not be the solution for a particular hum problem.

For those adept with tools, the Ace Lliminator might be unnecessary, since a similar unit is easily made on the bench. For those less inclined to do such things, the Model 3900 does facilitate breaking one of the stereo ground paths with ease — and the price is quite nominal.

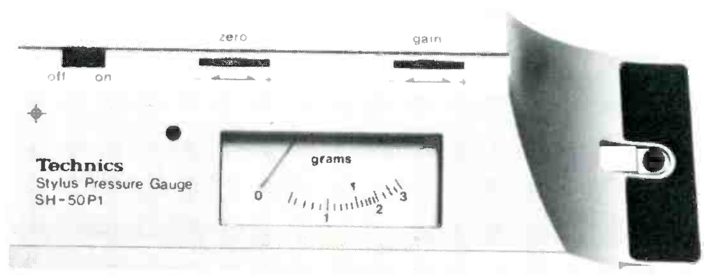
Howard Roberson

Enter No. 94 on Reader Service Card

6

TECHNICS MODEL SH-50P1 STYLUS PRESSURE GAUGE

Manufacturer's Specifications
Type: Semiconductor strain gauge electronic stylus pressure gauge, with "O"-point adjustment and gain control mechanism.
Power Source: Two d.c. 3-V silver oxide batteries (SR44 types).
Stylus Pressure Measurement Range: 0.5 to approximately 3 grams.
Semiconductors Used: Two semiconductor strain gauges, two transistors, and one LED.
Dimensions: 5¾ in. (14.60 cm) x 2 in. (5.08 cm) x 15/16 in. (2.38 cm).
Weight: 4.4 ounces (125 grams).
Price: $50.00.



To the best of my knowledge, this is the first electronic stylus pressure gauge to be marketed. The device is a precision instrument housed in a gray plastic case. The meter scale (1¾ x ¾ inches), calibrated to read directly in grams, is easy to read. For calibration accuracy, the SH-50P1 comes with an accurate 1.5-gram calibration weight. The gauge is a high sensitivity design which employs the piezo resistance effect to change pressure into electric resistance. The device makes use of a pair of semiconductor strain gauges to compensate for temperature changes, giving added reliability and extra sensitivity.

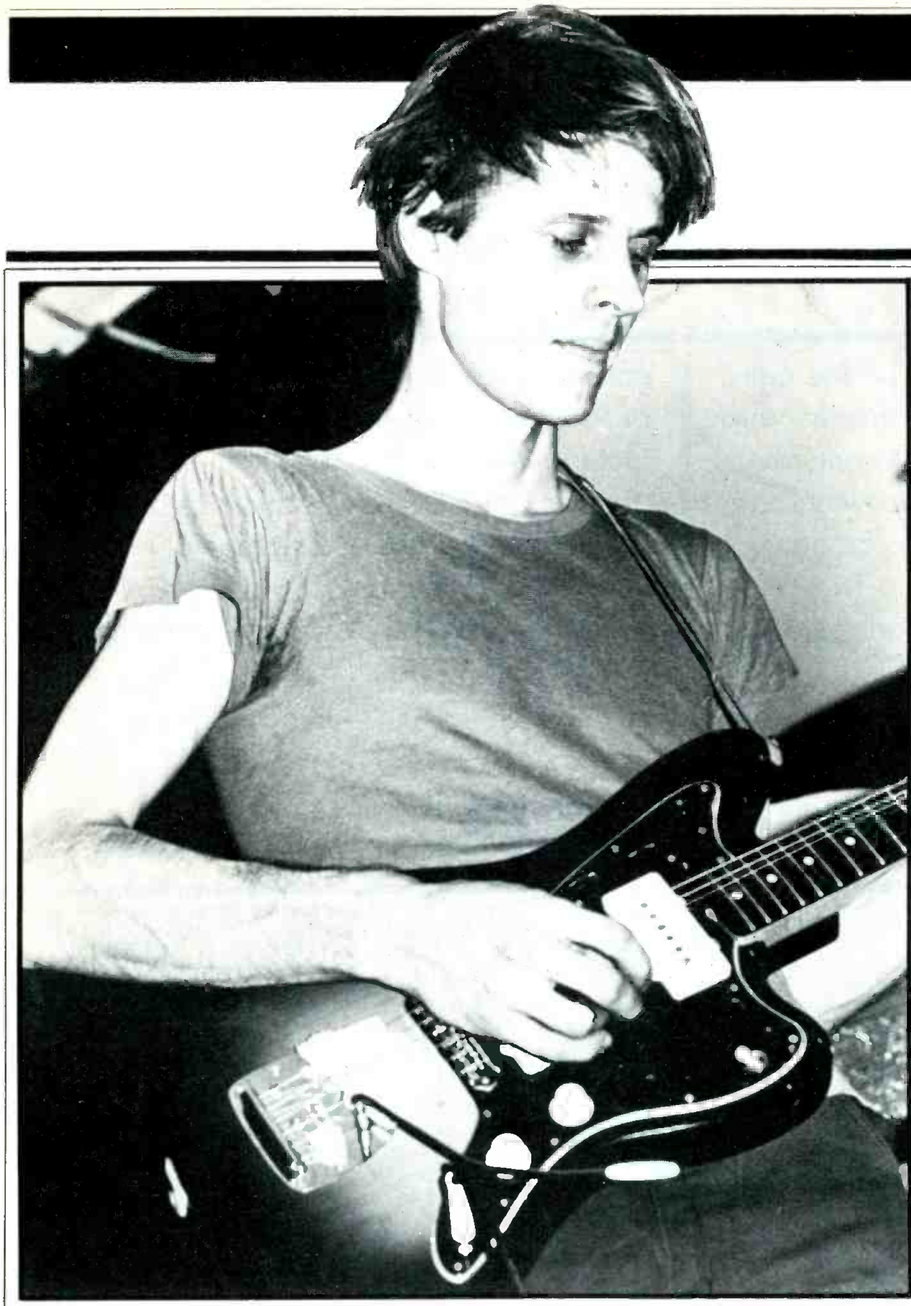
The gauge is simple to use. First insert two silver oxide (type SR44) batteries into their compartment, making certain that their polarities are aligned. When the unit is turned on, the LED illuminates. Immobilize the turntable platter when using the instrument, and place the gauge on the turntable mat (not on a record) with the center spindle inserted into the end slot of the unit. The meter is calibrated to 1.5 grams with the supplied calibration weight and the gain control, and the zero adjust knob is used to zero the meter needle. To measure the stylus pressure (tracking force), place the stylus tip in the dimple on the stylus plate and read the tracking force directly from the meter. To prevent damaging the stylus, remove it from the gauge each time the tracking force is readjusted.

I have used the Technics SH-50P1 stylus pressure gauge for several months, and it surpasses for accuracy any stylus pressure gauge I know of. Its scale accuracy was tested with analytical balance weights and found to have an accuracy of 0.05 gram (50 mg). I recommend this stylus pressure gauge without reservation to anyone in need of such a device.

B. V. Pisha

Enter No. 95 on Reader Service Card

MICHAEL TEARSON
JON & SALLY TIVEN



Dreamtime: Tom Verlaine
Warner Bros. BSK 3539, stereo, $8.98.

Sound: A-	Performance: B+

Tom Verlaine seems obsessed by the high end of the musical register. The guitars on this LP are all trebley, including the rhythm parts, the leads are close to shrill, and the man's voice seems to have no bottom either. It's no surprise that the guy comes across like a minstrel of urban angst with those starting points. A typical Verlaine composition has jolting rhythms, eerie lead guitar lines, and a vocal that sounds forced, to put it politely. In short, he's a purveyor of progressive New Wave music and for that reason *Dreamtime* is a lot more interesting than your average current rock LP. Verlaine's proficiency at making imaginative noises on guitar and a dramatic delivery of poetic lyrics bring his tunes far closer to pure art than his so-called peers get.

The nearest thing to a pop melody on the record is the chorus of "Always." Abetted by flanged guitar and finger-picking parts plus some uncharacteristic harmonies, the vocal in this section (thanks to doubling or tripling, we guess) is as commercial sounding as Verlaine has ever been on vinyl. The catchy rhythm of this tune also makes it the most accessible one on the album, although there are a few other candidates for Most Traditional Rock Song on *Dreamtime* — "Mr. Blur" due to its superior vocal and "Without a Word." The latter has an emotive chord sequence, and there's a romantic feel to the entire tune which most likely won't be heard on the radio much owing to its rough vocal working at cross-purposes to the inherent prettiness of the song.

One must applaud Tom's musical integrity that, from his Neon Boys days up until the present, has remained intact. Where his previous albums have seemed more sparse at times, this attempt goes for a slightly more lush sound without losing his distinctive anti-commercial touch. Some call Verlaine a genius, and others think him a musical incompetent — somewhere in between you'll find this guy who is no great shakes at vocalizing, struggles to hit notes on the guitar, and yet has a pretty amazing vision which he manages to convey despite his technical limitations. He is getting better at the craft of guitar playing, his songs are pretty much the same as they were in Television, and he's yet to take the world by storm. He probably doesn't even care, as long as he's able to continue his work — and people will probably continue to enjoy it for as long as he does.

Jon & Sally Tiven

October: U2
Island ILPS 9680, stereo, $8.98.

Sound: C+	Performance: B

When U2's debut album appeared at the dawn of 1981, it seemed like you couldn't open any music mag without bumping into the mugs of this young Irish band, the year's first press darlings. The album sold okay, but it hardly set the world afire. Just 10 months later *October* is here, and U2 shows some real growth. Their songs are generally more melodic and rounded, but without the power of the debut's "I Will Follow."

Producer Steve Lillywhite, coaxed into a second round with the band, again does an ear-catching job at the knobs, but a few comments are in order. As before, their sound is a doomy, dark, wall effect. But the drums are dull to the point of punchless, blunted by too much echo. Your gut never feels them. The Lillywhite mix, virtually a registered trademark by now, is here purposely gauzy and mysterious, and sometimes too much so as it gets in the way of focus. But the growing confidence of the band rings true with songs like "Gloria" and "I Fall Down" and the loping "Fire," material that sounds fine and gets better with repetition. *M.T.*

DIRECTORY ADDENDA

Each year, despite frantic phone calls, follow-up letters and telegrams, and the best of intentions of all concerned, there are some few bits of data which escape from October's Annual Equipment Directory and July's Car Stereo Directory. Some omissions are due to changes of location or personnel, a new and different product line, or—in the case of one manufacturer—an accident which put a press relations officer out of commission. As often as not, it's simply the press of manufacture and distribution. At any rate, we commend the following to your attention.—*E.P.*

INDEX OF MANUFACTURERS

A

Alpine
3102 Kashiwa St.
Torrance, Cal. 90505

AudioStatic
c/o H & H International
3047 West Henrietta Rd.
Rochester, N.Y. 14623

AVX
c/o Audiovox
150 Marcus Blvd.
Hauppauge, N.Y. 11787

E

Electrocompaniet
P.O. Box 173
Hollis, Maine 04042

G

Genesis Physics Corp.
Newington Park
Newington, N.H. 03801

GNP
Gross National Products
1244 East Colorado Blvd.
Pasadena, Cal. 91106

Gold Sound
P.O. Box 141
Englewood, Colo. 80110

H

Hi-Comp
c/o Audiovox
150 Marcus Blvd.
Hauppauge, N.Y. 11787

I

ILP
c/o Gladstone Electronics
901 Fuhrmann Blvd.
Buffalo, N.Y. 14203

Integral Research
4574 Beltline Rd.
Dallas, Tex. 75234

J

Jamo Hi-Fi
916 Ash St.
Winnetka, Ill. 60093

JBL
8500 Balboa Blvd.
Northridge, Cal. 91329

L

Luxman
Div., Alpine Electronics
3102 Kashiwa St.
Torrance, Cal. 90505

M

Magnadyne Corp.
P.O. Box 5365
Carson, Cal. 90749

Musical Fidelity
5183 Overland Ave.
Suite D
Culver City, Cal. 90230

N

Norman Laboratories
2278 Industrial Blvd.
Norman, Okla. 73069

North American Sound
4574 Beltline Rd.
Dallas, Tex. 75234

P

PSB Speakers
480 Dutton Dr.
Waterloo, Ont.
Canada N2L 4C6

Psionic Corp.
1969 Latham St., #33
Mountain View, Cal. 94040

Q

Quad
c/o Acoustical Mfg. Co.
Huntingdon, Hants.
England PE18 7DB

S

Shure Brothers
222 Hartrey Ave.
Evanston, Ill. 60204

SME
c/o Ortofon
122 Dupont St.
Plainview, N.Y. 11803

Snell Acoustics
10 Prince Place
Newburyport, Mass. 01950

Spectron Electronics
9627 Owensmouth Ave.
Chatsworth, Cal. 91311

Strelioff System Designs
5305 Tendilla Ave.
Woodland Hills, Cal. 91364

The speakers listed in the October 1981 issue for BGW Systems are manufactured by Tannoy and distributed under that name by BGW.

ANNUAL EQUIPMENT DIRECTORY

PREAMPLIFIERS

MANUFACTURER	Model	Unit Type: Kit=K; Tube=T; Phono Stg.=P; Mono=M; Moving Coil=MC	Frequency Response, Hz to kHz, ± dB	Maximum Output, V	% THD	% IHF IM Distortion	Rated SMPTE IM, Percent	MM Phono Sensitivity, mV, per IHF A-202 For 0.5 V Output at 1 kHz	MM Phono Overload, mV	MM Phono S/N, "A" Wtd., re: 5 mV, dB, per IHF A-202	High Level Sensitivity, mV	Tone Controls ?	Phono Input Capacitance, pF	Phono Input Impedance, Ohms	Moving Coil Input ?	Does Unit Invert Phase?	Weight, Lbs.	Price, $	Notes
ELECTRO-COMPANIET	Preamp-liwire MC-2	MC	1-150 +0, -3	26	0.001			2	600		100†	No	100 2000	47k 30	 Yes	Sel. No	2	250.00	†Tape adj.
ILP	HY6	M/K	0-100 +0, -3	4.5	0.005					90	100	Yes		47k	No			25.95	Model HY66, two modules, $48.95.
LUXMAN	C120A		10-80 ±0.5	18	0.007	0.007		2.0	300	87	130	Yes	95	50k	Yes		18	449.95	
	C300		0.5-140 ±0.5	20	0.005	0.005		2.0	300	89	140	Yes	50	50k	Yes		20	999.95	
	C5000A		1-150 ±0.25	18	0.002	0.002		2.2	300	89	145	Yes		Sel.	Opt.		30	1399.95	
	CL 34	T	3-70 ±0.5	10	0.008	0.008		2.0	300	89	170	Yes	10	50k	No		17.6	699.95	
MUSICAL FIDELITY	BB-1	MC	1-250 +0, -3	1	0.03	0.03	0.03	25		70†		No	220	Sel.	Yes	Yes	3	250.00	†Unweighted.
	AC-1	MC	1-500 +0, -3	2	0.03	0.03	0.03	25		70†		No	250	Sel.	Yes	No	4½	550.00	Dual mono, a.c. powered.
STRELIOFF	PA-1 & RS-1		10-50 ±1.0	20	0.10	0.10	0.10	0.5	250	87	50	No	Sel.	Sel.	Yes		25	2250.00	

AMPLIFIERS

MANUFACTURER	Model	Unit Type: Integrtd.=I; Kit=K; Phono Stg.=P; Tube=T; Mono=M; Basic=B	Cont. Ave. Watts per Chan. into 8 Ohms	Power Bandwidth, Hz to kHz	Rated THD, Percent	Rated IHF IM, Percent	Rated SMPTE IM, Percent	MM Phono S/N, "A" Wtd. re: 5 mV, dB, per IHF A-202	MM Phono Sensitivity, mV, per IHF A-202	Maximum Phono Input, mV	Rated Slew Rate, V/µS	High Level Sensitivity, mV	Class of Output Operation	Dynamic Headroom, dB	Does Unit Invert Phase?	Weight, Lbs.	Price, $	Notes
ELECTRO-COMPANIET	Ampliwire I	B	150	10-100	0.2							100	AB†		No	35	2195.00	†Class A to 20 W.
	Ampiwire II	B	45	10-100	0.2							100	AB†		No	28	1395.00	†Class A to 15 W.
ILP	MOS200	B/M/K	120		0.005	0.006	0.006	100			20	500				2	129.95	Kit, 2 modules, toroidal transf., 18 lb., $405.00
	HY400	B/M	240†		0.01	0.006	0.006	100			15	500	AB			4	99.95	†Into 4 ohms.
	HY200	B/M	120		0.01	0.006	0.006	100			15	500	AB			2	79.95	
LUXMAN	M300	B	150	20-20	0.008	0.008					200	900	A/AB			70⅜	1499.95	Pure Class A, 40 W + 40 W.
	M120A	B	120	20-20	0.015	0.010					130	900	AB			37	699.95	Mono, 300 watts.
	L450	I	55	20-20	0.03	0.03		86	2.0	150	90	190	AB			26½	399.95	MC Input, 300 µV.
	L480	I	70	20-20	0.03	0.03		88	1.2	150	120	190	AB			28½	499.95	As above.
	L580	I	100	20-20	0.03	0.03		88	1.8	170	160	240	AB			45	799.95	MC input, 60 µV.
	MQ68C	B/T	30	50-15	0.4	0.4						880	AB			34	799.95	
STRELIOFF	DC-1 50/50	B	50	20-20	1.0	1.0	1.0				10	1.75 V	AB	1.5		30	750.00	
	DC-1 100/100	B	100	20-20	1.0	1.0	1.0				15	1.75 V	AB	1.5		50	2000.00	
	DC-1 200/200	B	200	20-20	1.0	1.0	1.0				20	1.75 V	AB	1.5		55	2500.00	
	DC-1 400/400	B	400	20-20	1.0	1.0	1.0				25	1.75 V	AB	1.5		80	3500.00	

TUNERS

MANUFACTURER	Model	Unit Type: FM Only=FM; Kit=K	Mono IHF Sensitivity, dBf	Stereo IHF Sensitivity, dBf	Capture Ratio, dB	Alt. Chan. Select., dB Wide/Narrow	Mono Signal Strength for 50 dB Quieting, dBf	Stereo Signal Strength for 50 dB Quieting, dBf	Separation, dB, 1 kHz	Separation, dB, 10 kHz	THD, Mono/Stereo, 1 kHz, 100% Modulation	THD, Mono/Stereo, 6 kHz, 100% Modulation	S/N, Max., dB, Mono/Stereo	Switchable De-emphasis?	Net Weight, Lbs.	Price, $
LUXMAN	T400		10.8		1.3	65	15.0		45	38	0.1	0.2	75		16	299.95
	T450		10.3		1.3	65	15.0		45	38	0.08	0.2	75		16	399.95
	T115		10.3		1.4	75	15.6		45	39	0.15	0.2	76		13.2	499.95
	T14	FM	10.3		1.0/2.0	40/80	16.6/3.7		48	38	0.08	0.15	72		21	799.95

RECEIVERS

MANUFACTURER	Model	Unit Type: FM Only=FM; Kit=K	Ave. Watts/Chan., 8 Ohms	% THD	% IHF IM	Rated Power Bandwidth, Hz to kHz	MM Phono S/N, dB, "A" Wtd., re: 5 mV, per IHF A-202	MM Phono Overload, mV, per IHF A-202	Dynamic Headroom, dB	Mono IHF Sensitivity, dBf	Stereo IHF Sensitivity, dBf	Capture Ratio, dB	Mono Signal Strength for 50-dB Quieting, dBf	Stereo Signal Strength for 50-dB Quieting, dBf	% THD, 100% Modulation, 1 kHz, Mono/Stereo	Alt. Chan. Select., dB Wide/Narrow I.F. Bandwidth	Max. S/N, dB, Mono/Stereo	Net Weight, Lbs.	Price, $
LUXMAN	R3030		30	0.05	0.05	20-20	82	130		10.8		1.3	15.0		0.15	65	75	29	349.95
	R3045		45	0.05	0.05	20-20	85	160		10.8		1.3	15.0		0.10	65	75	31	449.95
	R3055		55	0.05	0.05	20-20	85	160		10.3		1.3	14.8		0.10	65	75	34	549.95
	R1070		75	0.025	0.025	20-20	82	160		10.3		0.9/ 1.9	14.2		0.06	48/80	75	40	749.95

TURNTABLES

LETTER CODE FOR SPEEDS
A—33, 45, 78
B—33, 45
C—33
D—16, 33, 45, 78
E—16, 33, 45
F—Cont. Variable

MANUFACTURER	Model	Speeds—See Code	Wow & Flutter, %, 33⅓, DIN 45-507	Rumble, dB, DIN 45-539-B	Motor Type	Drive System	Speed Inaccuracy, ± %	Speed Adjustment Range, ± %	Speed Accuracy Indicator Type	Straight-Line Tracking Arm?	Pivot-Stylus Dist., Inches	Multi-Play? If Yes, # Discs	Auto. Cue = C; Auto. Off = O	Max. Tracking Error, Deg./In.	Anti-Skate Adjustment?	Tracking Force Range, Gms.	Total Cable Capacitance, pF	Damped Cueing?	Dimensions, Inches, Inc. Dust Cover	Price, $
LUXMAN	PD264	B	0.035		D.C. Brush-less Servo	Direct		6	Strobe		9¾		C/O		Yes	0-3		Yes	17¼x5x14⅜	229.95
	PD277	B	0.030		D.C. Brush-less Servo	Direct		4	Strobe		9¾		C/O		Yes	0-3		Yes	18⅝x6x13¾	399.95
	PD375	B	0.030		Quartz D.C. Brush-less Servo	Direct					9		C/O		Yes	0-3			18⅝x6x13¾	599.95
	PD555	A	0.030		D.C. Brush-less Servo	Belt		2.5	Strobe											2899.95

TONEARMS

MANUFACTURER	Model	Overall Length, Inches	Pivot-Stylus Distance, Inches	Cueing?	Straight-Line Tracking Arm?	Removable Headshell?	Maximum Tracking Error, Degrees/Inch	Anti-Skating Adjustment?	Tracking Force Range, Gms.	Total Cable Capacitance, pF	Cartridge Weight Range, Gms.	Vertical Bearing Type	Lateral Bearing Type	Price, $	Notes
PSIONIC	LOCI	12⅛	9¼	No	No	No	0.3	Yes	1-5		1-10	Ball & Needle	Needle	510.00	
SME	Series III SB	12	9	Yes	No	No	⅓	Yes	0-2½	300†	0-5	Knife	Ball	260.00	†Adj.
	Series III B	12	9	Yes	No	No	⅓	Yes	0-2½	300†	0-5	Knife	Ball	350.00	
	3009-R	12	9⅛	Yes	No	Yes	⅓	Yes	0-5	300†	1.5-26	Knife	Ball	375.00	
	3012-R	16	12⅛	Yes	No	Yes	⅓	Yes	0-5	300†	1.5-26	Knife	Ball	430.00	
	Modified III SB	12	9	Yes	No		⅓	Yes	0-2½	300†	††	Knife	Ball	450.00	††Integrated cartridge, SME 30H.

LOUDSPEAKERS

MANUFACTURER	Model	Enclosure or System Type	Woofer Dia., Inches	Midrange Dia., Inches	Midrange Type	Tweeter Dia., Inches	Tweeter Type	Level Controls? M=Midrange; T=Tweeter; ST=Supertweeter	Anechoic Freq. Response Hz to kHz, ± dB	dB SPL/1 Watt/1 Meter	Recommended Min. Amp. Pwr., Watts	Crossover Frequencies, Hz	Impedance, Ohms; Nominal/Minimum	Dimensions, Inches	Finish	Grille Color and Material	Weight, Lbs.	Price, $
AUDIO-STATIC	ES 240	ES							40-20 ±2	95	50		8	27.2x51.2x1.6		Opt.	60	2195.00 Pair
	ES 480	ES							35-20 ±2	97	50		8	45.3x51.2x1.6		Opt.	100	3295.00 Pair
GENESIS PHYSICS	1	Ac. Sus.	8			1	Dome		58-20 ±4	89	12	1.8k	8/6	19x10½x7½	Wal. Grain	Black Cloth	19	218.00 Pair
GNP	SM-P1	Sat.		5¼	Cone	1	Dome		70-21 ±3	90	10	3.3k	8	12x8x7	Opt.	Brown Cloth	15	250.00 Pair
	SM-B1	Sat.		5¼	Cone	1	Dome		70-21 ±3	90	10	3.3k	8	12x8x7	Opt.	Brown Cloth	20	400.00 Pair
	LC-1	Sat.		5¼	Cone	1	Dome		70-21 ±3	90	10	3.3k	8	15½x7x13½	Black	Brown Cloth	25	850.00 Pair
	W-100 Bass Box	Subwoof.	10						36-.150 ±3	90	10	150	8	25x14½x12	Opt.	Brown Cloth	50	300.00 Pair
	W-101 Bass Box	Subwoof.	10						26-.150 ±3	90	10	150	8	25¼x16½x16¼	Opt.	Brown Cloth	65	440.00 Pair

MANUFACTURER	Model	Enclosure or System Type	Woofer Dia., Inches	Midrange Dia., Inches	Midrange Type	Tweeter Dia., Inches	Tweeter Type	Level Controls? M=Midrange; T=Tweeter; ST=Supertweeter	Anechoic Freq. Response Hz to kHz, ± dB	dB SPL/1 Watt/1 Meter	Recommended Min. Amp. Pwr., Watts	Crossover Frequencies, Hz	Impedance, Ohms; Nominal/Minimum	Dimensions, Inches	Finish	Grille Color and Material	Weight, Lbs.	Price, $
GOLD SOUND	3	Ac. Sus.	10			1	Dome		48-20 ±4	91	10	2k	8	11x17x26	Opt.	Opt.	42	64.00, Kit; Cabinet Extra
	5	Bass Ref.	8			1	Dome		44-20 ±4	95	4	2k	8	10x15x24	Opt.	Opt.	35	109.00, Kit; As Above
	6	Ac. Sus.	(2) 10	4	Cone	3½	Horn		42-25 ±4	95	4	400,4k	4	13x21x32½	Opt.	Opt.	71	139.00, Kit; As Above
	8	Bass Ref.	8	1	Dome	4x4¾	Ribbon		39-25 ±4	94	5	2k, 10k	8	11x17x26	Opt.	Opt.	49	219.00, Kit; As Above
	9	Bass Ref.	10	5.1	Cone, Dome	4x4¾	Ribbon		29-25 ±4	91	10	150, 2k, 10k	8	13x21x32½	Opt.	Opt.	76	249.00, Kit; As Above
	10	Bass Ref.	12	4x10	Horn	5x6	Horn	M, T	42-18 ±4	98	2	1.2k, 5k	8	15x24x37	Opt.	Opt.	109	309.00, Kit; As Above
	11	Bass Ref.	(2) 8	4	Cone	5x6	Horn	M, T	36-18 ±4	98	2	800, 5k	4	13x21x32½	Opt.	Opt.	94	349.00, Kit; As Above
	12	Bass Ref.	15	8x18	Horn	5x6	Horn	M, T	29-18 ±4	94	6	600, 5k	8	15x24x37	Opt.	Opt.	128	499.00, Kit; As Above
	14	Bass Ref.	18	10, 4x10	Cone, Horn	3½	Horn	M, T	23-21 ±4	95	6	200, 1.2k, 5k	8	17x28x44	Opt.	Opt.	196	769.00, Kit; As Above
INTEGRAL RESEARCH	SL2	Dual Port	10	4½	Cone	2	Dome	M, T	30-19 ±3	90	15	850, 3.5k	8/5	13¼x11¾x34½	Oiled Wal.	Black Cloth	50	299.95
JAMO HI-FI	J502	Bass Ref.	9			1	Dome		34-20			1.8k	4-8	19x10x9	Wal.	Gray Cloth	16½	139.95
	J702	Bass Ref.	9	4½	Cone	1	Dome	T	32-20			900, 4.5k	4-8	21x10x11	Wal.	Gray Cloth	22	219.95
	JCBR 902		8½	4½	Cone	1	Dome	M, T	28-20			800, 4.5k	4-8	24x12x11	Wal.	Gray Cloth	31	299.95
	JCBR 1302		11	4½	Cone	1	Dome	M, T	24-22			750,4k	4-8	28x14x13	Wal.	Gray Cloth	46	439.95
	JCBR 1702		13	2	Dome	1.7	Dome, Cone	M,T	22-22			350, 1.5k, 5.5k	4-8	32x17x14	Wal.	Gray Cloth	68	649.95
	Mini 80	Bass Ref.	6			1	Dome	T	38-20			1.9k	4-8	12x7x9	Wal.	Brown	18	149.95
	P120	Bass Ref.	9			1	Dome		35-20			2.5k	4-8	20x12x9	Wal.	Black Cloth	19	149.95
	P160R	Bass Ref.	11½			3½ x3½	Horn	T	25-20			2.2k	4-8	21x13x9	Wal.	Black Cloth	24	239.95
	P250R	Bass Ref.	13	4x10½	Horn	3½ x3½	Horn	M, T	22-20			1k, 4.8k	4-8	25x15x9	Wal.	Black Cloth	37	379.95
	P300R	Bass Ref.	(2)11½	4x10½	Horn	(2) 3½ x3½	Horns	M,T	22-20			1.2k, 5.2k	4-8	30x18x13	Wal.	Black Cloth	55	539.95
NORMAN LABORATORIES	8B	Ac. Sus.	10			1	Dome			89.5		1.5k	8/8	23x12x10	Oiled Wal.	Brown Cloth	28	199.95
	9B	Ac. Sus.	(3)10			(3)1	Domes	W, T		94.5		1.5k	4/4	45x15½x15	Oiled Wal.	Brown Cloth	75	549.95
	12B	Ac. Sus.	(2)10	2	Dome	(2)	Leafs	M, T		94		200, 3.5k	4/4	53x28x12½	Opt.	Brown Cloth	100	799.95
	11B	Ac. Sus.	10			(2)1	Domes	T		90		1.5k	8/8	23½x15½x12	Oiled Wal.	Brown Cloth	40	259.95
	14	Ac. Sus.	6½			1	Dome	T		84.5		1.5k	8/8	11½x8x6¼	Oiled Wal.	Brown Cloth	12½	159.95
	15	Subwoof.	10									200	8/8	20¼x16½x16	Oiled Wal.	Brown Cloth	45	259.95
NORTH AMERICAN SOUND	Studio Monitor	Bass Ref.	15	6x15	Horn	2x5¼	Horn		35-20 ±3	96	15	500, 6k	8/6	20x15½x54	Oiled Wal.	Black Cloth	165	1195.00
	Sovereign	Bass Ref.	15	6x15	Horn	2x5¼	Horn		38-20 ±3	95	15	500, 6k	8/4	18x15½x48	Oiled Wal.	Black Cloth	135	895.00
	Squire	Bass Ref.	12	6x15	Horn	2x5¼	Horn		42-20 ±3	93	15	500, 6k	8/4	16x15½x42	Oiled Wal.	Black Cloth	105	695.00
	Monitor	Trans. Line	9			1½	Dome		35-20.5 ±3	90	15	3.5k	8/6	13¼x11¾x36	Oiled Wal.	Black Cloth	52	339.00
QUAD	ESL	ES Dipole							45-18	86			15				36	1780.00 Pair
SHURE	SR112W	Bass Ref.	(2)8				Horn	T	45-16 ±5	97	10	2.6k	8/6	23⅛x15⅛x16½	Wood Vinyl	Brown Cloth	46	397.00
	SR112B	Bass Ref.	(2)8				Horn	T	45-16 ±5	97	10	2.6k	8/6	23x15x15¾	Vinyl	Black Cloth	39	385.00
	SR116B	Bass Ref.	(2)8				Horn	T	45-16 ±5	97	10	2.6k	8/6	23x15x15¾	Vinyl	Black Cloth	41	436.00
SNELL ACOUSTICS	Type A/II	Ac. Sus.	10	4	Cone	1	Dome	No	36-18 ±1.25	86	80	275, 2.5k	4/4	46½x23¾x13	Opt.	Opt., Cloth	97	2800.00
	Type 1	Tuned	10			1⅛	Dome	M, T	41-17 ±1.25	88	20	2.1k	4/4	32x18½x16	Opt.	Opt., Foam	80	1295.00
STRELIOFF	MS-1	Ac. Sus.	(2)5¼	(2) 1½	Domes	(2) 1	Domes	No	70-18 ±4	78	50	800, 5k	5/2	7½x7½x19	Opt.	Opt., Foam	32	1250.00 Pair
	MX-1	Ac. Sus.	(2) 5¼	(2) 1½	Domes	(2)1	Domes		70-18 ±4	78	50	800, 5k	5/2	7½x7½x19	Opt.	Opt., Foam	29	2000.00 Pair
	ME-1	Ac. Sus. Subwoof.	(2) 10					No	35-.150 ±4	78	50		8/4	24x24x48	Opt.	Opt., Foam	125	1250.00
	TS-1	Ac. Sus.	(2)10	(6)1½	Domes	(6)1	Domes	W, M, T	38-18 ±4	87	100	800, 5k	5/2	36x18x66	Opt.	Opt., Foam	210	7000.00 Pair
	TE-1	Inf. Baf. Subwoof.	18						21-.125	84	50		8/5	28x40x32	Opt.	Opt., Foam	180	3000.00 Pair

CASSETTE DECKS

MANUFACTURER	Model	Frequency Response, Hz-kHz, ±dB	Top Load=T; Front Load=F	Number of Heads	% Wow & Flutter, Wtd. Pk.	S/N, dB, with Dolby B NR	Dolby C NR?	dbx NR?	Fine Bias Adjust?	No. Preset Bias/EQ Posns.	No. Mike Mixing Inputs	Locking Pause Control?	Metal Tape Capable?	Limiter?	Memory Rewind?	Peak Level Indicator(s)?	Dimensions, Inches	Net Weight, Lbs.	Price, $	Notes
LUXMAN	K1	30-18	F	2	0.06	63	No	No	No	3		Yes	Yes			Yes		18.5	249.95	
	K117	20-20	F	2	0.04	70	No	No	Yes	3		Yes	Yes		Yes	Yes		15	399.95	Solenoid controls.
	K8	20-20	F	2	0.055	65	No	No	Yes	3		Yes	Yes		Yes	Yes		18.5	499.95	As above.
	K15	20-20	F	3	0.04	65	No	No	Yes	3	1	Yes	Yes		Yes	Yes		25.3	899.95	Dolby HX.
	5K50	20-20	F	3	0.03	70	No	No	Yes	3	1	Yes	Yes		Yes	Yes		27.5	1999.95	Three discrete heads, semi auto bias, azimuth osc.

EQUALIZERS

MANUFACTURER	Model	No. of Channels	No. of Bands	Bandwidth, Octaves	Boost/Cut Range, ±dB	Rated Output, rms V	% THD at Rated Output	S/N, dB, at Rated Output	Variable Center Frequencies?	Variable Filter "Q"?	Dimensions, Inches	Weight, Lbs.	Price, $	Notes
LUXMAN	G120A	2	10		12	1	0.01	110	No	No	18⅜x4⅞x11½	16	349.95	Monitor switch, input attenuator, overload indicator.

CAR STEREO DIRECTORY

RADIOS & TAPE PLAYERS

MANUFACTURER	Model	Price, $	Stereo (S), Mono (M), or 4-Channel (Q)	FM Sensitivity, µV (For 30-dB Quieting)	Selectivity, dB	Preamp Output?	Average Watts/Channel, per IHF A-202	Amplifier S/N Ratio, dB	% THD at Rated Output	Local/Distance Switch?	Number of Presets	Separate Tone Controls?	Cassette (C), 8-Track (8)	Auto Reverse?	Dolby NR?	Bias/EQ Switch?	Fast Tape Speeds?	In-Dash (I), Under-Dash (U), Convertible (I/U)	Dimensions, Inches
ALPINE	7120	229.95	S	19.2@ 50 dB	60	Yes	6	65	8	Yes		No	C	Yes	No	Yes	Yes	I	7x2x5¾
	7121	279.95	S	19.2@ 50 dB	60	Yes	6	65	8	Yes		No	C	Yes	Yes	Yes	Yes	I	7x2x5⅓
	7123	329.95	S	19.2@ 50 dB	75	Yes	6	72	8	Yes	5	Yes	C	No	Yes	Yes	Yes	I	7⅛x2x5⅞
	7124	219.95	S	19.2@ 50 dB	50	Yes	6	65	8	Yes		No	C	Yes	No	Yes	Yes	I	6¼x2x4½
	7125	199.95	S	19.2@ 50 dB	60	No	6	65	8	No		No	C	Yes	No	Yes	Yes	I	6¾x2x4½
	7128	299.95	S	20.7@ 50 dB	80	Yes	6	55	8	No	10	No	C	Yes	No	Yes	Yes	I	7x2x5¼
	7136	449.95	S	20.7@ 50 dB	80	Yes	6	70	8	Yes	10	No	C	Yes	Yes	Yes	Yes	I	6¼x2x5⅛
	7138	349.95	S	20.7@ 50 dB	80	Yes	6	70	8	Yes	10	No	C	No	Yes	Yes	Yes	I	7x2x5¼
	7205	379.95	S	19.2@ 50 dB	75	No	16	72	6	Yes	5	Yes	C	No	Yes	No	Yes	I	7⅜x2x5⅞
	7206	429.95	S	19.2@ 50 dB	75	No	16	72	6	Yes	5	Yes	C	No	Yes	Yes	Yes	I	7⅜x2x5⅞
	7217	239.95	S	22.1@ 50 dB	70	No	16	62	6	Yes	5	No	C	No	No	No	Yes	I	7⅜x2x5⅞
	7307	399.95	S	19.2@ 50 dB	75	Yes	Preamp	72		Yes	5	Yes	C	No	Yes	Yes	Yes	I	7⅛x2x5⅞
	7308	799.95	S	19.2@ 50 dB	60	Yes	6	65			10	Yes	C	No	No	Yes	Yes	I	7⅛x2x6¼
	7327	299.95	S	19.2@ 50 dB	60	Yes	Preamp	72				Yes	C	No	Yes	Yes	Yes	I	6¼x2x4½
	5400	299.95					15	72	8			No	C	Yes	Yes	Yes	Yes	U	6x2¼x5¾
	7114	149.95					6		8			Yes	C	Yes	No	Yes	Yes	U	5½x2x6¼
	7115	149.95					6		8			Yes	C	Yes	No	Yes	Yes	U	5½x2x6¼
	7216	219.95	S	5.0@ 50 dB	60	No	16	62	6	No		Yes	C	Yes	No	Yes	Yes	U	5½x2x6¼
AVX	950		S	1.5	60	No	5	60	10	Yes	6	No	C	No	No	No	Yes	I	7x2x6
	780		S	2.0	60	No	12	60	10	No	6	Yes	C	Yes	No	No	Yes	I	7x2x5¾
	685		S	2.0	60	No	12	60	10	Yes	0	Yes	C	No	Yes	No	Yes	I	7x2x5
	680		S	2.0	60	No	16	60	10	No	0	Yes	C	No	No	No	Yes	I	6¼x2x5¾
	730		S	2.0	60	No	5	60	10	No	5	No	C	No	No	No	Yes	I	6¼x1¾x4¾
	615		S	2.0	60	No	5	60	10	No	0	No	C	Yes	No	No	Yes	I	6¼x1¾x5⅛
HI-COMP	HCC-515		S	2.0	60	Yes	6	70	1	No	0	No	C	No	No	No	Yes	I	6¼x1¾x5¾
	HCC-551		S	2.0	60	Yes	3	70	1	No	0	No	C	Yes	No	No	Yes	I	6¼x1¾x5¾
	HCC-555		S	1.5	60	Yes	6	70	1	No	0	Yes	C	Yes	No	Yes	Yes	I	6¼x1¾x5¾
	HCC-565		S	1.5	70	Yes	10	70	1	No	5	Yes	C	Yes	No	Yes	Yes	I	7x2x5¾
	HCC-1026		S	1.5	70	Yes	10	70	1	No	0	Yes	C	Yes	Yes	Yes	Yes	I	7x2x5¾
	HCM-006		S	1.5	70	Yes				Yes	6	Yes	C	Yes	Yes	Yes	Yes	I	7x1¾x5¾
MAGNADYNE	MC2800	119.95	S	20.8 dBf	55	No	4	50	5.0	Yes	0	No	C	Yes	No	No	Yes	I	1¾x4⅝x6

SPEAKERS

MANUFACTURER	Model	Price, $ (If Sold Individually)	Price, $ (If Sold In Pairs)	Recommended Max. Power, Watts	Woofer Size, Inches	Impedance, Ohms	Frequency Response, Hz to kHz, ± dB	Whizzer (W), 2-Way (2), 3-Way (3), 4-Way (4)	Flush Mount (F), Surface Mount (S), Convertible (F/S)	Dimensions, Inches	Notes
ALPINE	6000		99.95	20	6½	4	55-16	3	S	6½ Dia.	
	6001		109.95	30	6x9	4	40-20	3	S	6x9	
	6104		39.95	20	4x6	4	100-15		S	4x6	
	6106		129.95	80		8	5k-50k		F	3½x3½x½	With crossover.
	6202		59.95	20	4½	4	100-18	2	S	4½ Dia.	
	6203		79.95	40	6½	4	70-20	2	S	6½ Dia.	
	6205		89.95	40	6x9	4	50-18	2	F/S	6x9	
	6206		79.95	50	5¼	4	50-20	2	F/S	5¼ Dia.	As above.
	6207		129.95	80	5¼	4	50-20	2	F/S	5¼ Dia.	As above.
	6302		119.95	50	6½	4	55-20	3	F/S	6½ Dia.	
AVX	TRYVOX 20			30	6x9	4	70-17	3	F		
	TRYVOX 25			25	5¼	4	65-16.5	3	F	6¼x6¼x3	
	TRYVOX 30			30	5¼	4	65-18	3	F		
	TRYVOX 40			25	4x10	4	70-18	3	F		
	COMP 100			50	4	4	50-20	2	S		
	COSC 5A			20	5	4	120-20	2	F	5¼x5¼x1¾	
HI-COMP	HCS-90			60	4	4	120-20	2	S		
	HCS-59			100	5¼	4	90-19	3	F		
	HCS-342			60	4x10	4	75-17	3	F		
	HCS-362			100	6x9	4	70-19	3	F		
	HCS-65			60	6½	4	50-22	2	F		
JBL	A15		179.95	30	5¼		40-15	2	F/S	5¼x2¼	
	A30		219.95	40	6x9		30-15	2	F/S	6x9x2¼	
	LE8T-H	135.00		50		8	35-15		F/S	8 Dia.	
	D208-H	90.00		50		8	60-10		F/S	8 Dia.	
	LE10-H	125.00		150		8	30-3		F/S	8 Dia.	
	LE5H	60.00		50		8	300-15		F/S	5 Dia.	
	LE21-H	45.00		35		8	2k-15k		F/S	4 Dia.	
MAGNADYNE	S700		119.95	50	5	4	50-22	2	S	5x4¼x7½	
	F695DB	69.95		60	6x9	4	35-24	2	F	3½ Dia.	
	S95D		99.95	40	6x9	4	40-22	2	F	3 Dia.	
	ASF80B	39.95		75	8	8	30-3		F	3½ Dia.	
	SF5DT		34.95	60	4	8	1k-24k		F/S		
PSB SPEAKERS	Alpha		240.00	60	4	4	100-20 ±2.5	2		4¾x5x9	
SPECTRON	700		259.00	70	5	4	60-20 ±3	2	S	8x5.4x2.75	
	760		279.00	80	6½	4	45-20 ±3	2	S	9½x6¾x3¼	

AMPS & EQUALIZERS

MANUFACTURER	Model	Price, $	Amp=Amp; EQ=Equalizer; Both=Both	Number of EQ Bands	Separate Controls for Each Stereo Channel?	Boost/Cut Range, ±dB	S/N Ratio, dB	Watts into 4 Ohms, per IHF A-202	% THD at Rated Output, per IHF A-202	Dimensions, Inches	Notes
ALPINE	3000	219.95	Both	5	Yes	12	65	18x4	8.0	7⅛x1⅝x5⅝	
	3004	119.95	Both	5	Yes	12	65	18	8.0	7⅛x1⅝x5⅝	
	3007	179.95	Both	5	Yes	12	65	18	8.0	7⅛x1⅝x5⅝	With preamp out.
	3002	249.95	Amp		No		85	65	8.0	8x2⅞x8	
	3006	69.95	Amp		No		65	18	8.0	4x1⅜x6	
	3008	149.95	Amp		No		75	40	8.0	7⅛x2x6	
	3011	149.95	EQ	5	Yes	12	80			5⅞x1¼x3⅛	
	3023	149.95	Both	7	Yes	12	65	18		5⅞x1¼x5⅞	
AVX	Amp 500B		Amp				60	40	10	4⅛x1⅛x6⅝	
	Amp 550A		Both	5	No	12	65	40	10	4x1⅝x5	
	Amp 575		Both	5	No	12	65	40	10	4x1¼x5½	
	Amp 600C		Both	5	No	12	65	40	10	6½x1⅞x6	
	Amp 700		Both	7	No	12	70	60	1	7x1¾x7¼	
	Amp 775		Both	7	No	12	65	40	10	4⅞x1¼x5¾	
HI-COMP	HCE-750		EQ	5	No	12	70			6⅝x2½x4¼	Semi-parametric EQ.
	HCE-707		Both	7	No	12	65	32	1	6½x1⅞x6	High and low level inputs.
	HCE-710		Both	5	Yes	12	65	60	1	7x1¾x7¼	As above.
	HCB-815		Amp				70	60	1	5½x1¾x4	As above, 4-channel amp.
	HCB-820		Amp				70	36	1	5½x1¾x4	High and low level inputs.
	HCB-830		Amp				70	120	0.3	7x3⅜x8¼	As above, 4-channel amp.
	HCB-860		Amp				70	120	0.3	7x3⅜x8¼	High and low level inputs.
MAGNADYNE	EQ41B	79.95	Both	5	No	12	65	25	5		
	EQ417B	99.95	Both	7	No	12	65	25	1		
	EQ42B	119.95	Both	7	No	12	65	25	1		
SPECTRON	600	269.00	Amp		No		95	50	0.05	3.7x7.1x5.5	
	602	369.00	Amp		No		95	75	0.05	3.2x7.5x5.7	
	302	229.00	EQ	3	Yes	20	72		0.03	1.6x4.4x3.5	

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DEADLINE- 1st of month two months preceding the cover date. If the first of the month falls on a weekend or holiday, the closing date is then the last business day before the holiday or weekend. ADS RECEIVED AFTER THE CLOSING DATE WILL BE HELD FOR NEXT ISSUE UNLESS OTHERWISE STATED.

BLIND ADS-Box numbers may be used at $5.00 extra for handling and postage.

GENERAL INFORMATION Ad copy must be typewritten or printed legibly and received on or before the 1st of the month, two months preceding the cover date. Display advertisers must make a space reservation on or before the closing date, material (Camera Ready Only) may follow by the 10th. The Publisher, in his sole discretion, reserves the right to reject any ad copy he deems inappropriate. All advertisers must supply: Complete name, Company name, Street address (P.O. Box is insufficient), and telephone number before ads can be published. Classified ads are not acknowledged and do not carry Reader Service Card Numbers. Frequency contracts not fulfilled will be short-rated accordingly. Ads submitted for a 3 time frequency or less are unchangeable. Classified ads are payable in advance **BY CHECK OR MONEY ORDER ONLY.** (Sorry, we can not accept credit cards.). Additional information available upon request. Contact: Laura J. LoVecchio, Advertising Coordinator, 1515 Broadway, NYC 10036 . . . Direct Dial (212) 975-7530.

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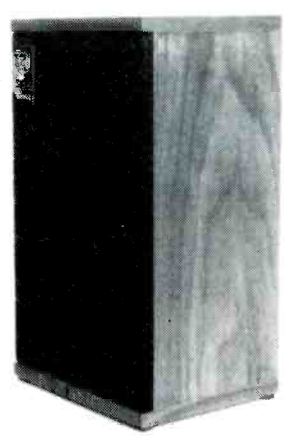

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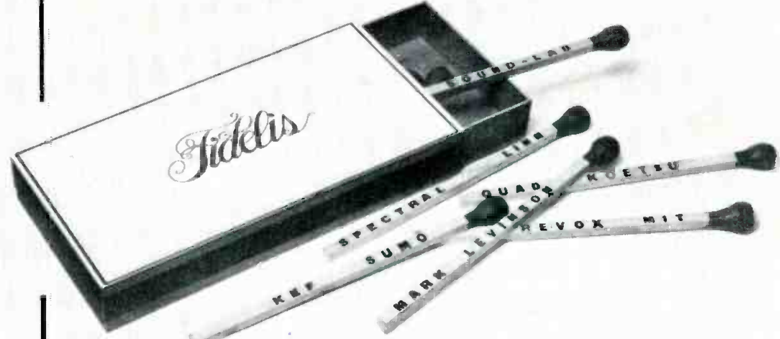

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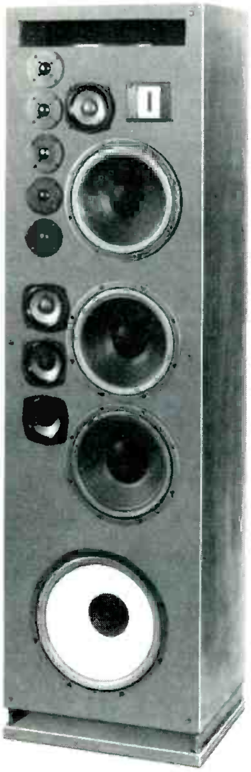

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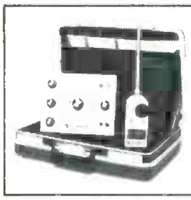

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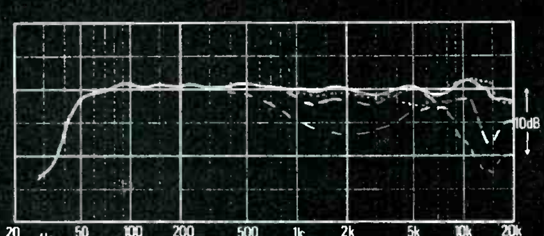

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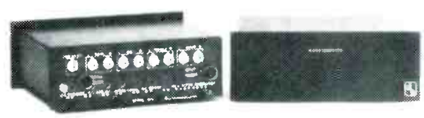

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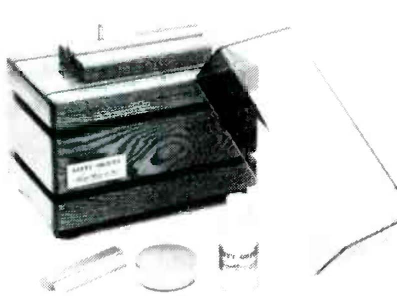

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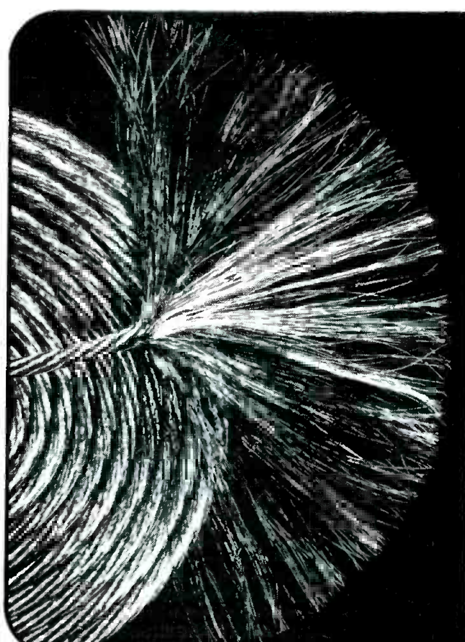

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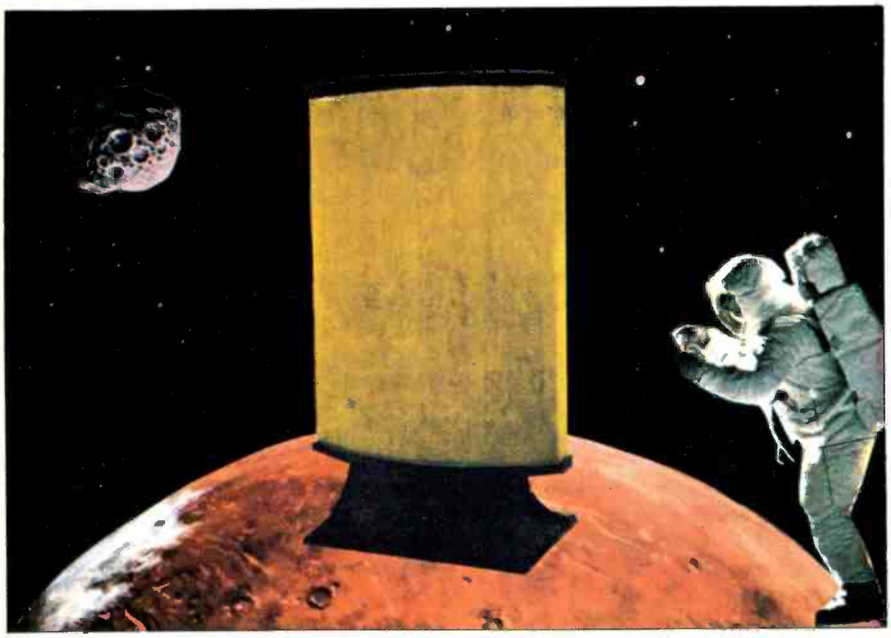
BERT WHYTE



Electrostatic loudspeakers in their various manifestations have been around the hi-fi scene for a long time and have held a peculiar fascination for many audiophiles. Such speakers have always been admired for their clean, open sound; low distortion, transparency and, above all, their lightning-fast transient response. Many people fail to realize that music primarily consists of transient sounds, and therefore accurate reproduction of such transients is of paramount importance.

Many audiophiles have been aware that the desirable attributes of electrostatic loudspeakers are usually offset by many basic problems inherent in this design. Fragility of the thin film of the speaker diaphragm, especially before the advent of Mylar, causes frequent failure due to discrete arcing when overdriven. Efficiency is low, dynamic range restricted, and in those speakers which are supposed to be "full-range" units, bass response usually falls off rapidly below 50 Hz. Added to this is the difficult capacitive load these speakers present to the amplifier.

Despite all of these problems, many audiophiles have continued to admire the special qualities of electrostatic loudspeakers. New models are a fairly rare occurrence in comparison to the never-ending flow of dynamic speakers to the hi-fi market. Hence the hearty welcome to the new Quad ESL-63 and several new electrostatic loudspeakers from the Acoustat Corp. of Fort Lauderdale.

Acoustat introduced its first electrostatic loudspeaker, Model X, in 1976. In recognition of the fact that all electrostatic loudspeakers present a highly capacitive load to an amplifier, the Model X had its own built-in direct-drive, solid-state/tube hybrid amplifier. The tubed output stage of the amplifier mated well with the capacitive load, but there were some problems associated with this unit. Of course, the basic idea of the built-in drive amplifier was to eliminate the input transformer that is common to all other electrostatic loudspeakers. The transformer is a source of various nonlinearities and exhibits other undesirable properties. While Acoustat had some technical problems with the drive amplifier, a more difficult problem was that most audiophiles already had their own amplifiers and resented the fact that they could not use them to power this electrostatic speaker. Thus, after considerable research, in 1980 Acoustat introduced the MK-121 Magne-Kinetic Interface passive drive system. This device (previously described in my May 1981 column) essentially is a "bi-former" design. Two specially optimized transformers cooperatively "overlap" at about 1500 Hz and handle the midrange frequencies, while one of the two handles bass frequencies and the other one, treble frequencies. Acoustat calls the MK-121 "revolutionary" and claims it is a near-perfect power/impedance match. Efficiency is very high and impedance is rated at 4 ohms — and is claimed never to drop below 3 ohms. The design is said to eliminate the spurious resonances and "ringing" of conventional transformers. With the MK-121 Interface, all solid-state and tube amplifiers can be used to drive Acoustat ES systems, and since most amplifiers deliver more power at 4 ohms, this is an added bonus.

The current Acoustat Models Two, Three and Four all use the same electrostatic panels. Acoustat hand-makes these panels in their Florida plant. Sheathed conductor grids are chemically welded to extremely rigid "honeycomb" plastic panels. Sandwiched between the grids is the conductive Mylar diaphragm, only 0.00065-inch thick with an equivalent mass of 7 mm of air! The MK-121 Interface accepts the incoming audio signals from a power amplifier, routes them through the special transformers, and thence to the wire grids. A bias transformer imparts a static charge to the conductive Mylar diaphragm. This grid "sandwich" permits true push-pull piston action over the entire surface of the diaphragm. The result is audio output with extremely low distortion and ultra-fast transient response. The electrostatic panels on the Models Two, Three and Four differ only in their number, with Acoustat claiming exceptional uniformity and consistency of performance.

I have had the pleasure of living with the Acoustat Model Four for some months now. This is the largest of the Acoustat electrostatic speakers, standing 59 inches high by 28 inches wide by 3½ inches deep. It has four of the electrostatic panels, the outer two panels being 9 inches wide and the inner two being 8 inches wide. The idea of the different widths is to stagger the individual resonances of the panels to avoid any possible reinforcement of a particular frequency. Two criticisms often directed at electrostatic speakers are their marginal bass response and their inability to reproduce music at high loudness levels. The Model Four's frequency response is listed at 28 Hz to 20 kHz, ±2 dB. The speaker is said to be capable of an out-

Illustration: Marc Yankus

put of 115 dB SPL at 22 feet in a 16 x 26-foot room on program peaks. I have been driving the Model Four with a Levinson ML-3 200-watt power amplifier and have played many recordings with substantial bass response, including my own Virgil Fox organ recording which has pedal frequencies below 20 Hz. While the Model Four cannot reproduce fundamentals of such low frequencies, it acquitted itself quite well with clean, smooth bass response down to 35 to 40 Hz. With heavy bass drum strokes and lower pitched tympani, the sound from these instruments was very clean, well defined, and of considerable impact. I am not saying that the bass response was of the full-blown, high-energy level available from a good subwoofer, such as that made by Janis Audio. (Incidentally, the Janis W-1 mates especially well with the Model Four if you are inclined to augment its bass response.) As for high-level playback, the Model Four meets its published specifications, and then some. Certainly in the average domestic listening situation, there is more output available than most music lovers would accept. The Model Four does quite well in coping with wide dynamic range, but when I hooked up a JVC 16-bit recording system for direct digital playback, there were some distressful sounds!

Like all of the Acoustat speakers, the Model Four is a dipole radiator. I have used them positioned well away from a panelled wall, with good results as to imaging and depth, but when I placed them in my Sonex-treated "live end/dead end" listening room, the absorption of the back wave was quite an aid. Such treatment with this sound absorber removes most first-order reflections and damps the back wave, so with no reflections arriving later in time, there is a dramatic increase in imaging and depth perception as well as more precise localization of orchestral instruments. Speaking of secondary arrival times, the panels of the Model Four are slightly curved (six degrees of arc), but the total displacement from a plane is less than an inch and therefore arrival times from all four panels are substantially the same.

The Acoustat Model Four is a mercilessly revealing speaker. It really is a reflection of the old computer adage "garbage in — garbage out." Play some analog or digital master tapes and the Model Four can give you gloriously realistic sound. Play some really high-quality records and your ear will delight in the clean, smooth response and incomparable transient attack and accuracy. But play some poor recording with "crackly" scratched surfaces, and the Model Four will give you a mirror image of this sonic horror. It should also be noted that in addition to the Model Four's clinical view of program material, it can be equally devastating in showing up poor quality links in the entire chain of reproduction. Try to use an inferior phono cartridge, for example, and the resulting screechy first violins in a symphony recording will cut your ears off! With fine recordings, the Model Four can reproduce violins with that magical sheen and airy transparency so sought after by the dedicated audiophile. Play something like the Sheffield drum record or M&K's *Hot Stix*, and the revelation of transient attack capabilities will help you understand what all the fuss is about.

I should mention that since Acoustat introduced the Models Two, Three and Four, there have been some worthwhile updates and modifications. The necessary parts, including a newer type of bias transformer, and the substitution of polystyrene and polypropylene caps for the original types, come in kit form and are available for $65.00. The modifications provide about a 1.5-dB increase in output, tighter low bass response, smoother midrange and top end, and even less distortion. These modifications were installed on the Model Fours which I have, and it does indeed make a fine speaker even better. There are no protection circuits in these speakers. Acoustat claims the panels are virtually "indestructible," and with more than 24,000 panels in the field, they have never had a failure! I can sum up my impression of the Acoustat Model Four by stating that it combines the near-legendary performance values of electrostatic loudspeakers while eliminating most of the drawbacks and establishing a very high standard of reliability.

From JVC comes word of an important new development. Would you believe a digital audio cassette recorder? It looks very much like our conventional analog units, but JVC has come up with a very high density (46.3k BPI) recording system to make this machine a reality. The cassette is the same size as our present audio cassette, and it uses metal tape. However, I have a feeling this tape is of the metal evaporated type. Tape speed is higher, at 7.1 cm per second. Evidently the PCM recording and playback is via new LSI (large scale integrated) chips. Quantization is "equivalent to 14 bits," and sampling rate is at the rather odd figure of 33.6k per second. Perhaps this was chosen with an eye to the future when a machine like this might be used with some of the European digital broadcast systems which use 32k sampling rates. Recording time is 30 minutes per side. On this tiny cassette tape width, four tracks for each channel are provided! One is a service track which permits random access, program indication, etc.; the other tracks are for data and error correction. The unit has

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an erase head and a combination record/play head. The tape transport is a direct-drive capstan system with a newly developed tape-tension servo system. Most significantly, JVC is emphasizing the use of prerecorded digital cassettes for this unit, and in fact, they have developed a high-speed duplicating system for such recordings. (JVC currently has a metal-particle tape duplication system for analog prerecorded tapes.) The new JVC digital cassette recorder is slated to become available in late 1982 or early 1983. As you might expect, pricing is not yet finalized, but an educated guess would be "somewhere between $2000 and $2500." This new system is expected to be demonstrated at the AES Convention at the Waldorf in New York and possibly at the CES in Las Vegas. We'll keep you posted. (*Editor's Note:* Pioneer and Sony showed basically similar units during the Japan Audio Fair in Tokyo; both use the Philips-type cassette, like JVC, but coding systems will be different for each of the three machines. While coding systems would have to be an object of standardization, the introduction and widespread use of particular A/D and D/A chips, which are only now being developed, seems to be the main stumbling block to production of single-unit digital audio recorders. Sony reports they are currently experiencing upwards of 70 percent success in making such chips. —*E.P.*)

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Vice President and General Manager

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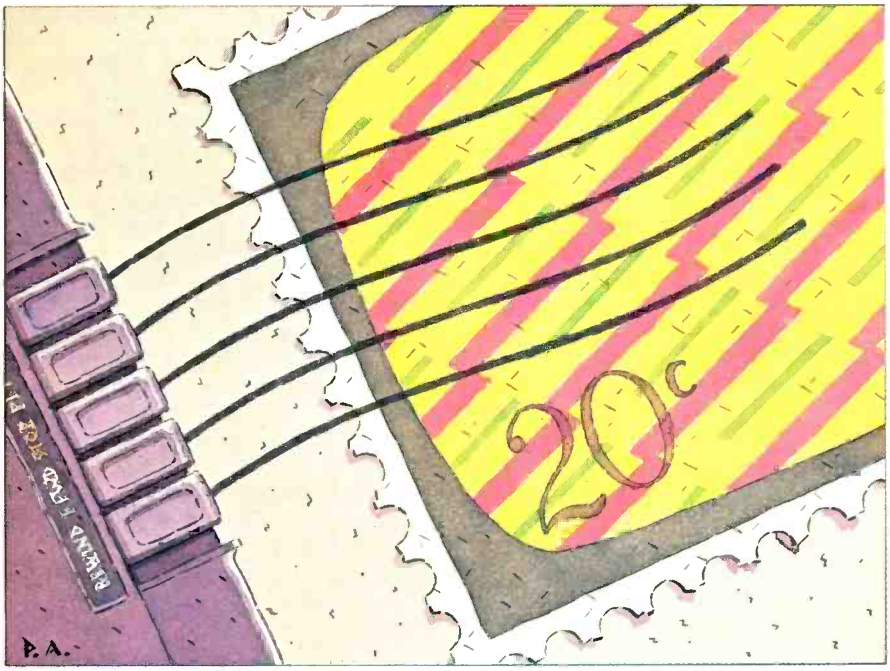

In the November 1980 issue of *Audio*, I reported on the introduction of a portable VHS videocassette recorder from the Technicolor Corp. What was notable about their Model 212 was that it weighs under 8 pounds and uses a mini-videocassette with videotape only one quarter-inch wide. A joint development of Technicolor, heretofore known for their beautiful color movies, and the Funai Electric Trading Co. of Osaka, Japan, the Model 212 caused quite a stir in video circles.

After the initial production run, Technicolor expanded their mini-video system and was kind enough to furnish me with the Model 212 VCR, plus its companion Model 5112 tuner and Model 412 portable color video camera. After using this combination for several months, I must say that the quarter-inch videotape format is not just a marketing gimmick, but quite an impressive technological development.

The Technicolor Model 212 VCR is a compact unit approximately 10 inches square and 3 inches high. With its rechargeable nickel cadmium battery it weighs only 7.4 pounds, making it easy to carry on one's shoulder with the carrying strap provided. The Model 212 uses a mini-videocassette which is deliberately slightly larger than a standard audio cassette, to prevent accidental insertion of same. Tape speed is 1.26 ips, and the standard V30 videocassette is loaded with quarter-inch tape and affords 30 minutes of recording time; a V45 videocassette is also available. Upcoming from Technicolor is some sort of "double-decker" videocassette which is supposed to permit as much as three hours of recording time. The standard V30 videocassettes weigh only 1.76 ounces. Technicolor envisions them being used as a sort of "video letter," interchanged by mail between friends or families, and for business use as well, when sender and recipient are equipped with the Model 212 and companion Model 412 video camera.

The heart of the Model 212 is a special micro-helical head system. The video head drum has two mono-crystal ferrite heads, an inscribed tape path on the drum to ensure tape alignment, and a rotary transformer to reduce mechanical wear in the head coupling circuit. The head helically scans FM modulation to NTSC standards. Technicolor states that resolution is 240 lines, with a video signal-to-noise ratio of 43 dB. This is comparable to many half-inch VHS videocassette recorders.

The Model 212 has typical piano key mechanical controls for rewind, fast forward, stop/eject, play and record. I found them quite positive in their action and reliable during months of frequent use. Also on the front panel is the removable cover for the battery compartment, a battery condition indicator, condensation warning lamp, and another lamp which indicates when the VCR is in the still-picture mode. Next to the cassette compartment on the top panel is a tape counter with memory function. On the right side panel of the VCR case is a 7-pin power connector, a 10-pin camera input/output connector, an earphone input connector, microphone input connector, a still-frame switch, and a tracking knob control to correct for video noise and distortion.

Furnished with the Model 212 is the Model 312 a.c. power adaptor which permits the VCR to operate off house current and also recharges the VCR's nickel cadmium battery in one hour, rather than the five or six hours usually needed for this operation. The Model 212 has an r.f. modulator for the usual Channel 3 or 4 playback, plus audio and video output terminals to facilitate dubbing between two VCR units. With the battery, the Model 212 will permit 40 minutes of recording with a video camera and 80 minutes of direct playback through a TV receiver. The Model 212 can accept signals from a standard half-inch VHS deck and, conversely, its output can be recorded on a half-inch VHS VCR. With a special optional cable, the Model 212 can be operated from a car battery via the cigarette-lighter socket. The tracking knob on the VCR, in conjunction with the still-frame switch, will permit frame-by-frame viewing at approximately 1.8 times normal viewing speed. I found the Model 212 VCR transport to run quite smoothly with low mechanical noise. Although this VCR does not have a gyroscopic stabilization system, in normal use with the video camera and with all the bounces and bumps and swinging to and fro that this entails, there were no adverse effects on transport speed.

The Technicolor VCR has a companion color TV tuner, Model 5112, a lightweight three-pound unit measuring approximately 9¾ inches wide x 3⅛ inches high x 11⅜ inches deep. The tuner, of the continuous tuning Varactor type with AFT (automatic fine tuning), is powered from the Model 212 VCR by a special input/output cable through the camera socket. It has VHF and UHF in-

Illustration: Philip Anderson

put terminals with front-panel illuminated indicators for same. A local/distance sensitivity switch is provided, as is a tape-run/stop button whose function can be remotely controlled. In the *Stop* position, power is derived from the VCR and channels may be selected for recording; in the *Tape-Run* mode the VCR starts to record. This tuner has good sensitivity and operates well in both VHF and UHF modes, but with all due respect to Technicolor the hook-ups necessary to accomplish such functions as recording one program off the air while viewing another program seem complicated and cumbersome.

As far as I am concerned, the real value of this Technicolor portable VCR is when it is used in conjunction with the new color video camera. The Model 412 is an excellent lightweight (4.8 lbs.) unit with a surprising number of refinements. Its 2/3-inch tri-electrode vidicon tube along with the F:1.6 zoom lens permits recording with as little as 75-lux illumination. The horizontal resolution is 250 lines and with the lens produces pictures that are crisp, of good brightness and contrast, clear, and clean, while color balance is also very good. (It is a sad fact of present VCR and video camera technology that the lenses of the cameras are far sharper than the 525-line NTSC standards can utilize.) The Model 412 camera features a comfortable pistol grip and an electronic viewfinder. Through it, the wide-angle (14 mm) and telephoto (84 mm) six-to-one zoom lens effects are easy to observe. In the viewfinder are several warning lights. When the camera is hooked up to the Model 212 VCR, pressing a remote button on the camera activates recording and a red "V" appears in the viewfinder. Pressing the button a second time stops recording, and the red "V" disappears. If light levels are too low for recording, a red "L" will be seen in the viewfinder. It will disappear when the iris diaphragm is opened to admit more light. If battery power in the VCR becomes low, a red warning "B" will appear. The electronic viewfinder can also be used to play back videotapes recorded on the system (albeit in black and white and on a very tiny screen). A control on the camera called the "white balance" is used to adjust for the color "temperature" of a given scene, to achieve correct color balance. The zoom controls, focusing mechanism and iris diaphragm of the lens worked quite smoothly.

I used the combination of the Technicolor Model 212 VCR and the Model 412 color video camera to make a variety of recordings, both outdoors with sunlight and indoors with photo floodlamps. The system was a pleasure to use as much for the fine quality of the tapes recorded as for the ease of use and handling this lightweight system permitted. Whether in sunshine or artificial light, I could not fault the good color balances, the clean blacks and whites, and the consistently good quality of the images. Resolution was certainly the equal of extended play recordings made on standard half-inch VHS videocassette machines. The camera was fitted with an omnidirectional electret condenser microphone, and as usual with almost all VCRs, audio quality, especially in respect to S/N ratio, was poor. The new Dolby C chips should certainly be incorporated in any updated versions.

Price of the Technicolor Model 212 VCR is $995.00; for the Model 5112 tuner, $149.95, and for the Model 412 color video camera, $950.00. A V30 cassette costs $8.95.

One final note. The tape used in the tiny V30 Technicolor videocassettes was apparently of the same type currently produced by TDK, Maxell, Fuji, and others for standard VHS use. Considering the small size of the Technicolor videocassette, it shouldn't be too expensive to use metal-particle tape, adjust the electronics for this, and assuredly get even closer to standard play quality of half-inch VHS videocassette!

THAT'S THE WAY IT WAS

WALTER I. SEIGAL

Radio dramas depended heavily on the network's Sound Effects Department. In addition to recorded sounds, played back from phonograph records, the CBS crew used some real devices, such as a cash register (middle) and a door (right), and some ingenious sound-alikes, including an automobile tire ready to be cranked (inset), behind which is a piece of sheet metal which was drummed to produce thunder. In this picture, taken in 1935, the head of the department, Walter Pierson, appears third from the left.

CBS Photos

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