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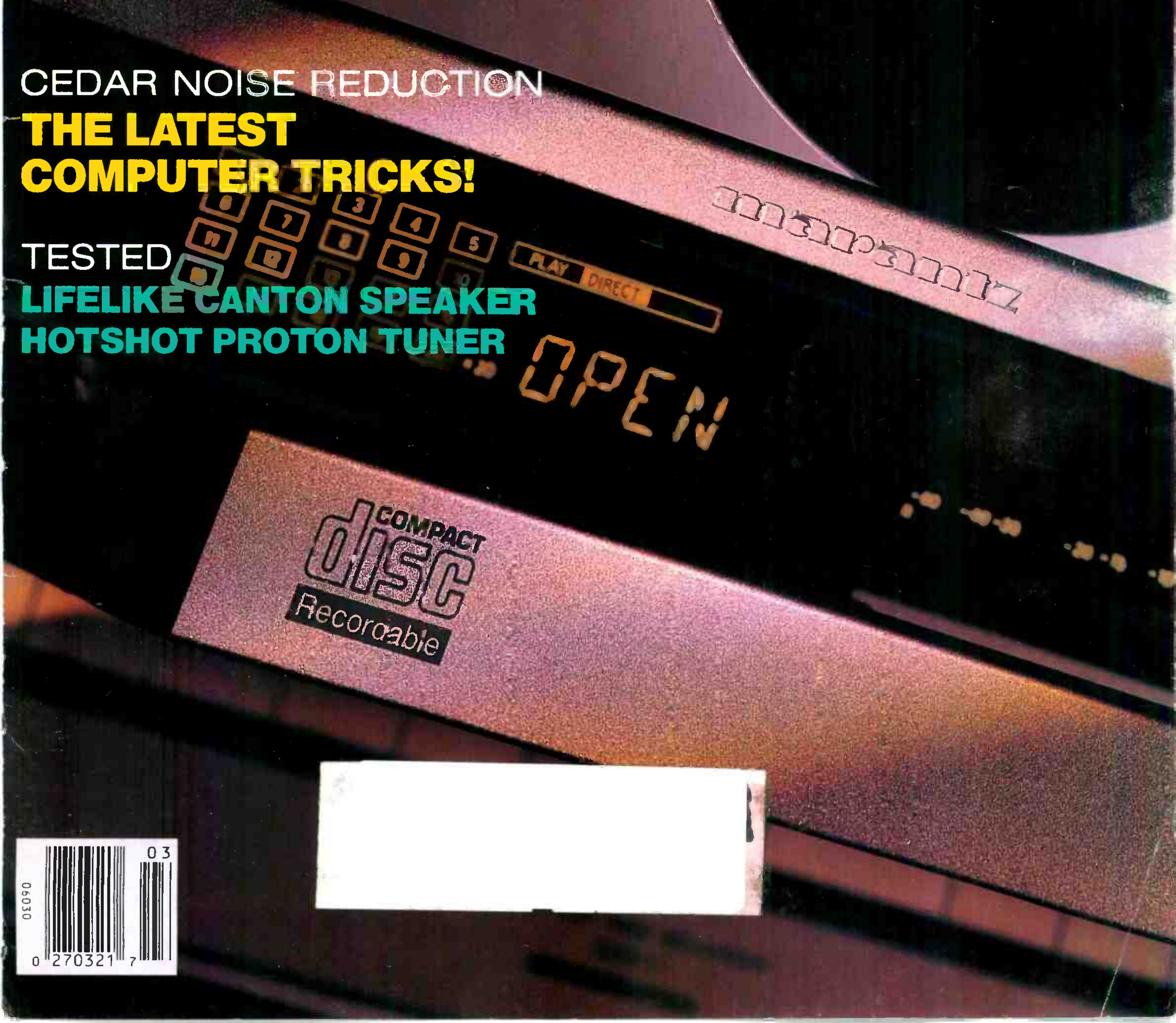

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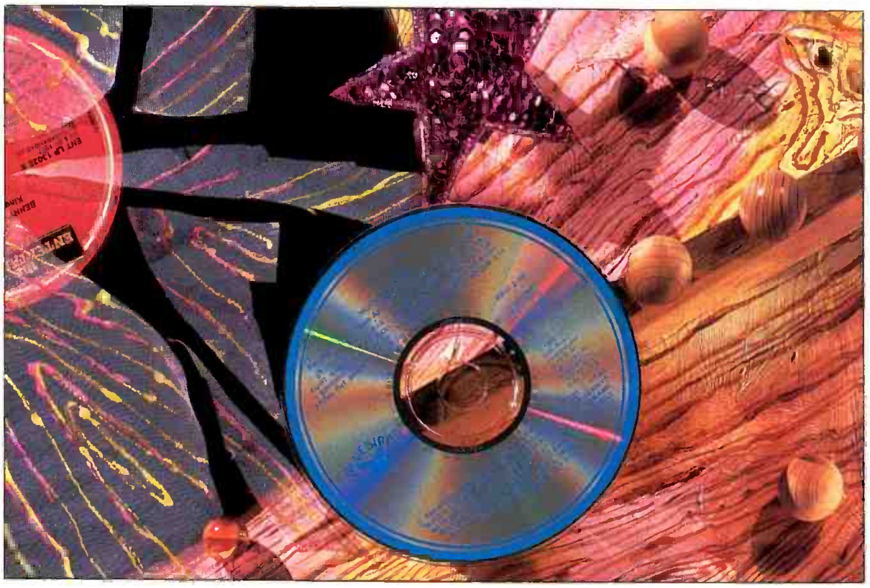

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Playing Type IV Tape

Q. I've read that metal-particle tape (Type IV) may be played on any deck. It was my understanding that metal tape should be played only on decks with the appropriate switching control. I was led to believe that this is due to the metal formulation being different from other formulations (Types I and II). If metal tape is played on decks without such switching, would there be damage to the heads or other parts of the cassette deck? Also, is there any difference in the head composition of decks with and without the switching control for playing metal tape or the other types?—E. T. Shields, Barboursville, N.Y.

A. Yes, metal-particle tape may be *played* on *any* deck. No harm will come to the heads or other components of the deck.

Cassette decks generally provide two kinds of playback equalization: 70 µS for Type II and Type IV and 120 µS for Type I. Type IV tapes require the same, 70-µS playback equalization as Type II tapes; if Type I (120-µS) equalization is used, the only result will be a bit of emphasis in the treble range, easily corrected by tone controls. So metal tapes can be played even on inexpensive equipment that has only the "normal" 120-µS equalization.

For *recording*, however, Type IV tapes require much higher bias than Type I or Type II cassettes. Recording with insufficient bias will result in high distortion and excessive treble. Some inexpensive decks and recorders cannot provide proper Type IV bias, and they may also be unable to adequately erase material previously recorded on metal tape.

Metal tape calls for suitable record heads in order to accommodate the greater bias current and greater signal current required by this formulation. In fact, in the early days of metal tape, one of the chief problems was to devise suitable heads for it.

Sticky Problem

Q. I'd appreciate your throwing light on a problem I've encountered with four or five commercially recorded cassettes during the last year. On each occasion my tape deck stopped during play. On removing the cassette and taking up the slack, I found that the tape was somewhat harder than normal to wind manually. Presumably this accounts for the stopping, but I'm puzzled about the cause of the resistance to tape motion. Usually the fast forward and rewind modes still work, although during the course of this I have sometimes heard unusual noises, notably an intermittent squeaking/sizzling noise. On three of the tapes involved, the problem has not recurred.—Evan K. Jobe, Lubbock, Tex.

A. Possibly owing to excessively low humidity, the tape may have picked up static charges that caused the tape layers to attract each other and therefore stick. Static charges could also account for the "sizzling" noise. Of course, this is just a guess. The tapes employed for prerecorded cassettes in general are not famous for being of top quality, and therefore might possess characteristics which led them to perform as they did. Components of the cassette might be responsible; for example, faulty slip sheets might interfere with easy tape travel.

If a tape still gives you the same problem, try giving it a vigorous slap across something not too hard, such as a book or your hand. And hope for the best.

Fidelity of CD Dubbings

Q. After carefully setting bias (manually) on my cassette deck, which has Dolby HX Pro, and using Dolby C noise reduction, I can still detect a slight difference between the dubbing and the CD. Is it unreasonable to expect the two to sound identical to 50-year-old ears?—Gerald Pasternack, Colts Neck, N.J.

A. In terms of signal-to-noise ratio, distortion, and wow and flutter, CD performance is considerably better than that of a cassette deck. Also, frequency response of a CD is flatter and more extended. On the other hand, the *measured* differences tend to be greater than the *audible* differences. On the whole, given a good deck and good tape and proper recording procedure, sound quality of a cassette deck should be quite close to that of CD.

Identical or nearly identical performance is promised by the DAT deck, which is at last on the market. On the other hand, the cassette format has taken an important step upward with the introduction of Dolby S noise reduction. This development not only improves S/N but is licensed only to deck manufacturers whose decks conform to high standards set by Dolby Laboratories. In 1992, we should see both the Digital Compact Cassette and the Mini Disc, which are claimed to closely approach (but not quite equal) Compact Disc performance. And finally, we have recordable CD, which has so far come down from about $150,000 to $7,000 or so but will probably become even more affordable in the future.

Remote-Control Compatibility

Q. I have a problem concerning remote control of my system. My receiver is a Kenwood, and my deck is a Pioneer. The problem is controlling my deck with the remote control of the receiver. I have written both companies asking about this, and both stated this should work, but it doesn't. I hope you can provide me with some advice, short of buying components of the same make. I am thinking of buying a universal remote control. Do you think this would work?—Tony Sanders, APO San Francisco, Cal.

A. Your question implies that the receiver's remote control is of the learning type, so that it can also control a cassette deck, VCR, etc. While a learning remote can ordinarily learn to control other components made by the same manufacturer, it may or may not be able to do so for components from other manufacturers. I gather that you have tried and failed.

Yes, a universal remote may solve your "problem." You should buy this item on condition that it can be returned within a stated time with no questions asked. I put the word problem in quotes, because I don't see it as anything but a minor inconvenience. Separate remotes, while occupying more space, are more quickly indentifiable as to what goes with what, and they avoid a rather intimidating array of buttons, some of which do double duty and therefore tend to be confusing.

If you have a problem or question on tape recording, write to Mr. Herman Burstein at AUDIO, 1633 Broadway, New York, N.Y. 10019. All letters are answered. Please enclose a stamped, self-addressed envelope.

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JOSEPH GIOVANELLI

Suppressing R.f.i.

Q. I am having an intermittent CB radio interference problem. My house is on a heavily travelled road, and my surround sound loudspeakers blast with this interference every time a CB-equipped car passes by. My receiver is a Pioneer VSX-5300, which contains a surround amplifier. About 30 feet of 18-gauge wire connect my rear speakers to the receiver.

The main, or front, loudspeakers are unaffected by these transmissions. If the surround circuits are switched off, those speakers also then don't pick up the interference. Putting the receiver into "mute" does not prevent the interference from being heard. Do you have any suggestions as to what's happening and how to cure it?—Larry B. Craven, Raleigh, N.C.

A. In instances like yours, the most common way radio frequency interference gets into a sound system is by way of the loudspeaker wiring. It acts as an antenna. True, it enters a late amplifier stage at its output, but the amplifier's feedback loop provides a good path for the signals to find their way into an early stage of the equipment, where they can then be rectified and amplified.

This is probably not the scenario in your case, because you explained that the receiver's surround circuits have to be turned on before you can hear the interference. If, however, your receiver is designed so that the surround channel's power amp is turned off along with the surround circuitry, that would explain everything.

If the interference comes from the speaker cables, this can be cured by bypassing each loudspeaker output terminal to chassis—yes, even the ground, or common, terminals. Use about a 0.01-μF disc capacitor at each terminal, keeping all leads as short as possible. You can also use ferrite beads. These beads can be obtained either split or in one piece with a hole through which the cable must pass. There are various types of these beads, and you want beads designed to be most effective at 27 MHz (if the interference is truly coming from CB transmitters). Keep the beads as close to the amplifier as possible. You may need to use several beads on each cable.

If the speaker cables are not the source of the trouble, then you may have to place beads on input cables or on power-line wiring. Even shielded cable can permit interference to get into the center conductor because the cable is really not 100% shielded.

Replacing Tweeters

Q. I have had a quality pair of two-way loudspeakers for about five years and have been pleased with them. Recently, however, for reasons that I am not sure of, the tweeters were damaged. This has brought about some questions about the repair of these loudspeaker systems.

I am assuming that replacement drivers are available from the maker, but I am curious about the results that I might be able to obtain by using different drivers than the originals. I would keep the low-frequency driver and the crossover network intact. Aside from the obvious considerations of finding drivers that match in impedance, sensitivity, and physical dimensions, what else must I consider for the results to be acceptable?—Timothy E. Gosman, Somers Point, N.J.

A. My first thought is that, unless you have a way to audition the new drivers, you may find after the new drivers have been installed that they do not perform as well as the original ones did. They may be peaky, or they might have less openness and transparency than the maker's choice of tweeter.

It is essential that the crossover point for the replacement tweeters be the same as, or perhaps a bit lower than, that of the original tweeters. You want to be sure that the transition between woofer and tweeter is as smooth as possible, at least as good as it was using the original tweeters.

Differences in cone placement with respect to the plane of the woofer could also make a difference in the sound, which again could mean that the best sound would be produced by using the original tweeters designed for use in the system.

"Unturned-Off" Hum

Q. I have noticed that my daughter's boom box emits a noticeable hum when plugged into the wall outlet although all functions are turned off. After that, I checked all of my radios. These are clock radios of everyday quality, and all of them emit this same hum, even though they are turned off. I must say that, with some of them, I have to place my ear right against them to hear the hum. Are these "humming" radios okay? I have been told by some friends that they might not be safe.—Robert E. Olsen, Madison, Wisc.

A. Most boom boxes that I have heard don't really turn off when the power switch is off. This is because these switches are located in the B+ line, which feeds the d.c. to the various components within the box. This is the only way—or at least the cheapest way—to wire such equipment. When these devices are plugged into the power sockets, voltage is applied to the power transformer *at all times*. Thus, the hum you hear is not coming from the loudspeakers but from the cabinet and is heard because of mechanical vibrations of this cabinet. Any power transformer, when it is fed from a power line, emits some mechanical vibration.

With voltage applied to the power transformer, the power supply is always producing voltage, even though this voltage goes nowhere when the radio is off. For greater reliability, unplug radios of this design when they are not to be used for extended periods of time.

Why are boom boxes wired as I've described? It is because they also operate from batteries. Placing the power switch as described provides a convenient way for you to disconnect the batteries.

Clock radios also use power transformers. Both the radio and the clock are supplied with voltage by these transformers. Therefore, the transformer must be connected to a power source at all times if the clock is to keep time.

Your children do not have to give up their boom boxes, and you don't have to throw out your clock radios. There are no significant safety problems associated with these pieces of gear.

If you have a problem or question about audio, write to Mr. Joseph Giovanelli at AUDIO Magazine, 1633 Broadway, New York, N.Y. 10019. All letters are answered. Please enclose a stamped, self-addressed envelope.

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BINAURAL ON THE FLY

Illustration: Donna Perrone

My own spaced-out experiments in roving binaural recording over many years—I have written of these in previous issues—have led me to a batch of very specific parameters for this unusual corner of the audio art. It is high time I brought them to some order and into print. Could be helpful both for pros eyeing (or earing) the field and for the jaded amateur in search of something with more audio punch than camcorder mumblings.

If you think, not having tried it, that headphone binaural sound must be startlingly different, as I've described it myself, even *uncannily* different—realistic enough to make your hairs stand on end and maybe turn them dead white overnight—I will not disabuse you! Binaural is truly *sensational*. What else can I say?

A lot else. To get down to the sonic earth, we need specifics. First, let me sum up a few more of what to me are memorable binaural recordings, as a guide to the sort of subject matter that is rewarding.

My earliest real field trip was with the already-noted Binaural Maggie, at the Ozark home of the well-known writer and naturalist gentleman/farmer Leonard Hall. June 1953 and spring had sprung, full blown, with a thousand birds singing on every branch. At 5:00 in the morning, Leonard hauled out a 50-foot extension cable and we set up Maggie out in the bushes, two mikes a head apart, and retired into the house to let the birdies resume their chatter. After a hearty breakfast, as I remember, we hauled Maggie back again and rewound the tape.

It was amazing! Leonard was the kind of naturalist who knew the names of every bird by feather, beak, and shape as well as by sound (and the same for all natural things—animal, mineral, and vegetable). He proceeded to name bird after bird in rapturous delight. He even wrote it all up in the *St. Louis Post-Dispatch*, if that was where his column appeared. What a superb way to record birds—in their natural ambience and at a natural, normal distance.

The sequel to that was, with my later and more portable equipment, a brace of bird recordings around my own house in which I refined the technique. Even without Dolby, with far too much background hiss in addition to the noises of leaves in the wind, distant birds registered just as well as those nearby, and just as real in the natural sound. My best was a recording of four different hermit thrushes competing, none nearer than 100 yards or so. It was the sound you hear, entranced, far, far away in the woods, a musician's dream sound, an overtone arpeggio of harmony at a dozen different pitch levels, into the supersonic (if you go up that high). By sheer accident this past year, 1991, after a lifetime of hermit sound, I *saw* a hermit singing only 10 feet away on a dead tree limb. I could see his throat vibrating as he sang. Very rare sight. But the sound is better.

A further sequel—not so pleasant. All enthusiasm, I took my shining way to the Cornell ornithologists who had been recording birds with a parabolic dish since the earliest audio and issuing them on many 78-rpm discs. Useful, but very false. They put your ears (in mono) about 3 feet from each bird, for an accurate but mostly unrecognizable sound. This is NOT the way we hear birds!

You can guess. My brilliant suggestion of binaural recordings was politely bypassed as of no consequence. To this day, that bird song library continues, as was.

Much later, I somehow got on the subject of binaural with my ever-ready friend Benjamin B. Bauer of CBS Labs. Bauer was testing the once-controversial Concorde jet noise, which had outraged vast numbers of people who lived under its flight path. CBS Labs was commissioned to make exact measurements, in Washington, D.C. and perhaps elsewhere, as the Concorde landed and took off, and Ben, with an accompanying crew, was the measurer. Ha! said I to myself. Why not binaural? The effect of loud sounds is not by any means just a matter of volume and power: It is the subjective impact of the particular noise that counts and can be harmless or devastating. A binaural recording, played respectively to the judges and arbiters as well as to the complainers (to confirm their feelings), could be very helpful. It would sound *as the Concorde sounded* right there on the spot.

Ben was one of those rare people who *listened*, vested interest or no. At my suggestion, he took a two-channel CBS recording team to Washington. I was, frankly, astonished. He understood.

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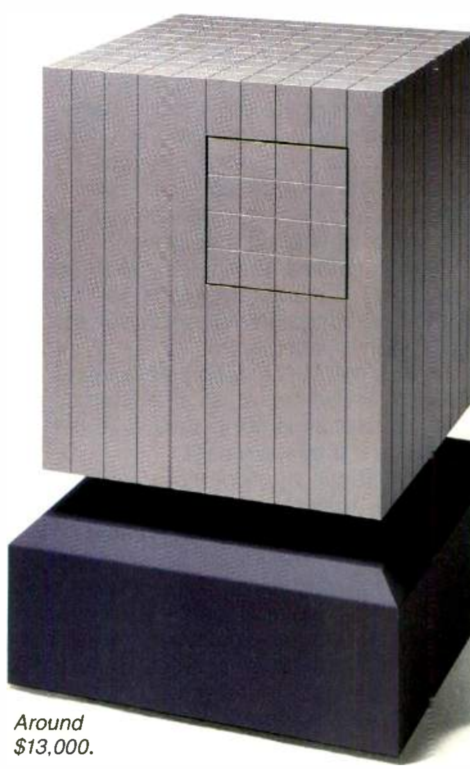

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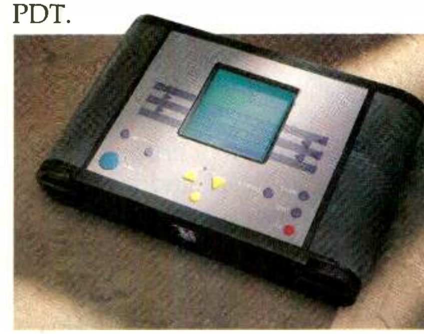

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If you think binaural sound must be startlingly, even *uncannily* different, realistic enough to make your hairs stand on end—you're right.

You can guess once more. The people in Washington unanimously turned down the idea of such a frivolous exercise in un-science. I never even got to hear that recording. But I *know* how it sounded. I've heard the Concorde live, and binaural is indeed like live, whether large or small! In many ways—but not all—it is *literal* in effect.

On the small side again, I shuffled around among piles of tapes, after last month, and found my Thanksgiving "cocktail party" recording, intact and perfect, exactly as recorded on Thanksgiving Day 1960. It was more than I had remembered—1-mil-thin tape with extra tape out to the very rim, a total of more than two hours of party conversation running all the way through the pumpkin pie (that's how I identified which was side two!), with all sorts of turkey sounds en route. I still haven't got through all of it but found a startling bonus on some of the added tape at the beginning, a recording of my brother and his four small children, five to 10 years old, a noisy and good-humored little gang all around me as I listened. Talk about realism! (But not in directionality—merely in *impact*.) The main purport of the dizzy conversation was "Uncle Ed's a zombie!" "No, he's a kunkle." So much for family-type recording. Those kids are now middle-aged, with their own. I will spare them the shock of hearing themselves.

Now for some principles I worked out during binaural recording of the Berkshire Quartet in rehearsal (see my column from last month).

What's the best location for binaural sound? Anywhere at all that sounds okay or useful via living ears. Use the mikes as if they *were* ears.

How about hyperbinaural, wider-than-average separation? I quickly found that hyper does indeed work—up to a point. The maximum distance, at least for my internal computer, was about 3 feet. No intervening head, obviously. At that separation you can still "fuse" the two aural images in your 'phones. A swollen head, but with enhanced spatial impact. Useful if done with care. Beyond 3 feet or so, the two images begin to be heard separately, not as a blend. (This is often true of standard stereo recordings heard through 'phones. Not a great impediment but not an advantage either.)

How close can the mikes be spaced and still produce a binaural, as opposed to a mono, effect? Here I was astonished to find that a definite binaural ambience is audible, as compared to mono, even with mikes virtually touching each other. An inch or so of separation. Switch back and forth from mono to two-channel, and you'll hear for yourself.

This finding should be of considerable interest to all who use variants of the "one-point" or coincident stereo mike technique. Many of these microphone systems already have a small separation built in, as between channels, and are therefore producing a binaural component for those who listen through 'phones. Might this create a misleading spaciousness for the recording engineer-on-location who must be inside his 'phones? The binaural complement will not affect the loudspeaker sound, unless infinitesimally. Hence, I would suggest, a potentially faulty judgment.

What effect is there binaurally, via 'phones, when spaced binaural mikes are set up at the usual stereo-based distance? (The "main" mike or mikes, not counting accent and ambience extras.) You are too close. Much too close. It is as though your seat were on a table 5 feet in front of the players. That may be interesting—it is in binaural—but it is *not* the "best seat in the house"! The rule: Set your binaural microphones where *you* want to sit to enjoy the sound. This is the simplest rule of all and the most difficult for people to understand, including plenty of pros.

A clincher as to realism in binaural: What happens when you walk right between a pair of spaced binaural microphones while talking, singing, making sound (that is, you walk through your own head)? The answer is—nothing. Binaural is NOT literal in many respects! You will merely hear the voice approaching, then receding again. Even with a dummy head, you could walk directly over the microphone/head combo for a similar recording.

We are being realistic, remember, according to the live sound. But two living people cannot walk through each other's heads without serious injury! Maybe it is just as well that binaural is not always literal.

BERT WHYTE

HOME IS WHERE THE HALL IS

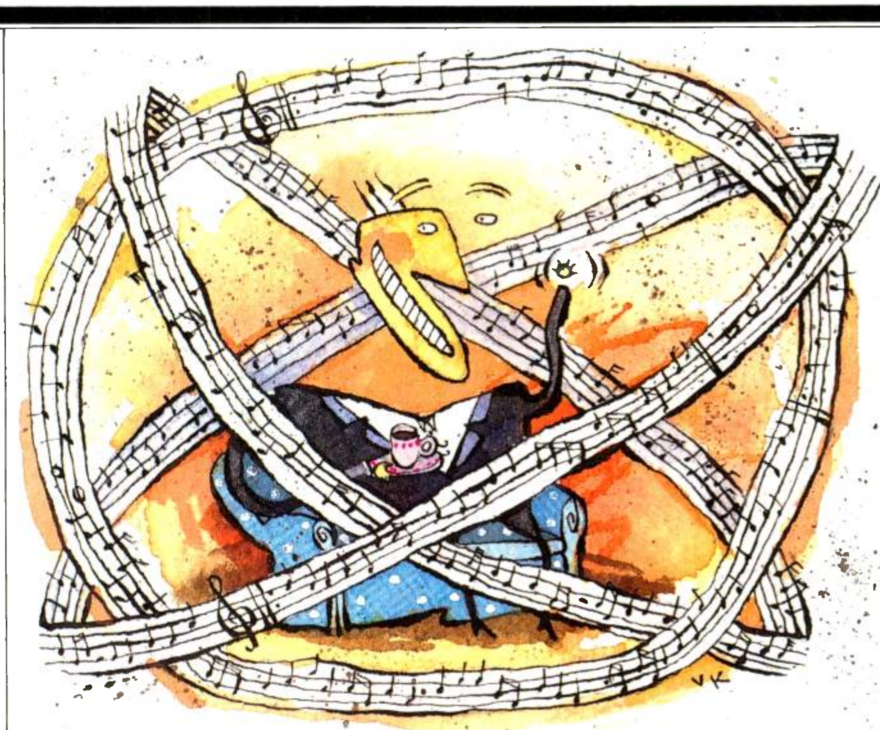


Illustration: Vala Kondo

Early in the stereophonic era, it was recognized that while stereo represented a major advance toward a more realistic approximation of live music, it could not provide the three-dimensional sound field of the concert hall. To simulate the spatial perspectives of music as heard in a concert hall, it was necessary to employ more than two audio channels. Much experimentation was done on multi-channel systems, with loudspeakers placed to the sides and/or rear of the listener. Various delay systems were used to enhance the spatiality of the stereo presentation. The availability of four-channel tape recorders led to recording the front stereo music signals on two of the channels and recording the reverberant ambience of the concert hall on the other two channels. Ultimately, such four-channel recordings were used as masters for SQ and QS matrixed quadraphonic discs and CD-4 LPs (which were discrete, with surround channels modulating an ultrasonic signal). Technical flaws, inherent limitations in the matrix mixes, and the presence of three incompatible quadraphonic systems all helped precipitate a marketing debacle and the early demise of these formats.

As most readers are aware, in the past few years Yamaha, JVC, Sony, Pioneer, Marantz, and other companies have marketed "sound-field" processors. These units, which utilize relatively inexpensive but powerful digital signal processing (DSP) circuits, purport to synthesize the acoustic characteristics of famous concert halls, based on acoustic analyses of these halls. These systems also require side and/or rear speakers. Properly set up and used intelligently, they can be quite effective in reproducing recorded music with a reasonable approximation of the basic acoustic characters of the concert halls selected.

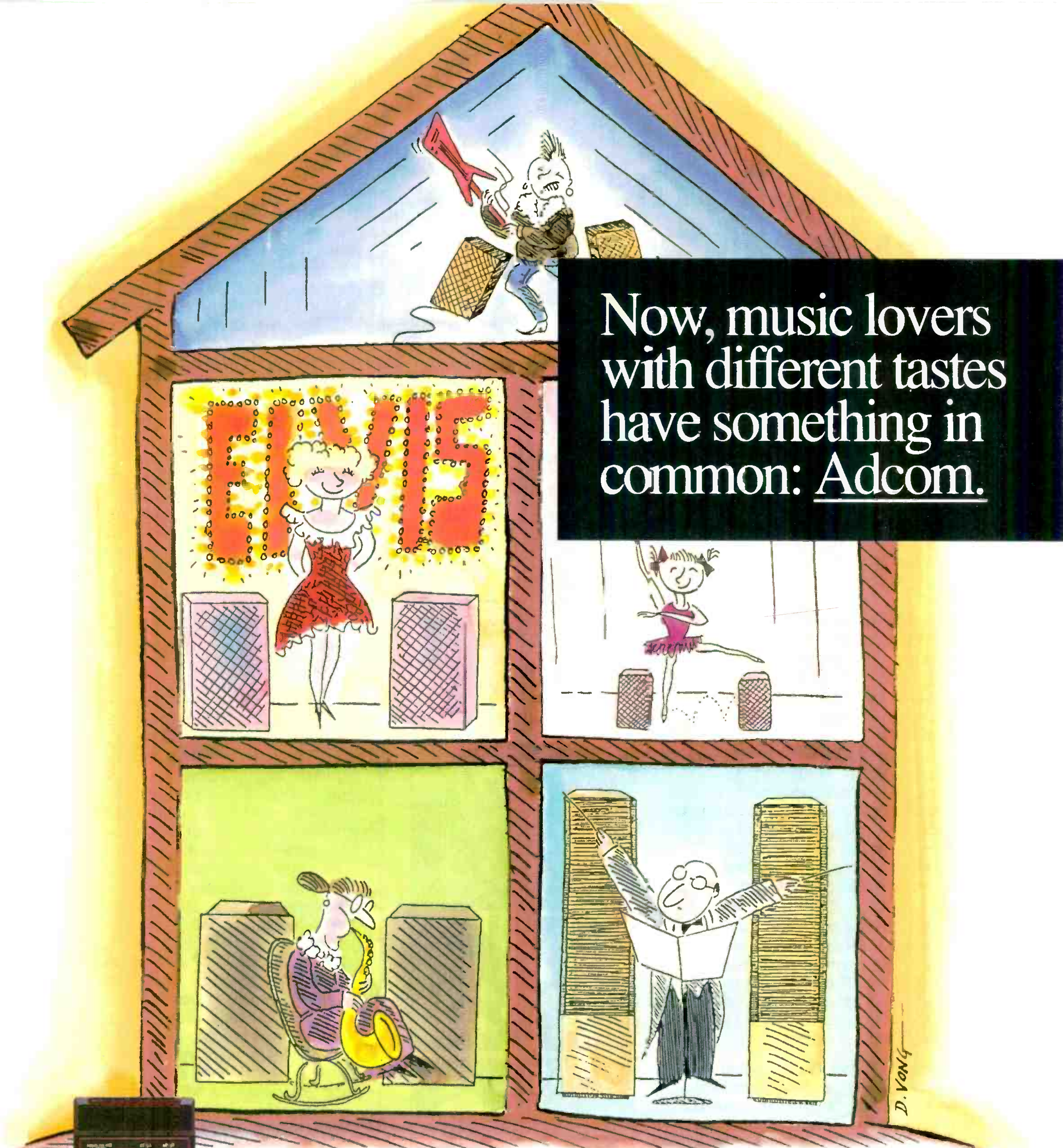
Dolby Surround also requires side and/or rear speakers, and the presence of Dolby Surround systems in so many homes has encouraged manufacturers to produce DSP units for ambience enhancement. It is also the reason for the current revival of Ambisonics, a system which has been dormant for some years. There is no question in my mind, or to those audiophiles and engineers familiar with it, that Ambisonics is by far the premier process for the most accurate and musical recording and reproduction of a live concert's original sound field.

It is now more than 20 years since Ambisonic sound was developed by Peter Fellgett of Reading University and Michael Gerzon of Oxford University in England. Ambisonics is a very ambitious concept, in that it uses the psychoacoustics of human directional hearing to replicate three-dimensional sound. Ambisonics is based on capturing both the acoustic pressure and the directional velocities of sound and uses the amplitude and phase of signals to convey a full 360° spherical sound field. Unlike quadraphonic sound, Ambisonic playback can create completely convincing and accurately localized phantom images between speakers, even between the main and ambience speakers on either side of the room.

In order to record Ambisonic sound, a special single-point microphone was designed by Michael Gerzon and Peter Craven in about 1972. Their Soundfield microphone, manufactured by Calrec Audio of England, has four single-diaphragm cardioid capsules closely spaced in a tetrahedral array within a common housing. The signals from the capsules are processed by addition and subtraction, together with equalization, filtering, and phase correction, to provide four signals that carry directional information from the entire sound field. These are known as "B-format" signals and are designated W, X, Y, and Z. The W signal is an omnidirectional pickup of the total sound field, X is a bidirectional (figure-eight) pickup of front-to-back sound, Y is bidirectional left to right, and Z is bidirectional up and down. A control box for the mike allows panning and steering the B-format signals in both the horizontal and vertical planes, which can be done in real time or later during mixing.

The four signals of the B-format are generally recorded on a four-channel tape machine. The ultimate expression of Ambisonic sound is to play back the four channels of the B-format tape through a decoder that feeds signals to six speakers (front and rear pairs plus speakers mounted in the floor and ceiling). This setup yields "periphonic" sound, reproducing the height as well as the horizontal position of each sound source.

For the consumer version of Ambisonics, on CD, the B-format signals



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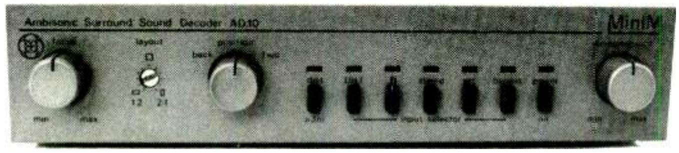
must be encoded to two channels. This is all horizontal surround sound, as there is as yet no provision for the Z (height) signal. The encoding system is called UHJ—"U" for universal, and "HJ" standing for a system developed by the BBC. Once the UHJ-encoded stereo tape is available, it can be transferred to CD in the usual way. Obviously, a UHJ-encoded CD must be played through an appropriate decoder to obtain Ambisonic sound. The Ambisonic decoder's circuitry takes into account some of the psychoacoustic mechanisms of human hearing, particularly in respect to directional information. In essence, the decoder "deceives" the ear/brain system into believing it is receiving a multiplicity of directional information in a smooth arc around the total sound field.

In the Ambisonic decoder, the stereo signal from the UHJ CD feeds a phase amplitude matrix that depends heavily on patented circuitry invented by my good friend (and former president of the Audio Engineering Society) Duane Cooper of the University of Illinois. The signal passes through shaping filters and then into the amplitude matrix. This matrix outputs the four Ambisonic channels, which are then amplified and played back through four speakers in a rectangular layout.

Presently, Minim Electronics of England manufactures the AD7 UHJ Ambisonic decoder at $390 and the more elaborate AD10 for $595. Both models have UHJ and stereo-enhancement decoding as well as controls that adjust the system's output to match the speaker layout used and to adjust the image's width to suit the listener's preferences. The AD10 also has controls to adjust image depth and front-to-rear location, and it can decode B-format. The Minim Ambisonic decoders are sold in the U.S. through Soundings Electrotec (P.O. Box 10004, Seattle, Wash. 98110).

As noted, one of the reasons for the renewed interest in Ambisonic sound is that many Dolby Surround systems with rear speakers are in use. Aware of this, Onkyo obtained a license for Ambisonic decoding from the British patent-holders and has incorporated a UHJ Ambisonic decoder into the new Model TX-SV909PRO receiver. This unit, priced at $1,799, features digital

Minim Model AD10 Ambisonic decoder



Dolby Pro-Logic decoding, DSP, and seven amplifiers. Mitsubishi has also obtained an Ambisonic license and built a digital UHJ Ambisonic decoder into a preamp available in Japan.

Nimbus Records in England has been the chief proponent of UHJ Ambisonic sound. Years ago, they issued UHJ-encoded LPs, which I heard through an early Ambisonic decoder. It worked well enough, but unfortunately I also heard the pop, crackle, and snap of the vinyl surface behind me in the rear channels. This was disconcerting enough to me at the time to negate the benefits of the surround ambience. But now Nimbus has several hundred UHJ-encoded CDs in their catalog, covering a wide variety of classical music. CDs, of course, don't have pop, crackle, or snap.

Recently the enterprising Collins Classics of England issued UHJ-encoded CDs of classical music. However, Collins took advantage of new Ambisonic recording and encoding equipment made by Audio + Design (also of England). This system takes a new approach: It uses elaborate 360° pan pots and a pan-rotate system to handle B-format signals, and it allows the use of independent mono sources in multi-channel recording (in fact, Collins used a 32-channel Mitsubishi digital tape recorder to make masters). This type of setup also permits multi-mike, multi-track Ambisonic recording of pop music.

Audio + Design also makes a professional UHJ Ambisonic decoding unit, imported into the U.S. by Gotham Audio in New York City (well known for importing such pro gear as Neumann microphones). The decoder has all balanced XLR inputs and outputs, so I tried it with the balanced output of a Wadia 2000 D/A converter and then hooked the decoder into the balanced tape loop of an FM Acoustics 266 preamplifier. Once the decoder's layout controls were set, I adjusted front/rear levels and played the Nimbus Ambisonic CD of Haydn's Symphony No. 100, the "Military" (NI 5159)

Thus began one of the most fascinating and stimulating listening experiences I have had in quite a few years. It was positively uncanny to be totally enveloped in the moderately reverberant acoustics of the very Esterházy salon where Haydn heard many of his works performed. There was no question as to the cleanness of the sound—that was to be expected—but the way the system conveyed the hall's spatial qualities, the orchestral balances, and the sense of natural musical timbres was simply stunning. The walls of my listening room just weren't there: I felt as if I were in that gilded salon!

Another Nimbus Ambisonic CD, of Chopin Etudes, Opus 10 and Opus 25 played by Vlado Perlemuter (NI 5095), was magical. What the Ambisonic recording and playback did for solo piano was truly quite amazing; the piano had palpable presence. Bass chords were hugely sonorous, and trills and runs were sparkling cascades of transient energy. Yet when the decoder's defeat switch was engaged, the results were devastating. The whole sound field simply collapsed to the front channels, and the stereo reproduction seemed flat and one-dimensional. Another push of the button, and I was instantly transported back into the performance venue.

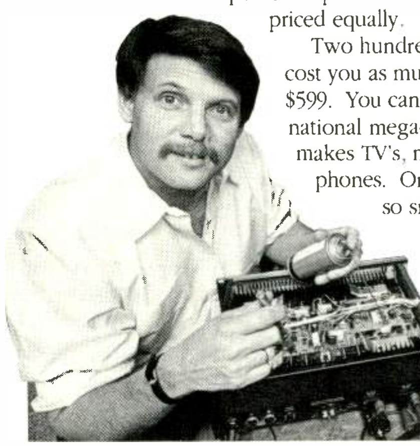
The Collins Classics Ambisonic CD of the London Symphony Brass (COL 12882) was another revelation. A suite of Bernstein's *West Side Story* was newly exciting, with the various trumpets, trombones, and French horns sounding with the brazen, bright qualities you hear from the live instruments. Percussion wasn't just clean transients; I could hear the cymbal clashes, tympani, and snares occupying a clearly localized space in the three-dimensional ambience of London's Barbican Hall. I listened for hours one day and never felt a trace of fatigue.

Best of all, when you play conventional stereo CDs through the UHJ decoder, their acoustic perspective is pleasingly enhanced by the processing of the out-of-phase "difference" information in the original stereo recording. This is a major bonus of the Ambisonic decoders, and the resulting ambience sounds more spacious and convincing to me than the ambience from some digital signal processors' synthesized venues.

Ambisonic sound has been in the wings for a long time. Now, with noise-free rear channels thanks to digital CDs, it may soon take center stage as a paragon of musical verisimilitude! ▲

HOW MUCH SHOULD A GOOD AMPLIFIER COST?

Reflections on the esoteric myths and economic realities of power amplifier design, by Bob Carver.



Thumb through *Audio's* Annual Equipment Directory and you'll see vivid proof that all power amplifiers are neither created equal nor priced equally.

Two hundred watts per channel can cost you as much as $8,400 or as little as $599. You can own an amp from a multi-national mega-manufacturer who also makes TV's, microwaves and cellular phones. Or an amp from a company so small that the designer is also the assembler and shipping clerk.

Can it be that amplifiers are sonically equal? Some seem to have muscular power reserves far beyond their FTC-rated output. Others sound great until they're challenged by a dynamic passage and then sound like a Buick hitting a row of garbage cans. Some are (to indulge in audiophile jargon) so "fluid" that you practically need a drop cloth under them. Others seem to sound harsh, "metallic" and brittle at any output level.

A casual comparison of perceived sound quality versus price tags may lead to an erroneous conclusion: that an amplifier must be *expensive* to sound good.

The truth is a bit more complicated: Cosmetic glitz aside, an amplifier's cost is primarily determined by its power supply.[1] In other words, within reason, you generally do get what you pay for when you buy a conventional amp design. But the key word here is "conventional."

My decidedly *un*-conventional Magnetic Field Power Supply is capable of outperforming conventional power supplies of the same size. Result: A significantly better power amplifier value for you.

Let me explain.

NO MAGIC. JUST FOUR CRITICAL QUANTITATIVE FACTORS.

When I fervently state that "*the sound of an amplifier need not be related to its price,*" you might think we're veering off into the land of Snake Oil and Gimmicks. Quite the contrary.

I and other members of the scientific audio community know that just four factors determine the sonic characteristics of an amplifier:

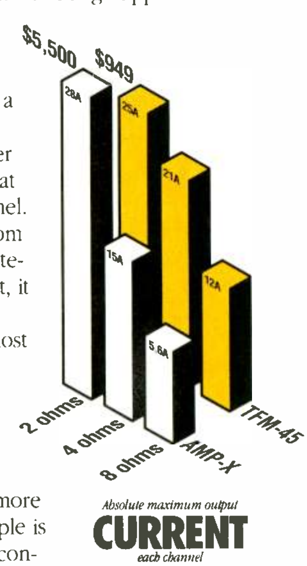
1. Current output
2. Voltage output
3. Power output
4. Transfer function *as evidenced by the interrelationship of frequency response and output impedance.*

These factors transcend the usual trivial debates over tubes vs. solid state, MOS-FETs vs. bi-polar, Class A vs. AB, silver Leitz wiring vs. copper, gold-plated front panels, WonderCaps and my favorite: hand-ground-open transistors filled with a proprietary crystalline substance that stops ringing (honest, I'm not kidding!). An amp can have any combination of these entertaining variables (plus special bricks stacked on top) and yes, sound wonderful...provided it ALSO has high current, voltage and power output and the correct output impedance.

Thus the Four Factors explain why expensive amplifiers generally sound better than cheap amplifiers. But also why that doesn't necessarily have to be the case.

FACTORS 1-3: THE POWER SUPPLY BEHIND THE SOUND

An amplifier's power supply produces current and voltage. A preponderance of one without the other is meaningless.[2] To maximize SIMULTANEOUS current and voltage output using traditional design approaches costs serious money. For example, we recently tested a competitor's $2,000 amplifier that was rated at 20 watts/channel. Believe me, from a parts and materials standpoint, it was worth $2,000, with most of that money being spent on an amazingly rugged power supply. Another more extreme example is my own ultra-conventional Silver Seven Tube amplifier design. Its "money-is-no-object" power supply helps set the price of a pair of S-7's at around $20,000.00.



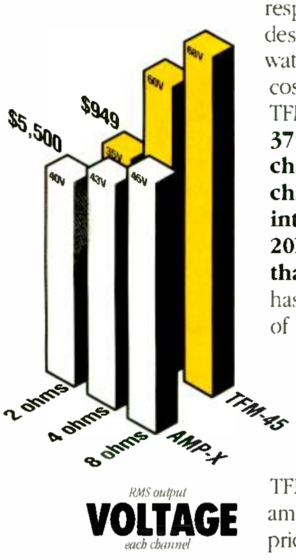
Now, since it is universally agreed among amplifier designers that current/voltage/power output directly affects the sound of an amplifier, and since good traditional power supplies are costly, price and sonic quality ARE often closely related.

But what if there was a way around the economic constraints of conventional, inefficient power supplies? What if there was a power supply that could deliver awesome simultaneous current and voltage into real-world speaker impedances without shocking your pocketbook?

TFM-45; 375 watts RMS/ch. into 8Ω 20-20kHz with no more than 0.5% THD ($949 sugg. retail.)and TFM-15; 100 watts RMS/ch. into 8Ω 20-20kHz with no more than 0.1% THD ($399 suggested retail).

That's just what my patented Magnetic Field Power Supply does. Without gimmicks, mysticism or loss of bass response. Simply put, a Magnetic Field Power Supply uses progressively more of each line voltage swing as amplifier power demand increases. It's just plain more efficient. How and why this works is explained in our new White Paper called *"The Magnetic Field Story Parts I, II & III"* which you can get free by calling 1-800-443-CAVR.

Right now, let's consider the tangible benefits. The series of comparison charts in this ad shows how my Magnetic Field Power Supply successfully challenges the previously hard-and-fast rule that high-performance power supplies must be expensive. Amp X is a highly-respected solid state design rated at 200 watts into 8 ohms. It cost $5,500. My TFM-45 is rated at **375 watts per channel both channels driven into 8 ohms 20-20KHz with less than 0.1% THD.** It has a suggested retail of $949.



Even more impressive is this same sort of comparison chart with the TFM-45 vs. other amplifiers in its own price range. In deference to how utterly we trounce similarly-priced, conventional competition, we've confined those charts to our new White Paper.

To summarize: Magnetic Field Power Supply technology allows reasonably-priced power amplifier designs to deliver simultaneous current and voltage levels previously only found in extremely expensive "esoteric" designs. Or to look at it another way, in a given price range (say $900-$1,000), Carver simply gives you far more for your money.

FACTOR 4: TRANSFER FUNCTION

Consider two hypothetical amplifiers with identical power supplies. Same power rating; same gain, etc. Yet they still sound different when powering identical speakers through identical cables.

Why? A fourth quantifiable factor is at work. One that, unlike power supply output, is totally independent of economic constraints.

I've left Factor 4 (transfer function/frequency response/damping) until last intentionally. Because until an amplifier can deliver sufficient power with simultaneous current and voltage (Factors 1-3), transfer function is immaterial.

Amplifier with resistor test load

Same amplifier connected to cables and loudspeaker.

Frankly, I'm guilty of not making this fully clear in the past. Some readers may have gotten the impression that by magically adjusting some arcane parameter called transfer function, one could somehow cause a cheap amp to sound like an expensive one. Nothing could be further from the truth. If there's no guts (power supply), there's no glory (optimized transfer function).

By transfer function, I mean the effect an amplifier's output impedance has on real world frequency response. I don't mean the flat, "DC to light" Rated Full Power Bandwidth found in column 11 of *Audio's* Equipment Directory, which is measured using a resistor as a load. Rather, I'm referring to the frequency response curve that occurs when an amplifier and speaker cables interact with a specific speaker.

As distinctive as a fingerprint, this curve determines the "sound" of each amplifier design. Its warmth or harshness. The quality of the bass. The definition of its upper registers. Even the configuration of the stereo "sound stage" it can create.

My engineering department and I are capable of making one amplifier design sound like another amplifier design to within 99 parts out of 100 (a null of 40dB). For example, we've used Transfer Function Calibration to closely emulate the sonic characteristics of my reference Silver Seven in our TFM-45 and TFM-42 solid state designs. In other cases we've used the process to simply adjust the sound of an amplifier to have pleasant but unique sonic characteristics: in general, a warm "tube" sound with rich, rolling bass and soft yet detailed treble (such as our TFM-22/25 , S-7t and TFM-15). Either way, we use painstaking measurement and adjustment processes to finetune output impedance/frequency response. Not magic.

And, needless to say, we start with highly capable power amplifier designs before the Transfer Function Modification process.

ARE YOU INTRIGUED...OR THREATENED?

My Transfer Function Calibrated power amplifiers have suggested retail prices of from $399 to $1,000. That I even dare to suggest they can sound as good as designs in the $2,000 to $6,000 price range has not endeared me with some audiophiles or underground magazine writers.

That's a real shame, because I have absolutely nothing but respect for well-made, high-ticket conventional amplifiers. Like Rolexes and Lamborghini's, they are a joy to own if you can afford them. But just as a Rolex doesn't tell time any better than the inexpensive watch I'm wearing right now, good sound does not necessarily have to be costly.

If this concept intrigues you, please visit a Carver dealer soon. Bring demo material you're familiar with and be willing to do some critical listening. Compare my designs to competition costing about the same amount as well as to more expensive models.

Your ears alone should be the final arbiter. I feel confident that you will join the tens of thousands of audiophiles who have gotten the best possible value by owning Carver.

Bob Carver

Bob Carver, President

CARVER

CARVER CORP., LYNNWOOD, WA, U.S.A. 1-800-443-CAVR
Distributed in Canada by Evolution Audio Inc. 1-(416) 847-8888

1 My definition of cosmetic glitz is any part of an amplifier whose sole audio contribution is to cause one's friends to go, "Ooooo!!" when they see one's new purchase. My own Silver Seven amplifier's hand-rubbed piano lacquer and solid granite surfaces meet this definition.

2 Since power (watts) equals voltage times current, the same wattage can represent significantly different combinations of voltage and current — and thus very different performance into the same load.

JOHN EARGLE

DATA TO THE MASSES

Illustration: Beata Szpura

A seminar on data reduction was held at the Audio Engineering Society's convention in New York last October. Ken Pohlmann chaired the seminar, which included comments from various system developers, recorded examples of the various systems, and general comments. I was a panel member and, as such, represented the community of recording engineers. My comments, in question and answer form, are presented in this month's column.

What are the commercial and economic requirements of a given data-reduction system? What is the primary application, when will it be on line, and what degree of data reduction is required?

Most of the proposed systems are vying for broadcast acceptance and use in program distribution systems where channel capacity is already overcrowded. There is only room for so many geosynchronous satellites, and in not too many years all available information capacity will be used up. There is a clear need for data reduction. For speech, the requirements may be minimal, but for music, great care has to be exercised in certifying a system or hierarchy of systems.

The Philips and Sony proposals for DCC and Mini Disc, respectively, are based on data reduction, but they may be considered, in some respects, as closed systems in that the user will normally access them via their analog inputs and outputs. The quality requirements are set by the company to satisfy an established standard for the nonprofessional user. A typical question that may be asked is: Will the DCC meet or exceed the established subjective standards for Dolby B or Dolby S cassettes? Only Philips can answer that question at this point.

Most of the proposed systems have as a target a four-to-one reduction in data. Some systems have been demonstrated that have greater data reduction, but they are generally relegated to speech applications.

How are psychoacoustical guidelines developed?

Most seminar participants agreed that psychoacoustics must be "virtually reinvented" if it is to be useful in evaluating proposed data-reduction systems. The vast bulk of published data on masking, for example, dates from the 1930s and was based largely on sine-wave and noise signals. Today there are wider bandwidth systems, better transducers, and new kinds of music. Engineers are also more sophisticated and can bring better measurement instruments to bear on the problem. They are also probably better able to identify specific population groups who may be more attuned to specific problems in a given data-reduction algorithm.

Whose ears are to be trusted? Should a system be designed for "nonaudibility" for a general population or for a specialized population?

There is no doubt that the engineers who work on data-reduction systems will be able to hear relatively small artifacts arising from a given algorithm. After all, they know what to listen for. The big question is, how will the artifact sound to groups oriented more toward music or music recording? Remember the CBS Copy-code affair of a few years ago? Recording engineers as a group were more sensitive to the effect of the proposed notch in the range from 3 to 4 kHz and were very much against it.

Can an algorithm be subjected to impartial scrutiny before it is released? If not, why not?

A big problem in the data-reduction game has been the general unavailability of working details of the various algorithms (although this situation has improved somewhat in recent months). Basically, most of the developers have patent positions they are trying to protect, so it may not be in their best interests to tip their hand. It is almost inevitable that the Achilles' heel of any algorithm will be discovered in time, given enough people listening to and playing with a given system. I think there is agreement that it is better to discover any problems earlier rather than later.

What is the impact of cost on the development of a system? Who determines cost/performance trade-offs?

It stands to reason that a more complex data-reduction system will perform better than one of relatively little complexity, in that it will be able to accommodate more types of signals more effectively. But an expensive system may not be acceptable in the mass marketplace. Therefore, somebody must be responsible for determining an operating point along the cost/performance scale. Are these decisions always made in good conscience? And whose conscience is it, anyway?

Psychoacoustics must be almost reinvented to be useful in evaluating any data-reduction systems.

What are the regulatory aspects of data-reduction systems?

For DCC and Mini Disc, we can assume that there are no regulatory aspects. But for broadcast applications, there are numerous regulatory organizations to be satisfied. The FCC in the United States and the European Broadcast Union (EBU) come to mind. Then there are the various state-run broadcast groups around the world, many of whom have come up with specific broadcast proposals.

What may be the biggest concern is the timetable that these organizations will impose on development, testing, and approval cycles. Will the necessary development work have been done by the time an approved system is to go on line? How much work can be done later to "clean up" a marginal system after it has been accepted? Remember past experiences in the approval of broadcast transmission systems in which the best systems were not always the winners.

What are the effects of cascading various systems?

Assume that there is a broadcast standard for data reduction and that a DCC recording is being transmitted. A listener at home wishes to record the program via a DCC recorder. What is the net data reduction when the listener replays the tape? This is a pertinent question, and one not easily answered. It is quite conceivable that a signal-related problem that was unnoticeable in any one of the segments of the chain could become quite obvious in the complex situation just described. Protocols will need to be developed early on that will identify, and possibly correct, any transmission problems.

What about the possibilities of improving transmission standards with the industry working toward agreement on a digital standard?

Even within the development framework of data reduction, there may be some aspects of radio performance whose basic standards can be improved. For example, FM stereo transmission is normally limited to 15 kHz at the high end because of possible problems of interchannel interference. These problems do not exist as such in digital transmission, and improvements can potentially be made. Certainly there will be improvements in dynamic range and freedom from multipath distortion, and it would be appropriate to include extended bandwidth as well.

What about future requirements? How crowded are communications channels today, and how crowded will they be in the future?

The major concern here is that a data-reduction system that will be adequate for the next 10 years or so will become inadequate by the year 2020. I would hope that by that time the world will be "wired" via fiber optics to such a point that there will no longer be any need to worry! ▲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HOME THEATER

A Pro's Way

Wynne Smith

home theater should incorporate superlative audio with state-of-the-art video in a comfortable setting. Unfortunately, if the design is improper, the result is usually nothing more than a loud and expensive system.

Stosh Silver, a 20-year veteran of the audio business, and his wife, Stanzi, recently decided that it was time for a home theater. "Our choices were to sell our house or put on an addition," Silver said. Their house, a quaint farmhouse located on nearly 20 acres in a rural

Photographs: Robert Lewis

section of upstate New York, was nearly paid for, extremely private, and the place they considered home. The Silvers opted for an addition.

All too often, once the decision is made to create a home theater, many people decide that they can do it themselves. Relying on the plethora of information available concerning surround sound, acoustical imaging, projection systems, and design, do-it-yourselfers believe it is only a question of assimilating information and shopping at the discount store.

According to Silver, this misconception can be the road to financial heartache. "Originally, the idea was that because my background is audio, I would design this killer home entertainment system," he said. "After all, I'm in the biz. First, Stanzi and I came to the conclusion that to do it properly we'd have to add on to the original house, but when we interviewed a number of construction firms, we found that none of the guys had a clue about acoustical design. Everyone understood our wish to maintain the integrity of the structural design, but no one understood the acoustical angle.

"The more involved we became, the more we realized that people are out there spending a lot of money for home theaters, relying on what they read, and trying to interpret it into their own design without understanding how it really works. It's pretty scary. I won't tell you how much we spent on the addition, but figure an average home entertainment system, audio and video, will cost upwards of $10,000. That's just the equipment; add the cost of an addition, and even one mistake can mean a real financial disaster. On the plus side, that's much less than a swimming pool or camper, and we can use it every single day of the year."

The addition, a post-and-beam structure, was purchased from Timberpeg. Its exterior closely follows the form and design of the original house. The home theater portion of the addition measures 16 feet × 20 feet, with a 9/12-pitch roof that makes the ceiling 15 feet high at its center point. Of course, dimensions for home theaters will vary according to the owner's personal preferences when an addition is being designed for this purpose, or if an existing room is being redesigned for use as a home theater.

Craig Fennessey, president of CSE Audio, the acoustical consultants for the job, explained, "When you walk into a room like Stosh and Stanzi's, you immediately take into consideration the cubic volume of the room and the location of the windows and doors. You explain the need to keep the seating all in one area for symmetry. We use a software program, Acousti-calc, that allows us to input information about the room and create a computer model of the acoustical environment. This can be done to any room, even prior to its construction. We can change wall surfaces, add furniture, add people, allow for window drapes (open or closed), and see a graph of the results within seconds. This ability to forecast helps us to avoid potential problems. The computer tells us if the room is potentially too live or if the room is too dead—a very uncomfortable environment for the audience. Based on our research, we can then assist the owner in sourcing materials that will give the room a reverberation time of a half second or less.

"In the Silvers' case, we saw a huge peak at 1 kHz on the plotted curve, which would color the sound of the room, making it very unnatural. We knew immediately that we would have to soften the walls or do something drastic to correct this. The plans called for the room to use painted drywall for all four walls. I suggested to Stosh that something needed to be done to soften the effect of the drywall. Stosh said, *Do-it-yourselfers building a home theater think they just need information and a discount store—an often costly misconception.*

'No problem,' and opted to use natural white pine panelling. The Silvers actually saved money because drywall is more expensive than white pine. The curve flattened out."

The white pine panelling was selected due to its porous nature, its sound absorption and diffusion of high frequencies, and its ability to transmit low frequencies. The Silvers chose a deep-pile carpet with thick padding to assist in deadening the sound in the room, and the windows are covered with draperies of extremely heavy fabric, also to absorb sound when necessary. The drapes have a blackout lining so that the room can be made pitch black for movie viewing during daylight hours; blackout linings are critical with front-projection video. Windows with drapes closed across them won't reflect any of the sound patterns that might destroy the effect of the surround system. Shutters, blinds, or lighter fabric draperies would not accomplish this. The back wall is convex to diffuse the acoustics, and the front cabinetry was built to absorb and diffuse sound. The goal was to create a reflection-free zone within the listening area for the left, center, and right speakers and at the same time have the surround speakers envelop the listening area with a uniform, diffuse sound field—just like a commercial THX movie theater.

"Finding an architect and a builder who understood acoustics and the ins and outs of home theater design was crucial," explained Silver. "Just the little tips, such as that you should never indicate that the room is a 'home theater' on the blueprints. 'Home theater' sets off all sorts of bells and buzzers at planning board meetings; it raises

Top left: Beginnings of the post-and-beam construction. The hatch goes to a new cellar beneath the media room. Top right: Nearing completion of the shell. Left: The addition was designed to blend with the architecture of the house.

Before you commit to using a contractor, determine that he has a successful track record working with acoustical design.

questions as to whether you're going to be charging admission and using the addition as an income-producing enterprise. Our architect knew this and suggested the addition be referred to as a 'great room' or a 'den.' It describes the function of the room accurately, and in our case we obtained approval from the planning board within three weeks."

"Find a firm that specializes in custom home audio and video design and installation," Silver continued. "You may not be putting an addition onto your home, but in some cases, for an hourly fee, many of these firms will work with you to select the best possible equipment for your application."

The Custom Electronic Design and Installation Association (CEDIA) can offer a list of custom installers and designers. (They can be reached at 800-CEDIA30.) According to Bud Rebedeau of CEDIA, there are no totally complete handbooks or how-to manuals for consumers deciding to create home entertainment centers; however, by employing bona fide custom designers and installers, consumers will avoid serious and expensive errors.

"I cannot stress enough the importance of seeing examples of prior efforts when you're lining up contractors for this type of job," cautioned Fennessey. "Make sure you're working with a firm that has a bona fide location, a storefront, an office, a showroom. Find out how long the contractor has been in business, whether he's licensed, and if he has liability insurance. What if his assistant puts a screwdriver through your Picasso? There are people out there—we call them 'the guys in blue vans'—who drive around and offer you bargain basement pricing,

Top left: Rear of the listening room, near completion. Placing the equipment niche at this end keeps its lights and dials from distracting listeners and viewers, and the white pine panelling prevents some acoustic problems (see text). Note the placement of the surround speakers. Top right: The viewing end of the room, under construction. Note the curved cabinet for the speakers, with JBL 4350 Studio Monitors (used as subwoofers) already in place. Left: Removing the room-wide speaker grille reveals the JBL speakers, Snell Multimedia LCR-500s for the front three channels, and absorbent material between them to prevent undesired reflections.

but the first time something goes wrong, where's the support? Ask to see completed jobs, or speak with customers the contractor has worked for in the past. Only after you have determined that a contractor has a successful track record with acoustical design should you commit to working with him.

"On larger systems, where equipment is located in many different parts of the room or house, special attention needs to be paid to the a.c. wiring The acoustical design contractor and electrician need to work closely. If the audio and/or electrical systems are incorrectly or incompatibly wired (or both), it will cause ground loops between different components. The result? Hum and buzz! Additional interference may be caused by light dimmers, fluorescent lights, or refrigerators switching on and off. My firm, CSE Audio, works hand in hand with clients and with the clients' contractors to help prevent problems of this nature. These problems can also be very costly to repair once a system is in place."

Stosh and Stanzi Silver had various reasons for choosing particular components. "Looking at this from a practical standpoint, money was a consideration," Stosh said. "So if we had something that worked well, such as our Thorens turntable, we incorporated it into the system. Because we wanted a larger-than-life theater experience, we went for a projection TV—certainly more of an expense, but it was worth it to us to spend a little extra money on this area."

According to Fennessey, "Once people decide on a home theater, they have three basic choices for the visual portion. Regular, direct-view TV sets can be viewed in either bright daylight or complete darkness, but there is a limitation in tube size. The largest tube in this category is approximately 35 inches. Rear-screen projection sets have up to 70-inch screens and can be viewed in even a reasonably brightly lit room. [Philips offers a UL-listed Wallvision set that can be installed directly in the wall, taking up very little space.] Front-projection TV offers the largest picture, but the room must be very dark for proper viewing. We discuss each option in detail with customers and assist them in determining which is best suited to their room and their viewing patterns."

For the Silvers, outstanding sound was also crucial. "We knew we wanted the real thing: A movie sound system. THX Home Cinema was the only choice. By using THX-licensed processors and speakers along with their room design criteria, we achieved a sound system that rivals a commercial THX theater's—right down to calibrated audio levels.

"THX design criteria don't sacrifice music playback quality either. With the Lexicon CP-3 surround processor, you can use its sound-field modes to create three-dimensional spaces. Imagine your favorite music being performed in an excellent-sounding concert venue. It's just incredible.

"We also wanted our system to be easy to use—one remote, one button to turn the whole system on and off. Believe it or not, that can be one of the most difficult things to design. We wanted the equipment out of sight, didn't want a lot of blinking lights flashing on and off next to the screen, so the room was designed with the equipment racks located behind us. The Videolink infrared remote repeater system allows us to point the remote at the front of our room and operate the gear in the back of the room."

Stosh Silver said, grinning, "Because I was in the business, I knew what was involved. That's why I used professional audio/video consultants and installers. It's actually cheaper to get it right the first time, and it's definitely far more enjoyable."

CEDAR noise reduction

Beth C. Fishkind

The digital revolution cut through the audio field with a double-edged sword. On one side, the Compact Disc provided a wide dynamic range and a silence-is-golden backdrop to the music. On the other side, these benefits exposed a great deal of noise on some old recordings remastered for CD. Pop, click, hiss, hum, buzz, and other manner of onomatopoeic characters swelled the ranks of foes that remastering engineers and producers battle.

But if digital technology caused problems, it's proving it can solve them too. Since the late 1980s, digital signal processing (DSP) techniques have enabled engineers and producers to restore old analog recordings that would otherwise be unlistenable. The first system to gain wide acceptance was NoNoise from San Francisco-based Sonic Solutions (see "Putting the Byte on Noise," March '89). Using high-speed computers, sophisticated DSP software, and an assist from a helping human hand, NoNoise removes sonic imperfections on media ranging from old recordings to film soundtracks. Some of the recordings processed with NoNoise include The Doors' *Live at Hollywood Bowl* (Elektra 60741-2), Andrés Segovia's *The Segovia Collection, Vols. 2 and 3* (MCA Classics MCAD-42067 and MCAD-42069), and Louis Armstrong's *Pops: The 1940s Small-Band Sides* (Bluebird 6378-2-RB).

Challenging NoNoise's dominance is a newer system called Computer Enhanced Digital Audio Restoration, or CEDAR, from CEDAR Audio Ltd. in Cambridge, England. Though the NoNoise and CEDAR setups are similar, CEDAR's developers say their system features a more advanced generation of DSP that makes it more effective as well as quicker and easier to use. CEDAR has been fast gaining acceptance since the technology became available in 1989, initially as a remote studio to which clients would send work, then as an in-house system.

Hundreds of recordings have been processed with CEDAR. Sony Music has used the system for many titles in its Roots 'n' Blues and Jazz Legacy series. BMG uses CEDAR for various reissues on Bluebird and RCA as well as for a lot of outside work, such as the Glenn Miller disc in Time-Life's Big Band series and reissues of Bing Crosby and Frank Sinatra through *Reader's Digest*. PolyGram has also used CE-

getting the grain out

Photograph: Wendy Braun, ©1992

DAR to clean up a number of Eric Clapton tracks.

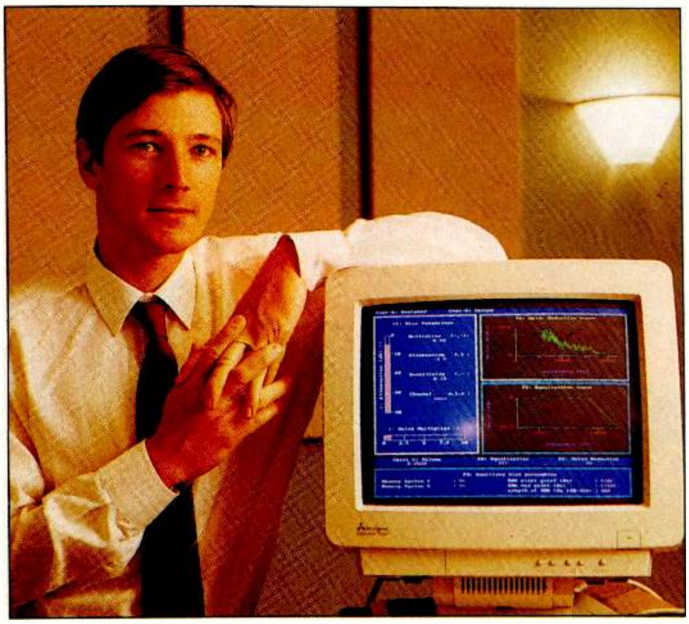
CEDAR operates entirely in the digital domain, so first the source recording must be transferred to a digital recording system, such as the Sony 1630. Then, a unit made by Harmonia Mundi Acustica, for example, converts the source to the AES/EBU digital signal that CEDAR requires for "talking" to the Sony or other recorder.

With the source prepared, CEDAR begins the first step to reduce noise: De-clicking. Here, a module in the CEDAR system removes clicks, pops, and other big impulsive noises. Because the system operates in real time, the signal passes through the module as if going through a compressor, reverb box, or some other piece of outboard gear, with instantaneous results. An upgraded version of the de-clicking module, introduced at the AES convention last fall in New York, checks the source up to four times for sonic imperfections—still in real time.

When this layer of coarse noise is gone, an underlying layer of crackle is often revealed. This is subjected to de-crackling, distinguished from de-clicking because the two types of noise aren't the same, according to Gordon Reid, general manager for CEDAR Audio. "If you put a waveform on the computer screen," he explains, "you can see the clicks [of the first layer of noise] very obviously—the little spikes and so forth—but crackle is completely invisible to the human eye." Because this layer is so difficult to detect, de-crackling involves a two-step process, performed by a separate module called a splitter/recombiner. First, the source is split into two—signal without noise versus all the noise and a tiny portion of signal. Only the latter half, noise with a bit of signal, is treated before the two sections are recombined.

The source is split as a precaution against mistaking a high-frequency transient for a tick of noise, since de-crackling involves adjusting the CEDAR system's sensitivity to magnify as many ticks as possible. For instance, the waveform of a screech trumpet, popular in jazz back in the '20s and '30s, could easily be mistaken for that of a series of little ticks, notes Jerry Graham, eastern sales manager at Gotham Audio in Manhattan, CEDAR Audio's U.S. sales agent.

After de-clicking and de-crackling, what's next is de-noising, the removal of such broadband noise as hiss, hum, and buzz. This first requires identifying whether the type of noise to be removed is from room rumble, tape hiss, media deterioration of a 78-rpm recording, or some other problem. Then CEDAR takes a sample (about 1/40th of a second) of the noise minus the signal, e.g., before the music begins or during a pause. This sample is captured in a noise-reduction curve (NRC), which is then viewed in a spectral display to see where music is—or, rather, isn't. The NRC is then modified to process or eliminate unwanted sounds between any two particular frequencies, or wherever else the user wishes. When a sample isn't available, the user can define and create an NRC based on prior experience.



The CEDAR system lives in a personal computer, as demonstrated here by Keith Millar, who is a development engineer for CEDAR Audio.

To tackle other problems, CEDAR also features a 512-node equalizer, which combines all manner of equalization, including parametric, graphic, bandpass, and band reject. The EQ can be used with the de-noising module or as a stand-alone. When used on its own for cutting frequencies, it operates similarly to a typical EQ: It cuts back the noise and the signal equally, which is the desired effect. For boosting frequencies, however, Reid points out that CEDAR's EQ provides "noise-free equalization," which boosts just the signal, not the noise.

"This doesn't mean that the equalizer doesn't introduce extra noise," Reid qualifies. "It means that if you've got a noise envelope you want to maintain for realism or whatever, and you want to boost part of the signal, you can do that without creating enormous noise levels, because CEDAR boosts only the signal portion of the overall source recording."

The full CEDAR system lives in an IBM-compatible personal computer. However, CEDAR Audio, in conjunction with Harmonia Mundi Acustica (HMA) and Daniel Weiss Engineering of Switzerland, has developed a real-time de-clicking unit for use with the HMA Model bw102 system. Two CEDAR/HMA units are needed for stereo operation. An independent, fully-automated rack-mount version is also planned.

The CEDAR/HMA unit, which made its debut in January '91, was a world first. But last summer, Sonic Solutions not only bowed its own real-time de-clicking option for its NoNoise system

Photographs: Dave King

but also beat out CEDAR Audio in offering a real-time de-crackling module. Sonic Solutions says its new algorithm eliminates both clicks and the leftover crackle in just one pass. CEDAR Audio introduced its real-time de-crackling module last fall. Thus, CEDAR and NoNoise are neck and neck in an ongoing race for advancements in eliminating noise. "Whatever X does, Y tries to implement as best they can," says Gotham Audio's Graham.

CEDAR

Despite offering the same end result of removing sonic impurities, CEDAR and NoNoise are actually conceptually different, Reid explains. NoNoise is an expansion of Sonic Solutions' editor, he points out, and less than 25% of Sonic Solutions' equipment marketed actually has NoNoise. On the other hand, CEDAR Audio's primary intention—its focus of research and development—has always been noise removal. Yet in response to customer requests, CEDAR Audio is working on an editor that will, in its final incarnation, have both full EQ and SMPTE control of all the CEDAR modules. The editor was expected to be available early this year.

> ***The de-clicking step removes big pops, de-crackling attacks the very fine layer underneath them, and de-noising goes after broadband hiss.***

Other CEDAR add-ons in development are a sampling-rate converter, a one-pass real-time compilation or assembly editor (as opposed to a waveform editor), and a real-time fast Fourier transform (FFT) in two or three dimensions with color and a resolution of 8,192 points (compared with the usual 500 or 1,000 points). CEDAR Audio says the FFT—more powerful than a spectral display—enables users to see which parts of the signal are music and which are noise, and it can show the effects of EQ on real music, not just on sine waves. A stereo phase-corrector module is also on the way, able to correct imperfections caused by recording-head misalignment. When used with mono recordings on vinyl, the phase-corrector module will also help engineers and producers determine the less noisy groove wall from which to take the source.

The NoNoise and CEDAR systems do pretty much the same thing in the same sequence: De-clicking, de-crackling, de-noising. Used with proper skill, the two systems can produce equally good results. The differences lie in *how* each system performs these tasks—and in the degree of difficulty for the system operator. CEDAR's developers do not want to force a recording engineer into becoming a computer engineer. "We want somebody who understands a compressor, a chorus unit, or something like that to be able to operate CEDAR without any great difficulty," Reid says.

CEDAR has a "point and shoot" friendliness because of AT&T's DSP32C chip, a high-throughput screamer straight from Bell Labs. (The DSP32C is also used in Patriot missiles, famous in the Gulf War for intercepting Iraqi SCUDs.) The chip operates special algorithms that snare the sonic imperfections around the signal waveform in a manner different from the NoNoise technique, providing better detection of pops and ticks and actually automating the removal process, claims Keith Millar, a development engineer for CEDAR Audio. These algorithms were originally developed in a Cambridge University engineering lab, whose main professor, Peter Raynor, is director of CEDAR Audio. The lab continues to advise the company on scratch algorithms.

CEDAR and NoNoise also differ in the removal of broadband noise. NoNoise takes a noise profile, or "fingerprint," that remains constant, whereas CEDAR continuously adapts to changes in noise. "The fingerprinting method is absolutely super for some material, a total disaster for others, and every shade in between," Reid says. He explains that a noise fingerprint works beautifully for light hiss on a modern master tape from the '50s or '60s, where tape hiss is fairly constant, but the method falls short on something like a 78 or a very early tape. "The very thing that makes noise *noise* is that it is spastic—a random statistical process," Reid notes. And the fingerprint is only truly accurate at the exact moment it was taken. "A hundredth of a second later—let alone a hundred seconds later—it's wrong," he says. "It's kind of, sort of, right on the average, but it's wrong." The result is that at some frequencies, not enough noise is taken away; at other frequencies, too much noise is removed. "And what happens when you take away too much noise is, of course, you start eating into the signal."

So how does CEDAR prevent this problem? Its method is to recalculate how much noise needs to be removed on a moment-by-moment basis. First, the user defines the parameters of the noise. Then, 44 times per second, CEDAR recalculates that profile. "We've given the system the ability to track the noise within certain limits," Reid says. "Though, if you make the limits too wide, it can do some fairly wild things."

These "fairly wild things" are the side effects of overprocessing and the reason why CEDAR—like NoNoise—requires operator skill during the de-noising stage. "What the computer can do is this constant updating and judgment of what the noise is, but what proportion of that to take away is still very much a question for a skilled audio engineer," Reid says. "But, of course, being real time, it's just like sitting at a mixing desk." If things don't sound right, all the operator needs to do is move the slider up and down until it's right; everything else is done by the computer. By manipulating two thermometer-style bar-graph controls, Reid explains, the CEDAR operator can create the conditions for removing the noise without damaging the signal. But CEDAR Audio's engineers haven't been able to devise a way to get the computer to judge how much noise should be removed.

Overprocessing with NoNoise can produce what some describe as a "pumping" sound. Though CEDAR avoids that, it does have its idiosyncrasies, according to Paul Brizzi, a BMG recording engineer. "You can't say it's overprocessed," he explains, "but you can't say it's real. Voices will start to sound disembodied and mechanical." He also notes that the CEDAR computer can introduce low-frequency artifacts as a result of overprocessing. Another side effect is "twittering," which he perceives as noise reduction reacting with the source.

"The real test," Brizzi says, "is to get rid of hiss without having all that happen. What has to be done is to continue tailoring the NRC and use the threshold controls too." The trick lies in the NRC's overall shape: A shape that works will match the signal, not the noise, with voice in particular being "devilishly hard to achieve," Brizzi adds. Experience and finesse help counter this challenge.

To avoid the side effects of overprocessing and retain the ambience of the original recording, many engineers and producers favor leaving a little noise in. Paul Goodman, a veteran engineer with BMG and a three-time Grammy winner, notes that because he works with a lot of very old sources that are fairly noisy and ticky, such as big band recordings and metal masters, he doesn't expect the end result to be completely clean. "I don't want the music touched, so I'll accept a bit of noise," he says. "As long as the big thumps and grotzl are out."

Larry Cohn, producer of the Roots 'n' Blues series for Sony Music, says he runs virtually everything he does through CEDAR. "It's absolutely top-notch at de-clicking," he says. However, he doesn't find CEDAR effective for removing "swoosh" and abrasive noises from metal masters. "Maybe no system can do this?" he asks.

Cohn attributes some of his dissatisfaction to having had early work done by CEDAR Audio at its Cambridge studio. "The work needs our sensibility, not theirs," he says, underscoring the importance of the producer's role. "For things such as [correcting] low-end rumble, we really have to do that." Last summer, Sony Music purchased the de-clicking and de-crackling modules of the CEDAR system for in-house use. Cohn is optimistic enough to predict that he'll see a 50% improvement in results.

CEDAR developers stress ease of use; they do not want to force a recording engineer like Sony Music's Larry Keyes into becoming a computer engineer.

Sony Music engineer Mark Wilder adds that while testing CEDAR's de-noising module, he and his colleagues detected some signal loss, which is why Sony initially didn't buy that portion of the system. However, he says Sony is now making the purchase owing to client pressure and because CEDAR Audio is refining the de-noising module. In addition, "You lose an ounce of signal but gain the benefit of ridding the source of some noise," he explains. "It's a better representation of what was going on at the original recording."

CEDAR Audio recently began selling the de-clicking module to companies that restore old 78s and other media. So-called wooded 78s, named for the wooden needles that were once used to play them, can have as many as 2,500 scratches per second nested in their grooves. With a price tag of about $25,000, the de-clicking module isn't cheap, but it's certainly less expensive than the full system, which sells for a little over $100,000. And in many cases, the de-clicker is all that's needed. "Unless you're looking for extremely fine ticks that are deeply buried," says Gotham Audio's Jerry Graham, "the first de-clicking module is usually enough."

One of CEDAR Audio's long-term goals is to make the system technology inexpensive enough to be attractive as a piece of high-end consumer audio equipment. Indeed, given later generations of powerful chips and matching software, CEDAR Audio would like to offer an off-the-shelf black box for audiophiles to play their old vinyl albums scratch-free. And if you ever grew nostalgic, you could just bypass your CEDAR unit for an antiquarian fest of pop, crackle, and buzz.

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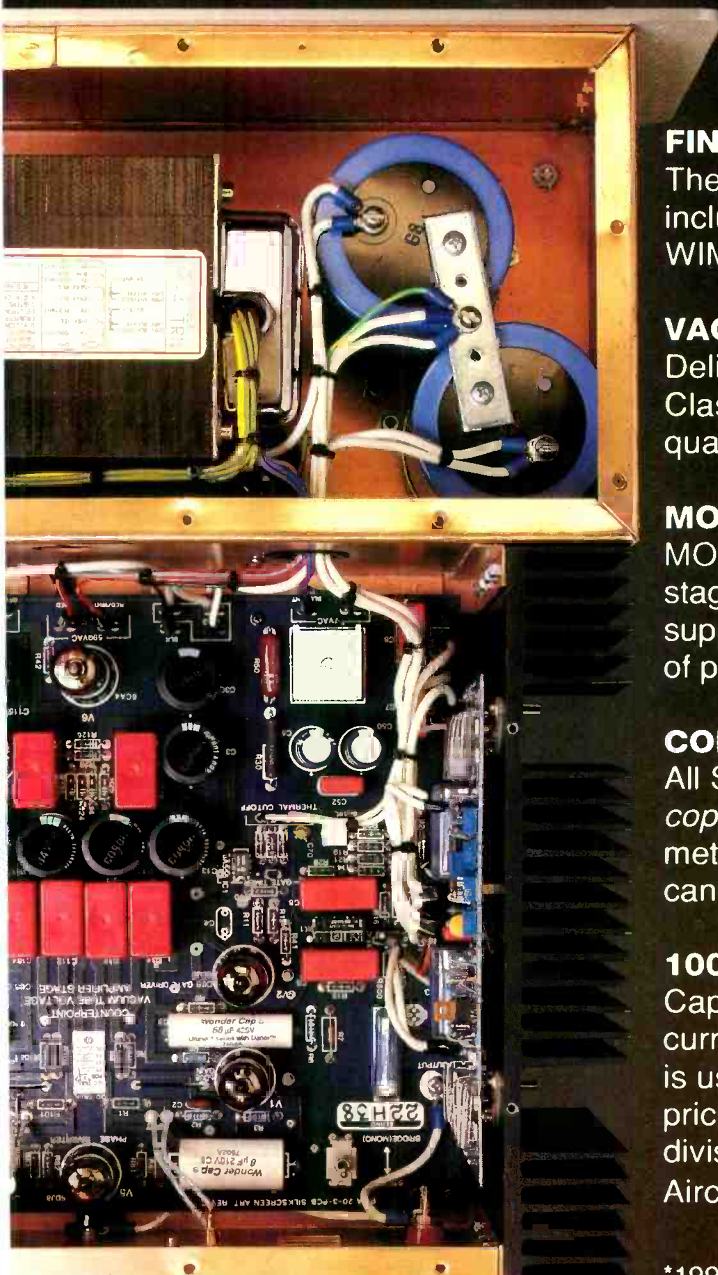

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Designed by John Curl

"Krell... Threshold... Madrigal... Rowland Research... Coda... Parasound. What !!!

Parasound?

How does Parasound manage a mention with the above said heavy hitters of the transistor amplifier world? Easy. The new 2200 power amplifier from Parasound has the type of power and performance that would be expected from the big guys, were they to build an amplifier at the two grand mark. The fact that the 2200 only costs $1,585 certainly sweetens the deal, making it a ridiculously great bargain.

But why Parasound?

Actually, this is the amplifier that I had been expecting to see from PS Audio, Superphon or Aragon; a real high calibre audio product that reeks of power, engineering savvy, and bang for the buck. Instead, **a small firm from northern California had the sense to recruit one of the best minds in the business - John Curl - to design for them a product capable of superior performance without a typically prohibitive price tag** to go along with it. John brought with him a full suitcase of engineering and design experience that few others in the industry could match or even dream of. Remember the "JC" designation on some of the Mark Levinson designs of the 1970's - that's John Curl. More recently, John has enjoyed great critical success with his Vendetta phono section electronics, it being declared "State of the Art" by several of the glossy mags. Then, add to the formula the Parasound company, whose reputation has been built on the value-oriented sector of the market. Parasound has put together a method of product development and marketing which emphasizes in-house design and overseas construction. Years of close work with their Taiwan manufacturing-facility has resulted in a relationship where both parties know what the other needs in order to produce **a finely crafted product; a product that's basically untouchable by the competition.**

THE AMP. The 2200 weighs in at 58 lbs., that's 6 lbs. more than the Krell KST-100 ($2,700), and only 2 lbs. less than the Madrigal No. 29 ($2,800). It's 19" wide, 8" tall and 19" deep if you include the fore and aft handles. It has balanced and single ended inputs (XLR & RCA), with a switch to convert to mono operation. The rear of the amp also has two sets of speaker terminals for those who desire to bi-wire or just want to hook up more than one pair of loudspeakers. Unlike Parasound designs of the past, the 2200 lacks the two attenuator pots on the front panel and the speaker terminals are honest-to-goodness 5-way binding posts. Both sides of the amp are flanked by an impressive array of "Rowland-like" heatsinks that run quite hot in order to dissipate the considerable heat generated by the 12 high-bias (over 6 wpc in pure class A) bi-polar output devices per channel. Considering that nearly all listening is done at one or two watts per channel, **the 2200 delivers a lot of class A-biased power.** Inside you'll find two 1.2 kVA toroidal transformers (one per channel) and 100,000 mfd of filtered power storage. A nice touch is the way all large capacitors are bypassed by smaller film caps for improved performance. This is the first amplifier I have seen in a long time that goes so far as to even bypass the larger filter caps in the power supply (a favored trick by many modifiers). Parts quality throughout is good... **the transformers, filtering caps, chassis, output devices and resistors are just about as good as you can get.**

I have operated this amplifier under grueling and strenuous conditions for almost three months without so much as a hint of trouble or breakdown. As said previously, this amp does tend to heat up a room if given the opportunity, running at about the same temperature at idle as it does wide open - a sign of proper high-bias or class A operation and certainly nothing to worry about.

THE SOUND. It sounds balanced. No aspect of its operation unduly draws attention to itself. The highs aren't grainy or smeared; the bass isn't bloated; the midrange isn't recessed, or forward for that matter; the stage isn't cramped; and, dynamics aren't compressed. What we have here is an amplifier that flat out refuses to do much wrong, while doing almost everything right. Is it a wonderful amplifier in the manner of the Allegro Cantata? You bet it is, but for different reasons (if this amp were not a wonderful product this review would have been written two months from now, or whenever I got to it).

The 2200 is one of the most powerful amplifiers you will ever come across, controlling loudspeakers with such aplomb so as to seem effortless. Transients with the 2200 can be awesome and are certainly on par with the mono Cantatas or anything else making 200 or more wpc. A mistake will take out woofers with a lethal ease, take my word for it. Without seeming forward (remember the balance referred to), the 2200 extends

 RAVE REVIEW

Ultra High Current Power Amplifier

into the bass region with incredible authority... enough to loosen the neighbors fillings and send the dog running for cover under one of the kids beds.

Clarity and the sense of space on a three dimensional stage were very good. Without effort I could pick out the location of instruments and vocals. Saxophone on "Jazz at the Pawnshop" had an excellent sense of presence, the sax standing clearly apart from the other instruments on the stage. Drums at right rear had perfect placement, and there was a nice feeling of left and right, up and down, as the drummer worked his way around the drum kit.

This amp has some pretty remarkable abilities when it comes to reproducing the feeling of a live event in the listening room. Resolution of inner detail was natural and very revealing, without seeming hyped or exaggerated. Images at the back of the stage were crisp and easy to locate. As a final point let me say that the 2200, after several months of use, continues to improve in its sonic capabilities.

CONCLUSION. When I first listened to the Parasound 2200 I got a funny feeling inside, a queasiness, if you will, regarding how to evaluate it. I'm sitting here with the Allegro Cantata and the Krell KST-100 thinking how *they* defined high-end performance at prices that were starting to be accessible to "Blue Collar Audiophiles", even if it was still a stretch dollar-wise. The Kaye amplifiers have always been a favorite and the Muse amps will forever represent good sounds, solid build, quality and value. How then do I tell you that there is another amplifier that **deserves nothing short of a rave review,** without BFS appearing to belong to the amp of the month club? Is it possible that there exists more than one exceptional amplifier out there? How do I maintain a sense of credibility with readers when I know for a fact that many of you will go into certain audio retailers only to be told that Krell stinks, Coda is a dog, Kaye is a looney or that Parasound is strictly mid-fi?

Due to space and time limitations we will not be devoting extensive editorial space to products that do not deserve it. For example, I have at my disposal a pair of B&K mono-blocks just like those raved about by Sam Tellig (Tom Gillette) of Stereophile. I have never cared for the sound of the amps and would put them somewhere above the AVA Fet-Valves, and below the Parasound 1200 or Soundcraftsmen Pro Power One (a true sleeper). I will not be reviewing the M-200 from B&K. If they come up with a new product that seems to me to be of value, I will look at it or have one of the other contributors look at it. Adcom has only made one good product in my opinion, that being the 535, no need to review the rest. A friend has the Aragon 4004, but it sounds soft and too laid back to be accurate. Yes, we look at quite a few products from Counterpoint, Parasound, Muse, Krell and mas, but that's for a reason - these products consistently sound ACCURATE while providing a value; not because they advertise, or give us things for free. I make a conscientious effort to print reviews of products that offer something to you, the readers. I prefer talking about Parasound and Fried products over Apogee loudspeakers and Air Tight tube amps because the Parasound and Fried are **not aimed at people with more money than brains.**

So this is how I'm going to approach the review of the Parasound 2200 power amplifier. **I want you to add it to the list of truly fine products that have something special to offer in terms of value regardless of what it's compared to or what anyone else says about it. It stands on its own in terms of build and performance, being basically as good (accurate) as any amplifier that I am aware of, and better (more accurate) than most."**

-- Martin DeWulf--

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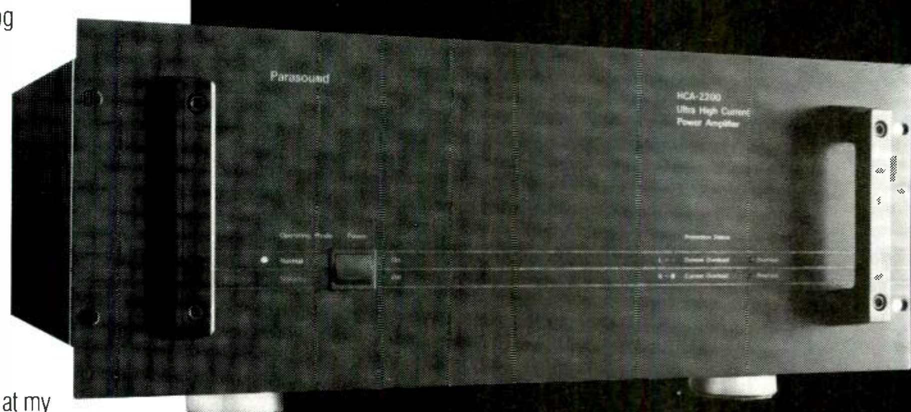


1

MARANTZ CDR-1 PROFESSIONAL CD RECORDER

Manufacturer's Specifications

Amplitude Linearity: Overall record/playback, ±0.1 dB; analog output section, ±0.1 dB, 20 Hz to 20 kHz.

Phase Linearity: Overall record/playback, 2.0°; analog output section, ±5.0°.

S/N: Overall record/playback, 89 dB; analog output section, 90 dB.

Dynamic Range (EIAJ): Overall record/playback, 90 dB; analog output section, 92 dB.

THD + N: Overall record/playback, 0.0063% (−84 dB); analog output section, 0.005% (−86 dB).

Channel Separation: Overall record/playback, 86 dB; analog output section, 88 dB.

Input Sensitivity: Microphone, 2 mV (10-kilohm impedance); analog line, 0.5 V.

Digital Output: 0.5 V peak to peak; maximum d.c., 0.05 V; load impedance, 75 ohms.

Analog Line Output: 2.0 V rms, ±1.5 dB.

Headphone Output: Output voltage, 6.5 V rms (open circuit); output power, 74 mW into 32 ohms; load impedance range, 8 to 2,000 ohms; output resistance, 120 ohms.

Power Requirements: 120 V a.c., 60 Hz, 40 watts.

Dimensions: 16½ in. W × 5⅜ in. H × 13¹¹⁄₁₆ in. D (42 cm × 13.7 cm × 34.7 cm).

Weight: 20.9 lbs. (9.5 kg).

Price: $7,000, including remote.

Company Address: 1150 Feehanville Dr., Mount Prospect, Ill. 60056.

For literature, circle No. 90

Longtime *Audio* readers may remember my test of a prototype magneto-optical disc recorder developed by Thomson-Brandt of Germany (March 1990). That unit could record discs over and over. However, although it could play conventional CDs, the recordings it made could not be used on conventional CD players, as its magneto-optical recording system encoded data by changing the polarization direction of reflected light rather than by changing the intensity. The Marantz CD recorder reviewed here is just the opposite: Its discs, once recorded, cannot be erased (which is why they are sometimes referred to as WORM discs, for Write Once, Read Many times), but recordings made by the CDR-1 *are* compatible with standard CD players.

A blank CD-R disc is divided into several areas. Next to the center hole is an area for mechanical clamping of the disc. An area near the center of the disc is subdivided into two parts: The Program Memory Area (PMA), where track numbers are recorded with respective start and stop points, and the Program Calibration Area (PCA), which is used to calibrate the laser energy needed for recording on the disc via a trial recording. For a partially recorded CD-R disc, track numbers with associated absolute start and stop times are stored in the PMA. Once a disc is fully recorded (up to 18, 63, or 74 minutes, depending on the configuration of the blank), a definitive table of contents (TOC) can be "written" into the lead-in area of the disc, after which further recording is impossible, even if the available time has not been used up. It is possible to "mark" parts of a program area, such as faulty recordings, as invalid so that these portions will be skipped over when the disc is played.

The substrate of the recordable CD-R disc is the same transparent plastic used in CDs. A spiral track is preformed into this substrate to hold the recorded data; the pitch of the spiral determines whether the disc will hold 63 or 74 minutes' worth of signal. (The 18-minute length is for 3-inch CD-R discs.) A blue-tinged translucent recording layer is coated on the substrate, but since it is then coated with a gold reflective layer, the recordable surface winds up looking green. A protective layer of plastic material is applied on top of the gold layer.

To store the digital information on a CD-R disc, pits are burned into the recording layer. The energy of the laser beam causes localized heating of the substrate material and the recording layer to approximately 482° F (250° C). The material of the recording layer melts and thereby reduces its volume. Constant switching between "writing" and "reading" power results in the creation of a bit pattern corresponding to that of a conventional CD.

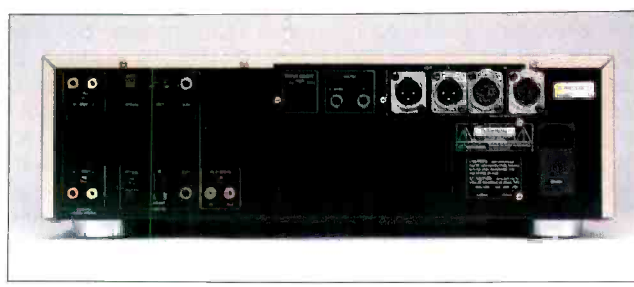
The input/record electronics (including A/D conversion, etc.), as well as the playback electronics (including D/A conversion not unlike that in conventional CD players), are, by now, familiar to those who have been following CD and DAT developments. The CD-R mechanism, however, is new. It houses a higher powered laser than is found in standard CD players, and it must be capable of very precise tracking, particularly during recording. This requires not only a high-precision transport but also electronics that can decode data from the preformed track and control the disc's speed of rotation.

Control Layout

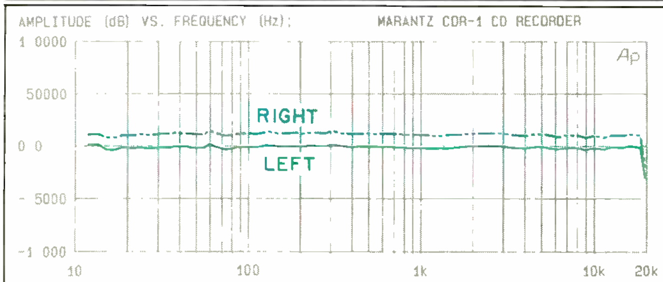
The "Power" switch and a 'phone jack and its associated "Level" control are at the left end of the front panel. A large display occupies most of the panel's upper section. Track numbers, the usual selectable time displays, programming information, type of repeat play, and shuffle-play selection are all shown here, when appropriate. In addition, the display shows such information as recording level, type of disc inserted, disc status, and the presence of errors (for example, programming nonexistent tracks or attempting to record on a conventional CD).

The disc tray is beneath the left portion of the display, while to its right are an "Open/Close" button, "Prev" and "Next" buttons for track selection, and the "Play" button. A long row of controls takes care of selecting the type of "Time" display, "Shuffle" play, "Repeat" modes, "Scan" (playback of the beginning of each track), normal and "Fast" search, "Stop," "Pause," "Mute," and record. To begin recording, it is necessary to press the record button and then "Play," conveniently placed just above. Record level and "Balance" controls are at the extreme right.

A hinged flap along the panel's lower edge conceals a row of smaller buttons. These are secondary controls for programming, direct track selection, setting and unsetting track-skip mode, and selecting analog or digital input, man-



Recordings made on the Marantz CDR-1 can be used on conventional CD players but cannot be erased and rerecorded.



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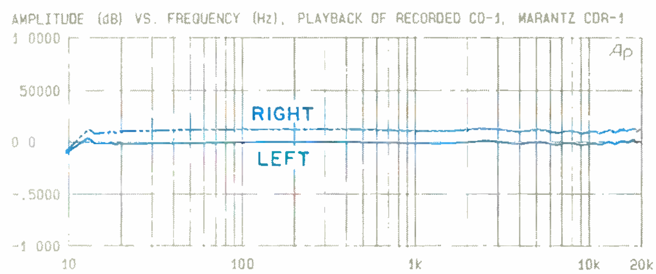

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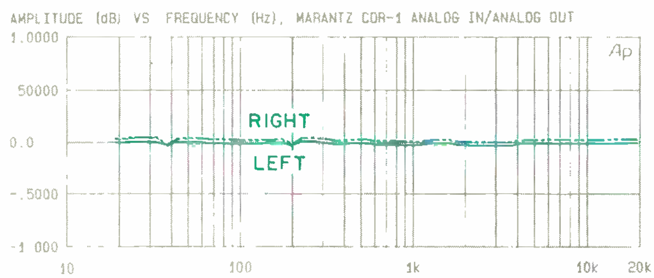

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Fig. 1—Frequency response for recordings made from digital test-generator signals (A), from a CD-1 test disc (B), and from analog test signals (C).

ual or automatic track numbering, and synchronized recording. Also here is a "Fix-Up" button, shielded by raised rims at each side to prevent accidental pressing, that applies the final table of contents to the disc. Before the TOC is fixed, the disc can be played only on a CD recorder, but more tracks can still be recorded. Once the TOC is in place, the disc cannot be recorded further, but it can be used on conventional CD players. Fixing the TOC takes about 3 minutes and starts automatically once the "Fix-Up" and record buttons are pressed. The display counts down the time as this takes place, so you know how much longer you must wait and when the TOC has been completely written.

The rear panel of the CDR-1 is equipped with the power cord input, analog input and output jacks (both unbalanced and balanced XLR types), coaxial and optical digital input and output jacks, a pair of quarter-inch microphone input jacks, an input selector switch (balanced, unbalanced, or microphone), and a pair of "RC 5 Remote" jacks. These last are to connect the recorder to other Marantz or Philips components using this control-link system, for multi-component operation by a single remote or for synchronized recording from a CD player with an RC 5 jack.

Measurements

The sample CDR-1 tested was a prototype and, according to representatives from Marantz, may well be improved upon. Nevertheless, the manufacturer felt confident enough to lend this unit. That confidence proved to be justified, even though error messages occasionally appeared on the display, requiring some tests to be repeated. I should also mention that TDK supplied a half dozen or so blank discs. Good thing, too, since in familiarizing myself with this recorder I ruined at least two discs by not properly executing the "Fix-Up" command when I should have. That said, I went about evaluating the CDR-1 by using a combination of tests I might have used with a DAT recorder and with a conventional CD player.

For my first tests, of frequency response, I tried three types of signals, each recorded on the CDR-1 using a TDK blank disc. Figure 1A shows the playback response of a recording made using digital signals from the DSP section of my Audio Precision test system. Figure 1B, for playback of a recording I made by copying my CBS CD-1 test disc, shows virtually identical results, including slight channel imbalance. Finally, I applied analog signals to the unit, via the line-level analog inputs, and plotted the curve of frequency response shown in Fig. 1C. Surprisingly, the channels were now perfectly balanced. Perhaps the slight imbalance that was noted previously was being offset by an opposite imbalance in the analog electronics prior to A/D conversion. In any case, response is still perfectly flat from 20 Hz to 20 kHz through the complete analog-in to analog-out record/play cycle.

A similar comparison was made for THD + N versus frequency (Fig. 2). The recordings made from the generator input and from my CD-1 test disc are similar, with results at 1 kHz ranging from around 0.003% to 0.005%, and with slightly lower readings in the right channel (dashed curve) than in the left over most of the frequency range. Applying analog signals to the line inputs at 0 dB (maximum recording level) yielded a recording with about 0.1% THD + N, higher than from the digital sources.

Having concluded that there was no significant difference between results obtained via digital signals from my test equipment and those obtained from playback of the copy of my CD-1 test disc, I conducted most of the remaining tests simply by playing back appropriate tracks of that newly recorded "clone" of my CD-1 test disc. Figure 3 is a plot of THD + N, referred to maximum recorded level, as a function of recorded signal amplitude. At maximum recorded level, left-channel THD + N is approximately −84 dB (corresponding to approximately 0.0063%), while right-channel THD + N is −89 dB (approximately 0.0035%). These results correlate reasonably well with those shown in Fig. 2.

The readings of THD + N were mostly noise, as actual distortion components were all well below 0.0004%.

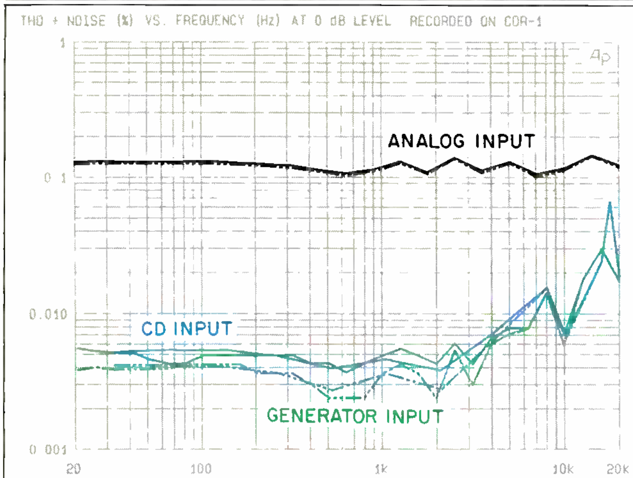


Fig. 2—THD + N vs. frequency for left channel (solid curve) and right channel (dashed curve).

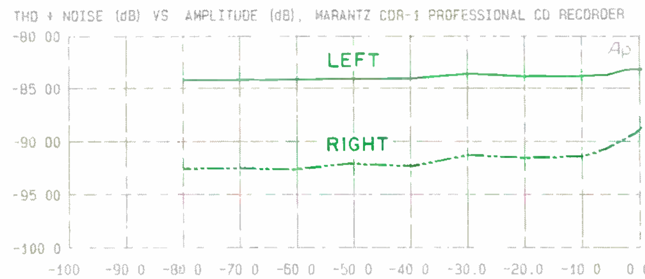


Fig. 3—THD + N vs. signal amplitude.

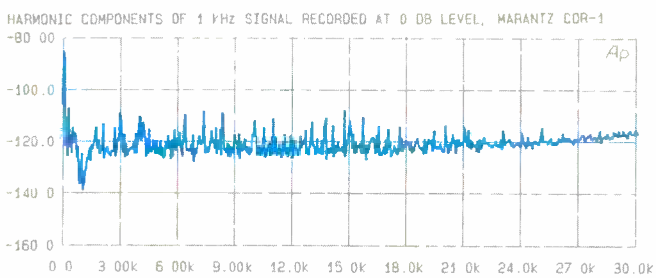


Fig. 4—Spectrum analysis of harmonics of 1-kHz signal recorded at maximum level.

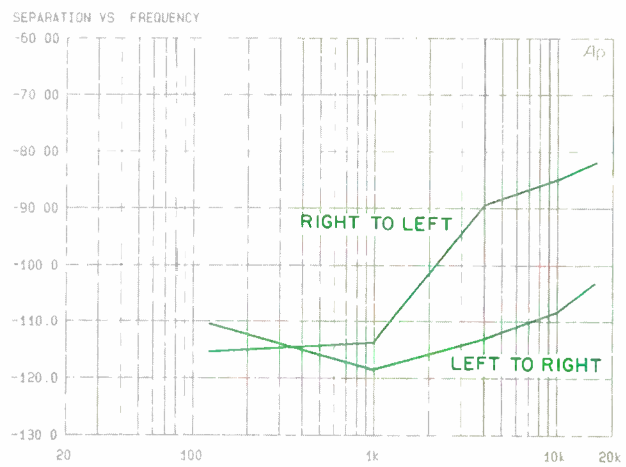


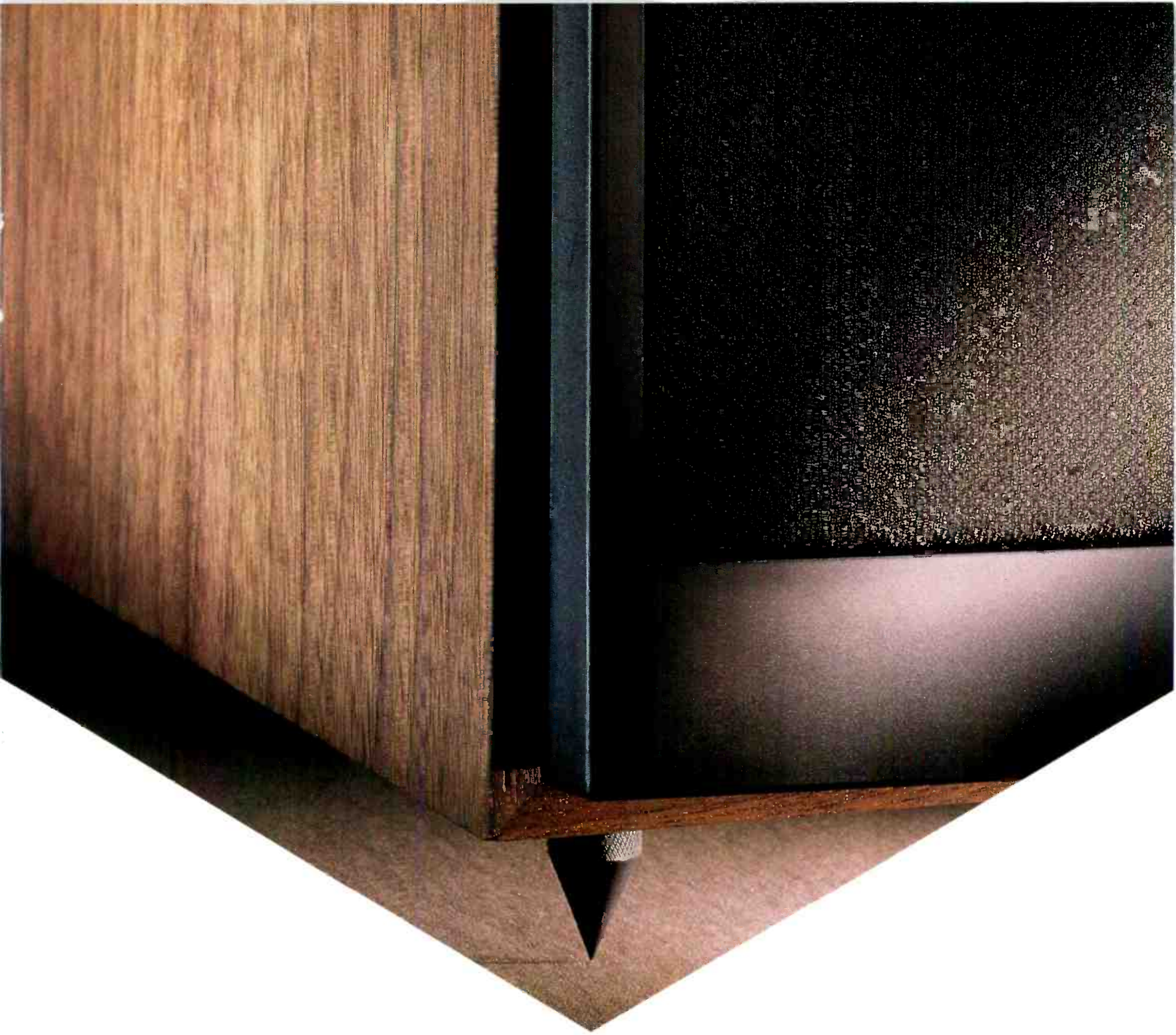
Fig. 5—Separation vs. frequency.

Next, I conducted an FFT analysis for a 1-kHz test signal recorded on a blank disc, to separate actual harmonic components from residual noise (Fig. 4). Whatever harmonic components could be observed above the residual noise floor are at least 110 dB below reference (maximum) recording level, suggesting that the earlier readings of THD + N were caused predominantly by residual noise and not by actual harmonic distortion. That −110 dB corresponds to a distortion percentage of only 0.00032%!

Figure 5 is a plot of channel separation versus frequency. Left-to-right separation is considerably better than right-to-left separation—though even in that worse direction, crosstalk is down around 113 dB at 1 kHz and is down more than 80 dB at 16 kHz.

The A-weighted S/N observed while playing back the "no-signal" track of my test-disc clone was 98.6 dB for the left channel and 101.3 for the right. For a recording of "no signal" made via the analog inputs and measured at the analog outputs during playback, S/N was somewhat poorer, 93.25 dB for the left channel and 94.87 dB for the right. With the weighting network removed from the signal path, a plot of residual noise versus frequency was made (Fig. 6). Clearly, the major source of residual noise (especially for the left channel) is power-supply hum rather than random noise, and even the 60-Hz hum peak in the left (worse) channel is still down by about 85 dB.

I measured deviation from perfect linearity for both high- and low-level signals. Because of residual noise present in this prototype recorder, the test equipment was unable to lock onto either dithered or undithered signals below −80 dB, so I am not showing these results. This doesn't necessarily mean that linearity was poor at low levels—simply that random noise prevented the test equipment from locking onto a discrete continuous signal. Suspecting that the noise might be present only on the clone of my CD-1 test disc, I inserted the CD-1 itself and repeated the linearity tests. Results were identical, suggesting that the noise was generated by the hardware, not the software. In any case, for readings down to −80 dB, I could not detect even the slightest linearity errors. This speaks well for the recorder's D/A conversion system—which, as I understand it, is a variation on the Philips bitstream (one-bit) approach. I was, however, able to evaluate the linearity of the A/D and D/A converters at still lower levels, by feeding in signals generat-



As a professional unit, the CDR-1's price is high, but it has balanced inputs and does not impose SCMS copy protection.

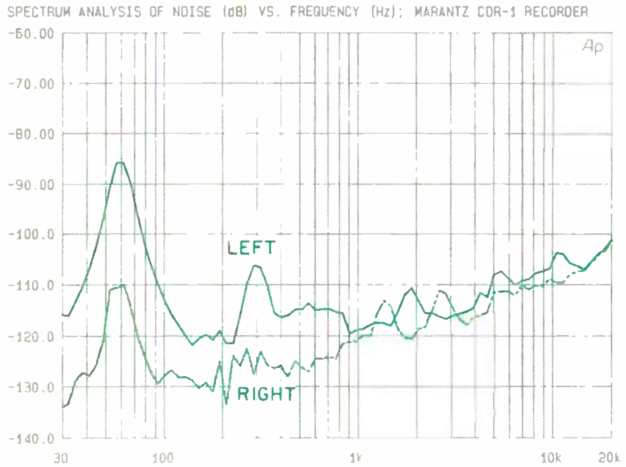


Fig. 6—Spectrum analysis of residual noise when playing "no-signal" track of "clone" of CD-1 test disc.

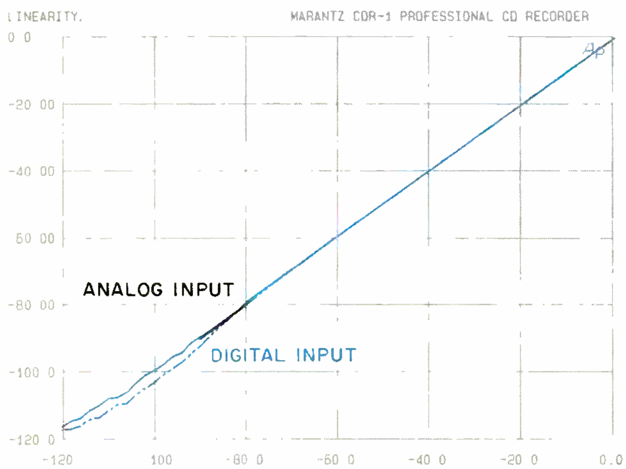


Fig. 7—Linearity (output vs. input) of A/D and D/A converters; see text.

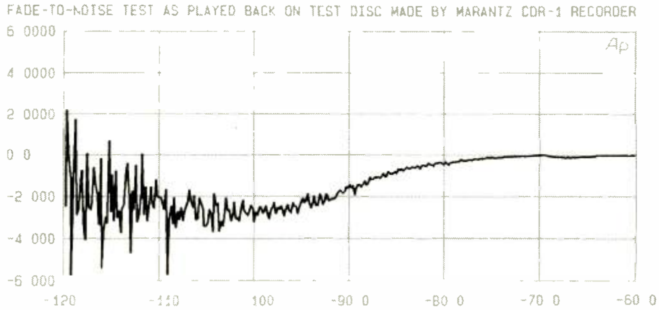


Fig. 8—Fade-to-noise test.

ed by my Audio Precision equipment and measuring the Marantz's resulting analog output without actually recording. Figure 7 shows output versus input for analog input signals down to −90 dB and for digital input signals down to −120 dB.

Figure 8 represents the fade-to-noise test I usually apply to CD players. In this case, the fading signal (from −60 to −120 dB) was derived from the clone of my CD-1 test disc. Deviation of approximately 2.0 dB is noted for signal levels below −90 dB, and the EIA dynamic range was estimated to be around 110 dB. Using the EIAJ method of measuring dynamic range, I obtained results of 93.1 dB for the left channel and 93.8 dB for the right. For my last test, I measured frequency accuracy of a 20-kHz tone recorded via the digital inputs; it was −0.0042%.

Use and Listening Tests

Marantz is very specific in calling this component a *professional* CD recorder. Its price, of course, suggests that it is intended for professional use, and it is available only in limited quantities. Furthermore, the CDR-1 does not contain the Serial Copy Management System (SCMS), which means that small studios or other professionals who need to make a small number of copies of digital program sources can do so without being restricted to single-generation copies. Furthermore, these studios will be able to do successive dubbing, overdubbing, and the like, much as they have been doing with analog tape recording equipment and professional DAT recorders. Studios also will be able to give sample CD-R discs to their recording artists prior to pressing conventional CDs. In short, the need for such a recorder in professional applications is obvious. Since the Marantz CDR-1 costs just over one-third as much as the least expensive CD recorder I'd heard of previously, it is more affordable for the budget-minded professional.

I conducted a few more experiments with this recorder, transcribing some favorite tracks from a few of my most treasured CDs onto a single CD-R disc. In subsequent A/B tests (playing the original CD and switching back and forth between it and the copy), neither I nor any visitors to my lab could tell the difference. Of course, these copies were made using the digital-to-digital mode; barring any extensive data dropouts, I would not have expected the results to be otherwise.

Although I did some CD-R recording using the microphone inputs, I saw little point in subjectively evaluating the results, as sound quality was necessarily limited by the choice and quality of microphones used. Suffice it to say that microphone input sensitivity was pretty standard.

The one thing I discovered early on in using this component is that you'd better be fully acquainted with operating procedures before you begin recording. Unlike magnetic media, CD-R discs do not forgive mistakes. If you make an error on a CD-R disc, you have only two choices: Apply the "Skip" code to that track, or discard the disc and start over again—and blank discs presently cost about $80 each. With that caution stated, I can only commend Marantz for managing to develop a CD recorder that's no bigger than some of the better CD players and that sells for far less than I would have expected. *Leonard Feldman*

Introducing a receiver with so much going for it, there's hardly enough room to do it justice.

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Hidden Control Panel

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When the RX-950 is used with other Yamaha RS-compatible components, the entire system can be controlled by a single remote control.

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Due to Yamaha's patented HCA Circuitry, the RX-950 delivers pure Class A performance, yet runs exceptionally cool. The amplifier in Yamaha's new audio-dedicated receiver will never degrade to Class AB, no matter how high the output.

A massive 11 lb. 6 oz. power transformer ensures high output power even when driving low-impedance loads.

The RX-950 features ToP-ART. A new system design that virtually eliminates interference between channels and delivers maximum signal purity.

Pure Direct Switch bypasses all tone and balance controls and the pre-main coupler to maximize signal purity.

Motor-driven input selector and volume controls with LED indicators. A superior system which eliminates the noise and distortion inherent in electronic switching.

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The RX-950 delivers 120 watts RMS per channel into 8 ohms from 20-20,000 Hz at no more than 0.015% THD. Or 180 watts RMS per channel into 4 ohms from 20-20,000 Hz at no more than 0.03% THD.

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For signal purity, exceptionally thick 1.6 mm high quality wire is used to route signals through the amplifier.

The thick base of the RX-950 has exceptional anti-resonance, anti-magnetic and superior damping characteristics.

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The new RX-950 combines the performance of the finest separates with the convenience of a receiver.

Ideally suited for multiple speaker installations. Up to six different zones can be controlled at one time through additional amplifiers connected to the two extra pre-amp outs.

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Tuner features Yamaha's Direct PLL IF Count Synthesizer, a microprocessor-controlled tuning system to lock onto the weakest broadcast frequencies.

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The heavy chassis and extra large feet of the RX-950 are designed for maximum vibration damping.

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2

PROTON AT-670 TUNER

Manufacturer's Specifications

FM Tuner Section

Mono Usable Sensitivity: 10.3 dBf.

50-dB Quieting Sensitivity: Mono, 15.3 dBf; stereo, 34.7 dBf.

THD at 65 dBf: Mono, 0.2%; stereo, 0.3%.

S/N at 65 dBf, A-Weighted: Mono, 83 dB; stereo, 74 dB.

Capture Ratio: 1.0 dB.

Alternate-Channel Selectivity: Normal, 65 dB; narrow, 80 dB.

Image Rejection: 90 dB.

I.f. Rejection: 110 dB.

AM Rejection: 65 dB.

Separation: 45 dB at 1 kHz.

AM Tuner Section

Usable Sensitivity: 25 μV.

Selectivity: 50 dB.

Image Rejection: 45 dB.

I.f. Rejection: 50 dB.

THD: 0.5% for 30% modulation by 400-Hz signal.

S/N: 45 dB at 10 mV.

General Specifications

Dimensions: 18½ in. W × 3⅞ in. H × 15⅝ in. D (47 cm × 9.8 cm × 39.7 cm).

Weight: 15½ lbs. (7 kg).

Power Requirements: 120 V, 60 Hz a.c., 16 watts.

Price: $400.

Company Address: 5630 Cerritos Ave., Cypress, Cal. 90630.

For literature, circle No. 91

It's always a pleasure to unpack a new audio component and discover that its styling is so carefully executed that it will grace any room decor. When that elegant styling is accompanied by superb performance, as the old song goes, who could ask for anything more? Such were my reactions when I placed the new Proton AT-670 FM/AM tuner on the lab bench. I shouldn't have been surprised. After all, styling of this, and other Proton 600 series components, was under the direction of Reinhold Weiss, an industrial designer who has gained international fame for his design work on many high-tech products. Weiss has the knack of creating audio and video components that are

Reinhold Weiss' visual design, Larry Schotz's r.f. circuitry, and Proton's production skills make the AT-670 a winner.

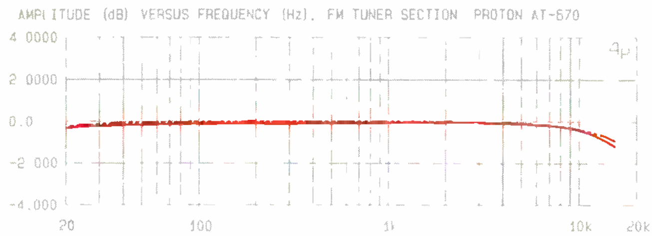

Fig. 1—Frequency response, FM section, of left channel (solid curve) and right channel (dashed curve).

pleasing to look at but whose looks don't get in the way of proper operation. As for the AT-670's circuit design, I need reveal only that Proton's special consultant for some years now has been Larry Schotz, who has no rival when it comes to r.f. design.

This combination of visual and electronic design talents, aided and abetted by Proton's production facilities, has produced a tuner that any FM radio lover and connoisseur of elegantly styled audio components would be proud to own. The only negative comment I have concerning this tuner's performance has to do with its AM section. Frankly, I can't believe that Schotz had anything to do with the design of the AM circuitry; it must have been left over from a much earlier model! In any event, most of us don't buy tuners of this category to listen to AM. For that purpose, a table radio usually does just fine.

The AT-670 lets you program 18 FM station frequencies and nine AM frequencies, for a total of 27 presets. The FM tuner section is equipped with the refined Schotz Noise Reduction (SNR) system, which can be turned on and off as required. Generally, it can be left on since, for strong signals, it does not impair reception quality in any way. The tuner also has a "Normal" (wide) i.f. mode and a "Narrow" mode. The latter is to be used only in areas where stations crowd the dial and interfere with one another, since it does degrade audio performance a bit.

Control Layout

At first glance, the black front panel looks as if it doesn't have enough controls to operate the AT-670. All you see are a tiny on/off button at the left, a "Preset" up/down switch, an AM/FM band switch near the center of the panel, and a large rotary tuning knob at the extreme right. Only close examination reveals a tiny button labelled "Open/Close." A push of this button, once power has been turned on, causes an entire section of the panel to move smoothly forward, disclosing additional required controls. (It reminded me of the many secret revolving doors we've all seen in detective and mystery movies.) The controls that come into view are a switch that turns on the "SNR" circuitry, another for selecting automatic or manual tuning, a third that selects "Mono" or "Stereo" operation, and a fourth that selects the "Normal" (wide) or "Narrow" i.f. mode of FM reception. Two tiny pushbuttons labelled "Memory" and "Enter," also found here, are used to set station presets. A softly lit display at the center of the front panel indicates stereo reception, tuning accuracy, and i.f. and tuning modes.

"Mains Control" jacks on the rear panel allow control links to other Proton 600 series components. This feature enables you to designate one unit of a Proton 600 series system as the master power controller and to turn all components on or off by pressing the power button on the designated master unit. In addition, major functions of this tuner, any other 600 series component, and even some Proton TV monitor/receivers can be controlled by Proton's AH-681 system remote. In addition to the usual output jacks at the rear of the tuner, there is an output level control and provision for mounting the pivoting AM antenna loopstick provided with the AT-670. The antenna input is a standard 75-ohm coaxial connector, but an impedance-matching transformer is supplied for those who use 300-ohm twin-lead cable from their antennas. Additional slide switches on the rear panel select 75-µS FM de-emphasis for use in the U.S. or 50-µS de-emphasis for use in some foreign countries, and 10-kHz (U.S.) or 9-kHz (European) spacing between AM channels.

Measurements

As usual, I tested the FM tuner section first. Figure 1 shows the frequency response. Output levels from both channels are virtually identical, and at 15 kHz response is down only 1.0 dB for the left channel and 0.8 dB for the right.

Figure 2 plots the quieting characteristics of the FM tuner. Using the "Normal," or wide, i.f. bandwidth, 50-dB quieting in mono is reached with a signal input of slightly less than 10 dBf (one of the best figures I have ever measured for this important specification), and 36 dBf of signal input produces 50-dB quieting in stereo. Repeating this test using the "Narrow" i.f. mode results in only slightly poorer 50-dB quieting sensitivity, 13 dBf in mono and 37.5 dBf in stereo. Turning on SNR while in this i.f. mode, however, makes the monophonic figure slightly worse (18 dBf) yet improves the stereo figure to 32 dBf. At a strong signal level (65 dBf), mono S/N is just short of 80 dB in "Normal" mode while stereo S/N is 73 5 dB, increasing to 75 dB at still stronger input signal levels. These results, though excellent by any standard, appear to fall slightly short of claims made by Proton in their published specifications. This is only because Proton quotes A-weighted S/N figures, which would inevitably be a bit higher than the figures I obtained. The EIA/IEEE Tuner Measurement Standard, which I use, calls for S/N measurements of FM tuners to be unweighted and to be made over the bandwidth from 200 Hz to 15 kHz.

Figure 3 shows how mono and stereo THD + N vary with signal strength. In the "Normal" i.f. mode, THD + N for 65-dBf signals is 0.08% in mono and 0.27% in stereo. Switching to the "Narrow" mode reveals the penalty incurred by using this mode to reduce interference from strong adjacent- or alternate-channel signals: THD + N increases to 0.46% in mono and to 1.8% in stereo.

I obtained close correlation between the results shown in Fig. 3 and those shown in Fig. 4. The latter graph shows

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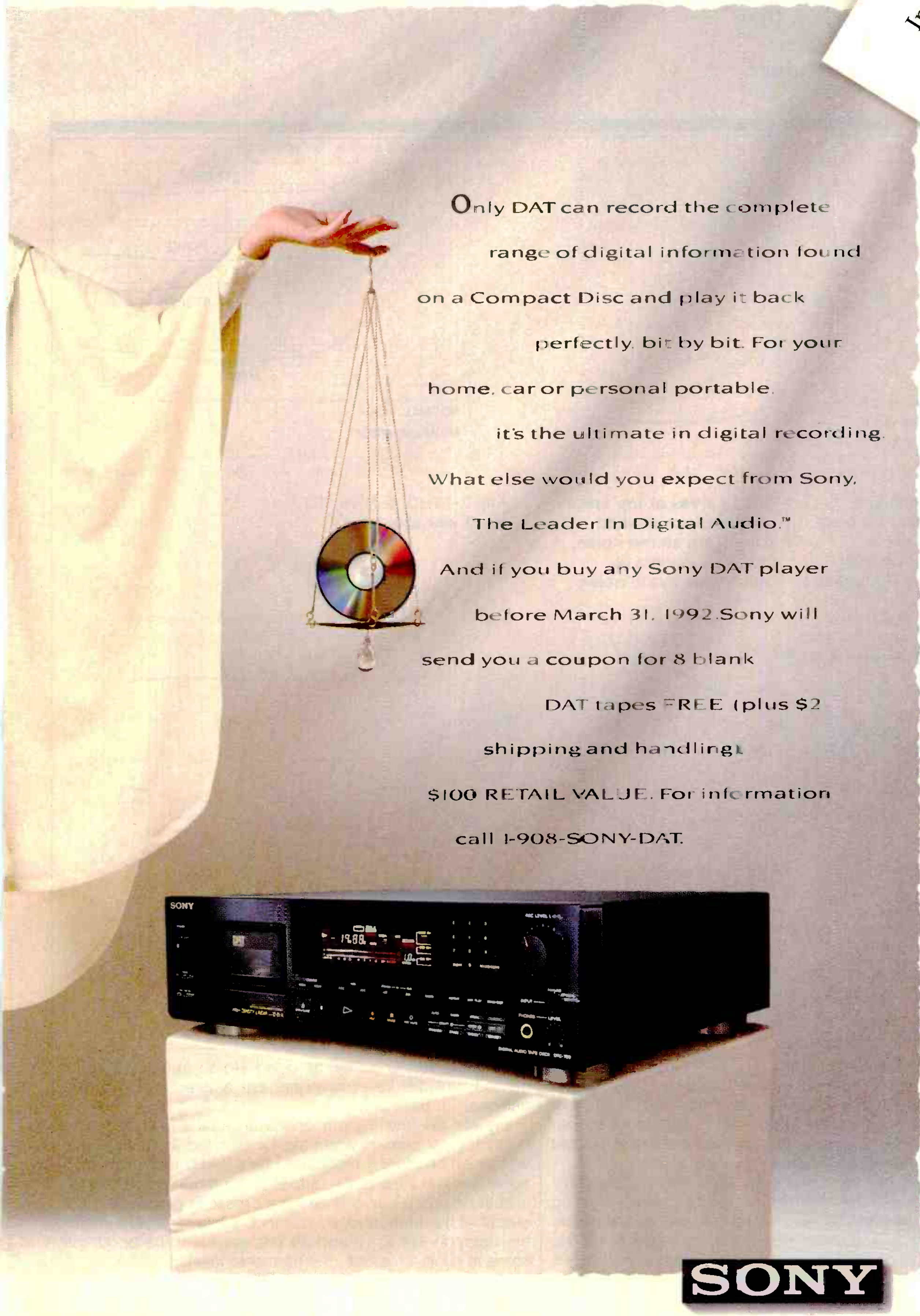
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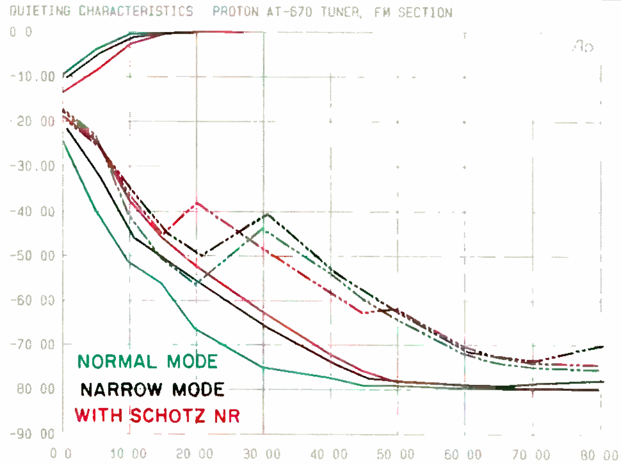


Fig. 2—FM quieting characteristics for both i.f. modes and for "Narrow" mode with Schotz Noise Reduction. Solid curves at top are audio output, dashed curves are stereo noise, and solid curves at bottom are mono noise.

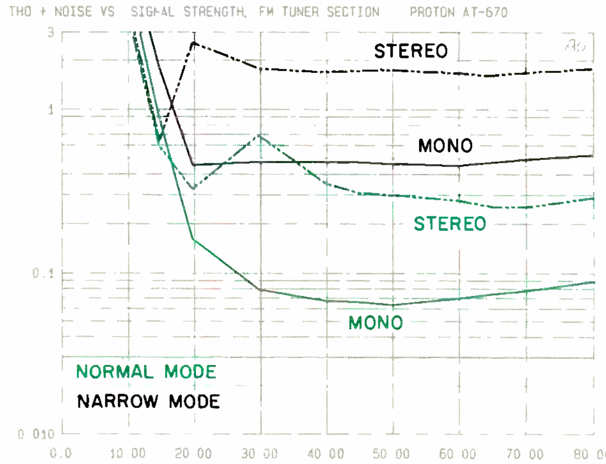


Fig. 3—THD + N vs. FM input signal level.

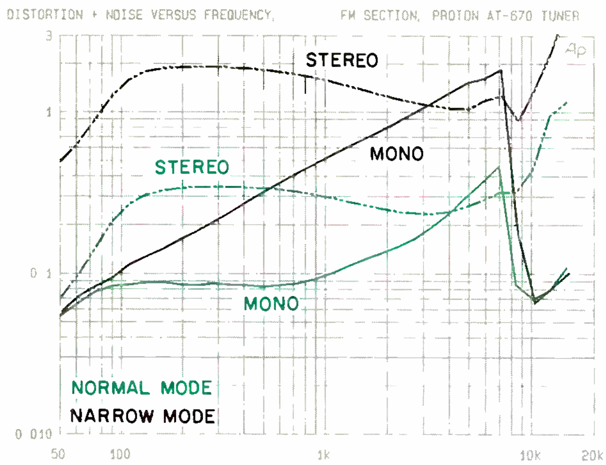


Fig. 4—THD + N vs. FM modulating frequency.

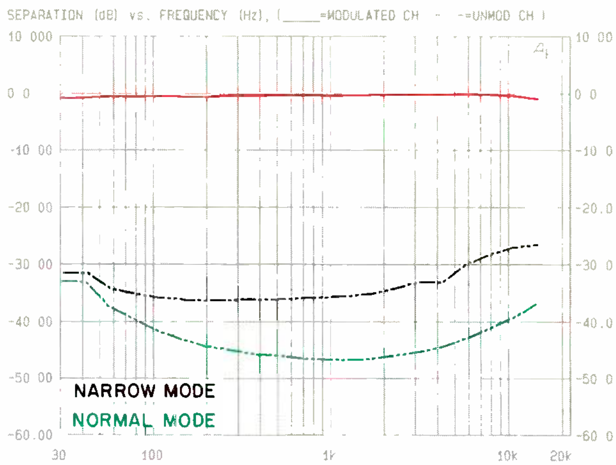


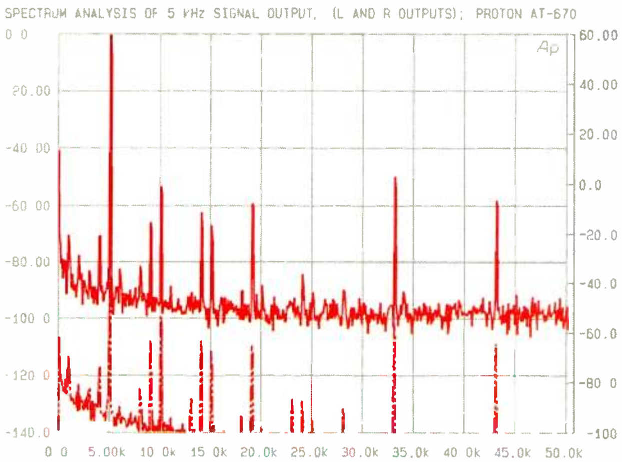
Fig. 5—FM frequency response (top) and separation.

THD + N versus modulating frequency. In the "Narrow" mode, mono distortion tends to rise rapidly with frequency, so that at 6 kHz (the highest frequency at which THD must be reported to conform to the EIA/IEEE Standard) it measures a very high 1.7%. Clearly, with this tuner it is advisable to use the "Normal" i.f. mode whenever possible.

As is usually the case, FM separation was considerably higher when using the "Normal" i.f. mode than when using the "Narrow" setting (Fig. 5). In "Normal" mode, separation at 1 kHz measures 46.5 dB, decreasing to 41 dB at 100 Hz and to 39.8 dB at 10 kHz. In "Narrow" mode, separation is reduced to only 36.5 dB at 1 kHz, 27.8 dB at 10 kHz, and 36.5 dB at 100 Hz. Of course, these are still perfectly acceptable levels as far as good stereo imaging is concerned, but the lower numbers are a direct result of the narrower i.f. bandwidth.

Figures 6A and 6B are spectrum analyses of left- and right-channel outputs when the tuner is fed a stereo signal whose left channel is modulated by a 5-kHz tone. The solid curve in each case is the output of the modulated channel, and the dashed curve shows the crosstalk products in the output of the unmodulated channel. While residual subcarrier components at 19 and 38 kHz appear to be about the same in either i.f. mode, the harmonic levels (at 10 kHz, 15 kHz, and so on) are considerably lower in the "Normal" i.f. mode (Fig. 6A).

Until digital broadcasting comes along, the AT-670 is well worth owning and enjoying.



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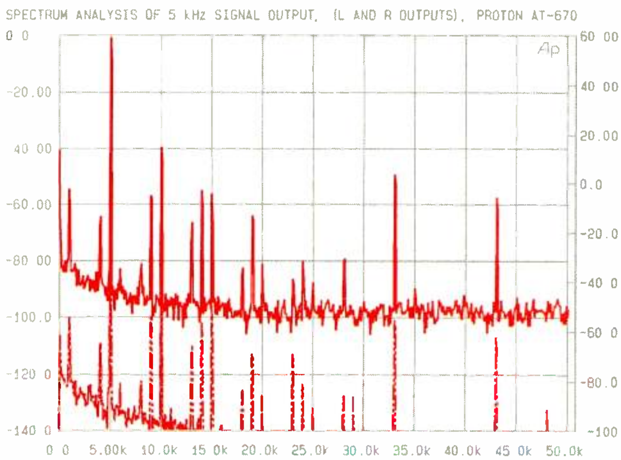


Fig. 6—Spectrum analyses of modulated left channel (solid curve, top) and unmodulated right channel (dashed curve, bottom), for "Normal" i.f. mode (A) and "Narrow" mode (B), with 5-kHz modulating signal. Use left-hand scales for top curve, right-hand scales for bottom.

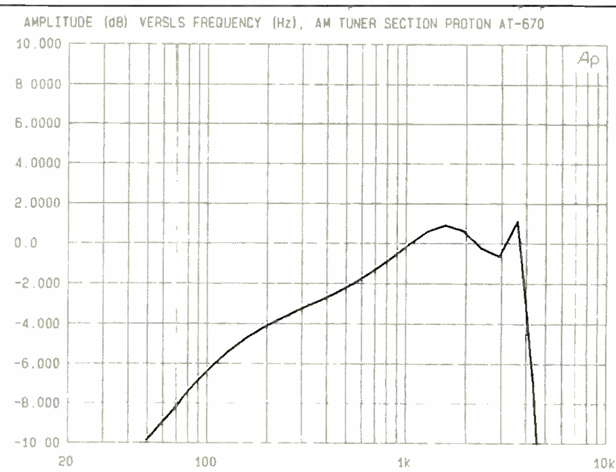


Fig. 7—Frequency response, AM section.

Capture ratio measured 1.2 dB. Image and i.f. rejection were both close to the 100-dB mark, the greatest rejection figures I can measure with my test equipment. Alternate-channel selectivity was 65 dB in the "Normal" i.f. mode and 82 dB in the "Narrow" mode. AM rejection measured 65 dB, as claimed.

At 30% modulation, harmonic distortion of a 1-kHz modulating signal for the AM section was 0.42%, better than the 0.5% at 400 Hz specified by Proton. However, the AM section's frequency response (Fig. 7) was so disappointing that I saw no purpose in testing this section any further. I can't imagine why Proton allowed an otherwise excellent tuner to exhibit such attenuation (the −6 dB point occurs at 110 Hz), especially since the −6 dB point for the treble end of the curve occurs at a better-than-average 4.2 kHz.

Use and Listening Tests

Despite the minimal number of front-panel controls, setting up presets for this tuner proved to be quite simple. The "+" and "−" rocker switch normally used to access presets is also used in combination with the "Memory" and "Enter" switches to create and store those preset frequencies initially. The operation of the rotary tuning control was quite elegant too. When you are in the automatic tuning mode, a slight rotation of the knob in either direction sets the tuning system up or down in frequency until the next usable signal is encountered. If you select manual tuning, however, rotating the control changes the tuned and displayed frequencies in 50-kHz increments.

Sensitivity of the tuner proved to be excellent. With my rotatable multi-element outdoor antenna, I was able to pick up some 58 usable signals, of which 47 were received in stereo. Of these 47 stereo signals, six were initially too noisy to be enjoyed in stereo. Switching on the SNR circuit made all but one of them acceptably quiet. Having discovered how effective the Schotz Noise Reduction circuit was, I simply left it on for the remainder of my listening tests.

These days, all too few FM stations put out the kind of clean, wide-range signal that can benefit from being received by a tuner such as the AT-670. If you are fortunate enough to live in an area where some FM stations are worth listening to, the Proton AT-670 is certainly a tuner worth owning and enjoying. After all, digital audio broadcasting, from the looks of things, is still many years away. Meanwhile, the AT-670 is a worthwhile alternative!

Leonard Feldman

What good is Dolby Pro Logic if you're powerless to enjoy it?

In the desire to turn everyone's living room into a movie theater, more and more manufacturers are featuring Dolby Pro Logic Surround Sound in their components.

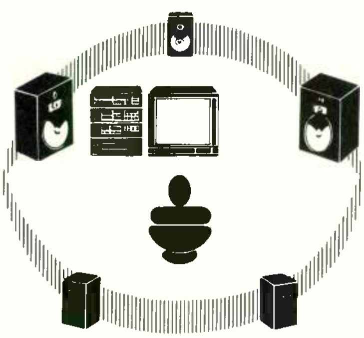
But, **featuring** Dolby Pro Logic and **delivering** Dolby Pro Logic aren't necessarily the same thing. Onkyo understands this difference, unlike those manufacturers interested only in their products having the latest "hot button" regardless of how well they incorporate it.

The promise of the Dolby system lies in its ability to create an extraordinary sensory experience. One you shouldn't be powerless to enjoy because your receiver or amplifier can't handle the demands of dialogue, soundtrack and special effects all at the same time.

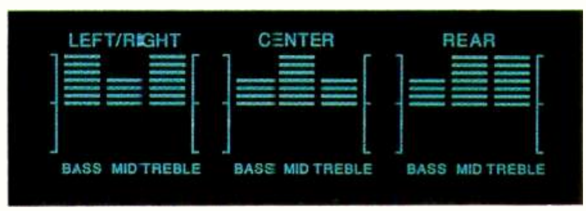
That's why Onkyo Dolby Pro Logic components are built with a strong amplifier foundation. Every model features Low Impedance Drive power supplies, consisting of heavy duty transformers (40% larger than many of our competitors), oversized capacitors and discrete output circuits.

And because we've taken no sonic shortcuts, our A/V components are rated into low impedance loads down to 2 or 3 ohms. These measurements, called Dynamic Power Ratings on a spec sheet, reflect the power reserves an amplifier must have to handle peak power demands. Onkyo A/V components give you the best of both worlds—power to spare for movies, the performance of separates for music.

At Onkyo, we don't believe in shortchanging the critical center channel either. Many of our Pro Logic A/V components have 5 separate amplifier sections, one for each channel, with the power matched between the left & right front and center channels. In this way, the relationship between the dialogue, effects, and music is in the exact proportion the director intended. If they're not, sounds that are supposed to come towards you and envelop you lose their impact, and whispered dialogue becomes overwhelmed.



Onkyo's home theater philosophy also takes into account the physical configuration of your home. An adjustable rear channel digital delay lets you tailor the surround effect to the size and shape of any room. For even more flexibility, our A-SV810PRO features an 8 Mode Digital Soundfield Processor, plus the ability to individually equalize the bass/mid/treble frequencies for each channel.



So, before you invest in any A/V receiver or amp, check to see how it stacks up in terms of Dynamic Power, center channel wattage, and the ability to shape the sound to your needs. Remember, a great Dolby Pro Logic experience requires more than just a logo on a faceplate.

It demands a company as dedicated as Onkyo to bring it to life.

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Onkyo's achievements in Dolby Pro Logic have been recognized by the industry through Audio Video International's awarding their 1991 HiFi Grand Prix Awards as "Product Of The Year" to our TX-SV70PRO Pro Logic Surround Sound Receiver, A-SV810PRO Pro Logic Surround Sound Integrated Amplifier and ES-600PRO Pro Logic Surround Sound Processor.

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3

CANTON ERGO 100 SPEAKER

Manufacturer's Specifications

System Type: Three-way, tower-style, vented box.

Drivers: Two 8¾-in. cone woofers, one 6⅜-in. cone midrange, and one 1-in. dome tweeter.

Frequency Range: 18 Hz to 30 kHz.

Sensitivity: 93.1 dB at 1 meter with 2.83 V rms applied.

Crossover Frequencies: 300 Hz and 3.5 kHz.

Impedance: 4 ohms nominal.

Power Handling: 180 watts.

Recommended Amplifier Power: Up to 250 watts per channel.

Dimensions: 11 in. W x 45⅜ in. H x 13¾ in. D (28 cm x 115 cm x 34.7 cm).

Weight: 79⅛ lbs. (36 kg) each.

Price: $3,500 per pair in walnut, oak, mahogany, or black or white ash veneer; $5,000 per pair in high-gloss black, white, or mahogany.

Company Address: 915 Washington Ave. South, Minneapolis, Minn. 55415.

For literature, circle No. 92

Canton was founded in 1973 in the village of Niederlauken in the Taunus Mountains of Germany, and now exports to more than 24 countries. The name is formed from the Latin word *cantare*, to sing, and the German word *ton*, sound. According to Steve Teachout, president of Canton's American operation, they prefer to be known as "a company that applies the laws of acoustics and physics competently, with known and proven methods and materials, rather than a company that develops new ways to move air."

The Ergo 100, next to the top of Canton's extensive range of home speakers, is a vented, three-way, direct-radiator system with two woofers operating in parallel. All drivers are made by Canton. The midrange and bass drivers have graphite-enriched polypropylene diaphragms. This material is said to provide high self-damping, which suppresses unwanted mechanical vibrations of the cone more effectively than conventional coated paper cones. The midrange driver is mounted in its own chamber and located above the tweeter. Canton feels that since the midrange reproduces the important human-voice range of music, it should be assigned the topmost position in the cabinet to correspond with the ear level of a seated listener. The system's metal-

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...presenting an unrivaled smoothness and liquidity to instrumental textures, a remarkable freedom from hash and grain, and throwing a huge sense of transparent space before the listener.

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—Robert Harley
Stereophile, Vol. 14, No. 11
November 1991

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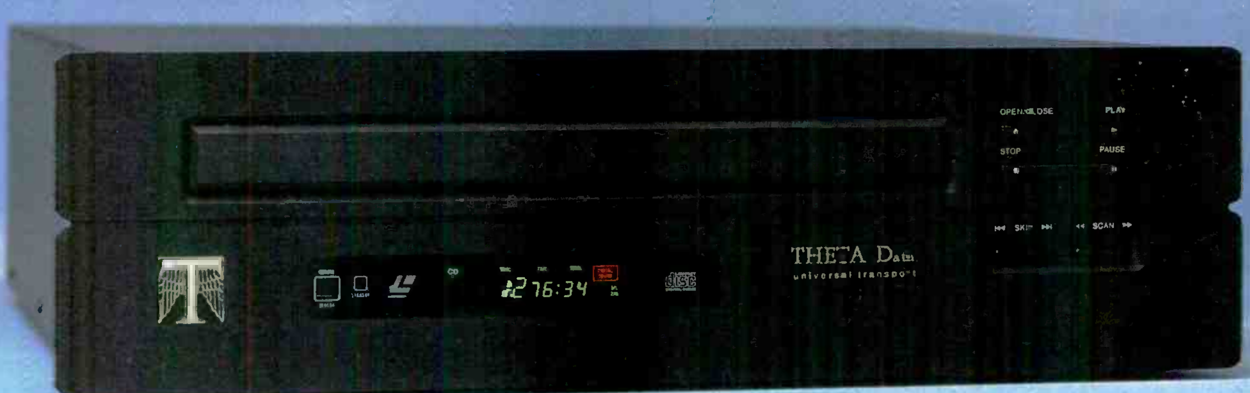

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The cabinet's rounded contours not only enhance the system's appearance but improve its sound by minimizing reflections.

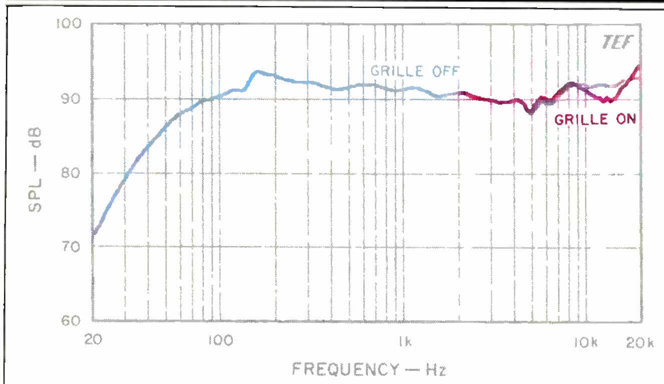


Fig. 1—One-meter, on-axis, anechoic frequency response, for an input of 2 watts into 4 ohms (2.83 V).

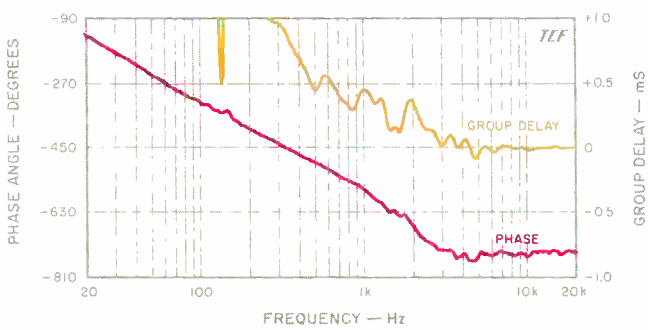


Fig. 2—On-axis phase response and group delay, corrected for tweeter arrival time.

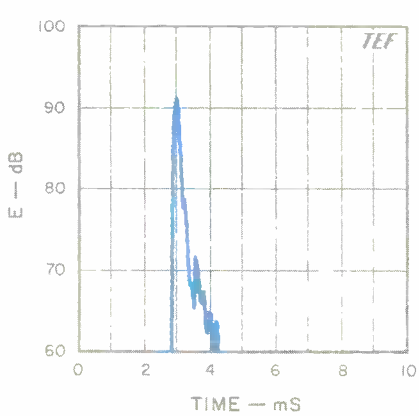


Fig. 3—One-meter, on-axis energy/time curve.

dome tweeter is made of aluminum and manganese with a soft fabric surround, and it has a diffuser lens to improve high-frequency coverage.

According to Canton, the crossover network has been optimized "especially with regard to phase lock reproduction and constant envelope delay times." This is said to guarantee that all frequencies in a musical selection actually reach the listener's ear at the same time.

The Ergo 100's cabinet incorporates a computer-optimized, bass-reflex (vented-box) configuration and has distinctly rounded contours that not only enhance the look of the systems but also improve sonics by minimizing reflections. All drivers are flush-mounted on the front panel, which is covered with a black sound-absorbing felt material. The grille is a self-supporting, perforated-metal assembly which fits into a groove. Connections are made through a pair of five-way binding posts at the bottom rear of the cabinet. Unfortunately, these posts are spaced apart by more than the standard ¾ inch, so they cannot accept normal double-banana plugs.

Measurements

Figure 1 shows the on-axis frequency response of the Ergo 100, with and without the grille. Measurements were taken with 2.83 V rms applied, at a distance of 2 meters on the tweeter's axis (about 36 inches above the bottom of the system) and then referenced back to 1 meter. Notable features include a relatively high sensitivity, a step in the response at about 150 Hz, and a modest lowering of level and slight response roughness in the crossover region from 2 to 7 kHz. The curve fits within a relatively tight window of +2.5, −3.0 dB from 60 Hz to 20 kHz. Below 60 Hz, the response rolls off gradually, attaining a roll-off rate of about 18 dB/octave below 30 Hz. Curves supplied by Canton were smoother through the region from 2 to 7 kHz, but those curves were measured at a height of 1.1 meters (43.3 inches), about even with the top of the enclosure, which is about 7 inches above the ears of a seated listener.

Averaging the curve over the range from 250 Hz to 4 kHz yields a sensitivity of about 91.5 dB, lower than rated. The lowering of level through the upper midrange region contributes to this. Below 10 kHz, the grille has only a slight effect on the response. From 10 to 16 kHz, the grille reduces the response but actually increases response above 16 kHz. Above 20 kHz (not shown), the response reached a maximum at about 21 kHz and then fell rapidly at higher frequencies. Comparing right and left units revealed a fairly close match of ±0.5 dB.

Figure 2 shows the phase and group-delay responses referenced to the tweeter's arrival time. The midrange lags the tweeter by about 0.4 mS, about 1.4 wavelengths at the 3.5-kHz crossover. This delay is partly due to electrical delays inherent in the crossover filter and partly to physical driver offsets. One significant feature of the curves is an anomaly at 150 Hz, which coincides with the step in the amplitude response.

Figure 3 shows the energy/time response of the system at 1 meter on axis for an input of 2.83 V rms. The test brackets the midrange's upper response and the tweeter's response below 10 kHz. The main arrival, at 3 mS, is quite compact,

The vertical off-axis and on-axis curves are the same shape, showing that horizontal coverage is quite good.

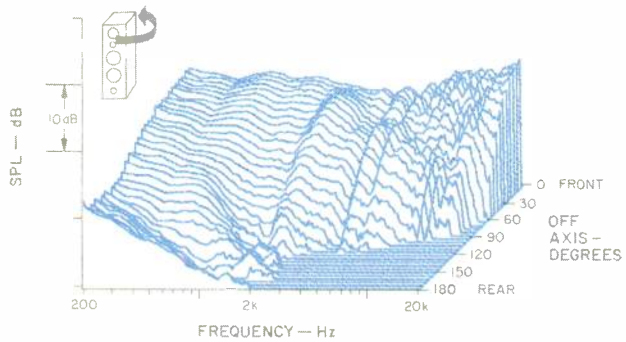


Fig. 4—Horizontal off-axis frequency responses, taken from the front, around the side, and to the rear of the speaker.

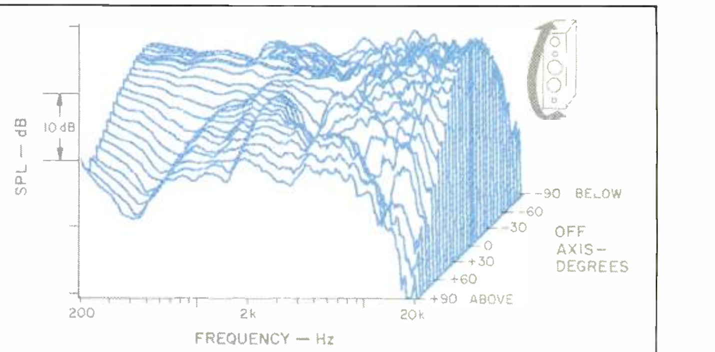


Fig. 5—Vertical off-axis frequency responses, taken from below, up the front, and to the top of the speaker.

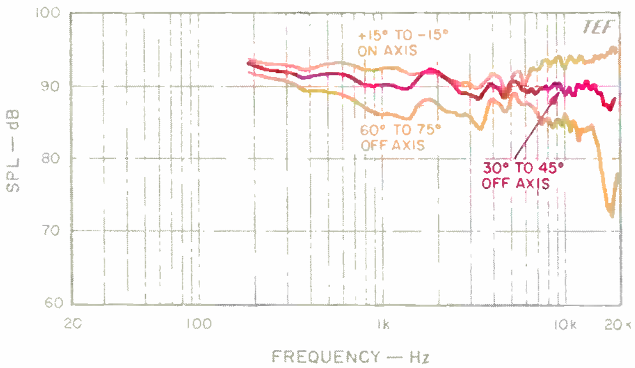


Fig. 6—Mean horizontal responses derived from data of Fig. 4.

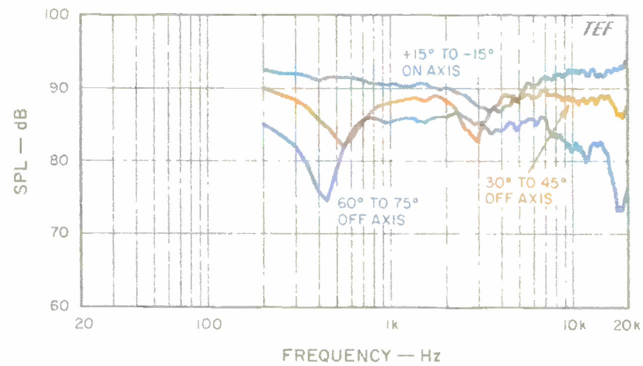


Fig. 7—Mean vertical responses derived from data of Fig. 5.

but the curve exhibits lower level arrivals 0.5 mS after the main peak.

The horizontal "3-D" off-axis curves are shown in Fig. 4; the on-axis curve is seen at the rear of the graph. The off-axis curves, in general, are the same shape as the on-axis curve, which shows that the horizontal coverage of the Ergo 100 is quite good and holds up well to beyond 15 kHz for angles out to ±45°.

The vertical off-axis curves are shown in Fig. 5. The on-axis response curve is shown in bold, halfway back, with the above-axis responses in the front of the display. The Ergo 100 exhibits narrowing vertical coverage at both the lower (300-Hz) and upper (3.5-kHz) crossover frequencies. Not seen clearly in the graph is the fairly symmetrical up/down response behavior through the 3.5-kHz region, which indicates only slight lobing. In the main vertical listening window of 0° to +15°, the response is quite uniform over the whole frequency range.

The NRC-style mean horizontal and vertical on- and off-axis response curves are shown in Figs. 6 and 7. The +15° to −15° horizontal curve (Fig. 6) is quite similar to the on-axis response, which indicates very good coverage in the primary listening range. The 30° to 45° response is quite close to the axial curve but with reduced level above 6 kHz. The lack of roll-cff above 10 kHz is noteworthy. The 60° to 75° off-axis response exhibits no major anomalies and stays strong out to about 14 kHz. These curves signify a system that should image well in the lateral plane.

Figure 7 shows the mean vertical responses. The on-axis curve is very similar to the corresponding horizontal curve but exhibits a depression in the 3.5-kHz region caused by increased directivity due to the fairly high crossover frequency. Examination of the individual curves that make up the ±15° curve shows a fairly even up/down behavior that indicates minimal lobing. (The midrange and tweeter are mostly in phase through crossover, a desirable trait.)

Harmonic distortion at 440 Hz was no more than 0.7% at 100 watts—so low that I didn't even bother showing it.

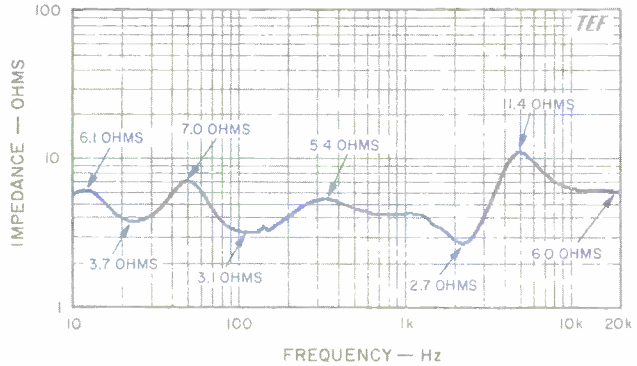


Fig. 8—Impedance.

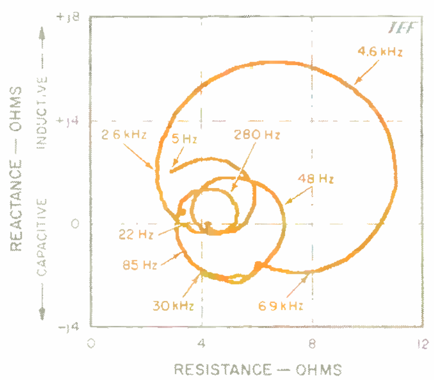


Fig. 9—Complex impedance, showing reactance and resistance vs. frequency.

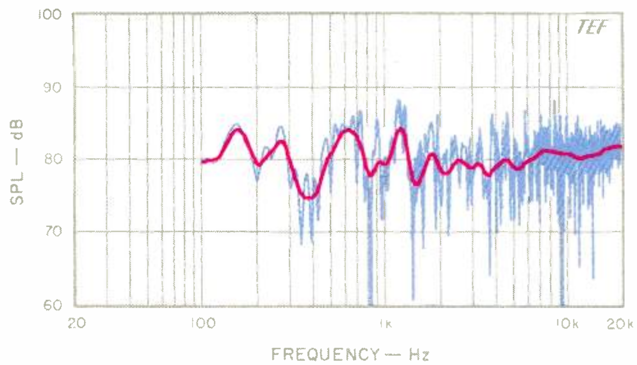


Fig. 10—Three-meter room response, showing both raw and smoothed data.

The main feature of the 30° to 45° response is the reduced level in the crossover regions (dips at about 500 Hz and 3 kHz), which indicates increased directivity in these areas. Except for a significant dip near the lower crossover, the 60° to 75° vertical response is quite close to the corresponding horizontal response. Also apparent in these curves is the lack of any severe treble roll-off below 16 kHz.

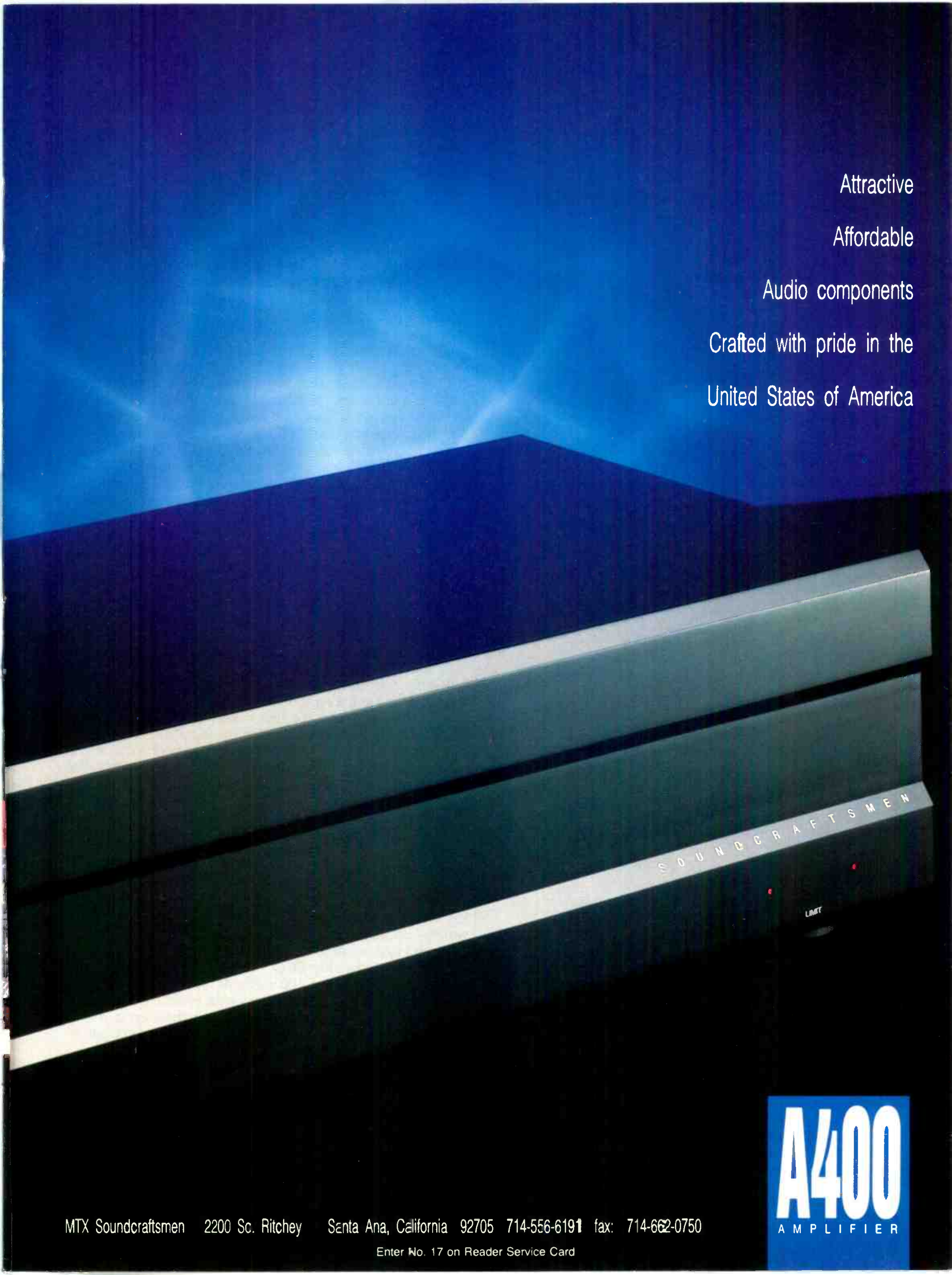
A high-level, low-frequency sine-wave sweep revealed one quite significant rear-panel resonance around 145 Hz, accompanied by some buzzing. This frequency coincided with the anomaly in the on-axis response noted earlier and also appeared later, in the system's measured impedance. Commendably, the woofer had no significant dynamic offset effects with the high-level sweep. The woofer's excursion exhibited no sharp reduction at the system's vented-box resonance frequency (roughly at 25 Hz). However, covering the port showed that the enclosure was providing a maximum reduction of woofer displacement of about 30% in the range from 24 to 30 Hz. In fact, the enclosure provided usable reduction in cone motion over a fairly broad range from 20 to 50 Hz. In this range, a significant portion of the total sound was radiated from the port. In the low-frequency range, with the port uncovered, the sound exhibited significantly less audible distortion than with the port covered. Some port air-rush noise was evident at higher levels, however. The port itself is a tube 6 inches long, with an inner diameter of 2¾ inches.

An examination of the port revealed that its inside end was covered with a thin piece of acoustic foam (stretched and glued tightly), which apparently provides deliberate resistance to the flow of air through the port. This changes the vented-box enclosure into a damped vented-box system, which has some of the advantages of both closed and vented systems. With damping, the vent's output covers a broader frequency range, thus spreading the beneficial effects of the port. The downside is that the distortion-reduction capabilities of the vented system are significantly reduced by spreading its effects over a broader frequency range. (This is covered more fully in my review of the Dynaudio Special One in the December 1990 issue.)

The enclosure is a tight-fitting, well-constructed cabinet whose medium-density fiberboard walls are unusually thick, a full inch. Two internal braces go completely around the inside of the cabinet, about one-third and two-thirds of the way down from the top of the enclosure. As the back-panel resonance showed, these braces apparently are not very effective in the range from 140 to 150 Hz. In a cabinet of this shape, theory suggests braces placed lengthwise on the panel would be more effective than crosswise braces; lengthwise braces raise the resonant frequencies much higher than crosswise braces do.

The sides of the enclosure are lined with fiberglass 2 inches thick, while an equal thickness of white batting-like material covers the rear. The upper portion of the cabinet is blocked off to form an enclosure for the midrange.

The woofer's linear excursion capability was a healthy 0.4 inch peak to peak, with a limit excursion of about 0.75 inch peak to peak (excellent values for an 8-inch woofer). The woofers overloaded gracefully at high levels. The nominal 8-inch woofer had an actual outside frame diameter of 8½



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The Canton Ergo 100s' high sound output at 20 Hz, and even higher output above 40 Hz, may render subwoofers unnecessary.

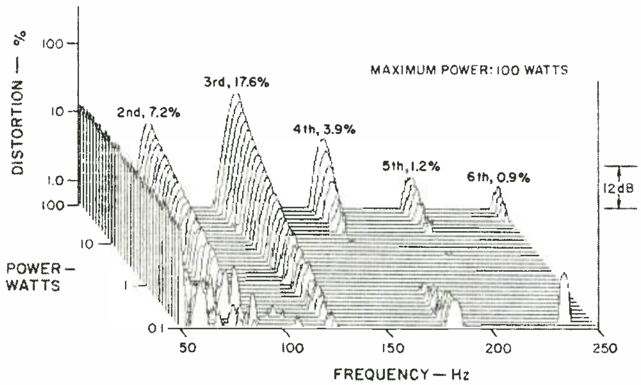


Fig. 11—Harmonic distortion products for the musical tone E_1 (41.2 Hz).

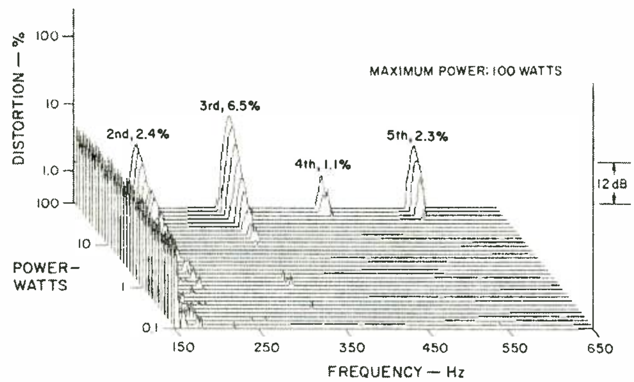


Fig. 12—Harmonic distortion products for the musical tone A_2 (110 Hz).

inches and an effective piston diameter, measured between surround middles, of about 6½ inches. Combined, the two 8-inch woofers have almost the same air-moving capability as a single 12-inch driver. The linear excursion capability of the midrange just about matched that of the woofers. The midrange driver would make a respectable bass driver for a two-way system. The effective piston diameter of the midrange was 4¼ inches, with an outside frame diameter of 6 inches.

The crossover of the Ergo 100 consists of 15 parts: Six inductors, six capacitors, and three resistors. Because two inductors are in series and two capacitors and two resistors are in parallel, the effective count is 12. Parts quality is very high, with 12-gauge wiring for the woofers and crossover drive and 14-gauge wire for the midrange and tweeter. All connections are soldered. The crossovers are on p.c. boards attached to the inside of the rear panel. The crossover is configured as a third-order low-pass filter for the woofers (one capacitor and two inductors), a fourth-order bandpass for the midrange (two capacitors, two inductors, and one resistor), and a second-order high-pass driving the tweeter (two capacitors, one inductor, and one resistor, including a series-RC impedance-correcting network).

Figure 8 shows the system's impedance plotted over the range from 10 Hz to 20 kHz. Three impedance minimums are seen, with the lowest being only 2.7 ohms at 2.2 kHz. The minimum at 25 Hz indicates the general range of the tuning of the vented low-frequency cabinet. A slight perturbation occurs at about 150 Hz, which coincides with the back-panel resonance. The Ergo 100 will be quite sensitive to cable voltage drop because of the system's relatively high maximum-to-minimum variation of 4.2 to 1 (11.4 to 2.7 ohms). Cable series resistance should therefore be kept low, limited to a maximum of about 0.040 ohm, to keep cable-drop effects from causing response peaks and dips greater than 0.1 dB. For a standard run of about 10 feet, 14-gauge or larger diameter wire is required.

The complex impedance from 5 Hz to 30 kHz is shown in Fig. 9. The phase angle of the impedance (not shown) reached a maximum of +54° (inductive) at the upper midrange frequency of 3.4 kHz and a minimum of −25° (capacitive) at the bass frequency of 71 Hz.

Figure 10 shows the 3-meter room response of the system with both raw and smoothed sixth-octave responses. The Ergo 100 was in the right-hand stereo position, aimed at the listening location, and the test mike was at ear height (36 inches), at the listener's position on the sofa. The system was driven with a swept sine-wave signal of 2.83 V rms (corresponding to 2 watts into the rated 4-ohm load). The response includes the direct sound plus 13 mS of the room's reverberation. Above 2 kHz, the smoothed curve is quite flat and well behaved and fits a tight window of ±1.8 dB. Excluding the 5-dB room dip at 400 Hz, the complete curve fits within a ±4 dB envelope from 100 Hz to 20 kHz.

Figures 11 and 12 show harmonic distortion versus power for the musical notes of E_1 (41.2 Hz) and A_2 (110 Hz). The A_4 (440-Hz) data is not shown because the distortion was quite low and did not exceed 0.7% at any harmonic at the 100-watt full-power level. The power levels were computed using the rated system impedance of 4 ohms.

Figure 11 shows the E_1 (41.2-Hz) harmonic distortion at power levels from 0.1 to 100 watts. At full power, the second and third harmonics reach moderate levels of 7.2% and 17.6%, respectively. The higher order harmonics are only significant above 10 watts. At 100 watts, the system generates a very loud 113 dB SPL at 1 meter at 41.2 Hz.

The A_2 (110-Hz) harmonic data is shown in Fig. 12. The third harmonic reaches only 6.5% at full power, with the second following behind at only 2.4% at 100 watts. The fourth and fifth harmonics are only significant above 50 watts. At 110 Hz, the system generates a very loud 121 dB SPL at 1 meter for 100 watts input.

Figure 13 shows the IM created when a 440-Hz (A_4) tone is mixed with a 41.2-Hz tone (E_1) of equal input level. At 50 watts, the IM distortion reaches only 4% and rises to 9% at

The Cantons' sensitivity was so high that my normal volume settings proved uncomfortably loud.

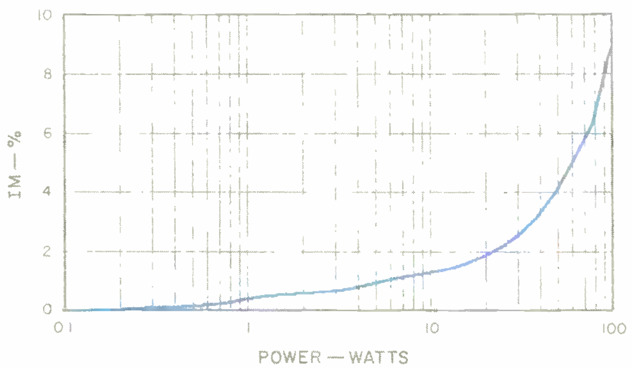


Fig. 13—IM distortion on 440 Hz (A_4) produced by 41.2 Hz (E_1) mixed in one-to-one proportion.

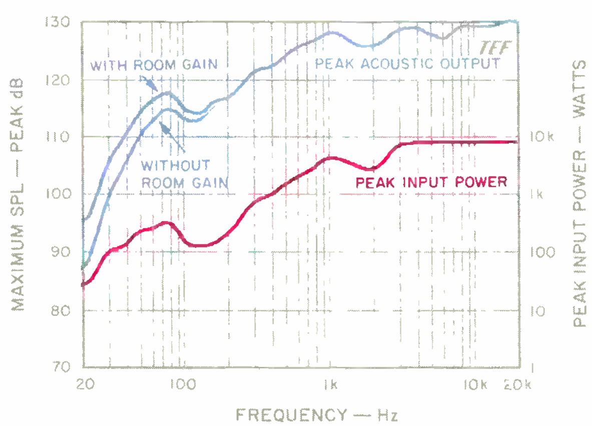


Fig. 14—Maximum peak sound output, measured at 1 meter on axis, and corresponding maximum peak input power levels.

100 watts. The relatively low IM is a result of the system's three-way configuration. The midrange mainly handles the upper frequency, while the woofer handles the lower.

Figure 14 shows short-term peak power input and output capabilities, as functions of frequency, measured with third-octave tone bursts. The peak input power (lower curve) was calculated by assuming that the measured peak voltage was applied across the rated 4-ohm impedance.

The peak input power rises with frequency, reaching about 300 watts at 80 Hz. Above this frequency, however, maximum power actually decreases to about 150 watts at 160 Hz and increases thereafter. The reduction in input power between 100 and 250 Hz was apparently due to inductor overload in the woofer's branch of the crossover, because the acoustic output waveshape turned into a triangle for higher power levels. The input power handling attains a level of about 9 kW (180 peak V across the rated 4-ohm load) at frequencies above 3 kHz. The slight dip in power handling between 1 and 3 kHz was caused by my test amplifier running out of gas, due to the Ergo 100's low impedance in this range.

The upper curve in Fig. 14 shows the maximum peak sound pressure levels the system can generate at 1 meter on axis for the input levels shown in the lower curve. Also shown is the "room gain" of a typical listening room at low frequencies, which adds about 3 dB to the response at 80 Hz and 9 dB at 20 Hz. A pair of the Canton systems in a standard stereo setup, operating with common-channel bass, will be able to generate higher bass levels. The peak acoustic output rises quite rapidly with frequency up to 80 Hz, where a maximum of about 114 dB is reached. After a moderate decrease, the output level continues to increase and attains levels in the range from 125 to 129 dB SPL above 3 kHz. The system's high efficiency and its high power handling above 600 Hz yield very high maximum output capabilities in this range. With room gain, the Ergo 100 exceeds 110 dB SPL above 40 Hz and generates very usable levels, exceeding 97 dB at 20 Hz and above. Subwoofers may not be required with this system!

Use and Listening Tests

Canton provides a well-written, 14-page instruction manual—not nearly as long as it sounds, because half of it is in German and five pages are devoted to the specifications of the Ergo line. The "Power Handling" section cautions you not to turn the volume up higher than is good for the speakers, adding that you can judge this by audible distortion as overload begins. But it also warns that this assumes sober listeners: "Alcohol raises the tolerance threshold for distortion. Many a loudspeaker has met its doom at a party where the wine was flowing freely."

The Ergo 100s are quite attractive. My review samples were finished in a very handsome oak veneer, and workmanship was first-class. The rounded upper corners helped the systems blend in with other furnishings.

The speaker terminals at the bottom rear of the cabinet are designed for finger-tightening only and not for a nut driver. As the terminal access space is somewhat small, I frequently felt I was not getting the terminals tight enough.

The speakers were placed about 10 feet from my sofa, about 6 feet from the short rear wall and 4 feet from the side walls, and they were spaced 8 feet apart. The systems were auditioned with their grilles off and were canted in towards the listening position. Most listening was done before the measurements.

My first experience with the Ergo 100s made me quite aware of their high sensitivity; normal volume settings on the Rowland Consummate preamp resulted in uncomfortably loud levels! I fired up the systems on the latest *Mannheim Steamroller Christmas* CD (American Gramaphone AGCD-1984) and was pleasantly surprised with the balanced, wide-range performance. Wind chimes, between the "Deck the Halls" and "We Three Kings" tracks, sounded extremely

Chamber music showed off the 100s' excellent imaging, with instrument placements that were quite vivid and distinct.

lifelike. The systems were well balanced but exhibited some upper bass fullness and did not quite have the low-frequency extension of my reference B & W 801s. The low end, however, was quite tight and well controlled.

The high sensitivity of the 100s serves well when reproducing the high peak levels of the special-effects sounds on *Ein Straussfest* (Telarc CD-80098). When this disc is played at high levels, the sounds of cork-popping and weaponry at the ends of cuts 3 and 4 will nail your head to the wall! The systems were also capable of creating clean, quite realistic levels on the marching band in the Boston Pops/John Williams *I Love a Parade* (Sony Classical SK 46747).

The Canton systems passed the pink-noise stand-up/sit-down test with only minimal changes in upper midrange tonality. The horizontal coverage equalled that of my reference speakers. On pink noise, some slight spectral unevenness and tonality were evident on the 100s when compared to my references. (My reference systems are very good in this regard, it must be pointed out.) Random noise, including pink noise, should sound quite bland and featureless; any discernible tonal characteristics would indicate that one frequency band was being emphasized over another.

On low-frequency, third-octave band-limited pink noise, the Canton systems credibly handled all the bands from 20 Hz up. At 40 Hz and above, the Ergo 100s were the equal of my reference systems. At the three lowest bands (20, 25, and 31.5 Hz), the fundamental output was not as strong as my references' and had somewhat more port wind noises. For these comparisons, the level was set just slightly below the overload point for the 20- and 25-Hz bands.

On the new Dire Straits album *On Every Street* (Warner Bros. 9 26680-2), my reference speakers had a somewhat livelier, punchier bass than the Cantons but did not sound quite as well controlled. However, room acoustics and system placement bear heavily on performance in this frequency range. The Cantons' reproduction of upper frequency vocal sibilants was slightly crisper and a bit more emphasized than my references'.

The excellent imaging capabilities of the Ergo 100 were demonstrated on the string chamber music of Schubert's Quintet in C (Sony Classical SK 46669, played on all Stradivarius instruments from the Smithsonian), where lateral instrument placements were quite vivid and distinct. When the preamp was in the mono mode, the image was centered and quite stable, of minimal width, and did not wander with frequency. Close right/left system matching is required to maintain a stable center image under these conditions.

To sum up, the high sensitivity and good looks of the Canton Ergo 100s, combined with their smooth, balanced, wide-range sound—as well as good imaging and low distortion—make them very worthy contenders in the floorstanding tower loudspeaker competition. *D. B. Keele, Jr.*

4

NAIM AUDIO NAP 135 MONO AMP AND NAC 72 PREAMP

Manufacturer's Specifications

Preamplifier

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

THD + N: 0.1%, 20 Hz to 20 kHz.

High-Level Sensitivity: 75 mV.

Maximum Output: 7.5 V.

Dimensions: Preamp and Hi-Cap power supply, each 8 in. W × 3 in. H × 11¾ in. D (20.3 cm × 7.6 cm × 29.8 cm).

Weight: Preamp, 6 lbs. (2.7 kg); power supply, 16 lbs. (7.3 kg).

Prices: Preamp, $1,395; power supply, $1,245.

Amplifier

Output: 75 watts into 8 ohms, 135 watts into 4 ohms.

Power Bandwidth: 3 Hz to 40 kHz +0, −3 dB.

THD + N and IM: 0.1%, 20 Hz to 20 kHz, at rated output level.

Sensitivity: 105 mV for 1 watt output into 8 ohms.

Impedance: 22 kilohms.

Dimensions: 17 in. W × 3 in. H × 11¾ in. D (43.2 cm × 7.6 cm × 29.8 cm).

Weight: 29 lbs. (13.2 kg).

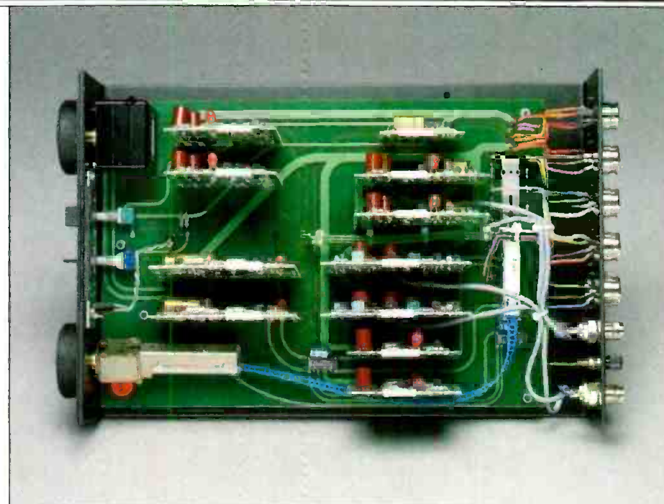
Price: $2,995 each.

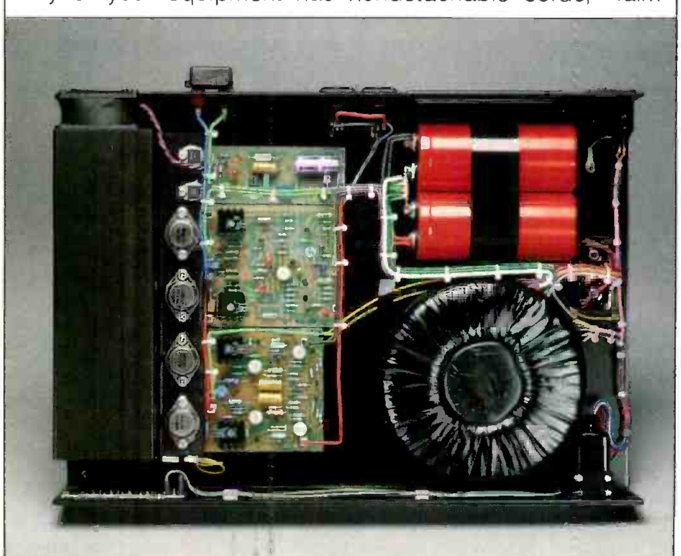
Company Address: 1748 North Sedgwick St., Chicago, Ill. 60614.
For literature, circle No. 93

Naim Audio is one of those English companies you hear about but whose products you probably don't get to experience unless you go out of your way to listen to them. In fact, the top-of-the-line NAC 72 preamp, the optional Hi-Cap (high-capacity) power supply, and the pair of NAP 135 mono power amps reviewed here are the first Naim equipment I have ever used. The company makes other components too, including tuners, integrated amps, electronic crossovers, and even speakers.

Trying to figure out how to hook up the Naim equipment was, at first, somewhat puzzling. A number of interconnect cables came along with the gear, most with some kind of DIN connector at one or both ends. I'm a knowledgeable audio engineer, and I was confused! The instruction manual was reasonably well written and covered most of what Naim makes, which enabled me to figure things out. According to Naim Audio of North America, dealers are required to install whatever they sell, and the manual is intended purely as a backup for the consumer. Even so, this manual, along with, perhaps, some help from the dealer, should enable the average customer to get things properly hooked up.

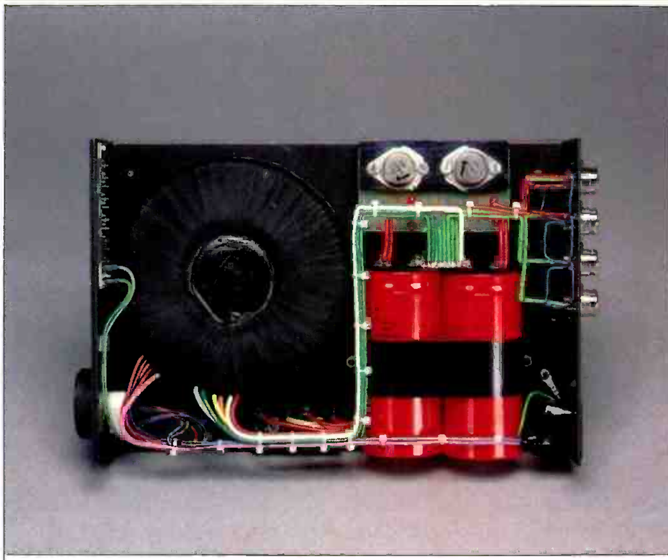
The preamp and Hi-Cap power supply are the same size, each about half the width of the NAP 135 amplifiers. Front-panel controls on the preamp include, from left to right, "Volume," "Balance," a three-position switch (for muting, "Normal," and tape monitor), and a five-position source selector. The volume control and selector switch have large rubber-sheathed knobs. When we look at the rear panel, the great difference between this preamp and more familiar units comes into focus: There isn't a phono connector on it! Instead, there are four BNC r.f. connectors, five DIN connectors with various pin configurations, and a ground post. (Although DIN connectors are actually rather common in European countries, they are rarely found on audio equipment imported into this country.) The BNC connectors are for phono and one auxiliary input. Naim thinks that these connectors make for better sound with low-level inputs. Both RCA-to-DIN and RCA-to-BNC cables are available, but if any of your equipment has nondetachable cords, Naim suggests you replace those cords' phono plugs with DIN or BNC types rather than use adaptors. Three of the DIN sockets share a commonly used five-pin geometry. One of these, labelled "Tuner," is used as a second high-level input. Two of its pins are used for the hot leads of the two channels and one is used for common. The next two five-pin DIN jacks are used for connections to two tape recorders. These connectors have two pins for the two channels' hot connections for record out, two pins for the hot connections for tape in, and the remaining pin for common. Next, a four-pin DIN connector, labelled "Output," is for both preamp power input and signal output. This connector passes both output channels to a host stereo power amplifier (such as the Naim NAP 90 or 140) and receives operating power back from it. The fifth and final DIN connector, a five-pin type with a different pin geometry, is designed for connecting the optional Hi-Cap power supply, required for use with amps (such as the NAP 135s) that do not have power-supply outputs. This jack passes both preamp output signals to the connecting cable but uses two pins for separate power to different parts of the preamp and uses one pin for common. When the adjacent "Output" plug is used to power the preamp, you insert a five-pin male dummy plug into this last socket to tie the two power-supply points inside the preamp together.





When using the Hi-Cap power supply to power the preamp, signals are fed to the power amplifier from sockets on the supply. The knob on this unit's front panel matches those on the preamp. The rear panel has a combination line-cord socket/fuse-holder that I've been seeing lately on new equipment, and four multi-pin DIN connectors. One socket, as previously mentioned, powers the NAC 72 preamp and receives the signals from it. The remaining sockets, all regular four-pin DIN format, feed signals to the system power amp (or amps) or feed both power and signal to the Naim NAXO electronic crossover, which would then feed the appropriate signals to multiple power amplifiers. My initial confusion about the numerous DIN connectors was replaced by admiration for this system engineering, as it allows so many different combinations of Naim components to be used with DIN interconnects.

Although hookup of Naim equipment is a bit unusual, the company's dealers are required to install what they sell.



Within the Hi-Cap supply's enclosure is a toroidal power transformer as big as you'd expect in a power amp, two bridge rectifiers mounted to the bottom of the enclosure, two 15,000-μF/63-V filter capacitors, and a voltage-regulator assembly. A p.c. board carpeted with green LEDs is mounted behind the translucent front panel to surround the black Naim logo with an attractive green glow; the preamp and amps have this same backlighting system.

Inside the NAC 72 preamp, the bottom area is taken up by a large motherboard. Numerous individual p.c. boards plug vertically into the motherboard via female clips that engage male pins on the motherboard. The input selector is a long linear slide switch at the rear of the motherboard, where all the signal connectors are. A plastic-sheathed metal tape, which works like a bicycle's brake cable, connects this switch to the front panel, where the control knob's rotary motion is converted to linear motion to activate the switch. These neat components allow the switch to be where it's needed for best electrical performance. A high-quality, dual 20-kilohm Alps volume control is mounted to the front of the motherboard, as are the balance and mode controls.

The front panel of the NAP 135 mono amplifier has a pushbutton power switch near its right edge. At the top left is the backlit Naim logo. As you look at the rear panel, on the left is a combination a.c. line-cord socket/fuse-holder. Next is an air-intake slot. In the middle of the panel is a pair of XLR connectors for signal input; one is wired to accept the left-channel signal from Naim's multi-conductor interconnect cable, the other to accept that cable's right-channel signal. To the right is a horizontally oriented dual-banana socket for speaker connections and, finally, the small cooling fan at the outlet end of the heat-sink tunnel.

Inside the amplifier, a large toroidal power transformer, two power rectifier bridges, and a pair of filter capacitors take up about half of the interior space. Running along the right-hand side is a horizontal heat-sink with a ledge on which four TO-3 and two TO-220 power transistors are mounted. Multiple fins extend to the right edge of the internal space. The right edge of the amp enclosure covers the open part of the heat-sink, forming the closed tunnel through which cooling air is drawn by the fan. Mounted under the ledge are three p.c. boards. These boards, from front to back, are for control of the cooling fan, main signal amplification, and power-supply regulation.

The same method of construction is used for all three of these Naim components. A U-shaped piece of metal forms each unit's rear panel, bottom, and front subpanel. A plastic front dress panel adorns each piece. The aforementioned chassis pieces slip into a cast or welded metal outer cover that makes up the top, bottom, and sides of the overall enclosure. The materials and workmanship are to a high standard.

Measurements

I began my testing with the NAC 72 preamp. As is my custom, I measured gain and sensitivity first (Table I). Concentrating on the line section of the preamp, I first checked what kind of bandwidth limiting was taking place in the filter stage and "AUX" input amplifier. Rise- and fall-times were measured at the tape output jacks for signals being fed into "Tuner" and "AUX" line inputs, with the "AUX" input amplifier set for unity gain. (A quick comment about rise- and fall-times: To be complete, one should talk about the separate rise- and fall-times of a pulse. However, in general they are the same unless some nonlinear phenomenon like slewing occurs. I'll abbreviate to just rise-time unless the rise- and fall-times are different.) Rise-times through "Tuner" and "AUX" were 5 and 9.6 μS, respectively, giving equivalent bandwidths of 70 and 36.5 kHz (using the usual rough formula that bandwidth equals 350 divided by the rise-time). This tells us that the tape output buffer is somewhat limited in high-frequency response and that the "AUX" input amp is more limited yet. Next, rise-times were measured at the main outputs, with "Volume" clockwise and "Balance" centered. Rise-time was now 8 μS for the "Tuner" input and 11 μS for "AUX." The former figure shows that the approximate bandwidth of the filter block preceding the "Volume" and "Balance" controls is about 44 kHz. The overall bandwidth

The volume control's two channels tracked within 0.3 dB down to −80 dB, the best tracking I have ever measured!

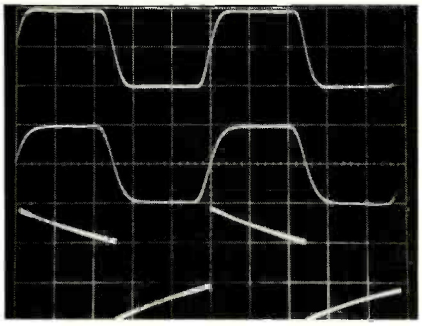


Fig. 1—Square-wave responses, measured at line amp output, for 10-kHz square wave through "Tuner" input (top), 10-kHz square wave through "AUX" input (middle), and 40-Hz square wave through "AUX" input (bottom). Scales: Vertical, 5 V/div.; horizontal, 20 µS/div. for 10-kHz traces, 5 mS/div. for 40-Hz trace.

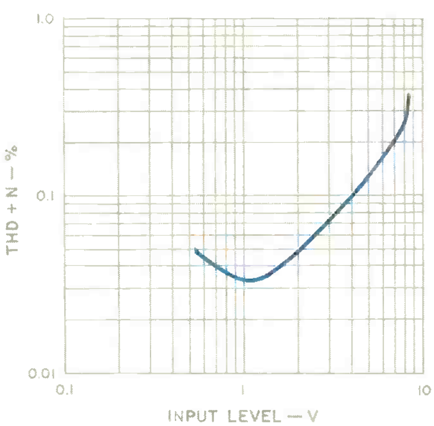


Fig. 2—THD + N vs. input level for 1-kHz signal applied to the "AUX" input. Curve is truncated below 0.5 V, as it would show noise more than distortion past this point.

through the "AUX" input to the main output is more like 32 kHz. A good feature of this low-pass filtering is that it has no overshoot, a result of its Bessel characteristic. The roll-off rate of the high-frequency filtering was 18 dB/octave. Figure 1 nicely illustrates this: Compare the 10-kHz square wave through the "Tuner" input (top trace) with the slower but nicely damped response to a 10-kHz square wave via "AUX" (middle trace). The bottom trace shows a 40-Hz square wave, applied via the "AUX" input, measured at the main output with instrument and IHF loading. With signal applied to the "Tuner" input, the low-frequency tilt was about 60% of that shown for the signal going into the "AUX" input.

Distortion from the line amplifier was found to consist of low-order second- and third-harmonic components, essentially constant with frequency over the audio range. Maximum output at the onset of clipping was about 8 V rms and was the same with instrument or IHF loading. Figure 2 shows how 1-kHz THD + N varies with output level for signals applied to the "AUX" input. With signal fed into the "Tuner" input, distortion is a little lower below 1 V output but is about the same above 1 V out. Signal acceptance at the "Tuner" or "AUX" inputs was quite good, taking about 8 V rms before the filter's amplifier block started to clip.

Line amplifier noise figures, referred to input, are given in Table II, along with IHF signal-to-noise ratios. As can be seen, the "Tuner" input, which does not have an active input amplifier, is quieter than the "AUX" input, which has a signal amplifier and band-limiting filter block. The input noise tabulated here is more from these circuits than from the line output amplifier which follows the "Balance" and "Volume" controls. In practice, though, the difference is negligible; this is demonstrated by the IHF S/N figures, which are dominated more by the noise of the line output amplifier. Recall that IHF S/N ratio is obtained by putting a 0.5-V signal into a line input and adjusting the system volume control for an output of 0.5 V. If active circuitry is present before the volume control, as in this instance, the S/N ratio of these

Table I—Gain and sensitivity, NAC 72 preamplifier.

	Gain, dB			
	Instr. Load	IHF Load	Instr. Load	IHF Load
	LEFT		RIGHT	
AUX to Tape Out				
Minimum	−13.2	−13.7	−13.1	−13.5
Maximum	+10.2	+9.7	+10.2	+9.3
AUX to Main Out				
Minimum	7.8	7.8	7.9	7.9
Maximum	31.2	31.2	31.2	31.2
Tuner to Tape Out	0	−0.5	0	−0.5
Tuner to Main Out	21.1	21.1	21.1	21.1
Phono to Tape Out	56.1	55.6	56.2	55.7
Phono to Main Out	77.1	77.1	77.15	77.15

	IHF Sensitivity	
	LEFT	RIGHT
AUX To Tape Out		
Minimum Gain	2.4 V	2.36 V
Maximum Gain	163 mV	165 mV
AUX to Main Out		
Minimum Gain	204 mV	200 mV
Maximum Gain	13.9 mV	13.9 mV
Tuner to Tape Out	525 mV	525 mV
Tuner to Main Out	44.5 mV	44.5 mV
Phono to Tape Out	830 µV	820 µV
Phono to Main Out	70.5 µV	69.5 µV

The power supply held its output voltage even when the a.c. line dropped to 85 V, so brownouts should not be a problem.

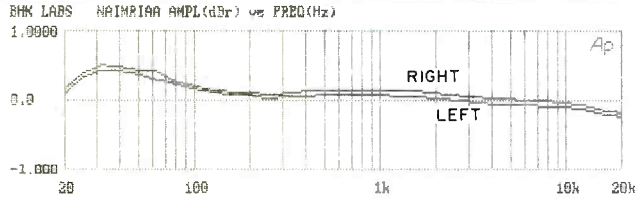


Fig. 3—RIAA equalization error, measured at tape output with instrument loading. With IHF load (not shown), the level dropped about 0.3 dB but response was unchanged.

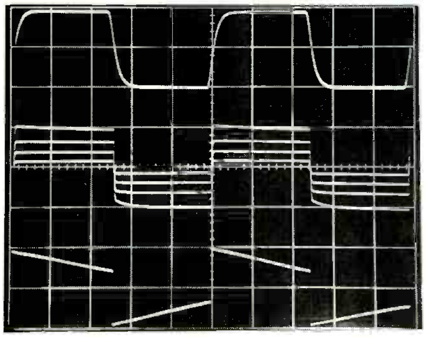


Fig. 4—Response of phono section to pre-equalized square waves of 10 kHz (top), 1 kHz at several input levels (middle; see text), and 40 Hz (bottom), all with instrument load. Vertical scales: Top and bottom, 0.5 V/div.; middle, 2 V/div. Horizontal scales: 20 µS/div. for 10 kHz, 200 µS/div. for 1 kHz, and 5 mS/div. for 40 Hz.

Input impedance at 1 kHz measured about 80 kilohms at "AUX" and about 30 kilohms at "Tuner." Output impedance was a low 5 ohms at the main outputs and about 560 ohms at the tape outputs.

Figure 3, the RIAA phono equalization error, shows quite a close match between channels. The most salient features of the equalization error are a slight emphasis in the region around 30 to 50 Hz and a slight roll-off in the top octave.

In the phono section, THD + N for 2 V output was almost 0.4% at 20 Hz, decreasing to about 0.2% at 100 Hz, getting down to the 0.05% area over most of the midrange, and climbing back to about 0.08% at 20 kHz. At an output level of 1 V, THD + N was 0.2%, 0.027%, and 0.06% for frequencies of 20 Hz, 1 kHz, and 20 kHz, respectively. Driving the phono preamp to output clipping revealed a relatively low output level for the supply voltage used. Output clipping occurs first on the positive half-cycle, at an output voltage of about 3 V rms. Considerable asymmetry exists; I had to drive the circuit a lot harder to see any negative half-cycle clipping.

Phono overload versus frequency is shown in Table III. Results are given for the left channel with instrument load only; the right channel behaved very much like the left. Loading the output with the IHF load of 10 kilohms in parallel with 1,000 pF of capacitance lowered the output level at visual onset of clipping by about 0.5 dB for the same measured input voltage. Notable is the relatively constant output voltage with frequency at the overload point. The electronics when fed a 0.5-V signal frequently exceeds that of the output amplifier when it is fed the attenuated signal delivered by the volume control.

Volume-control tracking between channels was found to be within 0.3 dB down to −80 dB! This particular control takes the sweepstakes for the best-tracking control I have ever tested.

Interchannel crosstalk was measured for both the "Tuner" and "AUX" inputs. As is frequently the case, crosstalk was not the same in each direction, being lower from the left to the right channel than in the right-to-left direction. Typical results were down more than 80 dB at frequencies below 1 kHz, increasing to −64 dB at 5 kHz and to −52 dB at 20 kHz. Crosstalk was in phase.

Table II—Preamp line section noise levels vs. bandwidth for input terminated with 1 kilohm, "Volume" control at maximum, and "Balance" control centered. The IHF S/N ratios for both channels were 86.8 dB for the "AUX" input and 86.2 dB for the "Tuner" input.

	Referred Input Noise, µV			
	AUX Input		Tuner Input	
Bandwidth	LEFT	RIGHT	LEFT	RIGHT
Wideband	21.0	20.6	13.6	13.6
20 Hz to 20 kHz	11.5	11.5	4.6	4.5
400 Hz to 20 kHz	11.3	11.2	4.3	4.3
A-Weighted	10.4	10.2	4.2	4.2

Table III—Phono overload vs. frequency for instrument load; left channel only shown.

Frequency, Hz	Input, mV	Output, V
20	0.52	3.0
50	0.67	3.0
100	1.0	3.0
300	2.5	3.0
1k	4.8	3.0
3k	8.2	3.0
5k	12.2	3.0
7k	16.4	3.0
10k	23.2	3.0
15k	34.0	2.9
20k	45.5	2.9

I can't recall an amplifier whose waveform changed so little when I added capacitance to its load.

onset of overload occurs when the input voltage reaches 4.8 mV at 1 kHz, which provides a nice, comfortable margin of at least 20 dB for low-output moving-coil cartridges (those with an output of less than 1 mV). I wouldn't recommend the use of the NA 323S phono board for high-output moving-coil pickups; Naim's NA 322 phono board, for moving-magnet pickups, would be better suited for them.

'Scope photos of phono circuit performance with pre-equalized square-wave signals are presented in Fig. 4. The top and bottom traces are for frequencies of 10 kHz and 40 Hz, respectively. In the middle trace, the test frequency is 1 kHz and output level is varied to show the effects of high-frequency overload with the out-of-band (above 20 kHz) energy in the pre-equalized square wave. At a little more than ±1 V, some asymmetry is becoming visible. The IHF load didn't materially affect this, which is pretty good performance in this test.

Referred input noise of the moving-coil phono board is listed in Table IV. Whether A-weighted or measured in the band from 400 Hz to 20 kHz, the noise is fairly low although not state of the art. Audible hiss should not be a problem except possibly with pickups having extremely low output.

Interchannel crosstalk in the phono circuitry, measured at the tape output, was outstanding—more than 90 dB down for frequencies as high as 300 Hz, decreasing to −81 dB at 3 kHz and to −74 dB at 20 kHz. This was for the worse, left-to-right, direction; in the right-to-left direction it was some 3 to 4 dB better.

A final note on the Hi-Cap power supply. The a.c. line draw was about 0.2 ampere. The power-supply regulators held up their output voltage at a.c. line voltages down to 85 V. Power-line brownouts are not likely to affect this unit.

For the NAP 135 power amps, Naim recommends against using any interconnect leads except their own, and against using a passive volume control. I had a problem with this, as I normally use a passive selector switch connected by a pair of 20-foot cables to my system power amps, which are between and behind the speakers. So one of the first things I measured on the amps was input impedance, to see if the input capacitance would allow me to use them with my passive switched attenuators. I came up with an input impedance on the order of 20 kilohms and an input capacitance of about 700 pF. I considered this amount, when

Table IV—Phono section noise vs. bandwidth and source resistance. The IHF S/N ratio was 74.6 dB for each channel.

Bandwidth	Source Impedance	Referred Input Noise, μV LEFT	Referred Input Noise, μV RIGHT
Wideband	0 Ohms	0.4	0.4
20 Hz to 20 kHz	0 Ohms	0.13	0.13
400 Hz to 20 kHz	0 Ohms	0.066	0.068
A-Weighted	0 Ohms	0.068	0.067
Wideband	100 Ohms	0.4	0.4
20 Hz to 20 kHz	100 Ohms	0.18	0.17
400 Hz to 20 kHz	100 Ohms	0.087	0.087
A-Weighted	100 Ohms	0.089	0.09

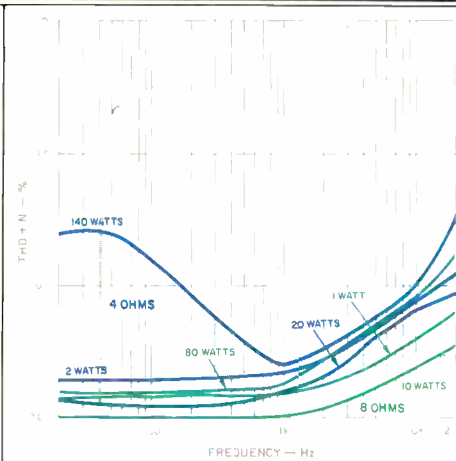


Fig. 5—THD + N vs. frequency as a function of power and load, NAP 135 amplifier.

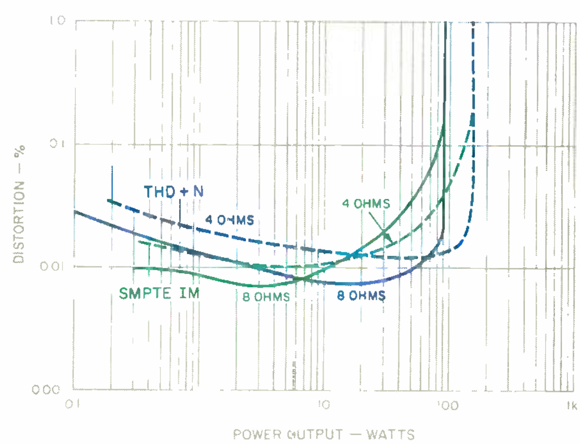


Fig. 6—SMPTE IM and 1-kHz THD + N vs. power output as a function of load.

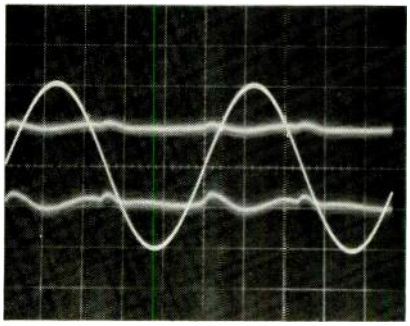


Fig. 7—Output and distortion residue for 1-kHz signal. For 10 watts into 8 ohms (top residue trace), THD was 0.008%; for 20 watts into 4 ohms (bottom residue trace), THD was 0.013%.

Some amplifiers without output buffers become unstable when driving low capacitance, but not the Naim NAP 135s.

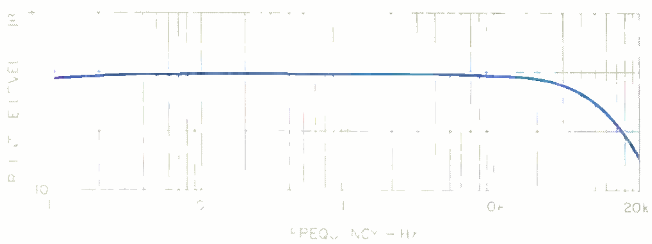


Fig. 8—Frequency response at 1 watt out into 8 ohms.

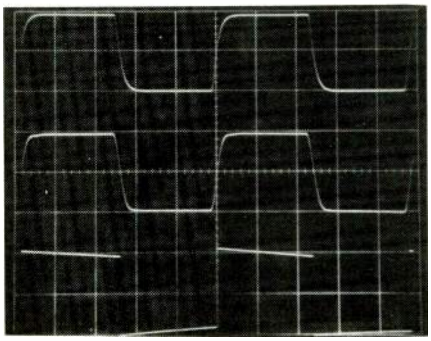


Fig. 9—Square-wave response for 10 kHz into 8 ohms (top), 10 kHz into 8 ohms paralleled by 2 μF (middle), and 40 Hz into 8 ohms (bottom). Scales: Vertical, 5 V/div.; horizontal, 20 μS/div. for 10 kHz, 5 mS/div. for 40 Hz.

Table V—Output noise of Naim NAP 135 amplifiers, Serial Nos. 58268 (amp A) and 58269 (amp B), with 1-kilohm input termination. The IHF S/N ratios were 88.8 dB for amp A and 85.0 dB for amp B.

	Output Noise, μV	
Bandwidth	AMP A	AMP B
Wideband	226	258
20 Hz to 20 kHz	213	242
400 Hz to 20 kHz	108	167
A-Weighted	102	154

paralleled with my interconnect capacitance of about 1,000 pF, to be too high to try the NAP 135s in my normal setup. This is not a negative comment on the amplifiers per se, as they will work just fine with Naim preamps.

Voltage gain was 28.7 dB with 8-ohm loading, which yields an IHF sensitivity figure of 105 mV. Measurements of THD + N as a function of frequency, power output, and load are shown in Fig. 5. Results are shown for only one of the power amplifiers, as the two were quite similar in performance. The rise in distortion below 1 kHz for 4-ohm loading at the 140-watt level is the onset of premature clipping in the positive half-cycle of the output waveform. How much the distortion increased was a function of how hot the amp was. Figure 6 shows both THD + N and SMPTE-IM distortion as a function of power and load. Typical harmonic-distortion residues at the 10- and 20-watt levels for 8- and 4-ohm loading are shown in Fig. 7. Even though the idling current is very low in this design, aberration at the waveform zero crossings is quite low. Some asymmetry in the distortion residue between signal half-cycles can be seen, indicating that the two half-cycles aren't perfectly matched.

Frequency response at 1 watt out into 8 ohms is plotted in Fig. 8. Four-ohm loading did not materially change the response. Related to the frequency response is response to square waves, seen in Fig. 9. The top trace is for 10 kHz with 8-ohm loading. The results of paralleling an additional load of 2 μF across the 8-ohm load are shown in the middle trace. This amp shows the least change of waveform on this test of any that I recall measuring, which demonstrates that it obviously doesn't have an output-buffering RL network. In some other designs that eschew such networks, some value of load capacitance below 2 μF can be found that will make the amplifier unstable. In this case, the amp was stable with all capacitance values below 2 μF. (Incidentally, when I tried to drive the output to higher levels with the 2 μF connected, the power supply's shutdown circuitry was activated, and I had to wait several minutes for the filter capacitors to discharge before the amp could be turned on again.) The bottom trace in Fig. 9 illustrates the amplifier's low-frequency response with a 40-Hz test frequency. Rise- and fall-times at an output level of ±5 V were 5.8 μS with 8-ohm loading and lengthened slightly to 6 μS with 4-ohm loading. The waveshape stayed exponential, like the top trace in Fig. 9, all the way up to voltage clipping with an 8-ohm load, which is a desirable characteristic.

Output impedance of the NAP 135 was essentially constant at about 0.23 ohm over the audio range, giving a damping factor of 35, referenced to 8 ohms. This constant output impedance, along with the relatively unchanging response with capacitive loading, should deliver consistent mid-frequency and high-frequency response with different speaker loads.

Noise at the amplifier output for different bandwidths is shown in Table V, along with the IHF S/N ratio. Although a trace of capacitor-charging current pulses could be seen in one amplifier's output noise, overall noise levels were satisfactorily low.

IHF dynamic headroom, based on a rating of 135 watts into 4-ohm loads, came out at 0.43 dB. Clipping headroom measured about the same, due to the regulated power supplies. In other words, the transient and steady-state power levels were the same, as would be expected. Clipping power into 8-ohm loads was about 86 watts. Maximum current delivery into a 1-ohm load was about +12.5 amperes, beyond which aberrations started to appear in the negative half-cycle.

The amplifier's a.c. line draw at idle was about 0.25 ampere. At an output of 140 watts into 4 ohms, the line-current draw was 3.3 amperes. The regulated power supplies permitted the unit to deliver 140 watts at line voltages

The Naim system gave musically satisfactory reproduction of both CDs and LPs, with good tonal balance and space.

down to about 104 V. This ability to put out full power with such reduced line voltage is impressive performance not matched by many other amplifiers.

Use and Listening Tests

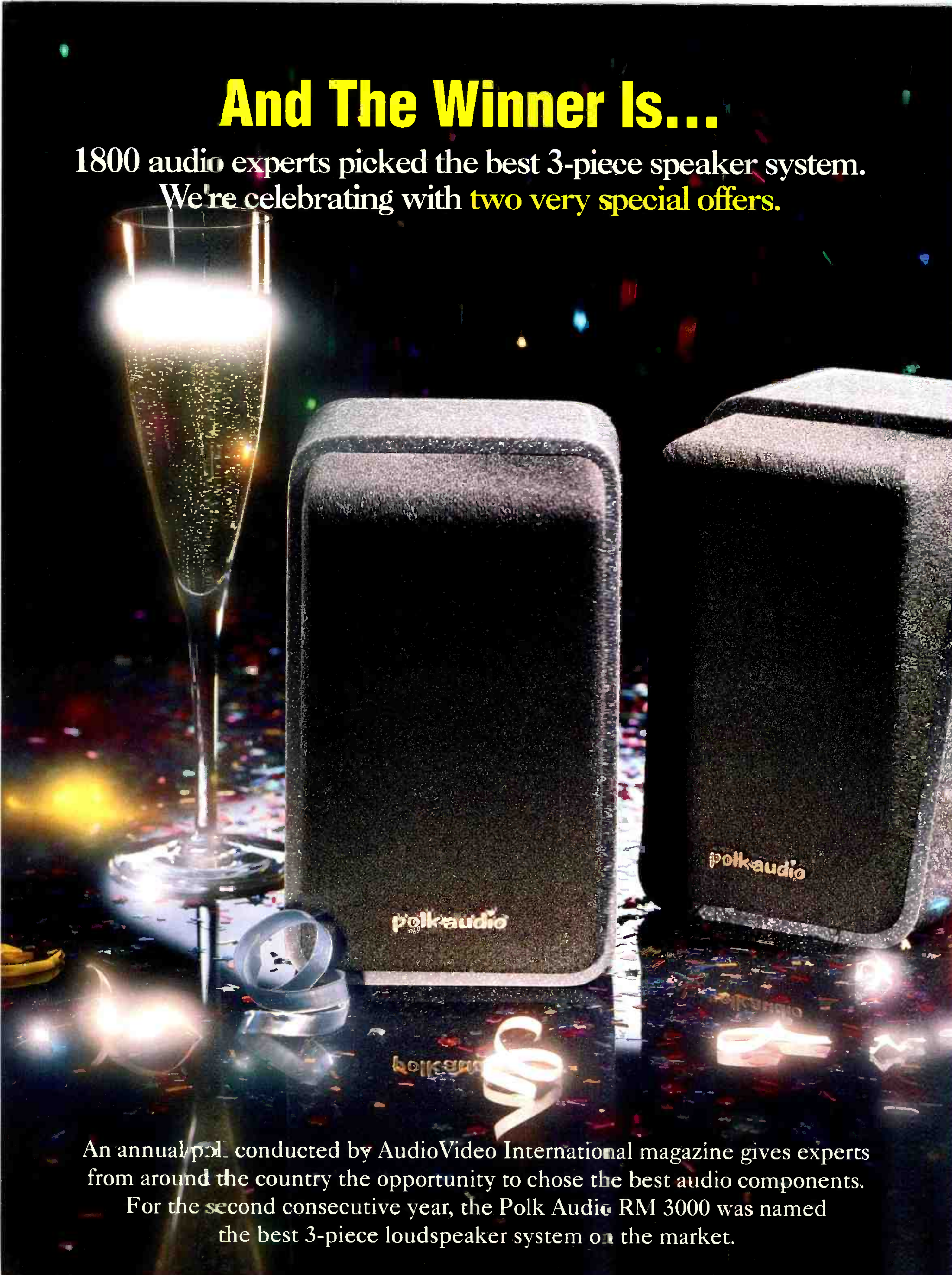
I initially decided to defer to Naim's recommendations and use their interconnect leads. The company sent me a made-up, 11-foot pair of their speaker leads, which enabled me to hook everything up with the power amps located behind the right speaker. Leads for my turntable and cassette deck were supplied by Naim and made by the Chord Company in England. I used the "AUX" input for my tuner and made up an adaptor with female Tiffany phono connectors wired into a five-pin DIN plug for my CD player, which was plugged into the "Tuner" input of the NAC 72.

CD reproduction was generally satisfactory and musical, but the upper midrange on a few discs didn't sound the same as through my usual reference setup. Record reproduction was smooth and musical, with low irritation levels and good tonal balance except for a feeling that the bass was a little weak. Space and depth were good but not outstanding. I have heard a better sense of space, depth, and air with other solid-state gear I have reviewed.

In an attempt to figure out where the irritation on those CDs was coming from, I used the Naim preamp to drive a Berning EA-2101 tube power amp via my usual 20-foot interconnect leads. (I hac no qualms about the preamp's being able to drive this load, as my tests had showed virtually no effect from using the IHF load.) With the Naim/Berning combination, some of the CDs sounded notably better, and musical resolution improved.

Despite the measured input characteristics of the NAP 135s, the maverick in me couldn't resist driving these Naim power amps from my passive selector switch/switched attenuator. I used a 2-meter pair of interconnects whose capacitance, plus the amplifiers' input capacitance, just about equalled that of my usual 20-foot interconnects. I used some adaptors to connect the phono plugs to the power amps' XLR inputs. This arrangement functioned perfectly. The sound was pretty interesting: Musical definition and space were better than when I used the amps with the Naim preamp, but overall, I preferred using the preamp with the Naim amplifiers.

I was able to enjoy music with the Naim gear. No glitches or surprises surfaced in using all the various combinations mentioned. Enjoyable as the Naim components were, my reference setup—using the selector/switched-attenuator unit and tube power amplifiers—was somewhat more musically convincing. As I have said before and will no doubt say again, these are my own observations and I do recommend that prospective buyers go out and give the Naim equipment a listen. *Bascom H. King*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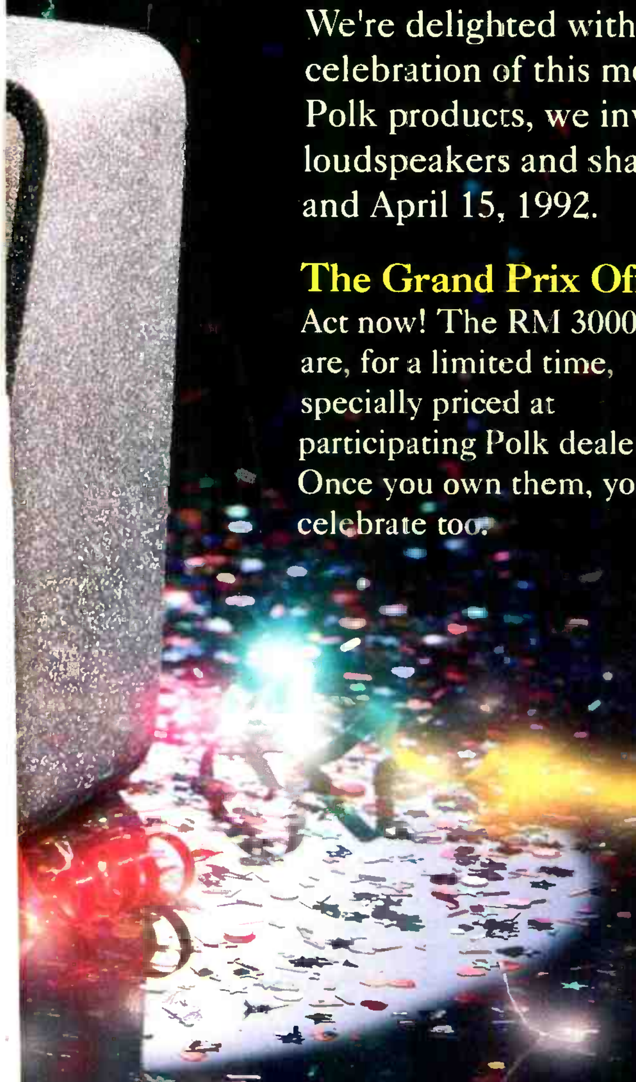

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GREAT BRITTEN

Britten: The Young Person's Guide to the Orchestra; Variations on a Theme of Frank Bridge; Sea Interludes and Passacaglia from *Peter Grimes*. BBC Symphony Orchestra, Andrew Davis.
Teldec 9031-73126-2, CD; DDD; 67:37.

Britten: Johnson over Jordan; Our Hunting Fathers; Shostakovich: Symphony No. 1. Phyllis Bryn-Julson, soprano; English Chamber Orchestra, Steuart Bedford.
Collins Classics 11922, CD; DDD; 75:52.

Britten: Music for Solo Piano; Music for Two Pianos. Stephen Hough and Ronan O'Hora, pianos.
Virgin Classics VC 7 91203-2, CD; DDD; 79:56.

It's moot how much Benjamin Britten's innate impulse to communicate musically may have led to his hiring by the BBC, and how much his yeomanship with the BBC helped him to develop the musical means to communicate on multiple levels even with listeners who harbored no interest in the intellectual baggage of 20th-century composition: Tone rows and such. Britten is perhaps the most direct and accessible of all major composers of our century.

For that very reason, I fear Britten's reputation has suffered diminution by snobs, but his music can be as deeply moving and satisfying as it is engaging. The fact that he has written so effectively for children—as both performers and auditors—documents his appreciation of, and appeal for, unsophisticated minds, but the sophistication with which he writes for them tells, as Paul Harvey would say, the other side of that story.

For anyone who has yet to discover Britten, the Teldec disc is perhaps the best possible introduction. Its three orchestral pieces are all top-drawer Britten and probably the best loved in his entire output. And Teldec has captured the pieces in the best orchestral recording I've heard in the past year, bar none. The BBC orchestra has never sounded better. Moreover, conductor Andrew Davis' way with the music is compelling.

On first hearing, the reading struck me as perhaps a little exaggerated; further listening has convinced me that it's largely a question of Teldec's wide dynamic range versus the constricted dynamics of the recordings against which I tend to measure these pieces. Perhaps Davis does go for energy more than refinement in some passages, but the whole can be recommended without reservation.

Illustration: Rick Tulka

The other two discs are welcome additions to the Britten discography but are much more for specialists. *Our Hunting Fathers*, a song cycle of poetry by W. H. Auden, is a major if oblique early antiwar statement. Soprano Phyllis Bryn-Julson sings well, but her diction doesn't help the rather obscure text—which mercifully is printed in the booklet.

"Johnson over Jordan" is of interest particularly for the sake of Britten's "swing" writing in one section. The suite (devised by Paul Hindmarsh), and especially its overall relation to the swing number, doesn't make a great deal of sense shorn of its dramatic context in the J. B. Priestley play for which it was written, however. The Shostakovich symphony—though written at a similar time in its composer's career and certainly of interest—seems an intrusion in this particular recording. The performances and recording (in EMI's Abbey Road studio) are more than competent.

The Virgin disc includes some real rarities—and some real juvenilia. Not that Britten was ever anything but an assured musician, even as a boy. He may misspell waltz ("walzt"), but the music contains no comparable falls from communicative grace. Stephen Hough plays the solo pieces, which dominate the recording, with idiomatic fluency and is ably partnered by Ronan O'Hora in the two-piano pieces.

The recording has the bright clarity and wide dynamic range we've come to expect from Virgin.

Robert Long

Mozart: Divertimento, K. 334; Adagio and Rondo, K. 617; Andante, K. 616; Quintet, K. 577. Jean-Pierre Rampal, flute; Pasquier Trio; others.
Sony Classical SK 47230, CD; DDD; 62:32.

Mozart for the Mozart Year and beyond—there can never be too much. This is an interesting and colorful "chamber" recording, a light but sophisticated dinner suite followed by three extraordinary very late works, two of them scored for real oddities, a mechanical organ and a glass harmonica. The only trouble is that this rates as a celebrity record, featuring the well-known and always impeccable flutist Jean-Pierre Rampal.

This affects, first, the microphone technique, which politely but persistently favors the featured artist. Not unpleasant but still noticeable. More important, it means twisting the very shape of the music so that the flute appears in every number—as a tasteful substitute, to be sure, but again emphasizing the soloistic approach.


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The Mozart is a vehicle for Jean-Pierre Rampal and his flute, and here the pieces are played with full musical intelligence.

The mechanical organ, of course, is not heard—four "live" instruments, led by the flute, play an arrangement. The flute replaces one violin in the quintet, which is in itself an arrangement of an opera aria with a lavish chamber accompaniment including two basset horns (clarinet family). As for the glass harmonica, its music is played on a celesta, an easy way out since the sound is not unlike the original. But the celesta entirely lacks the spine-chilling, otherworldly sound of the glass machine, a wet finger around the top of a drinking glass multiplied into an entire musical scale. There *are* players of this instrument! I've heard the Mozart that way. But again, this is a vehicle for Jean-Pierre Rampal and his flute, not for such heady distractions.

Celebrity or no, the music is played with full musical intelligence, and Rampal's prominence is not obtrusive. Or objectionable, of course, to those who go for this celebrity. He's a good one.

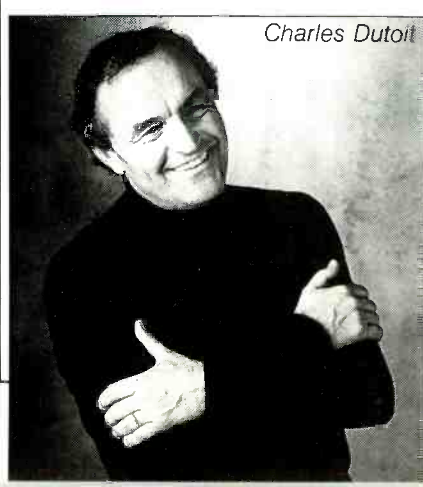
Edward Tatnall Canby

Elgar: "Enigma Variations" and "Falstaff." Montreal Symphony Orchestra, Charles Dutoit.
London 430 241-2, CD; DDD; 63:24.

No wonder London (English Decca) has put forth this unlikely all-French (Canadian) recording of the decidedly British music! A very superior pair of performances, the less familiar "Falstaff" done as carefully as the often heard "Enigma." French or no, these players show an uncanny degree of understanding of British ways of musical thinking back at the beginning of this century—when Romanticism was still in full Victorian flower, unabated, unabashed. Yes, the British did seem to exhibit the often mentioned time lag, a quarter century or so, right through the ages. But needless to say, there is more to music than the outward style.

"Enigma" was Elgar's youthful breakthrough work, a sensation in 1899. "Falstaff" is eons later, 1913, yet still very much out of later 19th-century program music. It's remarkably patterned after Richard Strauss (an amplified "Till Eulenspiegel" or perhaps a supercharged "Don Quixote") yet has an expert complexity that speaks of its own time, so soon before World War I.

"Enigma" is Elgar's only enduring success in the U.S. aside from "Pomp and Circumstance." Nobody over here ever bothers with "Falstaff"—or much else by the prolific and very experienced composer. Perhaps no greater difference in musical thought exists between America and the U.K. than the one concerning English music of the first half of this century! Yet, at last, I think there is a change. I learned some impressive Elgar choral music thanks to a recent English associate conductor of the Canby Singers. I am learning more right here; "Falstaff" gets better, however flamboyant, each time I play it. A vastly *professional* job and better organized by a lot than the endlessly rambling Strauss tone poems which are its model.



Charles Dutoit

Curious after-discovery: *That tune*—why do I know it so well? Suddenly it hit me: "Golliwogg's Cakewalk" by Claude Debussy, known to every pianist, child or adult, actually a somewhat bitter satire citing Wagner's *Tristan* theme most cruelly in the midst of grotesque proto-jazz. Is this pure coincidence? Who can say?

Edward Tatnall Canby

Great European Organs, No. 24: Silbermann Organ of Freiberg Dom. Dietrich Wagner, organ.
Priory 332, CD; DDD; 66:25.

Great European Organs, No. 23: Willis Organ of Salisbury Cathedral. Graham Barber, organ.
Priory 314, CD; DDD; 71:12.

This British specialty series lists these two CDs as Nos. 23 and 24—and for all I know may extend much further. How thorough! Somehow the CD format has invited the most extensive penetrations of special areas, even by labels very far from the entertainment mainstream. This, as in book publishing, is all to the good.

The risk, of course, is too much narrow professionalism. It looms here, at least for the general music listener. One gets the feeling of having dropped in on an organists' convention, not so different from a dentists' convention when you come down to it. But there is indeed enjoyable music.

The majestic early Silbermann organ in the Freiberg cathedral is surely one of the world's finest and also least changed since its debut in 1714. A glorious, gorgeous, big shiny sound, perfectly matched to the large acoustic in which it plays and here beautifully microphoned to bring that architectural resonance to our listening ears. This is the "baroque" organ at its best, as well as most individual. Such clarity, such a brassy, sharp-edged palette of tone colors! In all truth, these older organs are never sanctimonious or "churchy," even in the most solemn church music. The Mighty Wurlitzer is pale alongside them.

The music and performance are a bit something else. The composers led directly to Bach's writing but tend to be dogmatic, endless stretches of expert counterpart without the inner harmonic variety of Bach. Organist Dietrich Wagner, expert enough, somehow gives the same impression—authentic enough, I suppose! Especially in the program order. The opening Scheidt is audibly in D minor (in spite of the curious designation "noni toni")—actually D-sharp minor since this organ still plays in the older organ tuning, a half step above our present norm. This is followed by the French Clérambault, eight short movements in the same key, leading to a curious and unplesant monotony; then, for no particular reason, the rest of the CD is in a variety of keys and contrasting effects. The liveliest composer here is Johann Krebs, who wrote listenable chorale preludes on Lutheran hymn tunes.

After this, the Salisbury organ of No. 23, deep in the United Kingdom, is a startling contrast. It is English Victorian, 1876, and sounds in the recording about half the size of the German organ though it is actually quite a huge instrument. A stifled, high-pressure kind of sound, as I hear it, pushing against an inaudible acoustic—in a major cathedral! Strange, but probably true to the situation. This organ depends on sheer power rather than high color, to make itself heard. A vast uncolored bass that shakes the windows, a throttled treble and midrange—all the standard sound of the time. After a few minutes, you will adjust to it; the music claims your attention as it should. A strictly British beginning with an all-out show-off toccata and fugue by that pompously uninhibited Edwardian, Sir C. Hubert H. Parry, a rather awful piece (to my American ear!), after Bach but, of course, much bigger and louder. Then a set of "chorale" preludes (by Francis Jackson) on hymns well known in England, much more pleasing and well suited to the organ, and then we depart for standard continental repertory, the inevitable Karg-Elert, loudly impressionist with icky harmonies, and three gentler works, the best suited to this organ of any here, by André Fleury, born 1903, who apparently still flourishes at his Paris organ. *Edward Tatnall Canby*

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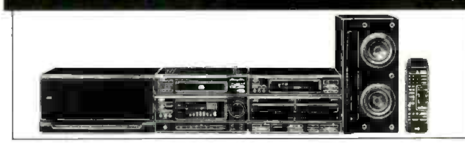

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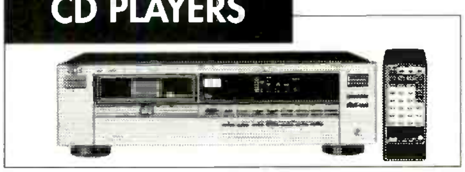

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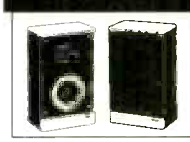

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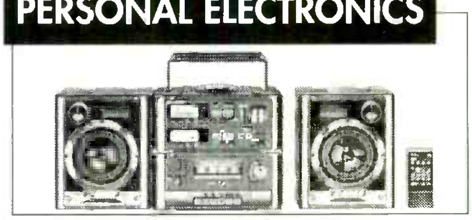

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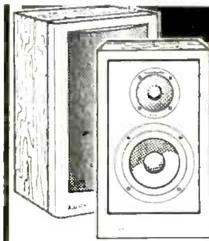

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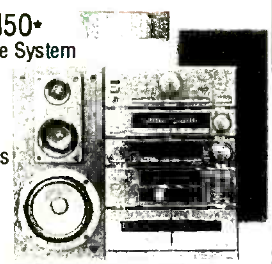

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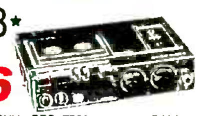

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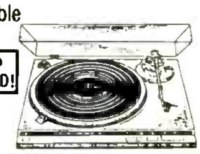

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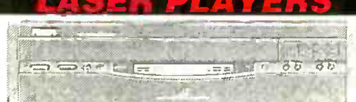

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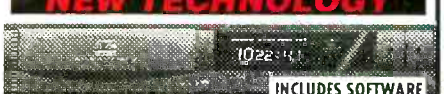

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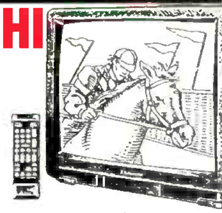

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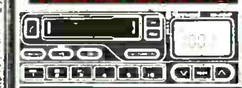

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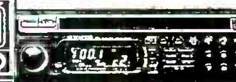

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COLE MINE

The Complete Capitol Recordings of The Nat "King" Cole Trio
Mosaic 138, 18 CDs; AAD; 16:52:51. (Available from Mosaic Records, 35 Melrose Place, Stamford, Conn. 06092.)

Sound: Varies Presentation: A+

Great artists always seem to be reborn: They constantly reappear, like the phoenix, giving each new generation a chance to interpret their greatness. It is no wonder that Nat "King" Cole was as big a hit in 1991—26 years after his death—as he ever was in life. Perhaps *Unforgettable*, the recent multi-platinum tribute album by his daughter Natalie, is most responsible for kick-starting the current wave of "Natmania." Nevertheless, the most important event for serious music lovers and Cole-lectors is the release of a massive 18-CD set from Mosaic.

The Complete Capitol Recordings of The Nat "King" Cole Trio is exactly that: 349 takes from 1942 to 1961. All but seven of the recordings are monaural. Michael Cuscuna, the reissue producer, went to great pains to locate original masters, resorting to 78s, transcriptions, or transfers only when the primary source was missing or in poorer shape than a secondary source.

The Nat "King" Cole presented in this collection—with only bass and guitar accompaniment—will be a revelation to those who never had a chance to appreciate, let alone *hear*, Cole's skills as pianist and arranger. We're all familiar with that oft-described "silky" voice that seemed to exude from the man as easily as if he were exhaling. But the elements of his style and interpretation are as deeply embedded in his approach to the piano and the trio arrangement as in his use of his vocal gifts.

A healthy smattering of instrumentals is included here. Even light classical melodies, such as Rachmaninoff's Prelude in C-Sharp Minor, are grist for the Cole trio's endlessly creative mill. The group was fond of providing instrumental overtures and solos for songs like "I'm in the Mood for Love," having great fun playing around with the melodic and harmonic structures. The wealth of beauty the trio continually unearthed from these familiar chord changes is a constant source of surprise and delight.

Novelty songs were very much a part of the popular music landscape during Cole's career, and all of the favorites are here: "Straighten Up and Fly Right" (his first hit, in November 1943), "Route 66," "Sweet Lorraine." Cole's subtle use of double-entendre, his ability to vary his touch and emphasis, and even his orchestrations were all harnessed in service of a song. I was most taken by his incorporation of stride, boogie, and blues in his piano style (he acknowledged Earl "Fatha" Hines as a strong influence), always embellishing without stepping on either the vocals or the contributions of guitar and bass. Even with two sets of chords on the piano and one set on the guitar, the music is always relaxed. Of course, Cole would achieve his greatest fame with love songs, and as demonstrated here in the trio setting, he lavished them with all the tender emotion and pathos he would later draw on as a soloist.

The trio's original guitarist was the great Oscar Moore; many aficionados believe that with the exception of Charlie Christian, Moore was the artist most responsible for developing the language of the modern jazz guitar during that era. After 10 years with Cole, he left to rejoin his brother, bassist Ernie Moore, and was replaced by Irving Ashby and later by John Collins. The trio's bassists included Johnny Miller, Joe Comfort, and Charlie Harris.

Cuscuna enlisted the aid of commentator Will Friedwald for most of the essays and annotations that guide the listener through this collection. Each recording has complete information on date, place, personnel, and previous availability. There are also short commentaries about the specific sessions. Extensive production notes, such as those explaining speed corrections, give details about the restoration process. Fortunately, Cuscuna had access to some of the key people who worked with Cole during the Capitol years, as well as to engineers who fully understand not only current technology but also the recording techniques of Cole's time—and who know how to obtain the best results in this kind of restoration project.


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Using computers and digital samplers produces stunning results for Dresher and Rothenberg as they merge structure and spontaneity.

When Nat "King" Cole made the transition to a solo career, one of the greatest vehicles of American music came to a screeching halt. Indeed, *The Complete Capitol Recordings of The Nat "King" Cole Trio* is not just a marvelous collection, it is an essential document of one of the most important groups in the swing-to-bop era. The set is also wildly entertaining; you look up after a while and realize it's three hours later than you thought.

Be forewarned that all of Mosaic's releases are in limited, numbered editions and that they often sell out quickly. *Al Pryor*

Opposites Attract: Paul Dresher & Ned Rothenberg
New World/Counter Currents 80411-2, CD; AAD; 56:30.

Sound: B+ Performance: B

Ned Rothenberg plays free music on reeds and shakuhachi. Guitarist Paul Dresher's background includes minimalism, music theater, and rock. On *Opposites Attract*, they investigate the tension between composition and improvisation with the added twist of computers and digital samplers.

Dresher has been working with a four-track tape loop system for over 10 years. For this project, he and Rothenberg created loops of samples, mostly sounds of their instruments, and then resampled the loops and synchronized them with a computer. It seems like a long way around the block, but the results are often stunning, merging structure and spontaneity as only the best jazz can.

The cyclical nature of the loops yields odd, multiple time signatures that lope along like an off-center wheel. However, a remarkable rhythm section—drummer Bobby Previte, electric bassist Anthony Jackson, and acoustic bassist Mark Dresser—manages to lock on and build up layers of shifting rhythms.

Each piece has a unique and sometimes contradictory character. While the music chirps like a jungle at night on "Orient and Tropic," Rothenberg carves a ruminative space on bass clarinet. "The Long Seven/Yuunik" uses loops of bass clarinet key clicks as percussion to frame a hellish, screaming electric guitar solo by Dresher. A suite called "The Untold Story" includes the kind of *Sturm und Drang* pointillism you might expect from the techniques used in this music. "Skronk," a pure sequenced piece, will have you crawling the walls with its cuckoo-clock repetition. But even in these works, some stunning moments emerge, like Previte's tom-tom solo across a honking looped horn chart on "Bolero in Straight Jabs."

Opposites Attract is only a partially accurate title. It should be *Opposites Obviate*, with Dresher reining in Rothenberg's abstract tendencies and Rothenberg freeing Drescher's usually controlled music. *John Diliberto*

AD INDEX

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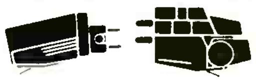

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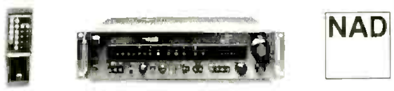

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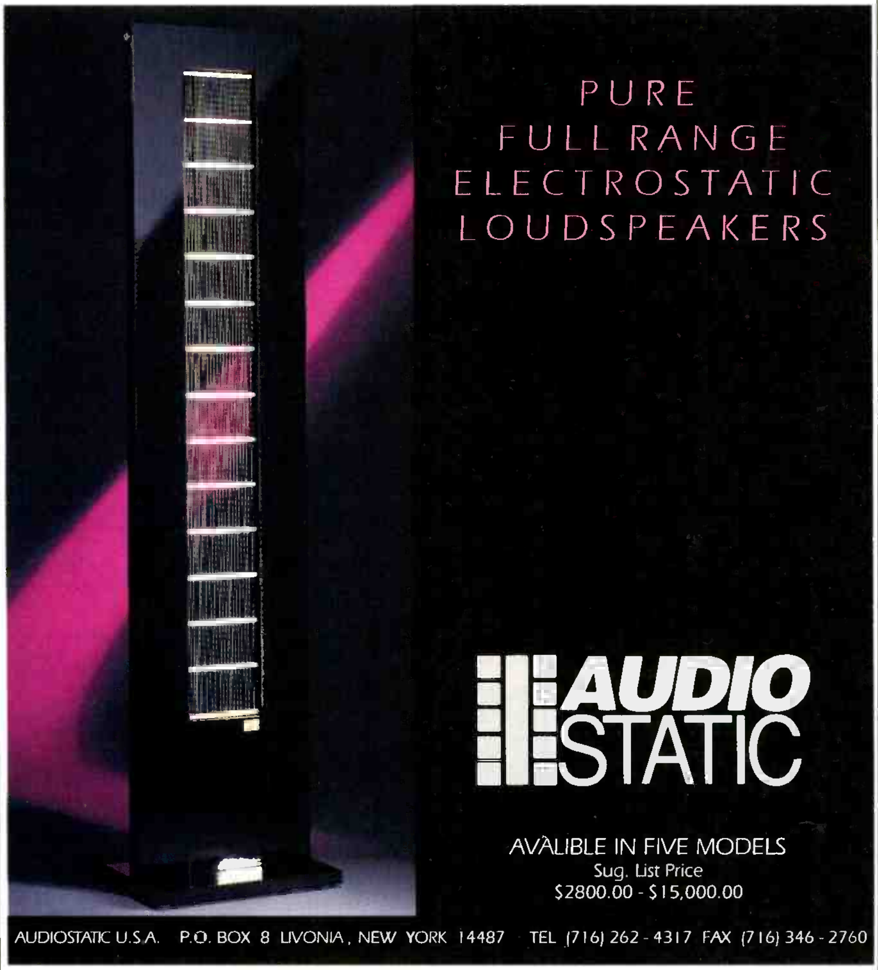

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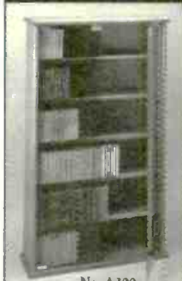
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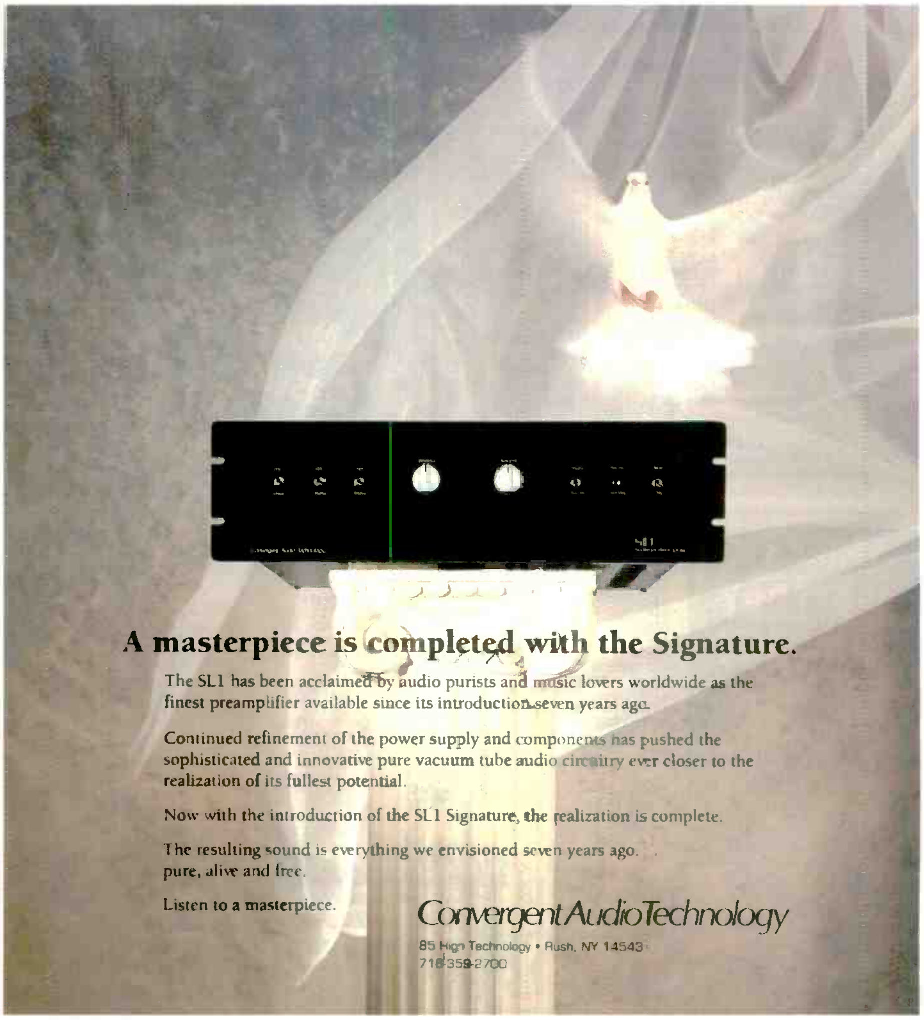

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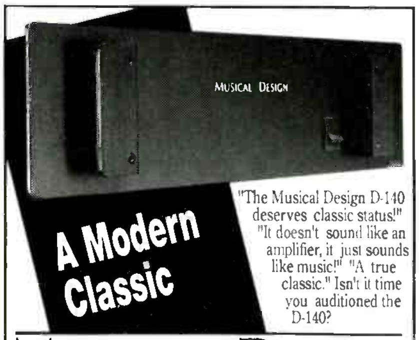

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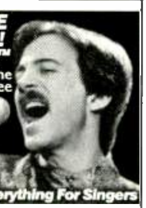

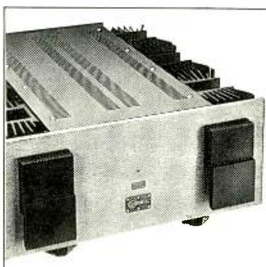

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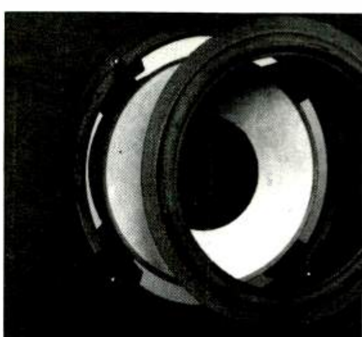

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