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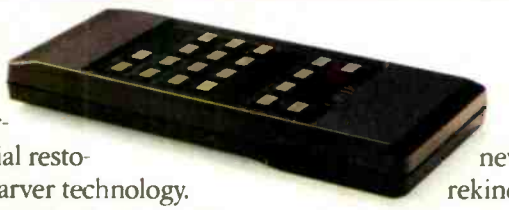

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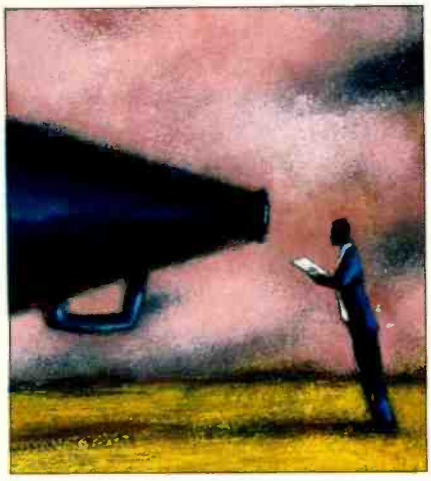

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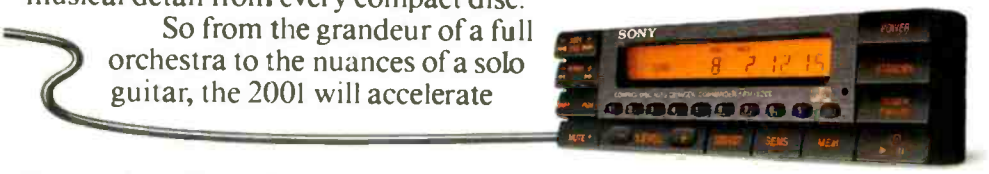

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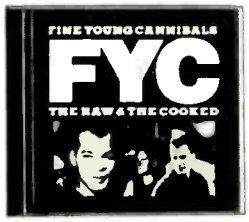

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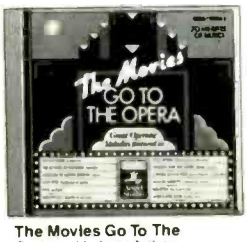

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SIGNALS & NOISE

Making NoNoise

Dear Editor:

The June 1989 issue contains a negative critique of the Sonic Solutions NoNoise system, by reader Richard P. Clancy of Ashland, Mass. ("Signals & Noise"). With Mr. Clancy's judgment of what he hears from the NoNoise-processed Jelly Roll Morton vinyl disc, I suspect that the culprit is not the NoNoise process at all. Here is why.

The Sonic Solutions system is implemented in the digital domain, *after* an analog master recording has been transferred into the Sony 1610/1630 Compact Disc compatible digital format. The Sonic Solutions process does not alter the music in the manner(s) described by Mr. Clancy, but the analog-to-digital conversion most certainly can . . . and probably did!

This is why a great deal of attention is now being paid to the front end of the digital recording process by the music industry in general. As you know, our Colossus four-channel PCM processor was designed first and foremost as an audio archival device, in which we believe accuracy is required when converting an incoming analog or digital signal.

As with such things as digital and quadraphony, the technological merits remain. It is only how they are implemented at the design-engineering stages and then utilized in the creative world. I might add that we have experienced the NoNoise treatment of live Colossus recordings, in which stage dimmers leaked into the mike cable at 60 cycles. Nice hum, no more—thanks to Sonic Solutions.

Brad S. Miller
By The Numbers
Incline Village, Nev.

Review Reviewed

Dear Editor:

I found the review of the Fuselier 3.8D speakers (June) to be most interesting. Having been a fan and owner of John Fuselier's speakers since 1982, I was particularly pleased to see his work finally get the recognition it deserves. Although I consider myself an audio enthusiast, I am not a self-confessed technical expert and therefore cannot comment on the data presented by author David L. Clark. Nevertheless, I do believe that I am able to ascertain high-quality sound reproduction and can unquestionably endorse Clark's statement that the Fuselier speakers produce an amazingly smooth response and realistic sound image across all frequencies.

I have owned and evaluated many fine speaker systems over the years, but I can unequivocally state that the Fuseliers are the only speakers I can listen to for hours without coming up wishing the sound were more realistic or suffering from "ear fatigue." I can only attribute this distinctive characteristic to the sophistication of the design and the quality of the components utilized by John Fuselier. The creative genius he has focused on sound reproduction is definitely to the benefit of the "musically mature audio enthusiast," as Clark so appropriately stated.

Much of the credit for the development and continued support of the Fuselier speakers must go to Julian Scharfman of Julian's Audio in Atlanta, Ga. Julian, recognizing John's creative talents, has personally championed the Fuselier speakers over the years, through good times and bad. He did this for one simple reason: He believed in the man and the quality of his product. Together, John and Julian have stood the test of time, and now, thanks to your article, the rest of the audio world will know of their work. Congratulations on being able to discern, from what must be a plethora of products, a speaker system that is truly worth the search and the money. I feel fortunate to have discovered Fuselier years ago, and hopefully the recognition provided by your article will not make it too difficult for others to obtain a pair.

Roger L. Gehri
Address withheld

Won Liners

Dear Editor:

At $15 per Compact Disc, some labels provide *minimal* liner notes and information. (I'm sure most readers would agree.) However, the next Grammy award for liner notes can go to Epic Records and producer Luther Vandross for Gregory Hines' debut album. The notes, credits, and information enable the listener to feel closer to the music. Very thorough.

Al Shaker
Detroit, Mich.

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Audio

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The value of all-integrated electronics is already well recognized. The advanced integration techniques in the MCD 7007 provide virtually all digital functions within the integrated circuits. Even the self-regulating and reference circuits are designed in the new VLS (very large scale) integrated circuit. You gain value because the VLS eliminates the need for factory adjustment. There is nothing to adjust so nothing can go out of adjustment assuring constant highest quality sound. You get very high standards of performance, consistency and reliability.

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The digital to analog converter (DAC) has been completely redesigned. In conjunction with the improved digital filter, it has yielded important improvement in amplitude linearity, right down to the lowest signal levels. The performance selected McIntosh 'Golden Crown' DAC delivers the highest achievable performance.

"Truly, the McINTOSH MCD 7007 Compact Disc player sets superlative new standards for musical purity and enjoyment. The massive effort of McIntosh engineers - - - - allows us to discover a universe of sound in which the least subtleties of harmonic tonal structure and the smallest of range changes are heard in just the right places."*

Revue Du Son

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- Appearance design that has long life, complements the living style, is complimentary to the owner, and is made of materials, whose characteristics permit 'a like new always' appearance.
- Easy to operate; The unique McIntosh designed panels are always easily readable in your choice of home lighting. They are obviously designed by human beings for human beings.
- Manufactured of carefully specified and selected component parts that have high quality and long predicted life.
- Assembled by highly trained craftspeople who are dedicated to quality, accuracy and perfection.
- Thorough verification of the desired capabilities and quality of performance by constant and complete testing throughout the entire manufacturing process.

The McIntosh C35, above all others, will satisfy these requirements while it gives you the best sound, the most flexibility, and the greatest ease of use.

The C35 has many useful features to enhance your listening and video enjoyment. They include: High level inputs to accommodate the traditional as well as all the latest audio sources. Any one of nine input sources can be selected from the front panel or by the handheld IR remote. Electronic tape monitor switches for two audio tape recorders, or the audio from two video recorders, or one audio recorder and the audio from one video recorder, allow either recorder to be heard from the main output.

Volume is adjusted by a motor driven precision potentiometer. Left/right tracking accuracy is controlled to a fraction of a dB. Volume is displayed on the front panel by LED's which display the percentage of rotation of the volume control.

A five-band program equalizer permits the adjustment and improvement of the loudness contrast of five important frequency ranges. Musical balance of source material can be adjusted to compensate for room recording differences or listener preferences.

A built-in headphone amplifier provides power to the front panel headphone jack. All front panel controls are available to influence private listening on headphones.

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The McIntosh MC 7270 power amplifier is designed to fulfill Digital Dynamic Range demands. It outperforms all competitors when listening to sound derived from digitally recorded tapes and compact discs.

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The compact disc is capable of **real life dynamic** range while noise generated from compact discs is inaudible. With the noise restraint removed it is both easier and dramatically more enjoyable to listen to music at much louder levels. To fully enjoy this new capability your amplifier must be able to receive three to ten decibels of overstress from music, and it must do this without severely distorting the sound! This is the real world of Digital Dynamics demand. How to achieve the performance demanded, which often lasts from minutes to only a few thousandths of a second, and to achieve the goal economically, is a real achievement. Power Guard is that achievement.

"The Power Guard system is most effective in making it impossible to hardclip the output of the amplifier. Regardless of how hard it is driven, it simply cannot develop an audible amount of distortion on musical program material - - - - . This feature should also mean a greatly reduced likelihood of blowing out a speaker, since clipping is a common cause of tweeter damage."**

McIntosh leadership in engineering has developed the Power Guard circuit which—(1) dynamically prevents power amplifiers from being overdriven into hard clipping—(2) assures that the amplifier will produce its maximum output without increased distortion—(3) protects your speaker from excessive heating. Power Guard is a patented McIntosh design (U.S. patent #4,048,573).

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AUDIOCLINIC

JOSEPH GIOVANELLI

CDs and Range Expanders

Q. My CD player's outputs are connected to the inputs of my range expander, which is calibrated from 1.0 (no expansion) to 1.5 (50% expansion). The sound coming from a CD is about 94 dB; does this mean that by using the maximum expansion of 1.5, I am getting an S/N of 141 dB? The manual for my expander says: "A 1.4 setting means that an input signal having a 40-dB dynamic range will be expanded to 56 dB or that an input having a 50-dB dynamic range will be expanded to 70 dB (1.4, or 40% times the input signal)."—Don Lacroix, Woonsocket, R.I.

A. What you gain by using a range expander is dynamic range. Because the dynamic range available on CDs is very large as it is, I am not convinced of the value of a range expander.

As for the S/N ratio, you can expect only limited improvement. For argument's sake, let's say a recording's noise level is at −90 dB and that the music is recorded within the range from −10 to −70 dB. In this case, the S/N ratio, when listening to the softest passages, is 20 dB. At full expansion, the noise level will be driven down to −135 dB, and the music's range will now be from −15 to −105 dB. Your S/N ratio, when listening to the softest passages, is now 30 dB.

However, you have also increased the music's dynamic range from 60 to 90 dB. If you now adjust your volume control so that you hear the loudest passages at the same level as you do at present, the softest passages will be 30 dB softer than they were before expansion. If you are listening at a low volume, you might not even hear those soft passages, though you certainly would hear no background noise.

On the other hand, if you set your volume so that you hear the softest passages at the same level as before, the loudest passages will now be 30 dB louder. This may be so loud that it produces overload in your equipment. You could damage your amplifier or your loudspeakers if your system has insufficient reserve power-handling capacity. Further, and most important, the loudest passages may well be loud enough to cause ear damage. While you can replace an amplifier or a loudspeaker, you cannot replace your ears.

To keep the music's dynamic range within reasonable limits, you will have to use only a moderate setting of your range expander. However, you can expect only a modest improvement in S/N. For example, if you set your expander to "1.1," the music's 60-dB dynamic range would expand to only 66 dB, and the signal-to-noise ratio at the quietest passages would improve by a mere 2 dB.

More About Filtered Water

In your January 1988 "Audioclinic" column, you may have spread some mistruths. Recommending inexpensive water filters to clean up inorganic water contamination is just about useless unless the problem is gross sediment. Most water carries suspended silicates, carbonates, salts, etc. that are measured in millimicrons. Most filters, regardless of price, have elements that only filter out particles 1 micron or larger in size. (For comparison, a human hair is about 5 microns in diameter.) The only filters that will work on these dissolved solids are "reverse osmosis" filters, which degrade rather quickly and need a great deal of service. The good of inexpensive filters is that they may remove some of the chlorine compounds which destroy many benign organisms, such as intestinal flora.

Most filters don't live up to the claims made by their manufacturers regarding removal rates. Distillation is the most consistent source of pure water. It will also give you the best-tasting product over the longest amount of time.—James Gillette, Berkeley, Cal.

Impulse Noise Eliminators

Q. I recently saw in a catalog a "transient noise eliminator" designed to eliminate small to medium ticks and pops from phonograph records. This sounds intriguing, but how does such a machine work? How can it "know" the difference between noise and the intended content of a recording?

The device's frequency response only extended to 10 kHz. How much loss of music will I notice when using a machine with this restricted response?—Joel Valder, Oroville, Cal.

A. When the stylus enounters a defect in the record groove, the resulting signal builds up to maximum intensity much more quickly than when the stylus encounters music signals, even from percussion instruments. Devices like the one you've described recognize this difference in rise-time.

If the device is limited in frequency response to 10 kHz, some subtle elements of music will be lost—not the fundamental notes produced by musical instruments (the piano's highest note is on the order of 4 kHz) but the harmonics of a tone, the "edge" of strings, the sheen of cymbals. To me, this makes music sound somewhat lifeless. But how much loss you'll notice will depend on your ears, your system, and the music you're playing. Even if the difference is enough to bother you, it may bother you less than the ticks and pops did.

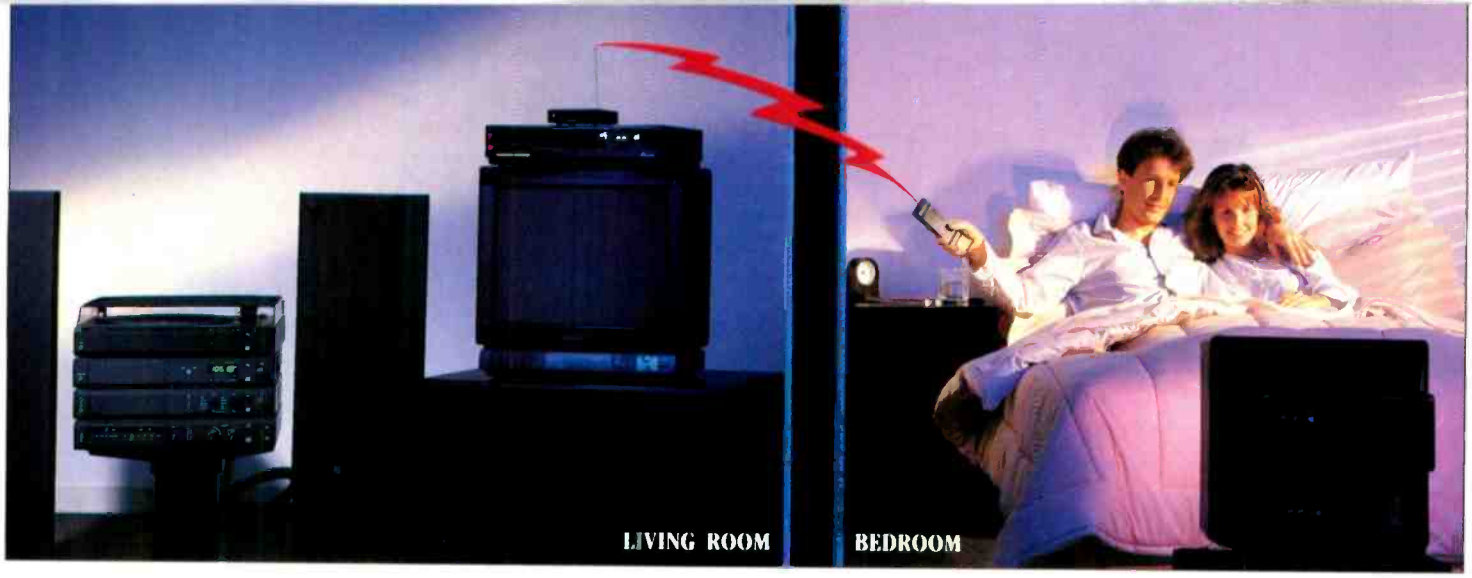
X-Ray Damage to Recordings

In the February 1988 issue, in response to a question regarding X-ray damage to audio recordings, you said that X-ray equipment can damage tape recordings because the X-rays partially demagnetize the tape. I'm not sure that this is correct.

X-ray damage to magnetic recordings has been discussed off and on for many years, and there has been general agreement that no one knows how the notion arose of possible damage to magnetic recordings. However, it may have been an assumption that grew out of a perceived kinship between magnetic and photographic media. There is no scientific evidence that X-rays, per se, damage magnetic recordings. However, X-ray equipment or, more specifically, transformers associated with it may cause damage through the generation of strong magnetic fields.

The 1970 edition of the 3M Company's Soundtalk *(Vol. 3, No. 1) reported that recorded test signals on a commonly used recording tape were not affected by even severe exposure to X-rays. The tape was given a 6-S exposure at a distance of 36 inches from an X-ray machine operated with 200 mA of current and 110 kV.*—Klaus Halm, East Point, Ga.

If you have a problem or question about audio, write to Mr. Joseph Giovanelli at AUDIO Magazine, 1515 Broadway, New York, N.Y. 10036. All letters are answered. Please enclose a stamped, self-addressed envelope.



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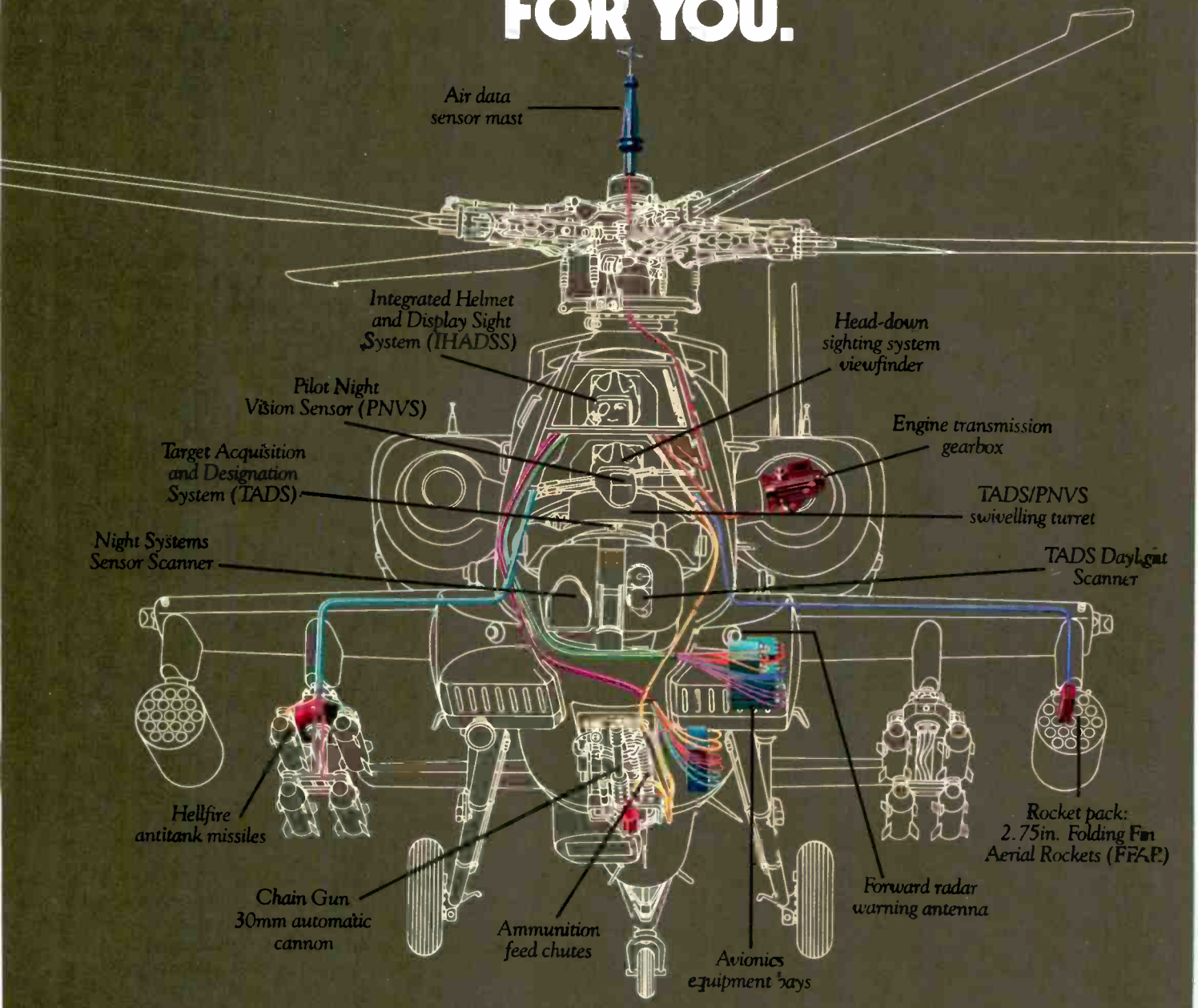

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TAPE GUIDE

HERMAN BURSTEIN

Mufflement

Q. I have a baffling problem with my cassette deck. At times, the sound suddenly becomes muffled but then returns to its wonderful, crisp nature. I have tried demagnetizing and cleaning the heads. Cleaning helps a little, but nothing seems to completely clear up the problem. What's wrong?—Paul Mendelowitz, Redwood City, Cal.

A. The muffled sound may be due to temporary azimuth misalignment between the playback head and the tape. That is, the tape may not be consistently moving at a right angle to the head gap. This could be due to a defective cassette that allows the tape to skew appreciably within the shell or to a defective mechanism in the deck.

Another possibility is that the Dolby circuit is not working properly, that something recorded on the tape—or something else—is causing it to go erratically into sharp treble cut. A third possibility is that the heads have not been cleaned well enough, thus allowing dirt or dislodged particles of magnetic coating to cause a slight space between tape and heads. A final possibility is an intermittent fault in the playback electronics.

Are Three Heads Better Than Two?

Q. I have a two-head cassette deck, but someone told me that a three-head deck is better. Why?—Michael Clark, Wichita, Kans.

A. A three-head deck, which has separate record and playback heads, plus an erase head, ordinarily has several advantages over a two-head deck, which has a single head used for both record and playback, plus an erase head. It permits monitoring the tape (immediately listening to it during recording) to assure that the recording is satisfactory and to facilitate tests and adjustments such as bias adjustment. Use of a separate head for playback permits it to have an extra-narrow gap, which is essential for extended treble response; such a gap is unsuitable for recording because it tends to short-circuit the audio signal. A separate head for recording permits a relatively wide gap—roughly five times the width of an ideal playback head gap—which is conducive to accurate, distortion-free recording. A separate playback head may be designed for maximum signal output, thus improving the S/N ratio a bit. This is achieved by a relatively large number of turns in the head's coil, but the resulting high inductance would make it difficult to drive high-frequency bias current through the head for recording purposes.

On the other hand, a two-head deck has the advantage of not presenting an azimuth problem, provided the same deck is used for recording and playback. An azimuth error in recording is compensated for by an equal error in playback when the same head is used for both purposes. With a three-head deck, it is quite possible for the azimuth alignment to differ in the record and playback heads, with a resultant loss in treble response.

Even though a three-head deck tends to be superior in performance and convenience, with good engineering and construction, a two-head deck can be very satisfactory. If your two-head deck enables you to make recordings that sound like faithful replicas to your ears, you should not feel something is seriously lacking.

Which Type of NR?

Q. My cassette deck includes both Dolby and dbx noise reduction. For taping voices, I wonder if one is better than the other.—Juan K. Ferry, Weymouth, Mass.

A. Whether taping voice or music, dbx NR achieves the greatest noise reduction—typically about 30 dB, compared with about 20 dB for Dolby C NR and about 10 dB for Dolby B NR. Generally, dbx NR doesn't do as good a job of maintaining frequency response as either Dolby NR, particularly at the low end. Also, the greater the noise reduction, the greater the tendency toward undesirable side effects such as sudden changes in level and bursts of hiss. Hence, some may prefer Dolby NR, even though dbx NR is quieter. On the other hand, side effects tend to be a very minor problem with present-day circuitry.

More on Head Demise

In the June issue, a reader asked how to tell when the heads in his tape deck are shot ("Head Demise"). I recently received a valuable commentary from Bob Ursdevenicz of Omaha, Nebr., who is manager of a company called National Sound. Ursdevenicz writes:

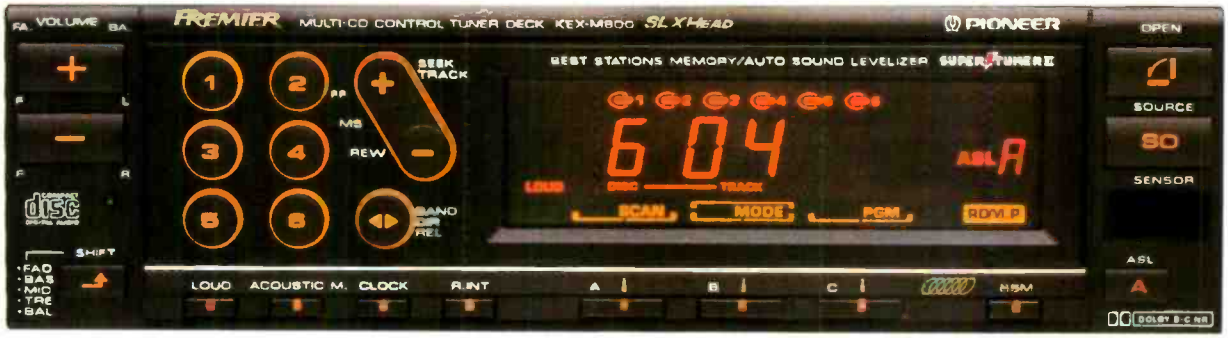
A method I have found to easily detect a worn tape head is to check it for "grooving." Most inexpensive tape decks use the softer permalloy tape heads. With heavy use, these heads develop a groove where the tape contacts the head. These grooves can be felt on a severely worn tape head, using a cotton swab stick or finger nail (careful!). When the tape travels over a grooved head, one channel will tend to lose treble response more than the other. This is due to the tape edge riding the groove and pulling the tape away from the head gap closest to the edge of the tape. When a deck gets into this condition, it is time to replace the head. If the deck is an inexpensive model, it is probably a good time to upgrade to a new machine, since most head changes cost $60 to $120.

Playback Discrepancy

Q. I own two high-quality decks and a CD player. Whenever I record, whether from CD to tape or from deck to deck, the meter readings are slightly lower in playback than in recording. For example, a level that occasionally reaches +3 dB in recording just reaches 0 dB in playback. Why? Is this normal? Is there something I can do or something I should have done?—David Marx, Putney, Vt.

A. Your situation is within normal bounds. The lower playback readings can be due to tape sensitivity or to the way the playback metering circuit has been adjusted. Sensitivity refers to the amount of tape output, in playback, produced by a given amount of signal input to the tape during recording. Some tapes have higher sensitivity than others, although this does not necessarily mean the former are better overall. The deck manufacturer may have calibrated the playback reading on the basis of a tape with higher sensitivity than the tapes you use. I think you should leave things alone.

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



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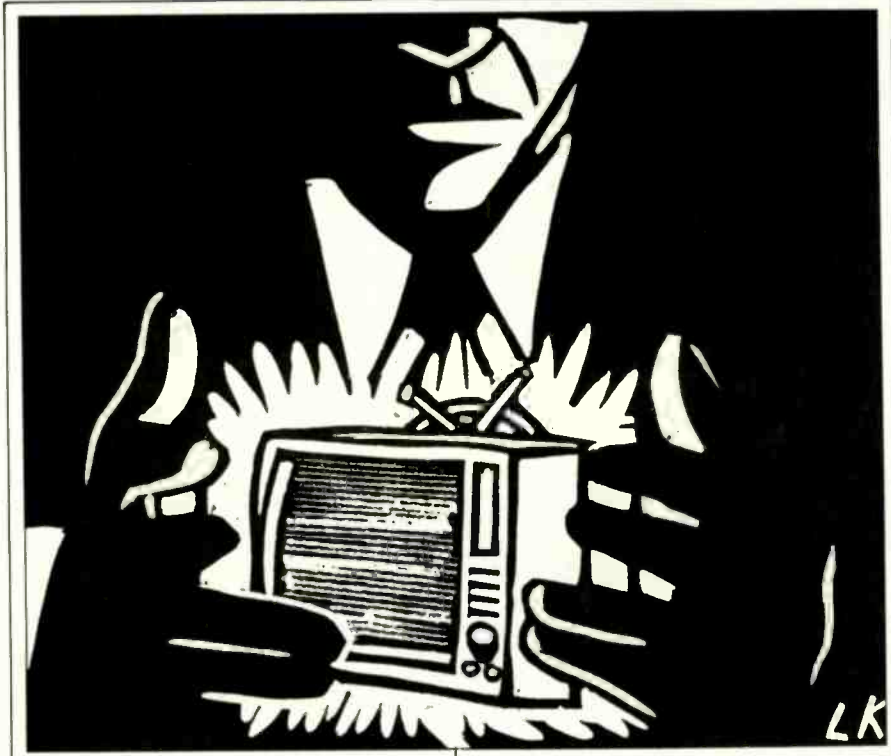

Illustration: Les Kanturek

Although there were experimental TV broadcasts in the late 1920s, many think of 1939 as the year of the birth of TV, and thus that in 1989, TV is celebrating its 50th anniversary. As might be expected, there is much hoopla about this event in the various media. There are, of course, nostalgic forays into the past, in terms of programming and technological developments, as well as much speculation and pontification about the future of the video medium. This includes predictions about the imminent arrival of high-definition television (HDTV) by starry-eyed writers in magazines and Sunday newspaper supplements who haven't the foggiest notion about the current state of this technology, let alone its political possibilities.

However, apart from these blue-sky ramblings, there are serious writers and engineers who are acutely aware of the actual state of affairs in respect to HDTV. These people know that there are complex interrelated technological, economic, and political problems with HDTV which are truly formidable. To complicate matters, although HDTV is treated as a sort of Holy Grail by many people, there are others who are adamantly opposed to any form of HDTV whatsoever. As an alternative, this latter group is solidly behind the idea of digital television and a nationwide fiber-optic network.

The avid proponents of HDTV view it not merely as a device to provide the public with a superior form of television but as something that can resurrect the American TV manufacturing industry. In their broader perspectives, they see HDTV as an opportunity—possibly a last chance—to restore the technological and economic base of the American semiconductor industry. Richard J. Elkus, Jr., a former executive with the Ampex Corporation, writing in *The New York Times* on May 28 of this year, pointed out that "three American companies created industries that became the foundation for many of the strategic world markets of today. The RCA Corporation was instrumental in the development of television. The Shockley Transistor Company spawned the semiconductor industry. The Ampex Corporation developed the field of magnetic recording." Elkus goes on to say that "Ampex introduced the videotape recorder in 1956 and the VCR in 1970. Ampex had nearly 100% of the patents in this field. But even though it had the technology, Ampex decided not to pursue the VCR market. As a result, it was taken over by the Japanese. And with that market went not only the majority of video recording technology but also a major segment of the support technologies."

This gentleman and others make very persuasive arguments for HDTV, and perhaps it is time to take a cold, hard look at the current status of this new technology. I suppose the most charitable thing to say about the HDTV situation is that it is muddled and not likely to be resolved for a long time. As you might expect, the FCC is a major contributor to the confusion surrounding HDTV, as their track record with technological developments in the past is not very encouraging. To be fair, central to their indecision and pussyfooting is the issue of HDTV compatability with our 50-year-old NTSC television. There have been some 19 different proposals for HDTV put before the FCC, but only about six of them appear to have sufficient technical merit and practicality to warrant consideration. It is obvious to most observers that after 50 years of limited-resolution NTSC, there is little sense in going to HDTV unless the full capabilities of this technology can be utilized. This means a system that will provide 1,125 lines of resolution, giving a picture quality almost on the order of a 35-mm slide. Those who have attended CES conventions and have seen closed-circuit demonstrations of 1,125-line television know what a dramatic visual impact these TV images have in comparison to standard NTSC video.

At present, the proposed HDTV systems from RCA, Philips, and Faroudja, as well as the Japanese Muse system, seem to have the most support. One of the major problems with HDTV is that if you want a full 1,125-line system, this would require a 12-MHz bandwidth, equivalent to two present, standard 6-MHz channels in the precious video frequency spectrum. This is presently regarded as technically and politically undesirable. Therefore, the RCA and Faroudja HDTV systems propose reduced resolution of about 700 to 900 lines, thereby reducing the video channel allocation. It should be noted that when an HDTV system is considered "NTSC compatible," it does not mean that standard TV sets would be able to

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Dion: Yo Frankie • King Of The New York Streets, etc. Arista 00825

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Poison: Open Up And Say...Ahh! • Good Love, etc. Capitol/Enigma 73989

Vanessa Williams: The Right Stuff Dreamin', etc. Wing/PolyGram 01110

20 Million Dollar Memories • The Everly Brothers, others. Laurie 20773

Don Williams: One Good Well • Learn To Let It Go, etc. RCA 62406

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Breathe: All That Jazz • How Can I Fall, Jonah, others. A&M 00505

Robert Palmer: Heavy Nova • Simply Irresistible, etc. EMI 00035

Tchaikovsky, 1812 Overture; • Chic. Sym./ Solti. more. London Digital 25179

Escape Club: Wild Wild West • Shake For The Sheik, etc. Atlantic 00804

Too Short: Life Is...Too Short • City Of Dope, etc. Jive 54041•

Elvis In Nashville, 1956-1971 • A Big Hunk O'Love, etc. RCA 00833

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Ronnie Milsap: Stranger Things Have Happened • Houston Solution, etc. RCA 01028

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The Decline Of Western Civilization, Part II Metal hits from the film. Capitol 00464

Bruce Hornsby And The Range • Scenes From The Southside RCA 80187

The Cowboy Junkies: The Trinity Session Sweet Jane, etc. RCA 01043

Major Glenn Miller & The Army Air Force Band 1943-44 • RCA/Bluebird 14720

Aretha Franklin: Through The Storm • Think, title hit, etc. Arista 01097

Bon Jovi: New Jersey 00516

Cocktail (Original Soundtrack) • Bobby McFerrin, Beach Boys, etc. Elektra 00459

Steve Winwood: Roll With It • Don't You Know What The Night Can Do?, etc. Virgin 54633

Roxette: Look Sharp! • The Look, Cry, Dressed For Success, etc. EMI 01106•

1969/Original Soundtrack Original '60s hits. Polydor 00724

Melissa Etheridge • Don't You Need, Occasionally, etc. Island 60352

Enya: Watermark • Orinoco Flow (Sail Away), others. Geffen 01041

Beethoven, Sym. No.9 (Choral) • Norrington conducts. Angel Digital 00467

Sheena Easton: The Lover In Me • Days Like This, 101, etc. MCA 00708

Lyle Lovett And His Large Band • Stand By Your Man, etc. MCA/Curb 00932

INXS: Kick • Need You Tonight, Devil Inside, etc. Atlantic Digital 53606

Bon Jovi: Slippery When Wet • Never Say Goodbye, etc. Mercury 43465

Karyn White • Superwoman, Love Saw It, etc. Warner Bros. 00832

U2: The Joshua Tree • With Or Without You, more. Island 53501

Samantha Fox: I Wanna Have Some Fun • I Only Wanna Be With You, etc. RCA/Jive 00676

Dirty Dancing/Original Motion Picture Soundtrack • RCA 82522

Dirty Dancing Live In Concert • Hungry Eyes, Yes, etc. RCA 01026

Guns N' Roses: Appetite For Destruction 70348

Chicago: 19 • Heart In Pieces, Runaround, more. Reprise 54404

Pavarotti At Carnegie Hall • Songs by Schubert, others. London 15311

Animotion • Room To Move, Send It Over, more. Polydor 01091•

Clint Black: Killing Time • A Better Man, others. RCA 01112•

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Led Zeppelin IV (Runes) • Stairway To Heaven, Rock & Roll, etc. Atlantic 12014

Crosby, Stills, Nash & Young: American Dream • Atlantic Digital 00714

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deliver a 1,125-line picture. Compatible in the context of the NTSC system means that standard television sets would receive HDTV transmissions, but without the benefits of the improved resolution.

Even as you read this, the Japanese are transmitting HDTV with their full 12-MHz, two-channel Muse system. Muse 6 and Muse 9 systems, which reduce the video bandwidth for HDTV by using a compression/expansion technique, are also available. The Muse HDTV is uplinked to a satellite, with three program channels available. The satellite's transmitter provides 100 watts per channel, considerably more than the 7.5 watts of most North American satellites. The usual Japanese rooftop dish antennas range from 15 to 30 inches in diameter. Reportedly, there are about 100 HDTV receivers in use that can provide 1,125-line pictures. However, there are an estimated one million rooftop dishes installed in Japan, and Mitsubishi is said to have a $135 adaptor that can convert the non-compatible Muse signals so they can be received by NTSC television sets. Of course, all of this might be dismissed as simply a one-upmanship public relations ploy, but they are undeniably transmitting HDTV signals.

The U.S. and Japan have many millions of NTSC television sets in use. Since the FCC says we just can't go back to square one and start all over again with HDTV, the enormity of the problems facing the adoption of HDTV are mind boggling. So, acknowledging the formidable obstacles to HDTV, is the alternative of digital TV and a nationwide fiber-optic network any easier to implement?

George Gilder, an advocate of this technology and the author of *Microcosm: Into the Quantum Era of Economics and Technology*, writing in the same issue of *The New York Times*, stated, "This new development is not high-definition television, which offers only a fourfold increase in picture quality over existing television. The real advance is the telecomputer, which couples digital and video technology with fiber optics. Unlike broadcast television, digital computer technology is fully interactive and responsive not only to keyboards, joysticks, and mice, but to touch, movement, and the human voice. . . . But interactive telecomputers have one key requirement: They must be fully digital. And because digital signals contain so much more information than the analog signals used to broadcast both conventional and HDTV programs, telecomputers will require a fiber-optics network."

This gentleman goes on to point out that fiber-optic cables can carry thousands of times more information than copper wires or radio waves, and that it is fortunate that fiber-optic and telecomputer technologies are under intense development by Bell Labs, Bellcore, Corning Glass, and hundreds of computer companies. Another interesting quote from Gilder's *Times* article is the following: "The chief obstacle to the introduction of telecomputing and the vast step forward in human communications and culture that it will bring, is the strange coalition of interests currently converging on Congress in support of HDTV. By diverting resources and political efforts from the vital and difficult drive to replace broadcasting with digital fiber networks, HDTV poses a dire threat to the future of American technology. HDTV, moreover, will offer its meager gains in picture quality only if the government continues to offer big subsidies to develop the technology. The biggest single subsidy asked of the government is to expand free access to the broadcast frequency spectrum at a time when those frequencies are acutely needed for higher value uses, like air and ground traffic control, cellular telephones, modems, and eventually even two-way wrist telephones. But in addition, the television industry now wants taxpayers to prop up its outmoded, largely analog television technology with subsidies for the development of HDTV. It makes no sense for Congress or the country to invest in this technology. . . . For the United States, television—including HDTV—is obviously little more than a pathetic dog. If this were not the case, then the private sector would invest in it without going to the government and asking for subsidies. . . . Congress must choose between the American computer and fiber-optics industries—our country's real fast-rising stars—and an outmoded television technology on which Japan and Europe have already wasted billions. In computers, the world's leading industry, the United States has 70% of the world's market. America also leads decisively in fiber-optics production and installation. But Japan dominates TV and HDTV technology. To help American competitiveness, Congress should break down the endless regulatory obstacles that stop telephone companies from putting fiber-optics networks into the home.

Obviously, the foregoing is one hell of an indictment of analog NTSC television and HDTV. Some of Gilder's arguments are very cogent, but quite a lot of them are just too facile and have their share of naiveté. There are some drastic notions here, as well. In essence, Gilder is asking for the abandonment of television broadcasting, and you can just imagine the tremendous lobbying against this by the TV networks. He also assumes a great deal with his discussion of bringing fiber-optic cables into the home. It is true that the telephone companies have already installed thousands of miles of fiber-optic cables. However, a fiber-optic connection to a home would be quite expensive, as we are not talking about the cheapie plastic fiber-optic cable that too often connects the output of a CD player to other digital equipment. The fiber-optic cabling to a home would have to be made of a special high-quality glass for optimum transmission characteristics. It must be protected by layers of special and expensive insulating sheathing and terminated by special ceramic/metal connectors which need precision glass lenses. The length of the fiber-optic cable to the home would also require that it be driven by a laser. Gilder also talks rather blithely about interactive digital TV. This would require either another fiber-optic cable or another signal at a different wavelength on the same cable. At present, costs would be about the same for each of these items.

In summation, neither HDTV nor the digital TV/fiber-optic technology is imminent. In fact, whichever technology prevails, it will be a long time in coming. In the best of all possible worlds, the digital fiber-optic technology would ultimately prove to be the best and most desirable, but my instincts tell me we will see HDTV first.

EDWARD TATNALL CANBY

SPINNING WEBS AND REELS

Illustration: Linda Bleck

Is audio a profession? You bet it is, even though it did not exist in any organized way—apart from electrical engineering—until after WWII. Do audio professionals know the extent to which their products influence people way out to the far audio periphery? Very few bother. Too busy.

They are specialists and must be. They live the intensely competitive life of the inner circles in any profession. They do not at all resemble the spider, who at the center of a huge web is instantly in touch with every tiny portion of that web through the elastic tensions that bind her to its most distant areas.

In audio, too, as in many professions, the maxim is that if it sells, it is good. The Great Public is being fed the right audio diet. (Feedback in terms of sales volume.) The public, even so, is often just a convenient set of ninepins—to change metaphors—by the thousands and the millions, to be bowled over and set up again, ready for another round. Knock 'em down, they bounce right back. Plenty of truth there! People do enjoy the game. But it gives one more convenient excuse to the busy specialist to avoid thoughts of peripherality—i.e., what people do and think in the boondocks of nonprofessionalism.

Nobody can criticize professionalism as such, especially today when specialization goes to such incredible complexities of detail. It is worth a man's life just to keep up, as many an older audio man knows. Our civilization depends on these highly technical areas, and audio, in its way, is as important as any of them. There just isn't much time to think about the audio periphery.

And yet the whole audio picture is enormous and getting larger all the time. Where would we be if all electronic communication vanished? Life, as it is almost anywhere on the planet, would collapse in chaos. A nuclear attack would not cause as much disruption—even bombs could not cover the world as does audio.

And so the inner professional world of audio goes merrily, intensely on in its own way, while the audio periphery does what it can and hopes for the best. It's like the old lady who trusts her automobile to get her there and back, knowing how to make it go but entirely ignorant as to how it does so. This is the huge, normal, gigantic, widespread audio periphery.

It is a sort of inside-out provincialism, perforce. The very center is that which is isolated, *not* the periphery—the suburbs, the ex-urbs, the boondocks! It is out there where the audio impact on civilization really matters. It seems inevitable in our present world, the insiders being necessarily so professional that they live within a sort of cage, an inner chamber of their own devising, jampacked and seething with activity like some priesthood of an ancient civilization. Their language, their thoughts and attitudes are largely out of touch with outside ways, though they are expert enough in designing the audio that will sell, and work, where the biggest part of audio lives.

The periphery exists on a vast scale. It is made of microcosms. A journalist, writer, video reporter reaches to the microcosm for a sense of reality—the television close-up, the "man in the street" (or woman), the studio interview. What one person says, we hope, represents the thoughts of millions, and so it often does. History, after all, is made up of microcosms, of individuals within the masses, individual happenings inside the great events, single objects (the Rosetta stone) which carry significance. I, too, must follow this lead—hence my recent column (June) on Mr. and Mrs. Charles Parent of Cornwall, Connecticut (she born in 1871, he, though he didn't say so, probably even older, born in the 1860s). These two talked to me from an historical audio tape, totally amateur but remarkably valuable as audio history. My job as a local "expert," relatively speaking, was to transfer those voices from an anonymous reel-to-reel tape onto cassettes for current use.

I, too, you understand, am in a part of the periphery—but far closer to the professional than to the outer fringe! I am perhaps the spider's assistant, to keep the lines of communication alive between inside and outside wherever I may. Out where I live, knowledge of audio technicalities is just about zero. And yet audio is very much *there*.

You can guess why I am back to the Parents. I have in hand a letter to the Editor (not to me) concerning that June column. It is from Tom Christopher, an enthusiastic young (I assume) audio professional who seems to find what I said almost incomprehensible—from a professional viewpoint ("Signals & Noise," August). He was astonished at what were, to him, my bumbling, ama-

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Our civilization depends on these highly technical areas, and audio, in its own way, is as important as any of them.

teurish efforts and wanted to know why I didn't "consult" any one of the reputable audio pros in my region who could "*ponder this obviously major dilemma*" (mine) as to what to do with those zany tapes I was trying to copy. He just couldn't understand: "He [meaning me] sounded like he was consulting *The Audio Farmers' Almanac*."

What this man does not understand is that there is a huge, active audio world outside his own probably well-equipped studio, low on basic knowledge of technical things but high on enterprise and appreciation of audio significance. Also, of course, low on equipment. And funds. This is not business! It is audio on its own, far beyond the commercial fringe. That operations could be so amateurish offends his professional soul. In his way, he is right. It would be nice to have a fully professional consultant and the latest and most extensive equipment layout available wherever any thought of audio exists, periphery or no. I admire his up-to-date enthusiasm. I suppose that he has access to the latest pro equipment for his work—he *has* to as a professional. No criticism! Good man . . . .

But he doesn't stop there. Unwisely, perhaps only rhetorically, he suggests that *he* is the audio man I should consult. "*I qualify and volunteer,*" says he.

Volunteer? For what consideration, I ask? A bit of glory, perhaps, a lot of fun, and a considerable amount of hard work. But no cash. That's what volunteer means. Out in the boondocks where it thrives.

The Cornwall Historical Society is the only enterprise of its kind in our town and perhaps the only one to have tried so early, courageously, to record the actual stories of earlier inhabitants in their own words. In the '60s, this took imagination and understanding of what audio recording means. Nothing stupid about that. You may have read the story of one major university that began a "Recorded History" series with long taped interviews of well-known persons, strictly confidential (to bring out the scandals as well as the glory of the past). Having recorded this priceless material, this school had it transcribed into words on paper, in whole or in part—and *erased the tapes*. To use them over again. Can you believe it? I thus lost hours of my own father's voice telling of his whole life in the literary world of the 1920s and '30s. I have only a few moments of that voice, taken off the air by myself in 1950 or so and *not* erased. However naïve they may have been in technical knowledge, the Cornwall Historical Society was at the forefront of audio thinking.

But volunteer work? At a wild guess, the treasury of this Society might have at this moment, say, $169 on hand, with which to buy stamps, stationery, put out historical leaflets, heat the old house now and then, and maybe purchase a few audio cassettes in case I want to do more work with the historical tapes. (I do.) This is much too small an organization for big-scale funding—and who, I ask you, would do the highly professional job of fund-raising? At what salary?

No salary, of course. This is a volunteer organization, and there are millions of them throughout our nation outside of the big cities, and even a few there too. Volunteer work is not a popular subject among professionals, business people, sales executives, but it lives on! It has to make do with what it can get, for no money at all—and often enough, it finds a bargain. Big-name people who give their services.

Yes, you audio professionals, you have to live. Money counts. But the greatest pleasure in most people's lives rests in the activities that can be managed without pay, beyond money. Some people catch onto this early, and their lives are the happier for it, whether for pure pleasure or for a worthy cause. Maybe it's just goin' fishing. Model railroading, I hear, is booming. Or better, it is the Cornwall Volunteer Fire Department, which protects my house admirably. No pay. Or the local ambulance corps. No pay. I must say that the very best things in my own life have brought me no cash, ever. Blood out of a stone? Many really worthwhile activities are inherently payless—if you can, you do them.

So let me go on to our friend the professional's generously conceived recommendations for those Cornwall tapes—the one I copied and the others to come. It is a marvelous worm's-eye viewpoint—full of goodies! And replete with many thousand dollars of equipment—*somebody's* equipment. The very best. And most professional.

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The greatest pleasure in most people's lives rests in the activities which can be managed without pay, beyond money.

An anticlimactic beginning. *"First identify the format."* As already mentioned, I did just that. Only took an hour or so, thanks to no identifications, hideous volume changes, overlays of one format on top of another—as was all too common in those early tape days outside (and inside!) the pro area. As noted, the format was 2-track reel-to-reel quarter-inch, at 7½ ips, one track only used, the other with assorted echoes, backwards and frontwards. A reused tape.

So here's what he would do next. *"Get some notch filters/equalizers and compressors . . . ."* For free? A couple of thousand dollars or maybe much more, right there. Out in the boondocks, we do not "get" that kind of equipment at the drop of a volunteer hat. *"Maybe even a de-esser for a kick."* This begins to sound like one of those luxury cruises to Antarctica. All you need is $15,000, plus airfare to somewhere. *"When bouncing to tape for editing, some noise reduction might be fun."* As an old noise-reducer and editor, I doubt this. Neither Burwen, dbx, nor Dolby himself could do much with the noise on these tapes. Maybe for a few more thou you could try some fancy digital stuff, the sort that would reduce shellac noise on a very worn-out Caruso original.

"A combination of equalization (voice is easy to isolate) and compression/limiting will make the words clear and the levels even." Yes, maybe. I did use some simple EQ, merely to tone down the hum and hiss and rumble. It helped. I also compressed—by hand. Easy when you memorize the words so you can hit the volume control at the right instant. But beware! The background noise, even with some NR, jumps up and down so radically that it distracts from the words. I tried; I know. So I did only a moderate hand compression. No cost, no extra equipment. We boondock people tend to be resourceful.

"If you must use tape (yech!) [in the copying], *noise reduction helps; my preference would be Dolby SR."* Aha, the very latest and best! At a cost. But if Dolby can do much more than I can with this material, he's even more of a genius. And why the *"yech"*? Do we store the stuff in a computer for later reference in Cornwall? (Computer, of course, donated.) As for the de-esser, no. You can't de-ess an "S" that isn't there.

The payoff, of course, is DAT. (I might have guessed that one.) *"I would also transfer the old tapes to DAT, then compress, equalize, and edit/sequence while going to another DAT. This gives you a nondegradable master for cassette duplication."* Duplication? And two DAT machines? My non-pro head spins. Is this what our friend is volunteering?

"If all this sounds like overkill, that's because it's 'like' professional." So be it. Amen.

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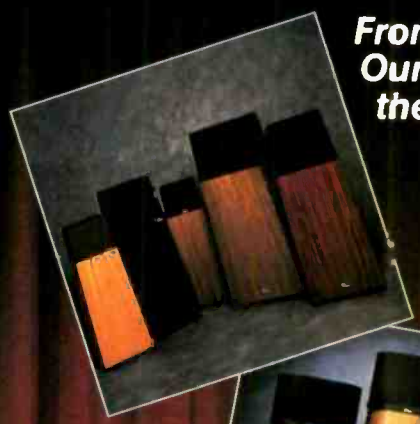

Stereophile 8-88

"So the bottom line is quite favorable: The Walsh 5 is a full-range speaker that is quite clean and images very well." "Sound staging is another strength and joy, and at their best the 5s can set up a very palatable illusion of the original performing space." "In its present incarnation it is one of the few dynamic speakers that my jaded electrostatic taste buds could live with."-Dick Olsher, Stereophile, Volume 11, Number 8 (August, 1988).[1]

Audio 6-88

"The Walsh 5 is one of the cleanest speakers available...I perceived remarkable depth and spaciousness to music well recorded in a concert hall. This spaciousness did not result in a vague mass of sound: image location is sharply defined and accurately placed...They are a masterpiece of the speaker designer's art."[2]

Stereo Review 1-88

"The sound of the Ohm Sound Cylinders was smooth, balanced and thoroughly enjoyable, well beyond what anyone would expect from such a small, light speaker. Its dispersion was subjectively complete, and we were never aware of the speakers as distinct sound sources, no matter how much we moved around the room...these speakers certainly offer impressive value for their price and size."[3]

New York Times 3-88

"...the various frequencies emerge in their natural phase relationship--more than in conventional designs. To what extent this accounts for the speakers fine sound may be debatable, yet there is no question that the Ohm Sound Cylinders represent an excellent bargain, with a clarity and richness of sound rarely found in a speaker of this size and price."[4]

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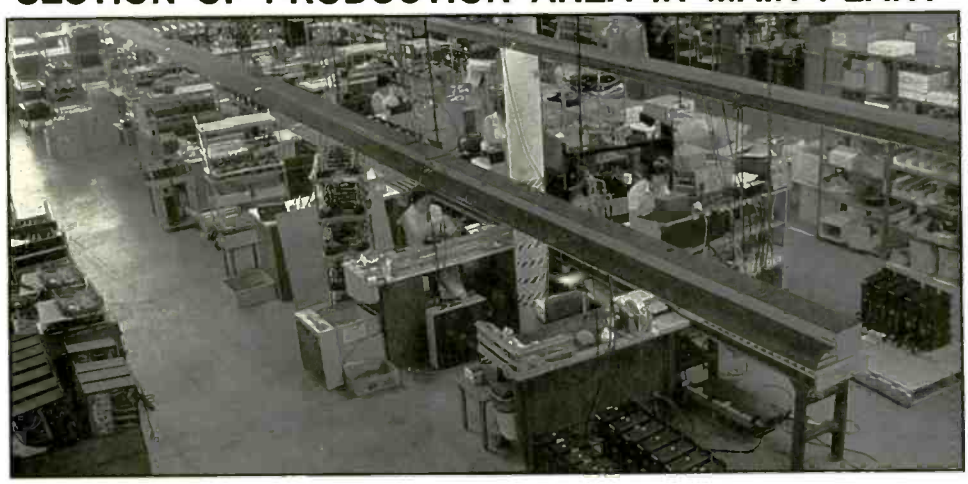

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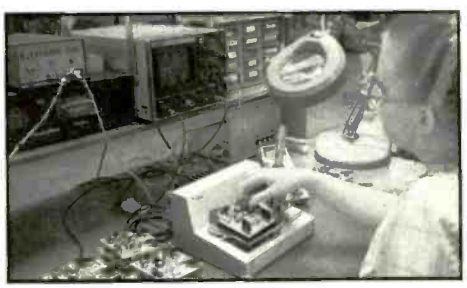

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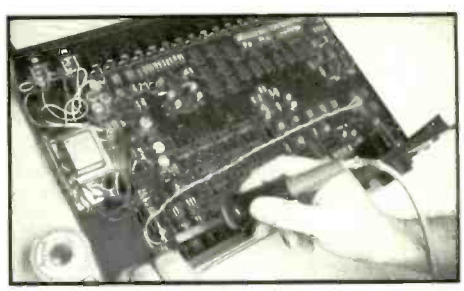

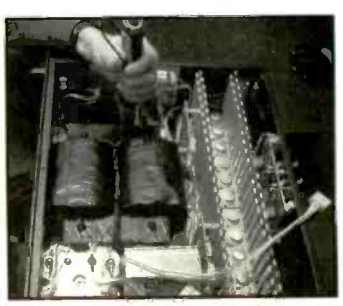

"...it brought out the best in all of the loudspeaker systems with which I tried it.."

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Says Leonard Feldman in his Test Report in AUDIO Magazine, Vol. 71, No.9:

"...it brought out the best in all of the loud speaker systems with which I tried it. I sensed an effortlessness about the musical crescendos reproduced from some of my CD spectaculars..."

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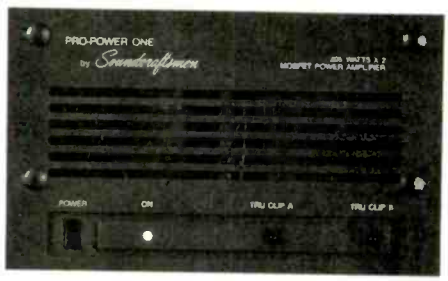
Pro-Power Three

DESCRIPTION: Same as Pro-Power Four, except without the LED power meters.

Pro-Power One

PRO-POWER ONE: The NEW PRO-POWER ONE amplifier provides all of the performance features of the PRO-POWER FOUR in a smaller, non-rack-mountable chassis.



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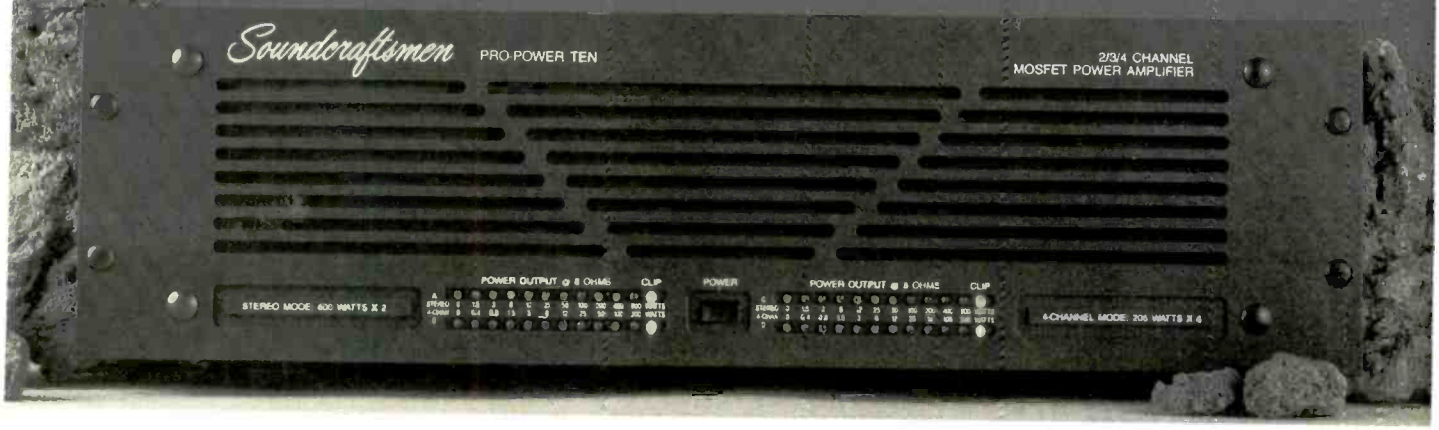

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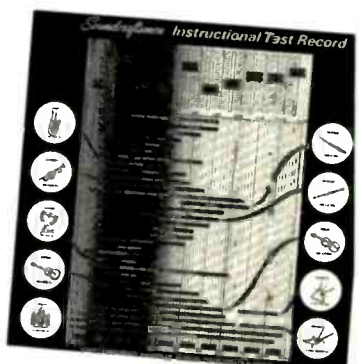

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Wire Talk

Frank Van Alstine runs a quality audio store called Audio by Van Alstine (formerly Jensen's Stereo Shop) in Burnsville, Minnesota. He's generally regarded as a pretty good electronics engineer and has occasionally issued products that show excellent grasp of the principles involved, together with innovative thought. The following is from Van Alstine's newsletter, *Audio Basics*. We let the copy speak for itself.

"Too may readers want me to tell them what magic cable and speaker wire to use! They don't want me to be honest and explain that there is no correlation between cable quality and price. They certainly don't want me to inform them that the only difference between the 'sound' of various cables is the way the real electrical characteristics of the cable—the resistance, capacitance, and inductance—load the driving source. They don't want me to say that any sonic differences can be replicated with 10¢ worth of resistors, capacitors, and inductors wired across the cable. They don't seem even to want to know that, if an amplifier is not load sensitive, the characteristics of the cable won't matter at all. None of that good electrical engineering advice is any fun at all.

"Magic is a lot more fun and is much easier to understand. So I keep getting call after call, and letter after letter, asking me only what brand of magic cable I recommend. And when I respond, the answer is perceived to be that I don't like magic cables. Wrong again! I don't like fraud. I don't like products that are represented and priced to have some mystic quality that does not exist and that the supplier knows does not exist. I don't like the fact that the entire high-end and mid-fi market has taken up selling high-priced cables as a way of making a quick buck and convincing you that their shiny pennies are fair trade for your quarters.

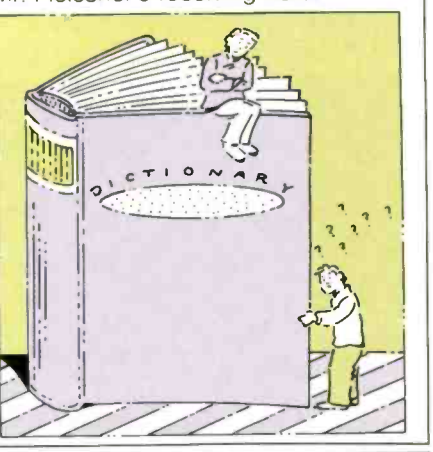
"I don't like magazine reviewers mindlessly listening to and evaluating magic cables and wires in endless, nauseating reviews without ever thinking about what is going on, about what they are really hearing or not hearing, and why. The concept that most electronics are excessively load sensitive and that changing the load changes the sound seems to be an alien thought too hard to understand. The concept that if the cable changes the sound, then the real problem is the source driving the cable, is never discussed. Nobody is willing to stand up and shout, 'Bullshit!'

"So when I demonstrate at a Show, obviously using standard cables and interconnects, I get to spend my time explaining why the sound was so good with 'bad-sounding' wires. Far too many of the visitors to our room were so brainwashed that they never understood that the sound was good because the equipment was not screwing up the source material, because I had done an adequate job of getting rid of the worst of the room's acoustic problems, and because the brand and cost of the cables did not matter at all."

Stereopticonfusion

The "stereopticon" slide of the Eiffel Tower in the January "Spectrum" was actually a stereo*scope* slide. I humbly accept this correction from Kenneth H. Fleischer of San Francisco, for the sake of truth and for the sake of proving I'm not old enough to have been around when stereoscopes were in vogue.

The two words *are* frequently confused. In fact, I heard someone make the same error at a party two days after Mr. Fleischer's note arrived. To my surprise, my gentle correction was received only with a frosty look, not the public thanks Mr. Fleischer's receiving here.



Walkman Marches On

Few audio inventions actually revolutionize our listening lives, and the ones that do are rarely inexpensive—at least initially. So hats off to an invention that did create a revolution, and did it on the cheap: Sony's Walkman, which celebrates its 10th anniversary this year.

To celebrate, Sony is bringing out a "Commemorative" collector's model, the WM-701S, in a production run of only 2,000 pieces. This $650 unit is a silver-plated version of the $220 WM-701C, featuring auto reverse, a wired remote control, rechargeable battery, and both Dolby B and C noise reduction. Sony also worked with Tiffany's to produce an even rarer model, the WM-701T. This model will not be for sale but will be awarded, by Sony, to "a select group of visionary leaders in the music and consumer electronics industries."

Illustrations: Teresa Anderko

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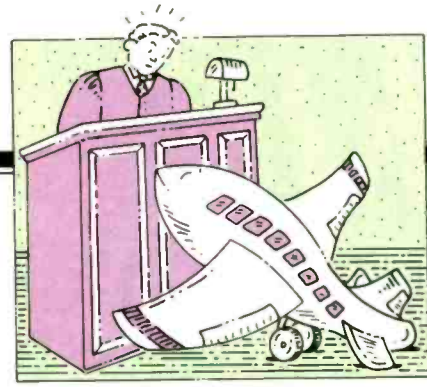
The American credo that a man's home is his castle has gotten short shrift when it comes to airport noise.



Noise in the News

Who is responsible for controlling airport noise? The federal government, say the airlines. Local government, say beleaguered airport neighbors. Who's right?

The answer is still blowing in the windsocks, but a recent U.S. Supreme Court action may help nudge the decades-old debate toward resolution. By refusing to hear a complaint brought by a Chicago suburbanite against O'Hare International Airport, the Court has opened the door for citizens to sue the city of Chicago (O'Hare's owner) for noise-related abuses. Though the case doesn't directly address the question of just who sets noise-control standards, it does tackle some closely related issues: Who's accountable for airport-noise abuses, and what's the proper forum for disputes over airport noise?

"By putting the ball back into state court, so to speak, the Supreme Court is forcing Chicago to face the real costs of poor airport planning," said Joseph Karaganis, a lawyer representing the O'Hare Citizens Coalition, a group of O'Hare's neighbors. Karaganis also represents Lawrence Bieneman, whose 1984 suit charged that O'Hare's noise lowered the value of his Bensenville home. Dismissing Bieneman's suit in December 1988, the U.S. Court of Appeals, Seventh Circuit (whose ruling referred to Bieneman as "a frequent filer"), declared that Bieneman, and anyone else, was free to sue Chicago in Illinois state court. "All residual power," commented Karaganis, "remains with the state in redressing injuries. This is what the appeals court's decision ruled." In May 1989, the decision was upheld by the Supreme Court.

For America's airlines, local control is an uneasy prospect. "Federal agencies still have the basic responsibility," said John Meenan, an attorney for the Airline Transportation Association, based in Washington, D.C. "Airport proprietors can go no further than taking limited action in controlling noise." Imposing local airport rules would inhibit airlines' business, said Airline Transportation Association spokesman William E. Jackman, creating "situations where you can fly one kind of aircraft into one city but can't fly the same plane into another place. That is no way to run an airline."

Yet across the U.S., communities and airports are taking steps to curb excessive jet noise. In California's populous Orange County, stated Karaganis, restrictions now prevent noisier jets from landing at John Wayne Airport. San Diego International Airport, among others, has a nighttime curfew.

O'Hare, the nation's busiest airport, has no such restrictions, said Karaganis, who claims that 90,000 homes in 20 Chicago suburbs are adversely affected by jet noise. He estimates a 1% to 2% drop in property value for every decibel over 65 dBA; that's a $15,000 to $30,000 loss to the owner of a $150,000 house in an area with levels of 75 dBA.

In Chicago suburbs like Elmhurst, Park Ridge, or DesPlaines, such levels are often exceeded, added Karaganis. "You get pop bottles exploding in cupboards, you get walls cracking. People can't hear themselves think. The American credo that a man's home is his castle has gotten short shrift when it comes to airport noise." *Tony Scherman*

V15 Turns XXV

It's now been 25 years since Shure Brothers introduced the first V15 phono cartridge. The original V15 featured an elliptical diamond stylus—the first of its kind, as Shure and I recall—and an optimized 15° tracking angle. With the V15 Type II (1966), Shure introduced its concept of "trackability" and the first of a series of trackability test records still in use by reviewers—including ours—today. The Type III (1973) featured a resonant frequency above the audible range and laminated pole pieces. With the Type IV (1978), the cartridge sprouted a Dynamic Stabilizer, a viscous-damped carbon-fiber brush system that reduced low-frequency resonance, drained static electricity, and swept dust and dirt from the groove. When Shure figured out how to make its beryllium MicroWall stylus shank (1982), they introduced the Type V, whose box doubled as a neat cartridge-alignment tool. One year later, the Type V gained a MicroRidge Stylus tip to become the V15 Type V-MR. So far, no Type VI has been hinted at, but even in this CD-oriented era, who knows?

Fourplay

Not content with merely stretching the CD's play length, as other companies have done ("Spectrum," September and December 1988), Nimbus wants to double or quadruple it. In their labs, they've succeeded in packing the pits on a disc twice as close as usual—and think they can double *that*. Playing the resulting "CD4X" discs would require a blue laser, and the only solid-state blue laser we've heard of is an experimental Matsushita device which costs about $10,000.

Nimbus says the CD4X will be used for computer data and video use, not audio. After all, few four- to seven-hour audio programs are likely to be sure-fire sellers (with all due respect to Wagner). On the other hand, I could see its use in giving CD3 discs and vest-pocket players the 80-minute capacity of today's full-size CDs.

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Julian Hirsch
Stereo Review, Sept. '88

Cambridge SoundWorks has created Ensemble,™ a speaker system that can provide the sound once reserved for the best speakers under laboratory conditions. It virtually disappears in your room. And because we market it directly, Ensemble costs hundreds less than it would in stores.

Henry Kloss, creator of the dominant speaker models of the '50s (Acoustic Research), '60s (KLH), and '70s (Advent), brings you Ensemble, a genuinely new kind of speaker system for the '90s, available only factory direct from Cambridge SoundWorks.

The best sound comes in four small packages.

Ensemble consists of four speaker units. Two compact low-frequency speakers reproduce the deep bass, while two small satellite units reproduce the rest of the music, making it possible to reproduce just the right amount of energy in each part of the musical range without turning your listening room into a stereo showroom.

Your listening room works *with* Ensemble, not against it.

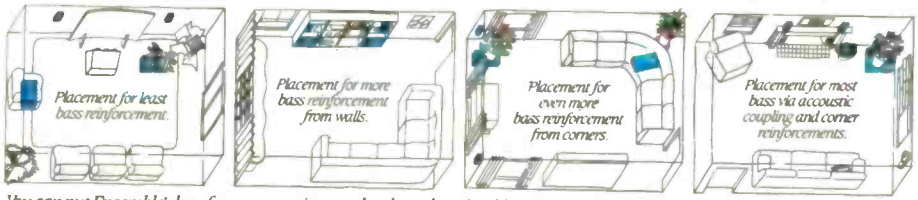
No matter how well a speaker performs, at home the listening room takes over. If you put a conventional speaker where the room can help the low bass, it may hinder the upper ranges, or vice-versa.

What Henry Kloss tells his friends

Every time I came out with a new speaker at AR, KLH, or Advent, my friends would ask me, "Henry, is it worth the extra money for me to trade up?" And every time I would answer, "No, what you've already got is still good enough."

But today, with the introduction of Ensemble, I tell them, "Perhaps now is the time to give your old speakers to the children."

Ensemble is a Trademark of Cambridge SoundWorks, Inc.



You can put Ensemble's low-frequency units exactly where they should go for superb bass. You can't do this with conventional speakers because you have to be concerned about the upper frequencies coming from the same enclosures as the low ones.

Ensemble, on the other hand, *takes advantage* of your room's acoustics. The ear can't tell where bass comes from, which is why Ensemble's bass units can be tucked out of the way—on the floor, atop bookshelves, or under furniture. The satellites can be hung directly on the wall, or placed on windowsills or shelves. No bulky speakers dominate your living space, yet Ensemble reproduces the deep bass that *no* mini speakers can.

Not all the differences are as obvious as our *two* subwoofers.

Unlike seemingly similar three-piece systems, Ensemble uses premium quality components for maximum power handling, individual crossovers that allow several wiring options and cabinets

Unlike seemingly similar satellite systems which use a single large subwoofer, Ensemble uses two separate, compact bass units. They fit more gracefully into your living environment, and help minimize the effects of the listening room's standing waves.

ruggedly constructed for proper acoustical performance. We even gold-plate all connectors to prevent corrosion. An even bigger difference is how we sell it...

Thousands agree: the best showroom is your living room.

We make it possible to audition Ensemble the *right* way—in your own home. In fact, Ensemble is sold *only* by Cambridge SoundWorks directly from the factory. Listen for hours without a salesman hovering nearby. If after 30 days you're not happy, return Ensemble for a full refund.

At only $499*—complete with all hardware and 100′ of speaker cable—Ensemble is *the* value on today's speaker market.

Call 1-800-AKA-HIFI† (1-800-252-4434)

Our toll-free number will connect you to a Cambridge SoundWorks audio expert. He or she will answer all your questions, take your order and arrange surface shipment via UPS. Your Cambridge SoundWorks audio expert will continue as your personal contact with us. We think you'll like this new way of doing business.

†In Canada, call 1-800-525-4434. Audio experts are on duty Mon.-Sat., 9AM–10PM, Sun., 9AM–6PM Eastern Time. Fax #: 617-332-9229.

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IVAN BERGER

WAIL TALE

Changing the Siren's Song

Many modern composers stay safely tucked in academe, but Max Neuhaus likes to compose for unusual niches of the real world. One of his works rumbles away in a subway ventilation chamber two blocks from my office, quietly convincing passersby that the subway has developed musical talent. And another Neuhaus opus may be coming soon to an emergency-vehicle siren near you.

Neuhaus' new siren songs are designed to be more informative, and perhaps occasionally more pleasant to hear than those in use today. "A siren should have a range of nastiness," Neuhaus told *The New York Times*. "It should be really nasty when people are in danger and less nasty when they're not." Consequently, his siren suite consists of four songs—a bell-like ping, a double tone, a swooping phrase of four notes, and a shrill whoop.

To help listeners tell where the sirens are coming from, their sounds are punctuated with pauses. Siren tones will be broadcast at different pitches from the front and rear of the vehicle, so listeners will be able to tell whether they're in front of or behind it. And the faster the vehicle goes, the more frequently its siren will sound.

As a result, no two ambulances, fire trucks, or squad cars in a given area are likely to emit the same sound at precisely the same time. This may help prevent many collisions between emergency vehicles responding to the same alarm—a problem when the siren on one vehicle drowns out any others in the area.

Modern music has been accused of sounding like police cars. If Neuhaus' system gets adopted by some manufacturer, police cars may start sounding like modern music for a change.

Illustrations: Beata Szpura

Sneaking in a Subwoofer

There are two common, traditional ways to hook a subwoofer into a car stereo system: Either use a stereo amp and a passive crossover, or an electronic crossover and separate amp channels for the satellites and subwoofer. If you want to run a mono subwoofer, you need a summing network after the crossover filters (active crossovers often include this) or a subwoofer with two voice-coils.

Now there's a third and fairly sneaky way to do it. Rockford Fosgate, Orion, and Phoenix Gold have stereo amps that can provide a mono subwoofer output in addition to their two stereo outputs. The trick works because the two amplifier channels are wired with opposite polarity, so a woofer bridged across one terminal of each would play all signals that the two channels had in common, gaining extra power from the bridged configuration. Meanwhile, each satellite speaker system is connected conventionally to the two terminals of one amplifier channel, and therefore receives just one channel of the stereo signal. Add some passive components to filter highs out of the woofer signals and to keep lows from the satellites, and you're in business. Or you can omit the filters and use the "extra" speaker as a center channel.

With this type of wiring, that center-channel speaker would play the sum of both the left and right signals, which is just what such a speaker should do. Orion points out that with ordinary bridging, which effectively turns a stereo amp into a more powerful mono amplifier, that speaker would get only the left or right signal. This is because most stereo amps, when bridged, accept signals only from one input jack.

These techniques would probably work with most bridgeable amplifiers. Check with your amp's manufacturer before you try it, though, just to be on the safe side.

Taxing Situation

Britain, I gather, is one country where you won't hear a lot of blaring, thumping car stereos going down the street. British restraint? No, British tax laws—not prohibitive imposts on car stereo, but the income tax. Personal income is taxed at a high rate, but such perquisites as the use of a company car are not. As a result, many people drive company cars instead of buying their own, and few invest their own money in upgrading the sound system of a car they do not own.

Take Ten

Introducing the new ten disc CD Changer, another industry first* from Ford.

Now you can enjoy hours of continuous music without having to load, unload, or store your compact discs while you drive.

This new state-of-the-art system uses interchangeable ten disc magazines in a changer unit that is stored safe and secure in the trunk of your car. And a full-function remote control allows the selection of any track on any disc at the touch of a button.

The new ten disc CD Changer is compatible with any Ford, Mercury or Lincoln equipped with the optional Ford High Level Audio or Ford JBL Audio system. See your local Ford or Lincoln-Mercury dealer for details.

The new ten disc CD Changer from Ford. We're sure you'll rate it a "perfect 10."

*First optional dealer-installed CD Changer available from a U.S. automobile manufacturer

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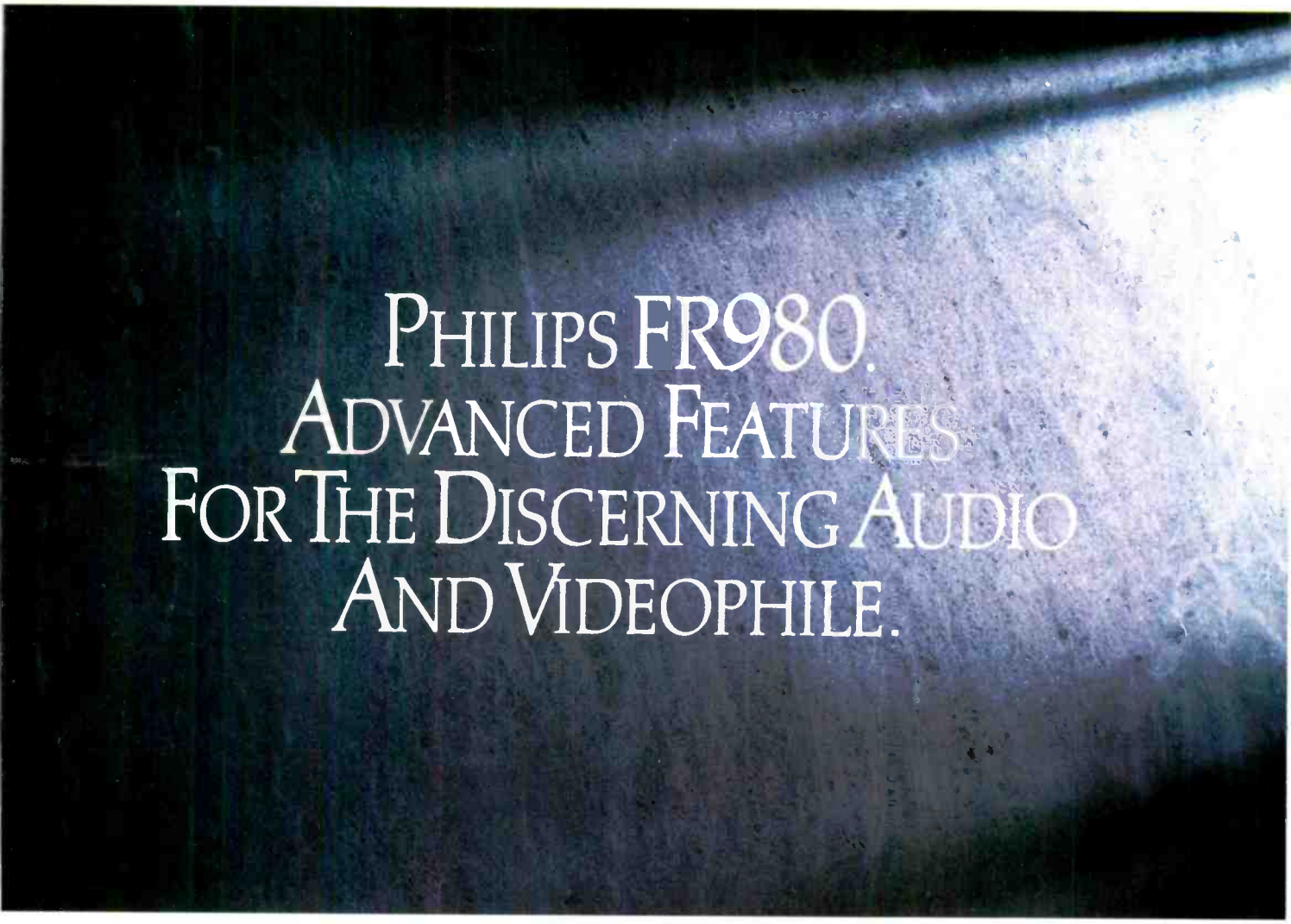

The engineers at Philips of the Netherlands steadfastly refuse to accept the commonly accepted. The result: The Philips FR980.

Arguably the most sophisticated A/V receiver available today.

Not only does the FR980 provide the world's most advanced technology, it also offers an extraordinary array of options to mix and match audio and video signals. The possibilities are virtually limitless.

Philips has designed and crafted an advanced receiver that keeps you abreast of emerging technologies like CD-V. Further, the FR980 incorporates three audiophile-quality listening modes to pamper you with impeccable sonic authenticity.

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The world's most sophisticated A/V receiver demands the most sophisticated remote control: a full "learning" type user-programmable remote. It features an alphanumeric LCD screen, and system memory to handle more than 740 different functions from virtually any infrared controlled component, audio or video.

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PHILIPS

PHILIPS

R. A. GREINER

BIT BY BIT

Illustration: Steve Dininno

During four days, May 14 to 17, 1989, about 400 persons listened to almost 40 hours of technical papers at the Audio Engineering Society's International Conference, "Audio in Digital Times." This event, held in Toronto, was the society's second major conference devoted entirely to digital audio and one of the most important conferences since the introduction of digital recordings to the general public some half-dozen years ago.

As one who has been deeply involved in digital signal processing for a number of years, I was impressed with the high quality of the papers presented and with the frankness and speed with which the attending audio engineers have approached the continued improvement of the technology and art of audio signal reproduction.

R. A. Greiner is Professor of Electrical and Computer Engineering at the University of Wisconsin, Madison. He teaches and does research in electroacoustics, acoustic measurements, applications of digital signal processing, audio system design, and noise control. He holds over a dozen patents in electronic instrumentation and audio systems and was elected a Fellow of the Audio Engineering Society in 1984.

The range of the conference can be appreciated by going over a list of the sessions' topics. They included: State of the art in technology and basic trends, conversion techniques and performance evaluation, professional digital audio, consumer digital audio, digital studio design and practice, digital signal processing, digital audio in film and broadcast, and several sessions on theory of digital signal processing. It is impossible to describe all of this in a few pages, so I have selected some of the topics which I think will be of greatest interest to *Audio* readers. I will also give my overall impressions of the state of the art of digital audio and of future trends which the conference represented.

Digital audio is a new technology—a new art, if you like—and the professionals at the meeting were in general agreement that it is not at the present moment perfect. In recent years, there have been some very poor digital recordings made and produced on both vinyl and Compact Disc. There have been a great number of superior recordings done as well, and they clearly greatly outweigh the poor ones. The important issue, faced at this conference, is that the problems which caused the poor recordings have been, for the most part, tracked down. This necessary step has been followed very rapidly with measures designed to solve the problems. As a result, most current and future recordings will continue to be better technically. The solutions, many of which were presented at this conference, are a combination of hardware advances, software design, and recording techniques.

One of the major problems has been, and is, the conversion of the signal from analog to digital and back. In some cases, the analog-to-digital converters, the necessary filters, and the digital-to-analog converters may have introduced artifacts into the recordings because they have not been as precise as the technology requires; in other cases, they may not have come up to the standards which have been set for the CD. Some early master digital tape recorders have not had full 16-bit accuracy and may not have been linearized with the correct amount of dither. Some have simply not been maintained or adjusted with enough care. In most cases, these are human problems as well as technical difficulties.

The development of digital integrated circuits has more recently made possible the development of more refined and theoretically better A/D and D/A conversion techniques. Oversampling during both the record and playback process and the application of digital filtering and noise-shaping techniques were the subjects of many of the technical papers presented. The results of these techniques, just now being implemented, are better S/N ratios, lower noise floors, much better linearity at low levels (probably one of the most important factors in perceived quality), and removal of anti-aliasing (or anti-imaging) filter artifacts that have made some CDs objectionable.

One of the major points of interest to the consumer is that these problems, which must be expected in a new technology, are becoming better and better understood and are being eliminated with advances in digital circuitry that are taking place on a daily basis. I believe that the critics of digital audio expected perfection to leap full grown from the bosom of technology. This

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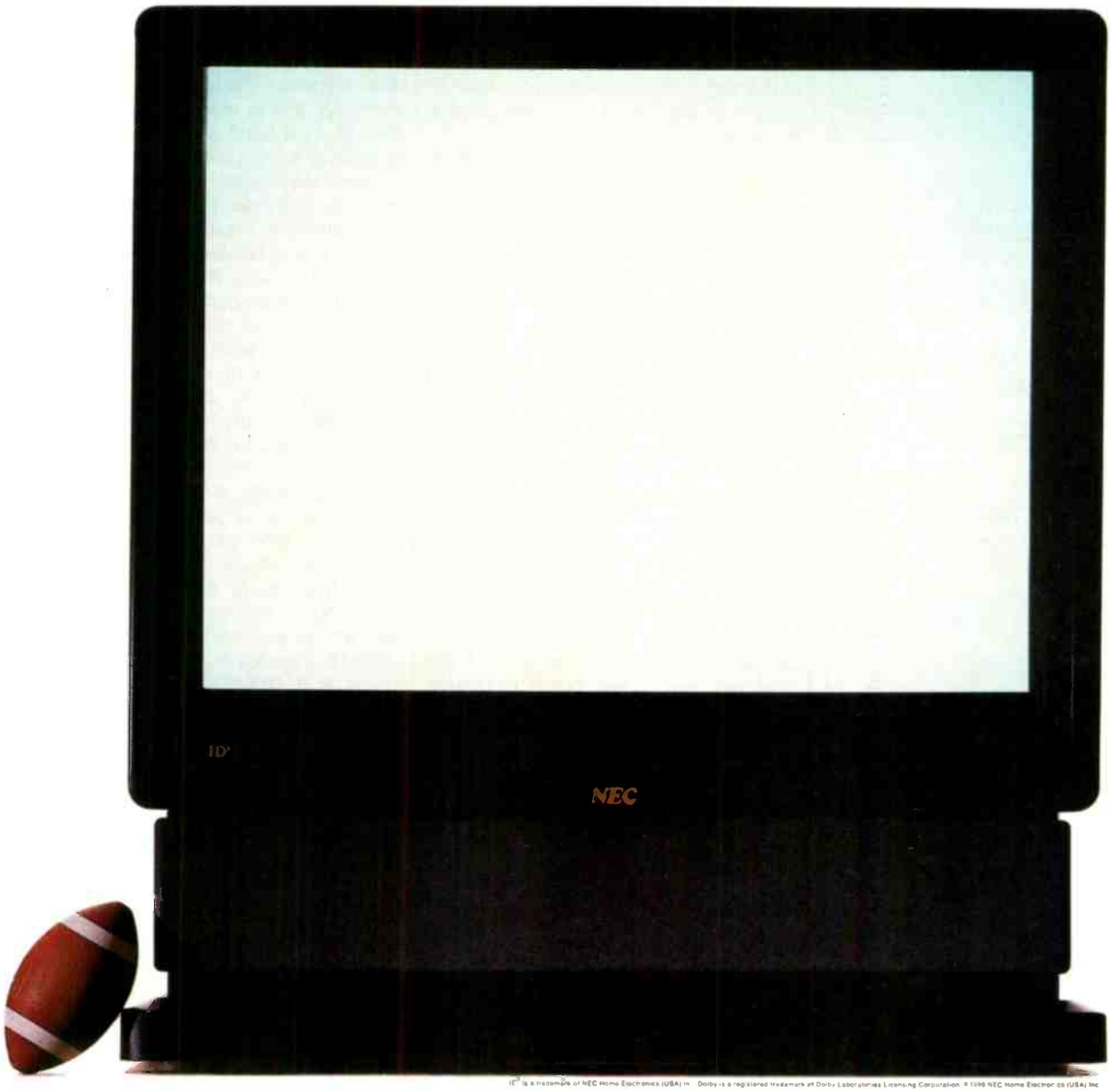

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The 52" ID-5282S from NEC. It takes improved-definition television to new heights.

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The critics of digital audio expected perfection to leap full-grown from the bosom of technology, but technology must grow and develop.

technology, like any other, has had to grow and develop. It is doing so at a rapid pace.

Some comfort and some distress might be taken from several papers presented which discussed the technical adequacy of the CD format specifications. The format requires that the sampling rate be 44.1 kHz and the quantization be 16-bit linear. The question is, "Is this adequate?" This very important question was discussed in some detail at the conference, in the light of what we now know about digital systems and human perception. For regardless of the use of frequency oversampling and higher quantization accuracy at either or both the recording and playback ends of the system the stored data on the CD has only this accuracy. The answer, as I heard it, was that the sampling rate is entirely adequate and the quantization accuracy was adequate, if carried out with full precision for the final storage of the digitized information, but finer quantization (more bits) is required in the intermediate stages of production because of the digital computations that need to be made at these stages. However, the standard is not much greater than that needed for the most critical applications. In fact, it may be just a bit on the marginal side for professional studio applications.

This is generally good news since it confirms the continued use of the current CD format for the consumer market. It is not the best news for those CDs which have been produced using a large amount of intermediate digital processing or equipment that has not been in virtually perfect operating adjustment. Fortunately, professional digital equipment is becoming available for studio use. This equipment uses higher bit quantization and oversampling, which allow high-speed, high-accuracy digital filtering and much of the other digital processing that might be required in the production of CDs.

An overview of the conference, I believe, suggests that there is reason for great optimism. In the next few years, audio production will move well beyond its current status and the final CDs which the consumer hears will all be of the quality of today's very best.

Over 12 hours of technical papers were given dealing with signal conversion between the analog and digital domains. It was made quite clear that this must be done with great precision and care. An excellent lecture/demonstration was given by Professor Lipshitz, current president of the AES, and his colleague Professor Vanderkooy, both from the University of Waterloo in Ontario, Canada. This lecture demonstrated all that can go wrong if the analog signal is not converted to the digital domain accurately and with just the right amount of dither. Various kinds of squeaks, birdies, noise, and hash were demonstrated and shown to be indigenous to certain kinds of conversion errors. That such errors exist in some currently available CDs was demonstrated by playing a number of examples. While these clearly audible defects are not common in commercial CDs, their mere existence is a bit shocking. In one of the worst cases, a Mozart piano concerto (CBS MK-37267), the music is modulated with noise and faded into dismal digital hash in a number of soft passages.

Several manufacturers presented papers describing their latest converters (IC chip sets), which provide 18- or 20-bit accuracy and a high degree of frequency oversampling. While only 16 of the bits are ultimately stored on the CD, high-accuracy conversion enables excellent digital filtering and assures that the rounded 16-bit words are, on the average, accurate to a small fraction of the lowest bit. It was shown that it is important to have accurate 16-bit conversion to actually get the full advantages of 16 bits in terms of S/N and linearity for very small musical signals. (The reader might appreciate that *Audio* has tested and reported on this very important feature of CD players for some time.)

The new high-accuracy converters use a technique called delta-sigma modulation, oversampling conversion, or noise-shaping digital conversion. Whatever term is applied, the converters use very high sampling rates—e.g., 6 MHz—and only a few bits, sometimes one. The data is then digitally filtered, decimated, and converted to 16- or 20-bit words at a normal sampling frequency. This process eliminates the need for anti-aliasing filters and can attain accuracies of 20 bits or more if required. The advent of

configuration, 2-way mono. This last

that the Bryston 10B Crossover uses NO integrated circuits in the signal

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Digital computations in intermediate stages of CD production require finer quantization (more bits).

"Polk's Remarkable Monitors Redefine Incredible Sound/Affordable Price"

"At their price, they're simply a steal" **Audiogram Magazine**

Monitor 10B — $349.95 ea.

Considered one of the worlds' best sounding loudspeakers and, in the words of Audiogram magazine, "At the price they are simply a steal." The Polk 10B utilizes dual trilaminate polymer drivers coupled to a built-in subwoofer for accurate bass response and superior dynamic range. A 1" dome tweeter perfectly complements the other drivers to insure outstanding reproduction of every type of music.

Monitor 7C — $274.95 ea.

Basically a smaller, less expensive version of the Monitor 10B. By offering superlative performance whether mounted on a shelf or a speaker stand, the 7C is a highly versatile addition to any audio system. How good does it sound? Audio Alternative magazine said, "It is amazing."

Monitor 5B — $214.95 ea.

Similar in design and performance to the Monitor 7C, however it utilizes an 8" subwoofer (rather than 10") and is more compact. The 5B represents one of the best values of the entire Monitor Series.

Monitor 5Jr. + — $169.95 ea.

Called the best sounding speaker of its price in the world regardless of size. It achieves life-like three-dimensional imaging which 10 years ago was not available in any bookshelf speaker at any price.

Monitor 4.5 — $122.45 ea.

Shares most of the high technology components and rewarding musical performance of the larger Polk speakers at a surprisingly low price. A critically tuned bass duct insures high efficiency and great bass performance despite its convenient compact design.

Monitor 4A — $99.95 ea.

Identical to the 4.5 in a smaller cabinet. Audio critic Lawrence Johnson called it, "an all around star of great magnitude." The 4A's affordable price means that no matter how small your budget, you can afford the incredible sound of Polk!

Matthew Polk's Vision: Superior Sound for Everyone

Polk Audio is an American company that was founded in 1972 by three Johns Hopkins University graduates who were fanatical audiophiles with a common vision. They believed that it was possible to make speakers that performed as well as the most exotic and expensive systems at a fraction of the price. Starting with only $200, they began by designing and manufacturing the Monitor Series loudspeakers. The Monitor Series combined the advantages of American high technology and durability with European styling and refinement. Over the years an unending stream of rave reviews, industry awards, and thousands of enthusiastic Polk customers have established the Monitor Series as the choice for those looking for both incredible sound and an affordable price. There is no better value in audio equipment today than a Polk Monitor series loudspeaker.

Uncompromising Standards at Every Price

A limited budget does not mean a limited ability to appreciate fantastic sounding music. That's why we put our best engineering efforts and only the finest materials into every Polk product regardless of price.

Every Polk Monitor Series speaker uses the same trilaminate polymer cone technology as the flagship SDA-SRS 1.2. Every Polk Monitor utilizes a 1" polymer dome tweeter, and most use exactly the same tweeter found in the SRS 1.2. All Polk Monitors employ costly multi-component crossover networks and ¾" thick high density, non-resonant cabinets. Pick up a Polk Monitor 4A, then pick up a comparably priced but larger speaker from a different manufacturer. You'll notice that the Polk is heavier, more solidly built, and sports a superior fit and finish. Now compare the sound. We are sure you'll agree with Musician magazine, which said Polk Monitors are: "Vastly superior to the competition."

Matthew Polk with his incredible sounding/ affordably priced Monitor Series loudspeakers. Front row (L to R) **Monitor 5Jr. +, Monitor 4A, Monitor 4.5** Back row (L to R) **Monitor 10B, Monitor 7C, Monitor 5B**

The Thrilling Sound of Polk Monitors

Polk Monitors achieve open, boxless, three-dimensional imaging surpassed only by the SDA's. Their silky smooth frequency response assures natural, non-fatiguing, easy to listen to sound, while their fast transient response results in music that is reproduced with life-like clarity and detail. In addition, dynamic bass performance, ultra-wide dispersion, high efficiency and high power handling are all hallmarks of Monitor Series performance.

There is a Polk Monitor Perfect for You

Each time you advance through the six Monitor Series models, you'll immediately hear a remarkable improvement in efficiency, bass response, and output volume. They are designed so that a smaller Polk played in a small room will sound nearly identical to a larger Polk played in a large room. A larger Polk in a small room will, of course, play that much louder with even better bass. No matter what price range fits your budget, there is a spectacular Polk Monitor Series speaker waiting to fulfill your sonic dreams.

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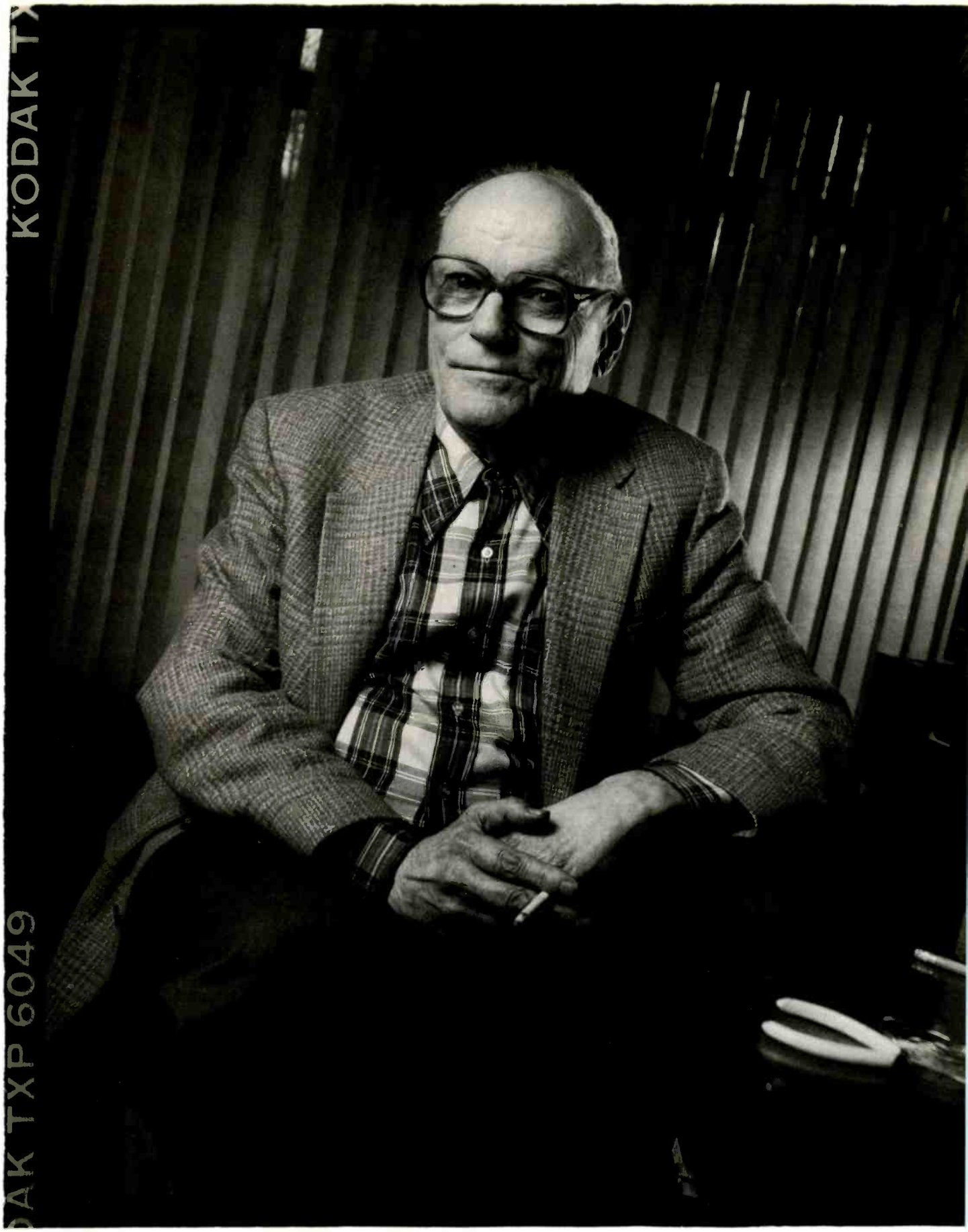
The Speaker Specialists

Where to buy Polk Speakers?
For your nearest dealer, see page 144



PHOTOGRAPH: ROBERT LEWIS

THE AUDIO INTERVIEW

Emory Cook

FIRST TAKE

In the 1950s, the press spun stories about Emory Cook which, three decades later, read like myth. Consider the following chapter in this hi-fi pioneer's media odyssey.

One morning, the founder and proprietor of Cook Laboratories got a call from a local real-estate agent. A client who'd just moved into a house near Cook's in the placid New York City suburb of Pound Ridge had phoned, threatening legal action. For much of the previous night, the new homeowner complained, the sounds of trains had hammered through the ambient darkness. Yet during their real-estate dealings, the agent had never so much as mentioned the nearby railroad line.

The only trains in Pound Ridge were those on Cook's recording, *Rail Dynamics*, one of the earliest titles in his highly popular "Sounds of Our Times" series. In about 1950, the fledgling record producer was the first to imprint the realism of railroading on disc, an achievement that won him the enduring affection of a growing audiophile community.

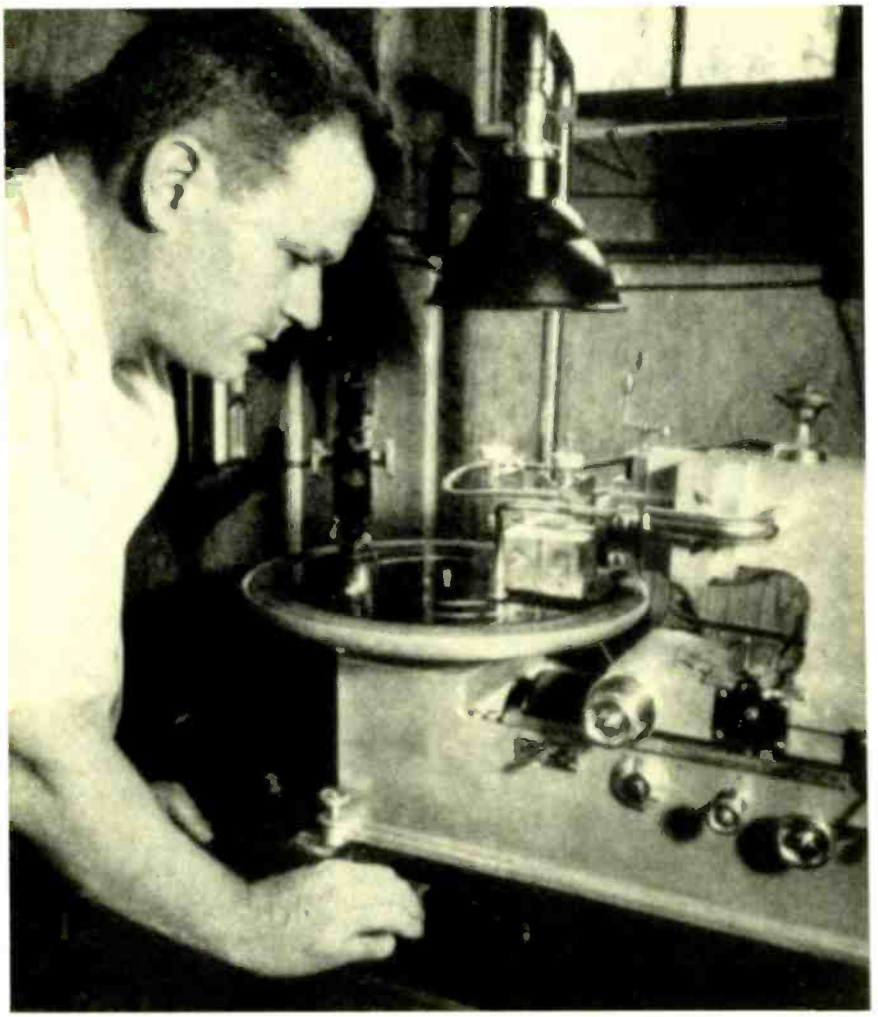
Those who took Cook's tour of sonic oddities could visit a chicken farm, a burlesque show, a naval cruiser, or an Air Force base. Hurricane-strength winds howled on his recordings, firecrackers exploded and babies bawled. There were musical dynamics, too, of course—including a New Orleans bugler, West Indian steel drummers, and organs played in a Mexican church, New York's Paramount Theater, and Boston's Symphony Hall.

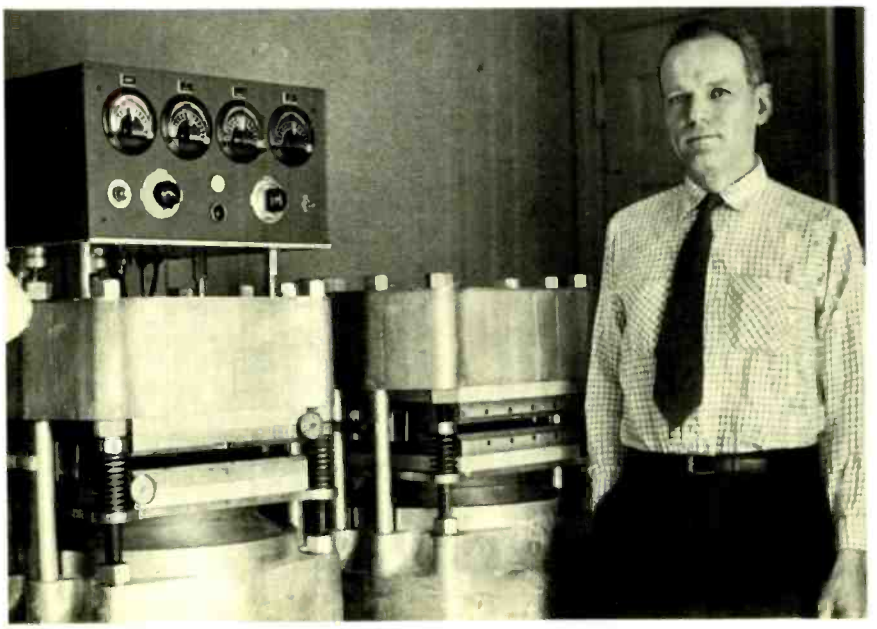
All this captured the collective imagination of the press, and parables about Cook abounded. It was written that valuable equipment had been lost to the tides when Cook recorded *Voice of the Sea*, an album of nautical sounds that took years to assemble. And that, while miking thunderstorms atop New

DAVID LANDER

Emory Cook

I got into the *record business* because of the *awful quality*





Hampshire's Mount Washington, he had come perilously close to being struck by lightning.

"Through . . . devotion to sound quality, he has become a kind of senior oracle of high fidelity," one writer reverently noted in *Musical America*. Another, in *The New Yorker*, devoted two installments to a profile of this "brash, quixotic" man with his "almost mystical reverence for sound."

Cook clearly has earned the respect these and other media accounts afford him. But while the anecdotes they contain are beguiling indeed, he now denies the veracity of many, including the one about the invisible Pound Ridge Railroad. Although Cook does concede that he may have come close to a prophet's fiery demise while recording on Mount Washington.

Viewed in the context of its time, this audio apocrypha is easily understood. After all, the '50s were heady days for hi-fi, an industry just entering adulthood. Its founders competed in an olympiad of sorts, and the most exuberant player in the tournament of decibels may well have been Cook himself.

Emory Giddings Cook was born in Albany, N.Y. on January 27, 1913. "Father happened to be Steinmetz's attorney (if of interest)," his *curriculum vitae* states with characteristic dry succinctness.

In 1932, after four years at Phillips Exeter Academy and one at M.I.T., Cook enlisted in the Army Air Corps. He was discharged two years later and matriculated at Cornell, where in 1938 he earned an E.E. degree. Jobs with New York Power and Light and with the engineering and construction departments of CBS followed. Then, from 1942 to 1945, Cook worked with the Navy as a civilian member of Western Electric's Field Engineering Force. For this, the Navy awarded him a commendation for developing a device to train fire-control radar operators.

At the close of 1945, Cook left Western Electric and started Cook Laboratories in his basement. A few months later, he was offering record companies a feedback cutter of his own design. In 1949, with the pro-

Photographs: Emory Cook Collection

of American-made *discs.*

duction of live radio shows on the wane, WMGM decided to convert several broadcast studios for recording. Cook, who had been producing masters for the station's sister company, MGM Records, was signed on to design and install recording equipment. This led to a consulting contract which lasted several years and helped subsidize Cook's other activities, one of which was the manufacture of test records. When Cook hung up a sign at his 1949 Audio Fair exhibit, stating that one of these records contained a 20,000-cycle tone, his display became a focal point for attendees.

The annual Audio Fairs, held at Manhattan's Hotel New Yorker, were a gathering place for the electronics trade as well as audio hobbyists and others curious about the new phenomenon called hi-fi. At these events, Cook often teamed up with speaker maker Rudy Bozak. His records—which included stereo program material as early as 1952—and Bozak's loudspeakers proved an irresistible combination. Converts to the hi-fi cult multiplied along with the two men's sales figures.

At least part of Cook's success can be attributed to the showmanship he displayed at these expositions: One year, he included a parrot in his exhibit, with a sign reading "Sales Manager" on its cage. His disdain for high seriousness was also evident in the whimsical copy he wrote for his record jackets and *The Audio Bucket*, a newsletter that seems ironically named, given the amount of arid humor it contained.

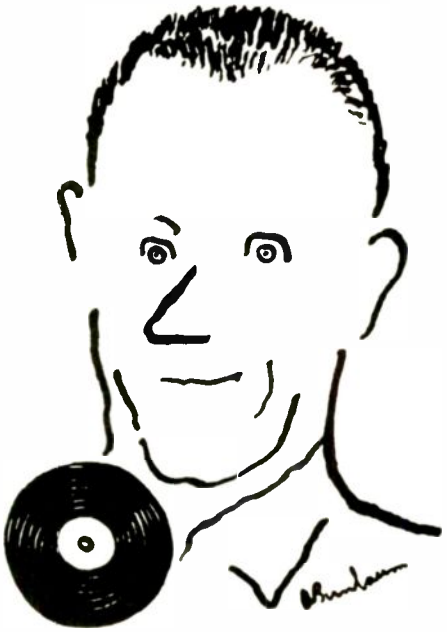
The nature and pervasiveness of this humor make it easy to believe that Cook, who once covered the center hole of his LPs to assure purchasers of their virginity, enjoyed inventing romances for innocent interviewers. It's also possible that some journalists missed the tongue-in-cheek tone of items in *The Audio Bucket* and rewrote them, deadpan, in their own publications.

Whatever the case, since Emory Cook denies so much of what his 1950s press clippings proclaim and sniffs at the persona they created, surely it's time to set the record straight. Here, then, are three warranted-to-be-true stories. Their dimensions are human rather than mythic, and they help reveal the measure of one of hi-fi's pioneers.

In the late '70s, Cook attended a recital by soprano Phyllis Curtin. He'd recorded her more than two decades earlier and hadn't seen her once in the intervening years. As he stood outside the auditorium, Curtin passed by, recognized him, and threw her arms around his neck.

Not long ago, Cook's lovely wife, Martha, got a call from a prospective record purchaser. He told her that he was a boy when her husband had come to his native Trinidad to record. He still remembered that, when Mr. Cook appeared each morning for his taping sessions (done, of course, outdoors), he invariably had pockets full of candy, which he would distribute to the children.

Lizzie Miles, a black singer from New Orleans who Cook discovered and recorded late in her career, sent him a number of letters. One of these contained a "hello to your staff" and the benediction, "God bless all of them." Miles concluded with a reminder to her producer, "Always remember," she wrote, "you made one old-fashion, creole, antique gal very, very happy." *D.L.*



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You were one of those hard-core hobbyists who, before the development of tape, was using a recording turntable to cut your own lacquers.

Just off the air. NBC. Toscanini. I think that was probably '44, '45—somewhere in there.

Wasn't it the poor quality of commercial recordings of the time that got you into the business of making records?

Most of the records made by U.S. companies were miserable compared with the European product. I admired the British in a general way because they made good records. They operated with greater care. In this country, we were making junk, crank-it-out junk that was just bad in many respects—acoustics, microphone placement, and particularly the mechanics of the pressings. The pressings were deplorable—off center, unflat, distorted, all that. Somehow, that did two things. I think it gnawed away at whatever feelings of patriotism might have existed in a young man. It also opened up an opportunity. Here was something that could be done that was at least worthwhile. I wouldn't have been in the record business except for that—bad product.

Was all American product really that bad?

Sometimes it wasn't bad, but it was never predictable. RCA sometimes made good records, but you never knew what they would be. They were unable to control quality.

Emory Cook

An LP's going to be played in a living room 99% of the time,

When you started your company after World War II, though, the point wasn't to make records. You started out making cutters, didn't you?

Feedback cutters. All cutters that are used today would be feedback cutters, but then there was only one, the Western Electric. On a feedback cutter, the driving coil has a sensing coil on it which is used to supply the feedback signal in order to discipline stylus motion. It's like a servo. Olson tried to make a loudspeaker like that, and did, but it didn't come off very well. Probably too fragile. I emerged from the war with a Western Electric license and, using their patents, built a feedback cutter for sale instead of for license. The record companies then paid a royalty to Western Electric for each operation, each record that was made on Western Electric's cutter!

What, specifically, were the problems you were trying to overcome with your cutter?

Distortion and frequency response. The cutters available in those days weren't very good. The 78-rpm records would establish that.

How did you get from cutters to making records?

In 1949, we exhibited test records at the Audio Fair run by Harry Reizes. We also had music records made in the studio simultaneously with MGM concert records. And people weren't interested in the cutter, they wanted the records. We went ahead and started making records then and there.

I understand you put up a sign up at that show saying you had a 20,000-cycle tone on a test record. Did anyone else have such a thing prior to that time?

Well, I hardly think so. If they did, they kept it to themselves.

I wonder how many people were actually capable of hearing it.

The curiosity is always there. Whether anybody could hear anything or not is another question. The famous question: "What! You mean you can't hear 20,000 cycles? What's the matter with you?"

You first showed your binaural recordings at the Audio Fair in 1952. Were these made with dummy heads and meant for headphone listening?

No. Absolutely not. They were made with microphones spaced 6 feet or more apart. I used the term binaural and shifted to stereo after the West Coast decided that was the language. The reason the West Coast did it is because they wanted to be different. If I called it stereo, they would have called it binaural, for all I know. They didn't like it that I started up first—naturally. I like [the term] stereo better anyway.

I understand these recordings created quite a stir at that show. Tell us about them, and about the hardware used to play them.

Well, there were two bands of grooves—one for the left channel, one for the right—two cartridges, and a bifurcated arm. [A company called] Livingston made an arm. Livingston is a town in New Jersey; Ched Smiley was the guy. And Scully made an attachment that you could put on any arm. You had the left channel on the outside, the right channel on the inside. You started them both at the same place, and it had half the elapsed time of a regular record of this time. So you connected one side to one amplifier and one loudspeaker, and the other to a second amplifier and a second loudspeaker.

How well did this system work?

I don't think you'd give them away as Christmas presents to your wife or girlfriend. It wasn't just duck soup, but it wasn't all that bad either.

It must have imposed serious time limitations. How much music could you get onto a disc? Enough to make it commercially viable?

Twelve minutes, roughly, would be about maximum. I never expected it to be commercial. It served as a lubricant, to get something started. But we

certainly sold a lot of records. Probably 500, something like that, of each one. We had, four, five, six records.

Acoustical space is now an important factor in recording. Did people in the record business think much about that in the early '50s?

I certainly did. All you had to do was go around New York and see a half-dozen studios. Commonly, I would say, the biggest one you'd find would be about the size of this room—28 × 35 feet or so, with a high ceiling. This is something you don't do with a concert orchestra. If it's a jazz band—well, maybe—but there's going to be no acoustics. Reverb chambers were sometimes used. Other than that, you had this horrible business of doing it dry in a place this size when it should be three or four times this size. I don't know if you remember Toscanini and Studio 8H. That was one extreme. That had no acoustics, and it sounded that way. Pretty unpalatable.

What was your concept of the ideal situation?

You have to imagine something that's similar, in acoustical behavior, to a typical living room. There is no such thing but, keeping that in mind, you have to recognize that this is the sort of place a recording's going to be played in 99% of the time and behave accordingly. Normally, living rooms are terribly small, so you can't expect the feeling of having been in a concert hall if it's a concert hall, or a theater if it's a theater, or a nightclub if it's a nightclub just by putting the microphone down the throat of a horn and then reproducing it in somebody's living room. It isn't going to sound right. You don't have to be too smart to know that's not the way to do it.

How did you do it?

Well, I used the old live-end/dead-end studio idea. What you do is plug one ear. You have to get accustomed to the business of sticking your finger in one ear or the other, whichever, and becoming a microphone. Two ears are not a microphone.

Certainly not a monaural microphone.

A so-called stereo microphone is not two ears either. They [the stereo channels] are too close together, for one thing—besides which, they don't handle incoming information in the same way at all. So you have to find a place

Drawing by A. Birnbaum ©1956 1984 The New Yorker Magazine, Inc.

[for one microphone]—and oftentimes, it's very sensitive, within an inch or so—and then do the same for the other microphone. You have to plug one ear and listen.

How did you arrive at that technique?

I think I learned it from a guy who used to work in the ERPI Studios in the Bronx. Gordon Jones. But you can't just pick up and do it, see. You have to establish a norm in this condition, and you have to listen long enough in your life—through the weeks, through the months—for it to become the norm. The best man I knew for that was Joe Kuhn out of Chicago, who I brought in to help with the MGM installation at 711 Fifth Avenue. He was totally deaf in one ear. I don't know whether it was the cortex or the ear or what, but he couldn't hear a thing out of one ear. This is an interesting thing, because he was an ideal microphone. Of course, you have to be insensitive to being laughed at—the young-timers would laugh—but that never bothered me much.

Did you have a favorite microphone placement configuration?

No, no. It depended on the scenario. It just takes knowing what you're hearing. That's all.

And the scenario for you invariably involved recording in the field.

I never operated in studios. I'd always do it in the field. Let me tell you something that's pretty serious. If you've got to bring a symphony orchestra into a studio, then they don't feel comfortable. They can't hear each other; that's not a normal environment. You get a different type of performance—unless you've got hard-bitten professionals—

Emory Cook

You can't get a concert hall sound by putting a mike in a horn

than in the field, in their own natural environment. If you put a steel band inside four walls, you can't record it. You've got to record it outdoors.

What microphones did you use?

I designed my own. Capps made it. It wasn't particularly innovative. What was good about it was that I had a damped cavity in the backplate, which nicely cancelled the refraction pattern. Oftentimes, an omnidirectional microphone—depending on the size (this was about an inch in diameter)—will give you a little bulge at 8 kHz. This one went out, bureau-of-standards flat, to 15 kHz, and with that damped cavity, it was set up to cancel the refraction bulge.

You said your mikes were always at least six feet apart.

Never less than six feet. If the room is too small for that, you don't use it. If you have a room that small, then it's not stereo anyhow.

Do you feel there should be a maximum space between mikes?

I don't think you can say that. In the Paramount Theater organ job, the microphones were 80, 100 feet apart probably. When recording an organ, you have to get close to the shutters or you don't get it. It would sound like a mammoth cave.

You developed a method of manufacturing records called Microfusion. Instead of stamping vinyl discs, you molded them by fusing powder particles. How did this come about?

K. R. Smith [a former executive at Muzak who had started his own plating firm] and some professor had developed the idea of a sintered vinyl biscuit, sort of like a sponge. He had a machine in his basement which cranked out 7-inch biscuits more or less automatically. One day, he took me down there after dinner and showed it to me, and I was completely taken aback. I'd never seen anything like it before; it was a great big surprise. So we started out to make one big enough for 12-inch. This would have been about 1954.

You found that this process resulted in less surface noise?

There were a lot of good things about it, but at one point, they [Smith's company] were taken over somehow by a bird dog for Dutch Philips who sought out opportunities for them all over. By that time, we were trying to run a sintering machine producing 12-inch biscuits. And suddenly one day, this guy called and said, "You're going to stop. We're going to come over and take the machine out."

Did they actually have a patent on the process?

Oh, yeah. They'd filed. I had a license, but they said, "Sorry—no longer licensed." So we decided we'd do it without sintering. It took us two years, but we got into doing it with the powder without sintering. It's a little difficult to describe. It's a whole series of procedures that allowed it to be done from the straight powder, which of course is even better than sintering because

heat history is the enemy of all plastic. Heat history is the product of temperature and the time during which the plastic has been subjected to that temperature. Something that has not gone through an oven, that's been changed from a powder to a tangible biscuit that can be picked up, is bound to be better.

And you used this process right up until the time you sold your company last year. Obviously, you still feel it's superior to hot extrusion.

Not just that, but you don't have to make several thousand records at a time to do it economically. You can make a couple hundred, a hundred, whatever you like.

Back in the late '40s, you developed a recording process that you called QC. What, specifically, was that?

It was a means of tailoring the signal, before it got to the cutter, in such fashion that you could cram a much higher level on a record without abusing the playback function. It's easy enough to make a record that's impossible to play properly just by pouring it in. Making it playable is what that was directed at.

Did you compress the signal?

Well, it depends on what you call compression. We would dip the bottom end very momentarily; it would come right back again. It doesn't get noticed.

What else gave your records the edge over so many others?

A great deal of attention to detail in mastering and plating.

You always did your own pressing?

After 1954, we certainly did.

You had a pressing plant in Trinidad for a number of years. When was that? And why did you start it?

It probably started in '56, '57—somewhere in there. We exported from there to Barbados, Jamaica, Antigua, and England. We had been exporting fantastic quantities of records to Trinidad. A lot of the people that bought them didn't have phonographs. They had nothing to play them on, but they'd put them up on the wall or someplace, against the time they would. Music is more important to many people overseas than it is to us. To us, you know, it's a pastime and a plaything and very agreeable, but it isn't food and drink. To some other people it is.

You've linked the growth of television with the recording industry's growth. Didn't you predict, back in the earliest years of television, that the medium would create a backlash and send a lot of people running to their music systems?

The escape was always away from the television set. One way to get away from this thing is to harness yourself to a radio or records. The common problem with radio is that you never can find a station that plays what you want to hear at the moment. Record sales statistically, could be offset against TV sets. They did this. The industry did careful research of this sort. Let's take nice capsules—the population of Peoria, Ill., for example. When they installed [television in] Peoria, it was done in an orderly way and all at once as much as possible. This is the way it happened in the '40s. TV sets were sold to X percent of the available homes inside of six months. And it turned out that, six months later, you got this increase in record sales. It is inescapable that record sales went well up time after time after time. Very. very interesting. It's never been published.

You did some medical experimentation with white sound which, as I understand it, is actually a derivative of white noise.

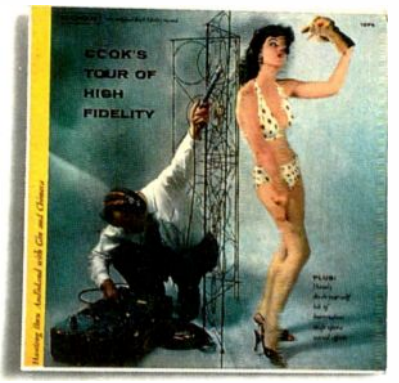
Well, we call it white sound because noise is a term which has negative connotations.

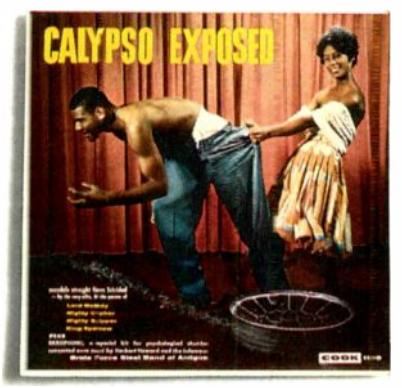
You used it as a pain killer?

It's probably more like a distraction. It doesn't kill anything. It diverts. My guess is that it jams up the cortex with meaningless information. It's like a jammed-up switchboard. All the telephones are ringing, and there's nothing you can do.

And you've documented this on film?

Oh, yes. I have film of an elevation and extraction [of a tooth] on, I think she was an 8-year-old girl wearing earphones. And we had a chalazion [a cyst in the eyelid] operation done by an ophthalmologist who was a friend of mine. They're both in the same film. We showed these two things down at Bethesda, Maryland, the Naval Hospital—the dental thing for the dentists then the chalazion [for ophthalmologists]. They're both about 10, 20 minutes long. And when the chalazion thing came on, all the dentists got up and left. They couldn't stand the sight





Emory Cook

You have to stick *your finger in* one ear to *be a mike.* Two

of blood coming from the eye [laughs]. And vice versa for the ophthalmologists. You know this is true. It happened all morning long.

So the technique is effective.

Oh, sure. But it takes some control and discipline on the part of the patient, which isn't bad. You've got something to do instead of nothing. It doesn't do much good for an appendectomy; I don't think it would work for that. The obvious goal is the labor room. It's just beginning to come into the labor room. And this is now—how many?—nearly 30 years later.

Let's move on to your recordings. One of your first commercial records was a collection of music boxes. What led you to produce that?

Didn't cost anything. I mean, it cost very little to record. After all, it wasn't a union musician.

What made you think people would buy such a thing?

Well, it was coming on Christmas, and it seemed like a possibility. It's a Christmasy kind of sound. Besides, it also had "Jingle Bells" on it [laughs]. It was basically nostalgia.

Somebody once said your greatest innovation was the royalty-free record.

That was Frank Walker. He was head of MGM Records and, before that, manager of RCA Victor. He was absolutely right [laughs]. I have no objection to his having made the remark. It was a perfect remark.

The first record of yours that audiophiles are likely to remember is Rail Dynamics, *the recording of trains. Didn't you work on that mainly at night to avoid extraneous sounds?*

You can't do it any other way. They always have lights. You go to a railway station or a switching yard, and you'll find there's plenty of light around.

Just where did you go to record?

Mostly Peekskill; some of it was Harmon [both north of New York City]. Harmon was where they used to switch from electric to steam to go West.

And you wanted the steam?

Sure. Peekskill is a mountainous area. Very nice for acoustics, across the Hudson River and back. The sound bounced across.

Did you have to get permission from the New York Central to do this?

We got permission. I oftentimes had at least one person helping because it's a lot of luggage, a lot of weight to hassle on up the steps of a passenger car.

You said the original version of Rail Dynamics *was recorded directly onto disc. Does that mean you did a later version on tape?*

I added to it with tape later because then we went to stereo. The first one was released in mono on 10-inch. Then, when it was converted into 12-inch, we made it into stereo. Of course, that had to be done on tape.

And this was around 1950. What made you think people would buy a recording of trains?

Well, I really was very apprehensive about the idea. I then became quite surprised, and apparently some of the other folks [in the record business] did too. Because MGM pressed them all, it was very evident to them that a lot were being sold. That's where that royalty-free record remark came up. Frank was the boss at MGM.

But why trains?

Well, is there such a thing as nostalgia? And hadn't everybody ridden on a train—at that time? Now you find people all over who've never even been on a train.

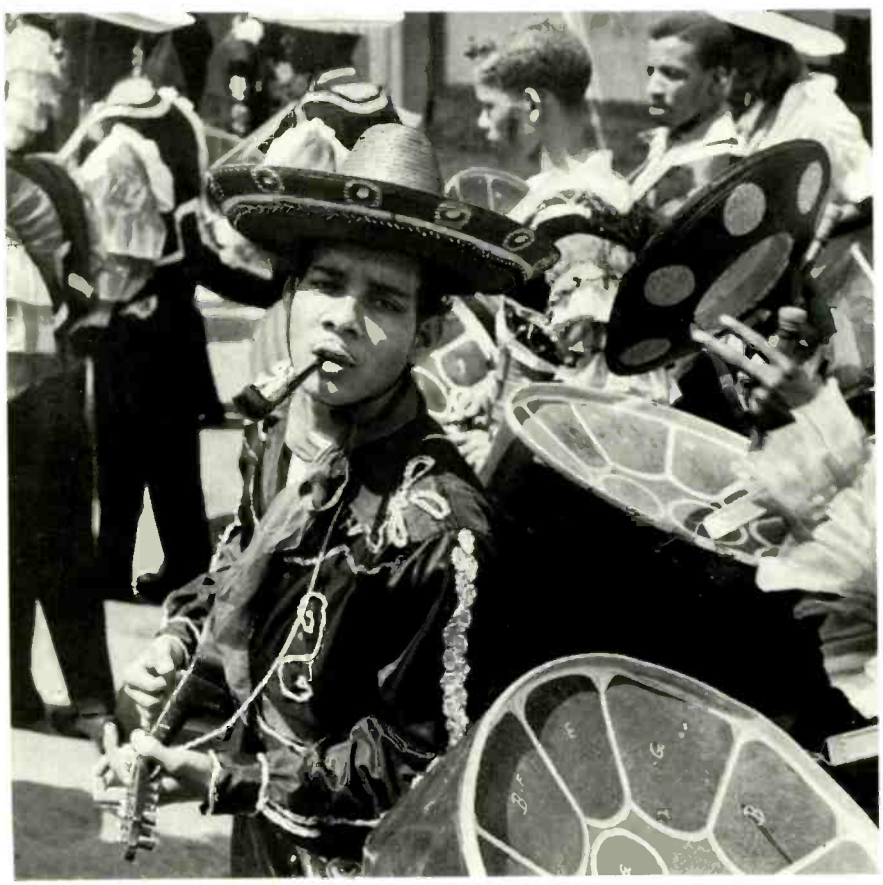
Well, the toy train industry isn't what it was in the 1950s, but it's still chugging along, isn't it?

At one point, we went up here to American Flyer [formerly based in New Haven, Connecticut, not far from Cook's Fairfield County headquarters] and tried to get them to use this record in connection with selling their trains. The guy came out with a very potent remark—finally—a logical reason. "The record is too good." He didn't mean that as a compliment. He meant it's too realistic. The train takes imagination, the record doesn't. Well, it probably could have been done by doubling the speed of the record [laughs].

Another one of your recordings was called Voice of the Sea. *Didn't that take a long time to produce?*

It was probably three or four years. I'm just guessing, but it was a long time.

And you did an enormous amount of travelling for it.



ears are not **a mike.**

Not all at one time. I guess that started up in 1953, perhaps '54. Going up the coast of Maine till the roads tended to get narrower and narrower, and back through Massachusetts—heaven knows everyplace else. The Queen Mary horn came out of Manhattan, the Lower West Side. We rode on the cruiser *Columbus* at one time. They were on route from someplace to someplace. I already had Navy connections of some obvious merit.

And your idea was to capture the various sounds one would hear aboard such a ship?

Yeah. General quarters and all that.

In one of your newsletters, an item alludes to the equipment you lost while making Voice of the Sea.

That's somebody else's gag. No, that never happened. I might have lost a microphone somewhere, but I didn't make an issue out of it.

You released a record with some mysterious ionospheric sounds on it. Precisely what were they?

Nobody I know is around anymore who would be able to answer that question in scientific terms. It relates to shock impulses. A high-intensity lightning strike, let's say in the Southern Hemisphere, will be propagated in the ionosphere to the Northern Hemisphere, very much like a wave guide. But it will describe a semicircle and be guided by the magnetic lines of force. Going back and forth, these will give off electromagnetic energy, some of which is at audio frequencies.

How were these sounds picked up?

With a very, very long wire for an antenna, away from civilization—no power lines, no homes, no other disturbances—because the level is very low.

These sounds were provided to you by a scientist who did the actual recording. Another scientist, someone named Hugo Benioff from the California Institute of Technology, provided you with earthquake sounds. How were these sounds recorded?

That's simply what came off the seismograph. But it was reproduced at quite a few times its actual speed.

I believe you pointed out that what the seismograph records is not really audible until it's speeded up. Did the result actually sound like an earthquake?

No. Unless you're right on the fault, you won't hear snapping and crackling.

You once recorded a burlesque show. A New York Times *review of that record reported you smuggled your equipment in. Was that actually the case?*

No, of course not. [The burlesque show's producers] were delighted for the publicity.

Where did you set up all your recording equipment?

In the pit, with the orchestra. I put the mikes on stage on a foam-rubber pad. That was the sneaky part of it, because it wasn't supposed to be commanding attention from the audience. The big thing is the gate, you know. You don't want to interfere with the gate under any circumstances.

How did the showgirls react to being recorded?

Well, these people are hard-bitten. You know, it's amusing. At least it was something different that night.

At one point you went from pressing your own records to manufacturing discs for other people. When did you get into that?

1958, '59.

And when did you record the last title for your own catalog?

Probably '59.

In terms of unit sales, at what point did something become a best seller?

For us? 50,000, I would say.

You did a number of recordings that featured New Orleans jazz performers. How did you find these artists? Lizzie Miles, for example.

Just walking along the street in New Orleans, in her case. She was a pro. She was 60 when I found her.

You've transcribed and kept segments of letters she sent you. You seem to have gotten to know her pretty well.

Probably as well as any white would have.

Emory Cook

Lizzie Miles had **something else** *besides*

She says in one letter—it's dated February 12, 1955, Lincoln's Birthday, which is probably a coincidence—that "only an unprejudice [sic] genius like you could realize that I could do better than what you heard me with that bunch of loud discords I was hollering with."

She was trying to be nice. Well, I was unprejudiced and still am, I think. it gets in your way, if you're prejudiced, depending on what you want to do.

It certainly would have kept you from a lot of what you did. All the black music from the Caribbean that you recorded—the Calypso, steel bands, and such. In fact, you had an entire Ethnic Series of recordings in your catalog.

Oh, yeah. Much of that is out of Trinidad. And Granada.

Are you an amateur anthropologist?

Sure, sure—very amateur [laughs].

Seriously, did an interest in anthropology prompt some of this?

Well, I met Herskovits [Melville J. Herskovits, a Northwestern University anthropologist] one time. He was commissioned by the Carnegie Corporation, back in the early '20s, to make a study of "the Negro in the Western Hemisphere"—that was the language used—and he went on with that for a long time. I remember running into him at one point. A lot of the folk material collectors did.

Some of the folk material you collected was never released. Can you give any examples of this?

I have some material from the Sierra Madres and other parts of Mexico and the Gulf Coast, I think.

What did you record in the Sierra Madres?

Indians. Tarahumara Indians. They sing and whistle and blow on pipes. There's also drumming. They're probably almost extinct now. They're headed for extinction, if they're not. They're unable to reproduce. Nobody knows why.

Don't you think material of this kind should be made available somehow?

It will be made available. It's not going to burn down with the building. The Smithsonian has expressed some interest in it.

We started to talk about Lizzie Miles. What was the first album you did with her?

I think it was *Clambake on Bourbon St.*, the one where she ran with the whole orchestra and shouted. She was a shouter. She had become a shouter. She didn't need the microphone. That was all right; that's Lizzie. But there was something else there besides the business of being able to belt it out like a 50-watt amplifier.

She gives you credit for sensing that.

Well, sure. I sat her down in a chair and she sang to herself. I asked her if she ever sang to herself at home.

You called one of her albums Hot Songs My Mother Taught Me. ***Were these tunes really passed down that way?***

I think all those songs were in piano sheet music. People don't realize how far back the sheet music business goes.

How far back did her songs go?

I'm just guessing, but some of them were 19th century, for sure.

You recorded a bugler in New Orleans, Sam DeKamel. Did he make a living playing the bugle?

Well, he did that and he sold waffles on the street. That was how it started. The bugle was how he attracted customers, made them know he was in the street, you know. If you don't happen to be looking out the window and say, "Oh, there's Sam," you wouldn't know. He'd go by. You've got to do something. You've got to sing or wave rattles around or make some kind of sound.

And there was a singer named LaVergne Smith.

Yes, LaVergne Smith, whose boyfriend was a calliope player.

You pronounce it "cal-ee-ope." I always thought it was "cuh-lie-uh-pee."

Well, we call it "*cuh-lie-uh-pee*" up here, but they call it "*cal*-ee-*ope*."

Is he the performer on your record, Calliopes & Nickelodeons***?***

No, that's not a calliope. That's a diminutive version of a calliope. It's a contraption that was made up for Milton Kaye, who used to play it on the Henry Morgan show on WOR. It sounds sort of like a calliope, and it'll gurgle if you threaten it, but it's powered by compressed air instead of steam. The other instrument on the recording was a Link piano. Link was a company in Binghamton, N.Y. that made a version of a player piano that included a full-blown marimba. The biggest player pianos were commonly used in bars or places of community gathering, where you dropped in a slug and got three, four minutes of music. They're built like organs. They all run on air with perforated paper, parchment.

But LaVergne Smith's boyfriend played a real, steam-driven calliope? Where?

He played on the [river boat] *Delta Queen*. That's where he was playing then. These boats had pretty much disappeared by then. There weren't too many of them left.

You said this instrument's keyboard required so much force that it actually wore down his fingers.

His fingers really were stubby like that. They were worn down to the first knuckle.

Come on!

It was really true. You wouldn't believe it. They were shorter. He wasn't born that way, you could be sure of that.

You also recorded a New Orleans jazz performer named Wilber DeParis for Atlantic. Engineering other companies' recordings wasn't something you did much of, was it?

No. Very little. But that was stereo. It was important to do something in ste-

reo for the 1952, I suppose it was, Audio Fair. And that was produced in binaural form.

One of your recordings was called Speed the Parting Guest. ***According to an item in*** The Audio Bucket, ***the idea for this was generated at a dinner party, and it was supposed to be a collection of jarring sounds—something someone could play "to get rid of a visiting fireman," as it was phrased there.***

No, no. It was a percussive record, and we just called it *Speed the Parting Guest* because of the wild music. But it's music. They were all musicians playing instruments. The idea was percussion. The fellow that organized it was Jimmy Carroll, Mitch Miller's arranger. He was a good friend. The title came later. You know, what are you going to call it? God knows. So we called it, *Speed the Parting Guest*. But it wasn't a bunch of sound-effects men doing this, that, and the other. It wasn't supposed to be tongue in cheek. It was percussion—one of the things that is very difficult to reproduce.

And the record from Cuba, Jawbone of an Ass. ***An animal's jawbone was actually used as an instrument?***

Oh, yes. Like a *chac-chac*, a gourd with pebbles. You rub a stick across the teeth.

One of your top artists was an English organist named Reginald Foort. Tell us something about him. When did you first record him?

1952. Reggie, after the war, had somewhat of a problem. During the war, the BBC had an organ in a couple of trailers, and he used to go around England giving concerts. It helped the war morale a lot. He was very popular. He was on the BBC constantly before the war as well as through the war, so his popularity was immense in England. Everybody knew his name. But that faded.

You had him play in a number of places. Was the so-called "Mosque" in Richmond, Virginia the first?

Well, yes. The first job was in the Shriner's Temple, which really was just a rather large theater. I guess it seated a couple of thousand people. It had a working organ in it. It was being maintained by a fellow that worked in the telephone company.

You were apparently the first to record a 16-cycle organ tone. I believe that was with Foort in Symphony Hall, Boston. Didn't even he tell you it couldn't be done?

That's right. I said, "Do it anyway," so he did. He was cooperative enough to do that.

And you really did get it?

Oh, yes.

But how many speakers of the time went down that far?

These did [indicates speakers at one end of his 35-foot listening room]. In the [Audio Fair] exhibit in '54, these were the speakers that were used. It was in a masonry room in the Hotel New Yorker.

These are the legendary Bozaks. What's in them?

Eight 12-inch woofers. You can't get more than eight without making the box bigger. Then it won't go through the door.

That's in the bottom cabinet [4 feet wide × 5 feet high × 21 inches deep]. What's in the enclosure resting on top of each one?

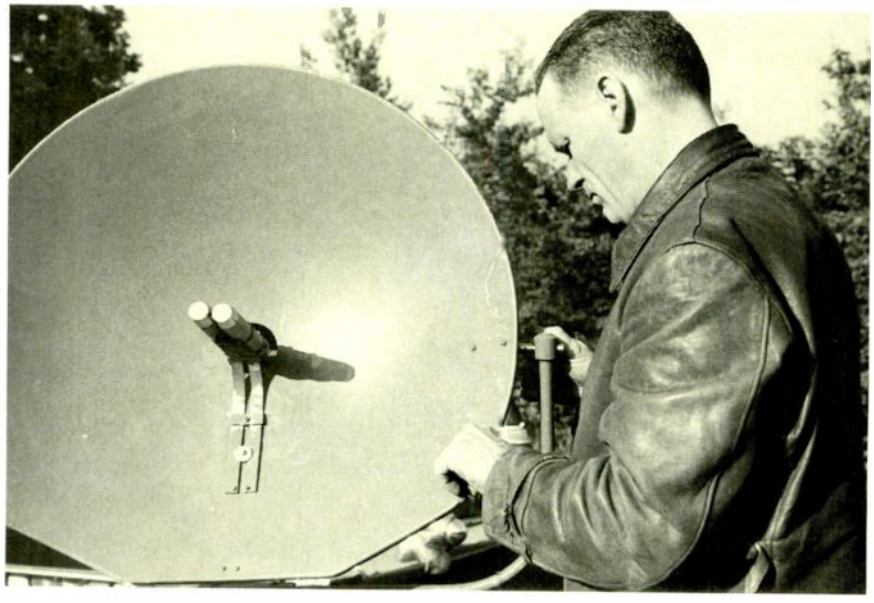
Two 6-inch midrange speakers and a tweeter cluster.

Right. Rudy's aluminum drivers. Someone who was at that show described standing in your room. He said he could feel the legs of his trousers flap.

The pedal frequencies were heard in the lobby sometimes—felt was more like it. It's not something you could resolve and say, "Oh that's an organ" or whatever, but it's strange how it would travel around the hotel and up and down the elevator shafts, then come out in the lobby. A feeling—no music, a feeling. It was perceived as something to alert you. It wasn't intended [laughs]. And it wasn't loud in the room. These things were played only somewhat louder than you would play them in your own living room. Because the room was full of people, you know. It was simply jammed.

Let me suggest something to you. Back in the early '50s, high fidelity was a novelty to most people, and the media was naturally curious. Not just industry press or buff press but general interest publications like Time ***magazine and*** The New York Times. ***Their writers came to the Audio Fairs and ran into a pair of real showmen, you and Rudy. They heard your recordings of trains and organs reproduced over his speakers. They heard stereo discs for the first time. Then they went back to their typewriters, described the experience, and got millions of readers interested in the phenomenon of audio. So maybe, just maybe, you and Rudy Bozak deserve a large part of the credit for making high-fidelity a household term.***

Well, I don't think it was planned that way by anybody, including me or Rudy. It just happened that way because, I guess, it did sound good to people.



The THX-equipped screening room at Lucasfilm's Skywalker Ranch.

Photograph: ©1989, Douglas Salin

THX®

SOUND SYSTEM

CERTIFIED HI-FI FOR THE MOVIES

In the early 1950s, the introduction of the magnetic-stripe soundtrack to theatrical film releases made excellent sound possible in the cinema. By the mid-1960s, however, the number of magnetic-stripe releases was sharply reduced primarily for economic reasons, and except for a comparatively few theaters equipped for the rare 70-mm "road show" release, most theater sound systems had become "standard" (i.e., designed for 35-mm "Academy" mono optical soundtracks). While this promoted uniformity of reproduction both nationally and internationally, improvement of theater sound for all intents and purposes came to a halt. In the meantime, home stereo equipment development surged ahead, ultimately providing wider frequency range, lower distortion, and better octave-to-octave musical balance than theatrical systems.

Several new technologies were applied in the early '70s to both soundtracks and the old theater systems. Dolby noise reduction, applied to both magnetic and optical sound releases, permitted considerably wider frequency range and lower distortion.

A new, highly practical four-channel 35-mm release-print format, with the Dolby Stereo Variable Area (SVA) optical soundtrack, was developed to answer such objections to magnetic formats as high release-print and theater-maintenance costs. Widespread use of "room" equalization became possible because of advancing technology. But along with the use of equalization came the realization, by theater installers, that widely used theater loudspeaker systems—unchanged in fundamental design since the 1940s—had very notable deficiencies. Indeed, "room" equalization was actually being used as an attempt to compensate more for loudspeaker deficiencies than for acoustical variations among movie theaters.

Against this background, Lucasfilm Ltd. set out, in 1980, to design a new dubbing theater for soundtrack re-

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TOMLINSON HOLMAN

recording at its Sprocket Systems division in San Rafael, California. For the sound system, the objective was to bring together for the first time:

New knowledge, including the research of Neville Thiele, Richard Small, and Siegfried Linkwitz, among others, in the field of loudspeaker and crossover design;

Recent hardware developments such as constant-directivity high-frequency horns and high-powered amplifiers of moderate cost;

The greater understanding of speaker/room interaction resulting from the research of Roy Allison and others;

Further research into the acoustics of large rooms, which had continued all along in the field of sound reinforcement, where speech intelligibility (as in the cinema) is of great importance, and

The substantial improvements in soundtrack and theater-electronics technology (such as third-octave equalization) promulgated by Dolby Laboratories.

The installation was finished in 1982, and what first surprised us was that it didn't sound like a movie theater but much, much more like a great, big home high-fidelity system. The frequency-range extension and smoothness apparently accounted for the difference; it just didn't sound like the honky, narrow-band systems we expected. People experienced with home systems and those experienced with theatrical ones were both surprised. Out of a conviction that particularly the increased clarity would be of significant benefit to the soundtrack mixing process, several of the new systems were ordered and installed in dubbing theaters in the Los Angeles area. After the equipping of dubbing theaters—a prerequisite for any new technology to "make it" out in the real world of film exhibition—it was an easy step for Lucasfilm to then introduce the THX Sound System concept for use in exhibition theaters. Presently, more than 300 theaters are equipped with the system, both in the U.S. and overseas, with new theaters being added at an ever-increasing rate (see "Where to Hear THX").

THX in Brief

The word "system" is properly used in describing the THX development, though apparently something of a misnomer. With the exception of the proprietary electronic crossover network leased to licensed theaters, Lucasfilm does not manufacture or supply hardware. Rather, the licensed theater is required to meet a series of standards for loudspeaker drivers and their installation, power amplifiers, sound processors, theater acoustics, extraneous noise from sources both within and without the theater, and projection (brightness, screen condition, etc.). A theater which meets these standards is then licensed as a THX theater—initially. Thereafter, it must be inspected by Lucasfilm technicians every six months and recertified as a THX theater every year. In this way, Lucasfilm attempts to prevent the corruption of the initially high standards that would inevitably result from wear and tear and misadjustment.

The improvements which result from the synergy of all these elements can be summed up, in comparison to the best pre-THX systems, as a frequency range wider by a full octave in both the bass and in the treble; noticeably smoother, more naturally balanced sound overall; audibly lower bass distortion; more even audience coverage, and greater dialog intelligibility. The THX System should not be confused with a soundtrack process such as Dolby Stereo; it has been designed to improve the reproduction of any film.

Screen Loudspeakers

The loudspeaker systems of the 1940s, whose direct descendants include the Altec A4, are still used in the majority of theaters. They were competently and even brilliantly designed, using all the theoretical and practical knowledge then available, to accommodate the requirements of the theaters and soundtrack technology. However, since then several factors changed which called for a reassessment of theater loudspeaker design. For one, high speaker efficiency was paramount among early design goals because amplifier power was expensive and limited; today, amplifier power is not difficult to come by. For another, the loudspeakers of the 1940s were arranged to have their best midrange dispersion characteristics cover both the main floor and the balcony, yet few current theaters have balconies. Further, today's stereo is enhanced by using more uniformly controlled dispersion characteristics.

In addition, in the '70s, a great deal of new knowledge was added to the field of loudspeaker design. The traditional theater speaker system—a short-horn bass section with multi-cell tweeter—had served long and well, but when the THX Sound System parameters were established, there was a need to develop new standards based on current theory and practice. The most noticeable problems of older loudspeaker designs are: Deficient low bass and high treble response; distortion at high sound pressure levels, which is particularly evident on bass material; a characteristic "camel-back" shaped frequency response, resulting from a combination of crossover-network and midrange dispersion characteristics documented by third-octave pink-noise measure-

WHERE TO HEAR THX

The following theaters were equipped with the THX Sound System as of June 1989.

Alaska
Tom Moyer Fireweed, #1, Anchorage

Arizona
Cineplex Eldorado, #3, Tucson
Mann's Buena Vista, #2, Tucson
Mann's Christown Fiveplex, #3, Phoenix
Mann's South West 8, #3, Phoenix
Mann's Galleria 6, #5 & 6, Tucson

Arkansas
UA Cinema City 7, #6, Little Rock
UA Lakewood, #4 & 5, Little Rock

California
AMC Century City, #1-4, Los Angeles
AMC Kabuki, #1, San Francisco
AMC Main Place, #5 & 6, Santa Ana
AMC Puente Plaza, #5, City of Industry
Cineplex Beverly Center, #1 & 2, Los Angeles
Cineplex Century Plaza, #2, Los Angeles
Cineplex Plaza, #1, Daly City
Cineplex Universal City, #1, 2, 4, 5, 7, 8, 10, 11, 13, & 14, Los Angeles
Cineplex Odeon Cinema/Westwood, Westwood
Edwards Hutton Center, #1 & 8, Santa Ana
Edwards Towngate, #8, Moreno Valley
Edwards Upland, #6 & 8, Upland
GCC Avco Center Cinema, #1, Westwood
GCC Fallbrook Square, #3 & 5, Canoga Park
GCC Fremont Hub, #1, Fremont
GCC Sherman Oaks Cinema, #1 & 2, Sherman Oaks
GCC South Bay, #1, Redondo Beach
Krikorian Terrace Cinema 6, #1, Rancho Palos Verdes
Mann's Bruin Theatre, Westwood
Mann's Chinese Theatre, #1-3, Hollywood
Mann's Crow Canyon, #1, San Ramon
Mann's Festival 9, #7, Hayward
Mann's Grove 9, #1-9, San Diego
Mann's National Theatre, Westwood
Mann's Puente Hills, #1 & 4, City of Industry
Mann's Village Theatre, Westwood
Pacific Crest Theatre, Westwood
Syufy Cinema 21, San Francisco
UA 8 Brea Marketplace, #7 & 8, Brea
UA 8 Movies, Escondido
UA Citrus Heights, #5, Sacramento
UA Coronet Theatre, #1 & 2, Westwood
UA Galaxy Theatre, #1 & 2, San Francisco
UA Granada Hills, #3, Granada Hills
UA Horton Plaza, #2, San Diego
UA Lakewood Movies 6, #6, Lakewood
UA Movies 8, #8, Clovis
UA Thousand Oaks, #2, Thousand Oaks
UA West Pasadena, #4, Pasadena
UA Woodland Hills, #2, Woodland Hills

Colorado
UA Academy 6, #4, Colorado Springs
Mann's Century 21 Theatre, Denver

District of Columbia
AMC Union Station 9, #3
Cineplex Wisconsin Avenue Cinemas, #4 & 5

Florida
AMC Coral Ridge, #5 & 6, Ft. Lauderdale
AMC Crossroads, #1 & 2, St. Petersburg
AMC Olde Hyde Park, # 6 & 7, Tampa
AMC Pleasure Island, #2, 5, 6, & 9, Orlando
Cineplex Hillsboro West, #3 & 6, Tampa
Cineplex Hoffner Center, #1 & 6, Orlando
Cineplex Mandarin Corners, #1 & 6, Jacksonville
Cineplex Sandlake, #3, Orlando
Fox Pompano, #5, Pompano
Fox Sunrise, #3-6, Ft. Lauderdale
GCC Coral Square Cinema, #4, Coral Springs
GCC Northdale Court Cinema, #5, Tampa
GCC Miracle Center, #4 & 5, Coral Gables
Muvico Apollo, #1, Hialeah
Muvico California Club, #1-6, North Miami
Wometco Shadowood Square, #6 & 7, Boca Raton
Wometco Weston 8, #1 & 2, Sunrise

Georgia
Cineplex Southlake Festival, #5 & 6, Morrow
GCC Merchant's Walk, #1, Marietta
GCC Parkside, #5, Atlanta

Illinois
Cineplex Bricktown, #1, Chicago
Cineplex Commons at Chicago Ridge, #4, Chicago Ridge
Cineplex Grove, #1 & 2, Downers Grove
Cineplex McClurg Court, #1, Chicago
Cineplex North Michigan, #1 & 2, Chicago
Cineplex Oakbrook Plaza, #1, Oakbrook
Cineplex Ridge Plaza, #3, Arlington Heights
Cineplex River Oaks, #1, Calumet City
Cineplex Rivertree Court, #1 & 4, Vernon Hills
GCC Woodgrove, Woodridge
GCC Yorktown Cinema, #1, Lombard

Kansas
UA Ranch Mart, #1, Overland Park

Louisiana
GCC Esplanade, #4, Kenner

Maryland
Fox White Marlin, #1, Ocean City
GCC Security Square, #1, Baltimore

Massachusetts
GCC Chestnut Hill, #1, Newton

Michigan
Jack Loek's Lincoln Park, #3, Lincoln Park
Jack Loek's Studio 28, #1 & 7, Wyoming
Nat. Am. Showcase Cascade, #2, Grand Rapids

Minnesota
Cineplex Edina Cinema, #4, Edina
GCC Har Mar Cinema, #1, Roseville

Missouri
AMC Metro North, #5 & 6, Kansas City
Wehrenberg Clarkson 6, #1, Chesterfield
Wehrenberg Kenrick, #1, Shrewsbury
Wehrenberg St. Charles, #1, St. Charles
Wehrenberg Union Station, #3 & 4 St. Louis

Nevada
Gold Coast Theatres, #1 & 2, Las Vegas
Riverside Casino, #1-3, Laughlin

New Jersey
Cineplex Newport Center, #4 & 5, Jersey City
GCC Bridgewater Commons, #2, Bridgewater
GCC Essex Green, #1, West Orange

New Mexico
UA Winrock, #4, Albuquerque
UA Four Hills, #6 & 7, Albuquerque

New York
Cineplex Green Acres, #3 & 6, Valley Stream
GCC Pittsford Plaza, #3, Pittsford
GCC Thruway, #6, Cheektowaga
GCC University, #5, Amherst
Nat. Am. Brookhaven Multiplex, #13, Medford
Nat. Amusements Sawmill, #3 & 4, Hawthorne

North Carolina
Cineplex Matthews Festival 10, #5 & 6, Matthews

Ohio
GCC Northland Mall, #1, Columbus
GCC Ridge Park Square 8, #1, Brooklyn
National Cinema South, #1, Boardman
National Montrose Movies 8, #3, Copley
National Severance Center, #2, Cleveland
National Great Northern Movies, #7, North Olmsted

Oklahoma
GCC Penn Square, #8, Oklahoma City

Oregon
Cineplex 82nd Street, #1-6, Portland
Moyer Salem Center Movieland, #1, 3, & 4, Salem
Moyer West 11th, Eugene
Tom Moyer Eastgate, #1, Portland
Tom Moyer Lloyds Center, #1 & 2, Portland
Tom Moyer Tigard, #1, Tigard

Pennsylvania
Fox Coventry, #3-6, Pottstown

Tennessee
AMC Fountain Square, #7 & 8, Nashville
Cinemark Movies 7, #5, Knoxville
Malco Germantown, #5, Memphis
Malco Winchester, #5, Memphis
UA East Towne, #1, Knoxville

Texas
Cinemark Main Place, #1 & 4, McAllen
Cinemark Movies 12, #3 & 4, San Antonio
Cinemark Movies 12, #3 & 4, Austin
Cineplex Spectrum, #2, 3, & 8, Houston
GCC Barton Creek, #3, Austin
GCC Highland 10, #5, 6, & 9, Austin
GCC Northpark West Cinema, #1, Dallas
GCC Towneast Mall Cinema, #4, Mesquite
GCC Valley View, #2, Dallas
Presidio Arbor Cinema 4, #2-4, Austin
Presidio Lakehills, #1, Austin
Presidio Lincoln Center, #1-3, Austin
Presidio Southpark Cinema 3, #1, Austin
Santikos Century South, #1, San Antonio
Santikos Embassy, #6-9, San Antonio
Santikos Galaxy, #3, San Antonio
Santikos Galaxy Annex, #11, San Antonio
Santikos Northwest, #8, San Antonio
Santikos Northwest Annex, #11, San Antonio
Santikos Westlakes Landing, #9, San Antonio
United Artists Theatre, #2, 6, & 7, Dallas
UA Arlington South Cinema, #4 & 5, Arlington
UA Bedford, #5 & 6, Ft. Worth
UA Berkeley Square, #4 & 5, Plano
UA Cinema 6, #1, Hurst
UA Cinema 6, #1, Amarillo
UA Huen 10 Theatre, #4, Ft. Worth
UA Las Vegas Trails, #4 & 5, White Settlement
UA Northpark, #6, Odessa
UA Northstar, #4 & 5, Garland
UA Phelan 6 Theatre, #1, Beaumont
UA Prestonwood Creek, #1 & 2, Dallas
UA Skillman 6 Theatre, #4, Dallas
UA South 8 Theatres, #4 & 5, Dallas
UA Towneast 6 Theatre, #4, Mesquite
UA Walnut Hill Cinema, #3, Dallas

Utah
Cinemark Movies 8, #3, Provo
Cinemark Movies 7, #4, Sandy

Virginia
AMC Courthouse Plaza, #8, Arlington
Cineplex Pembroke, #1 & 8, Virginia Beach
GCC Springfield Mall, #1, Springfield
Nat. Amusements Lee Highway, #1, 2, 11, & 12, Merrifield
Nat. Amusements Mt. Vernon, #1, 2, 9, & 10, Alexandria

Washington
Cineplex Oak Tree Cinemas, #3, Seattle
GCC Gateway Center, #8, Federal Way
GCC Lincoln Plaza, #4, Tacoma
Tom Moyer Alderwood Cinemas, #1 & 2, Lynnwood
Tom Moyer Crossroads, #1, Bellevue

THX Certification Pending
UA West Esplanade, #4 & 5, Kenner, La.
Holiday Briggsmore, #1, 2, & 5, Modesto, Cal.
Rand Arion Park, #2 & 4, San Antonio, Tex.
Rand Exchange Park, #3 & 6, San Antonio, Tex.
Cineplex Chelsea, #6 & 7, New York, N.Y.
Krikorian Diamond Bar, Diamond Bar, Cal.
Pittsburgh Galleria, #3 & 4, Mt. Lebanon, Pa.
Wometco Kendall 9, #1 & 2, Miami, Fla.
UA East Hills Mall, #2, Bakersfield, Ca.
UA Sierra Vista Mall 6, #2, Clovis, Cal.
Commodore Theatre, Portsmouth, Va.
Cinerama Rowland Plaza, #1, Novato, Cal.
Rancho Niguel, #1-8, Laguna Niguel, Cal.
Cineplex World Wide Center, #1, New York, N.Y.
GCC Bay Plaza, #1, Bronx, N.Y.
GCC Great Hills Plaza, #1 & 8, Austin, Tex.
GCC The Fountains, #8, Plantation, Fla.
Blockbuster Palace, #7 & 8, Wichita, Kans.
Cinemark Sugar Creek, #5, Tallahassee, Fla.
Edwards Newport Ctr., #1, Newport Beach, Cal.
UA Emery Bay 10, #3 & 4, Emeryville, Cal.
H & M Wharf Theatre, #1-3, Lahaina, Hawaii
Trans-Texas Shawnee Cinema 6, Shawnee, Okla.

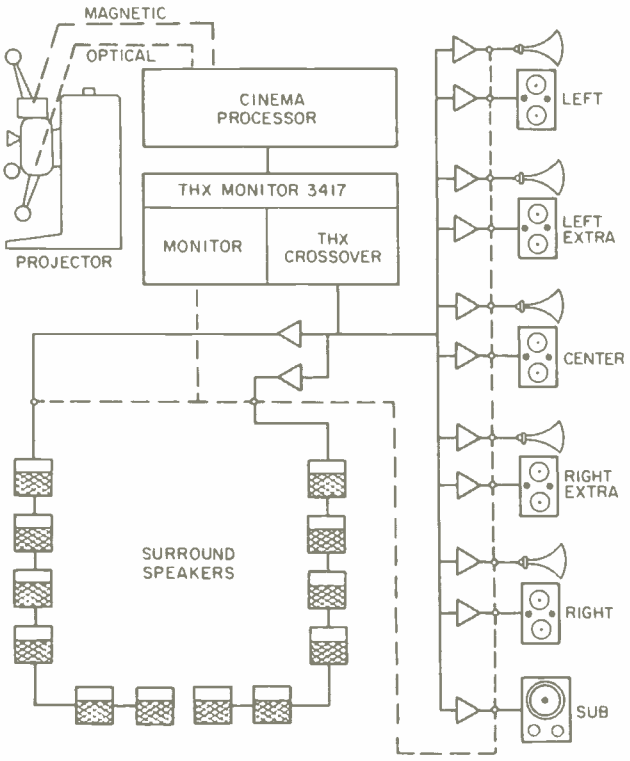


Fig. 1—Block diagram of typical 70/35-mm THX Sound System. Theaters using only 35 mm do not require the "Left Extra" and "Right Extra" screen speakers.

Fig. 2—The behind-screen speaker baffle, as seen from the rear.

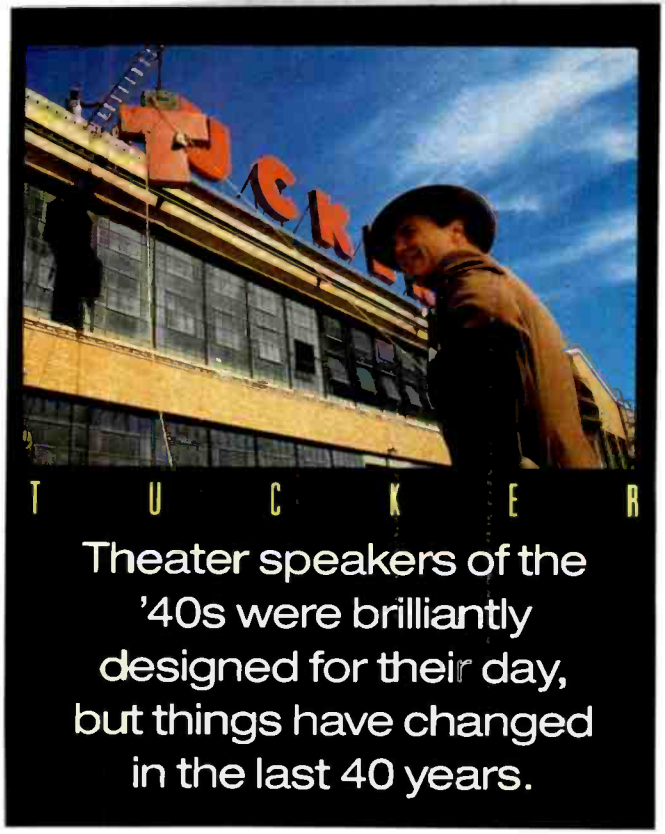
ments of hundreds of movie theaters, and non-uniform audience coverage.

For improved low-frequency performance, a direct-radiator woofer system was specified for the THX screen loudspeakers (see "Approved THX Equipment"). Two 15-inch drivers are stacked vertically in a vented box designed according to Thiele-Small parameters, which characterize the loudspeaker driver and box as mechanical analogs of an electrical high-pass filter. At the higher end of its operating range, because of the stacked configuration of the two drivers and their dimensions, the dispersion characteristic of the woofer system narrows to match that of the high-frequency system, which is necessary to ensure consistent response over the horizontal and vertical angles required for maximum dialog intelligibility and proper left, center, and right stereo localization. The crossover frequency is chosen as that where the directivities of the woofer and tweeter sections match.

Thiele-Small theory predicts that this woofer system would have relatively flat response to 40 Hz, below which it would fall off at 24 dB per octave. However, initial measurements. with the speaker placed as it would be in a typical theater, did not confirm this. Further investigation revealed that the first system tested was measured by its manufacturer mounted flush in a wall, well away from floor reflections. Once we duplicated the conditions of measurements, the predictions of theory could be confirmed; these woofers do go down to the predicted 40 Hz. We therefore specified that the three behind-screen systems (five in some 70-mm installations) be resiliently mounted in a large rigid baffle just behind the screen (Fig. 2). This baffle is treated with absorbent material to prevent high-frequency reflections between it and the screen, eliminating the destructive and constructive comb-filter effects of early reflections; the baffle has the further benefit of preventing the loss of low frequencies into the cavity behind the screen. No "Allison dip," as documented by Roy Allison, is found, since the woofer box is flush with the baffle. Low-bass distortion of this system is far less than in traditional theater systems, and power handling is adequate for theaters seating up to approximately 1,000. In larger theaters, the woofers can be used in multiples (devotees of low-frequency horn designs who question our use of direct radiators should see "Direct Radiators and Horns"). Additional subwoofers are required for 70-mm installations and are typically used in 35-mm installations to handle the special effects between 20 and 40 Hz recorded on many modern movie soundtracks.

Above 500 Hz, frequencies are handled by a compression driver combined with a constant-directivity horn whose directional characteristics are specified for the particular theater. Horns remain the best high-frequency choice for theater sound because of the need for high intelligibility in large spaces—one of several ways in which the requirements for theater sound reproduction differ from those in the home. Compared to direct radiators, horns deliver the maximum amount of direct sound to listeners while minimizing delayed reflections off the walls and ceilings that degrade intelligibility. Stereophonic localization is also improved by using directional loudspeakers to keep the ratio of direct-to-reverberant energy high at the listening location.

The constant-directivity horn (Fig. 3) is a relatively new development, originally designed for sound-reinforcement applications. The high-frequency compression drivers required for adequate power handling in large rooms, although improved in recent years with such new



diaphragm materials as titanium, nevertheless have inherent high-frequency roll-offs caused by moving mass, air trapped between the diaphragm and phasing plug, and non-ideal suspensions. Previous multi-cell, radial, and exponential horns achieved flat on-axis response by narrowing vertical dispersion with increasing frequency, a form of "spatial equalization." The constant-directivity horn, on the other hand, is designed to produce a uniform directivity pattern with non-flat response, reflecting the roll-off inherent in the driver, which can then be equalized electrically. The result is that uniform response is obtained over a much wider "listening window" than was possible with earlier designs.

A whole class of such horns has been developed, with coverage ranging from 120 × 40 degrees to as narrow as 50 × 30 degrees; of these, the 90 × 40-degree horn is the most commonly used. The high-frequency sections of the screen speakers can thus be tailored to the geometry of an individual theater's seating area. Like the low-frequency sections, the high-frequency sections can be used in multiples for covering unusually large areas or for specialized coverage of theater balconies.

The THX Crossover

The THX System's screen speakers are bi-amplified in conjunction with the proprietary THX electronic crossover, which is leased to the theater as part of the licensing procedure. Bi-amplification has several benefits which have been demonstrated in other professional applications, including the ability to play at higher levels without audible distortion for a given

Fig. 3—Two constant-directivity horns, the Electro-Voice 9040T (A) and the JBL 2360A (B).

DIRECT RADIATORS AND HORNS

Horn or direct radiator? For years, proponents of low-frequency horns have been spreading such rumors as "direct radiators have 10 times the distortion of horns because they work 10 times harder" and touting the "high efficiency" of horn designs (indeed they are highly efficient, but only over a very narrow frequency range). To resolve this controversy once and for all, we measured simple total harmonic distortion of a bass horn and of a vented-box direct radiator of equivalent cone area, installed side by side in a baffle wall at a dubbing stage. Each speaker was fed with sine-wave signals having the same voltage as that which would produce pink-noise levels of 85 dB, C-weighted (the calibration level for mixing and replaying Dolby Stereo releases) at the listening location. The results, shown in Table I, speak for themselves—note that the larger the negative number, the lower the distortion. Particularly at audible, significant higher harmonics, the direct radiator's distortion is lower. Apparently, the touted theoretical advantage of the horn system is overwhelmed by sources of distortion not considered by its advocates.

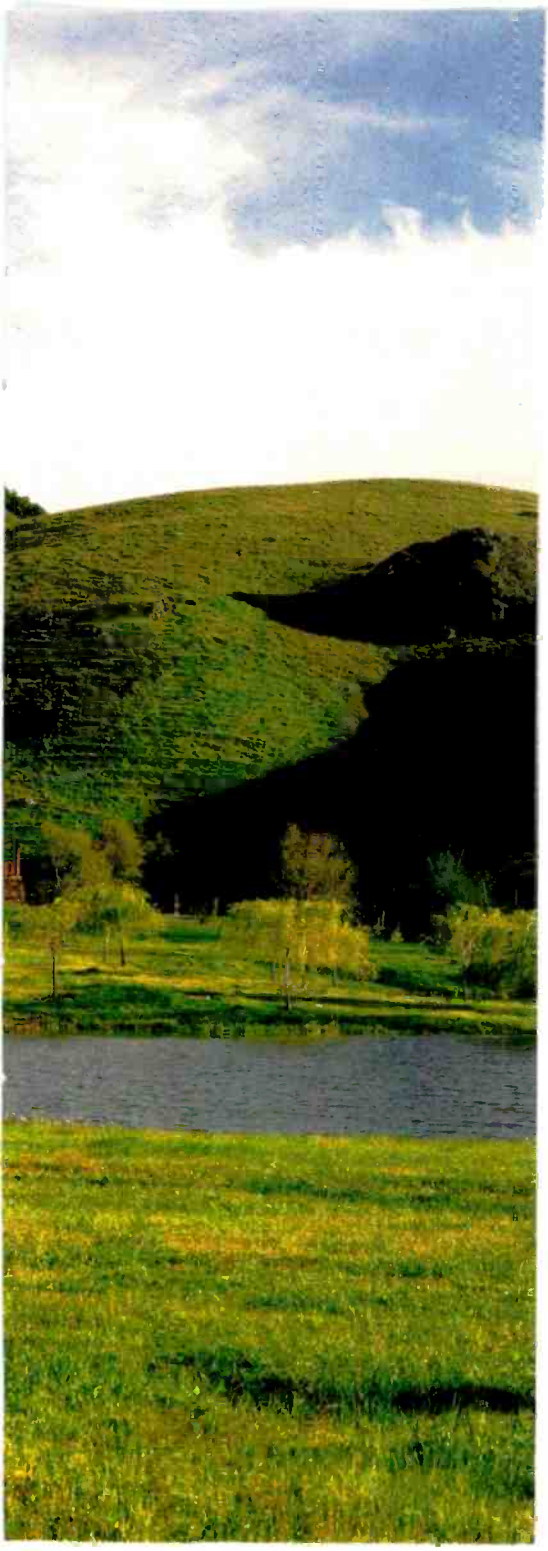
Table I—THD of a bass horn and a vented-box direct radiator of equivalent area.

Harmonic Number	40-Hz Distortion by Harmonic, dB		80-Hz Distortion by Harmonic, dB		400-Hz Distortion by Harmonic, dB	
	Horn Loaded	Vented Box	Horn Loaded	Vented Box	Horn Loaded	Vented Box
1	0	0	0	0	0	0
2	−6	−16	−36	<−70	−44	−50
3	−28	−24	−41	−39	−51	−67
4	−40	−34	−70	−68	−67	<−70
5	−32	−40	−47	−58	−67	−70
6	−50	−37	−75	<−80		
7	−33	−42	−54	−70		
8	−47	−46	<−80	<−80		
9	−36	−50	−63	−77		
10	−50	<−50	<−80	<−80		
11	−42	<−50	−70	−80		
12	−50	<−50				
13	−43	<−50				

The technical building at Lucasfilm's Skywalker Ranch.

amount of amplifier power and the ability to do more signal processing at low levels with an electronic crossover than at high levels with a passive crossover. In most installations, a stereo power amplifier is assigned to each screen speaker, with one channel handling the low-frequency system and the other the high frequencies; typical installations use 250-watt/channel power amps. While on average program material the tweeter requires less power than the woofer, having the same power available for the tweeter as the woofer ensures proper reproduction of non-average peaks, such as a cymbal crash. Since in theater sound the source material is known, the sound system can be designed to have more headroom than the program source, thus ensuring that distortion due to clipping never occurs, and this is the course taken in THX.

The THX crossover network circuit is fourth-order Linkwitz-Riley (L4). The network has steep skirts—24 dB/octave measured acoustically on both the woofer low pass and tweeter high pass—and is 6 dB down at crossover (500 Hz). This amount of attenuation leads to greater tweeter power handling than do most networks, which are only 3 dB down at crossover. Unlike some other electronic crossovers, the THX crossover is matched to known drivers, thus providing accurate L4 characteristics. This combination of network and drivers yields iden-



APPROVED THX EQUIPMENT

The equipment specified for THX use will vary with the specific installation. The list below shows equipment approved for THX Sound Systems as of May 1989; the equipment used in a given installation will be based upon theater volume and dimensions. Additional models in all categories are regularly undergoing evaluation by Lucasfilm, and several manufacturers have developed products specifically designed to meet THX Sound System standards.

LOUDSPEAKERS

Screen System	Compression Drivers	Horns	Woofers
Altec 10A/MR945A	Altec 906-8A	Altec MR-945	Altec 8254
Electrc-Voice TS9040D-LX	Electro-Voice DH1A	Electro-Voice 9040T	Electro-Voice TL606DX
JBL 4675A-8LF	JBL 2445J or 2450J	JBL 2360A	JBL 4648-8
			Peavey 215

Subwoofers		Surround Speakers	
Altec 8154	JBL 4645	Boston Acoustic A70T	JBL 8330
Altec 8184	JBL 4788	Electro-Voice TS8-2	Kintek KT-340
Cerwin Vega SW18	Kintek KT-90 (powered)	Frazier F2350	
Electro-Voice TL3512	Peavey 118		

BOOTH EQUIPMENT

Power Amplifiers

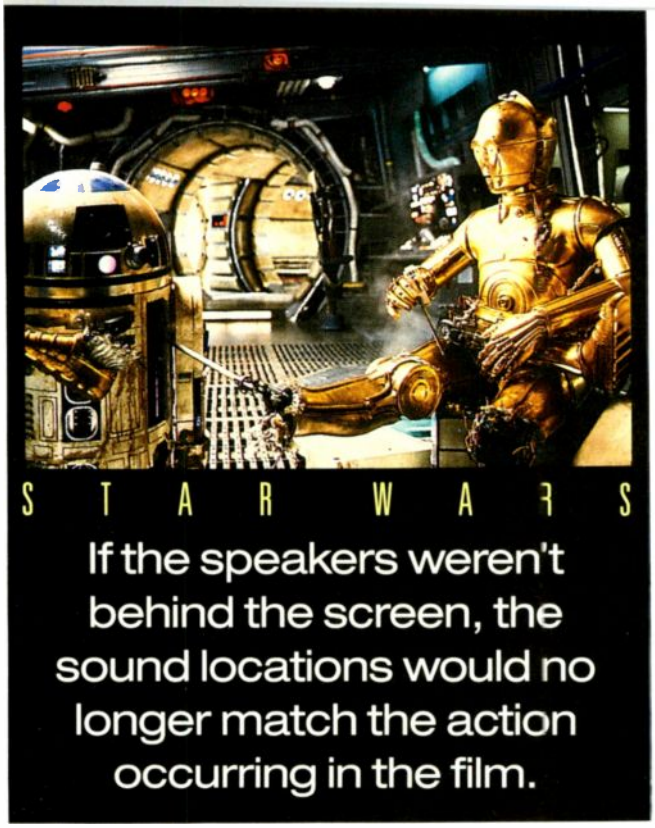
Altec 1270B	Crest Audio 1501A	JBL 6260	QSC 1400
Altec 9444A	Crest Audio FA-800	JBL 6290	QSC 1700
ART SS1200T	Crest Audio 4000	Kintek 1100	QSC 3350
Ashly FET-500	Crown Micro Tech 600	Kintek 1110	QSC 3500
BGW GTB	Crown Micro Tech 1200	Kintek 1111	Smart TA-440
BGW 750E	Crown PS400	NAD 2200	Soundcraftsmen 900X2
BGW 7500	Electro-Voice AP2600	Peavey CS 400	TOA P150-D
BGW 7500T	Hafler DH-500	Peavey CS 800	UREI 6300
BGW 8000	Hafler P-505	Perreaux 8000C	XeTRON XPA-240X2
Bryston 4B	JBL 6230	RAMSA WP-9220	Zetka 600 Series II

Monitor/Crossover Card Frame
THX Monitor 3417

Processors
Dolby CP-55
Dolby CP-100 with SA4
Dolby CP-200

tical phase versus frequency response for both woofer and tweeter and complementary amplitude versus frequency responses; hence, there are none of the frequency-dependent radiation tilts of conventional networks. The result is uniform axial, power, and phase response throughout the critical midrange. When the system's amplitude and group-delay responses from 250 Hz to 1 kHz (from one octave below to one octave above crossover) are measured by FFT methods, both amplitude and group delay are remarkably flat.

The use of an electronic crossover network allows for additional signal processing critical to system performance. Close-tolerance high-frequency equalization compensates for the characteristic falling high-frequency response of the compression driver, as well as compensating for screen loss and adding a correction factor to match the system to the worldwide standard "house curve" described by ISO 2969 curve (Fig. 4), sometimes referred to as the "wide-range" or "Dolby Stereo" standard, as opposed to the Academy standard. These compensations minimize the requirement for tuning the final installation; in many instances, less than ±3 dB of "room" equalization has been necessary to achieve the center line of ISO 2969 from 40 Hz to 16 kHz. The THX crossover also incorporates a 1.9-mS time delay to compensate for the distance between the acoustic centers of



the direct-radiating woofers and the horn tweeters. Finally, a high-pass filter at about 30 Hz prevents woofer overexcursion from program material and from noise below the lower frequency limit of the vented-box/speaker system.

Attempts to move the screen loudspeakers out from behind the screen, to reduce the screen losses, have been made over the years. The problem is that the sound directed to the left, center, and right loudspeakers is intended by the sound designer to occur on the screen. Sound systems above the screen inevitably draw one's attention upward; those outside the screen draw it outward. It doesn't make much sense for Indiana Jones' footsteps to come from the black masking at the side of the screen when we see him enter the cave in *Raiders of the Lost Ark* on screen left. Humans localize extremely well in the plane that includes the three screen speakers, so errors in direction are quite important. Mixers spend a great deal of time placing sounds correctly, and it is the job of the sound system to reproduce them in the same position they were placed. Since screen losses amount to a simple 6-dB/octave filter, they are easy to overcome with electrical equalization, and so cinema screen loudspeakers properly belong behind the screen.

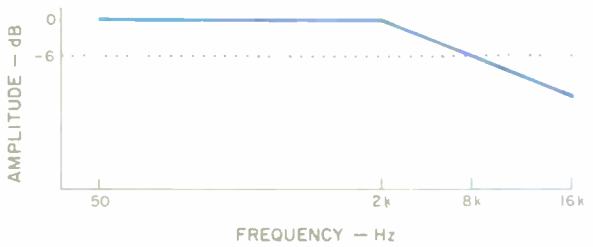


Fig. 4—ISO 2969 "house curve."

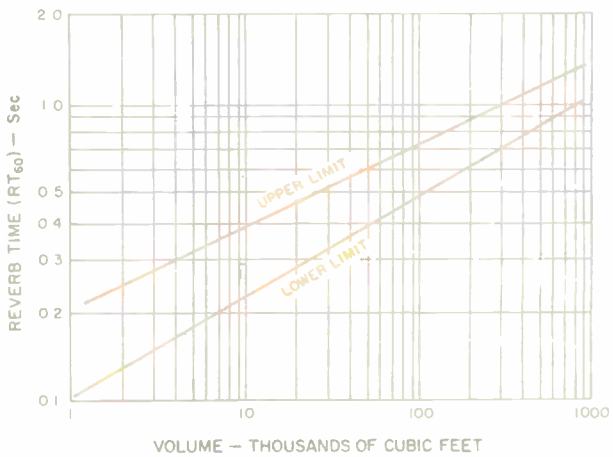


Fig. 5—Upper and lower reverberation-time (RT_{60}) limits for THX theaters of various volumes, at 500 Hz.

The Surround Channel

The objective of the surround speakers and their installation is to envelop the audience with nondirectional sound through the use of a large number of small, broadly dispersive loudspeakers with overlapping patterns. This approach is directly opposite to that taken for the screen speakers, where the objective is the highest ratio of direct-to-reflected sound possible, consistent with uniform audience coverage. The surround field should be as diffuse as possible; we do not want the audience to be particularly aware of where the sound is coming from, which is precisely what we *do* want with the screen speakers. This is because there is no meaning for sound images which are not associated with the picture. Given the need for broad dispersion and the fact that the speakers are used in multiples so no one speaker need handle undue power, the systems we have found most appropriate are modified versions of home bookshelf models.

The number of surround speakers, their spacing along the side and rear walls of the theater, and their height are calculated using formulas developed to ensure uniformity of coverage. The final requirement for the surround channel as a whole is that it have the same power-handling capability as one screen channel. An additional formula for calculating the required amplifier power is based on the number of surround speakers, their sensitivity, the average distance from the speakers to the center of the room, and the maximum sound pressure level required. To further minimize the need for post-installation tuning, surround speakers are now available with high-frequency response tailored to provide the ISO 2969 curve.

Theater Acoustics and Noise

All the foregoing would, of course, be of limited use in a theater with poor acoustics, or with a high ambient noise level from a defective air-conditioning system, or with an adjacent theater in a "multi-plex" operation. In addition, widely varying theater acoustics would make it

impossible to achieve a prime goal of those involved in film production—that the audience accurately hear what the director intended in the final sound mix, as well as see it. The goal in enforcing theater acoustics standards is not just good sound, but sound as close as possible to the sound in the dubbing theater.

In a room, the listener is exposed to three sound fields: The direct field, the early reflections, and the reverberant field. THX speaker systems are designed to provide appropriately uniform response of the direct field at virtually all seats in the theater. By working closely with the theater owner and acousticians, as necessary, it is our goal to achieve the same response as the direct sound for early reflections and for longer term reverberation as well. Among other things, this means choosing construction and decoration materials that do not absorb or enhance any particular frequencies.

Reverberation in theaters must be within reasonable limits to produce good articulation throughout the room. Too little reverberation may lead to an unnaturally dead sound, while too much smears together the speech syllables so vital to film sound articulation, and can alter music and effects as well. After considerable research, THX theaters are required to have an RT_{60} (the time it takes for a stopped sound to drop 60 dB in level) at 500 Hz within the limits shown in Fig. 5. Ideally, the RT_{60} at other frequencies should be the same; measurements are made at each octave band from 63 Hz to 8 kHz (some variation from the ideal times shown in Fig. 5 is permitted at various octaves). Finally, the character of the decay should be as smooth as possible—free of "flutter echoes" and the discrete echoes which can occur from long delayed reflections from the back wall. Contrary to current practice in some recording studios, which are comparatively small rooms, this usually requires deadening the back wall of the theater.

Standards are set for maximum permissible noise levels within the theater and isolation from noise outside the theater. The start is a simple listening test, which often identifies easily remedied problems such as an improperly gasketed door to the outside, noise from the projection booth, or an air-conditioning system which hasn't been properly cleaned and maintained. The absolute maximum background noise level in the theater with the air-conditioning on is specified, by octave band, in Noise Criteria curve NC-30 (NC-25 is recommended) as shown in Fig. 6. The curves reflect the ear's decreasing sensitivity to lower frequencies. As Fig. 7 shows, most non-THX theaters do not meet NC-30.

With the popularity of multiple-theater complexes, it was necessary to set minimum standards for isolation of the THX room from adjacent theaters. These standards have been based upon playing a variety of films in the dubbing theater and recording the level in each octave from bass to treble, moment by moment; it turns out that isolation at lower frequencies is most often the problem. From this data, the minimum standards for isolation between theaters were developed (see Table II). These standards take into account the masking effect of air-conditioning noise, the fact that such noise does not precisely follow the NC-30 curve, statistical analysis of soundtrack measurements, and a realistic requirement for wall construction. The underlying engineering principle is economic; to require that nothing at all be heard from an adjacent theater under any condition is unrealistic, but it is acceptable to permit something to be heard less than 1% of the time when one theater is playing soft dialog and the other is playing loud music and effects.

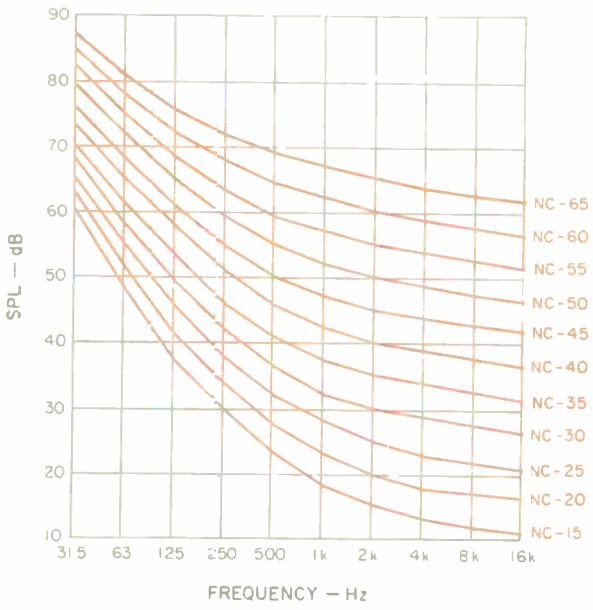


Fig. 6—Background-noise criteria curves. The NC-30 curve is the maximum allowable in a THX theater; NC-25 is recommended where practical (after Beranek).

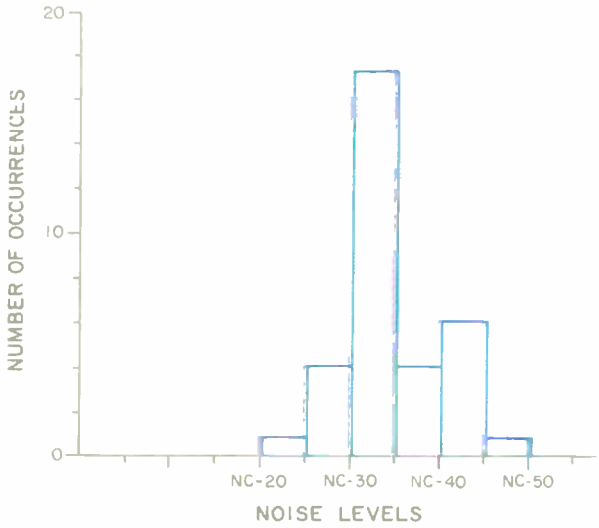


Fig. 7—Statistical distribution of background-noise levels in typical theaters. Most of the theaters in this survey, made by the Theater Alignment Program for the National Association of Theater Owners, would not qualify for THX certification without modifications.

Theater acoustics must be carefully controlled so that the audience hears what the director heard in the final sound mix.

Theater Certification

It is one thing to recommend improved hardware, ways of installing it, and specifications for the room itself; indeed, we are not aware of any prior attempt to attend, in such depth, to so many elements of sound reproduction in the theater simultaneously. It is, however, quite another to see that it is all carried out properly in the first place, and then, a few months or years later, check that it all still sounds the way it should. This is where the THX licensing program comes in, with its certification and recertification procedures. The goal is that the movie goer will hear what was originally heard in the dubbing theater *whenever* he sees and hears a film in a THX theater.

After a theater has received preliminary information on what the THX program is and requests the next step, engineers go out to inspect the theater and run a battery of tests. We then develop a specific package for that particular theater, including the equipment and the steps that need to be taken to bring the theater in line with respect to acoustics and noise levels. The services of an acoustical consultant may be necessary. As the work proceeds, consultation occurs, as needed, with the equipment installer, contractor, architect, and/or acoustical consultant to provide assistance and to ensure that standards are met. For example, many practical measures are recommended, such as changing the diffusers on an air-conditioning system for lower noise, steps to minimize "flanking paths" (i.e., direct sound paths from the outside or an adjacent theater), and when to schedule "down time" for installation. We also warn theater owners that taking down an old screen to install the baffle may result in damage that will require the screen's replacement.

Once the installation is complete, Lucasfilm engineers then return to the theater, fully align the entire sound system, make measurements, and make sure that theater personnel and service technicians are aware of the system's proper operation and maintenance. Assuming all tests are passed, the theater is then certified for one year, with the further requirement that, in six months, proof of continuing performance is provided. The system must then be tested again at the end of the first year and recertified, starting the cycle over again—proof of performance in six months, and recertification one year later. This ensures that the audience hears what it is supposed to, and that a theater using the THX trademark is genuinely and regularly meeting standards.

Table II—Acoustic noise reduction required between adjacent theaters.

Octave Band, Hz	Required Reduction, dB
31.5	38
63	48
125	52
250	54
500	66
1,000	66
1,000	66
4,000	66
8,000	66

Typical Specs

Screen channels, left, center, and right, should test within ±2 dB of ISO 2969 curve, 40 Hz to 16 kHz, when measured with pink noise and temporal and spatial averaging throughout the listening area at seated ear height. Bass extension should go to 25 Hz by means of subwoofers. The calibrated sound pressure level, for reproducing the absolute levels during the mix correctly, should be maintained within ±2 dB over the seating area. The system must be capable of playing any film format without clipping distortion, while the theater's background noise level must be less than NC-30 and its reverberation time within the bounds shown in Fig. 5.

Conclusion

When Lucasfilm set out, about eight years ago, to create a state-of-the-art dubbing theater for use in post-production work to begin with *Return of the Jedi*, we had little idea that it would involve improving the state of local cinemas. In retrospect, however, that involvement now seems logical. For one thing, we found the state of the art to be practical and surprisingly affordable. For another thing, as producers of films reflecting new technology in such areas as special effects, it only makes sense to facilitate the best, most advanced methods for their exhibition to the movie-going public. No one could reasonably expect that the majority of theaters will make the effort and expenditure necessary to install the THX Sound System. Yet we are impressed and pleased with the significant number of theater and theater-chain owners who feel that offering their patrons "the best" is worthwhile artistically and is profitable. With the addition of the next-generation improvement to optical soundtracks, Dolby Spectral Recording, we think the theater experience has come to be what it was for me as a kid, the best recorded sound you could hear.

Since the THX Sound System is an elaborate collection of theoretical and practical improvements combined into one comprehensive program, it is impossible to credit everyone who participated. From mathematicians to materials scientists, and from measurement specialists to acousticians, all who have helped are thanked here. A

—**Leonard Feather,** Celebrated Jazz Critic for the L.A. Times, Washington Post News Service and Author of many books including *"The Jazz Years—Earwitness to an Era."*

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A-9

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1

PARADIGM 7se LOUDSPEAKER

Manufacturer's Specifications

System Type: Bookshelf-size, two-way, vented box with critically tuned resistive port.

Drivers: 8-inch (200-mm) woofer, 1-inch (25-mm) dome tweeter.

Frequency Range: On axis, 60 Hz to 20 kHz, ±2 dB; 30° off horizontal axis, 60 Hz to 15 kHz, ±2 dB.

Sensitivity: 88 dB SPL at 1 meter for 2.83 V rms input.

Crossover Frequency: 2.3 kHz.

Impedance: 8 ohms nominal.

Recommended Amplifier Power: 15 to 100 watts at 10% clipping.

Dimensions: 24 in. H × 10½ in. W × 11¾ in. D (61 cm × 26.7 cm × 29.9 cm).

Weight: 55 lbs. (25 kg) per pair.

Price: $469 per pair.

Company Address: c/o AudioStream, P.O. Box 2410, Niagara Falls, N.Y. 14302.

For literature, circle No. 90

"Paradigm (par' a dim), noun: Serving as an example or model of how something should be done." Thus start a number of ads for AudioStream, the American distributor of the Canadian "Paradigm" line of loudspeakers. This definition is a lofty goal indeed for a company to strive for in any product they make. This review describes the Paradigm Model 7se, a moderate-size, relatively low-cost, two-way vented system with an 8-inch woofer and 1-inch dome tweeter. Read on to find out how well the 7se matched the goal stated in the definition.

The 7se is the middle member of a line of 10 moderately priced two- and three-way systems from Paradigm Electronics. Paradigm, formed in 1982, is one of a number of Canadian manufacturers that have taken advantage of research and test facilities made available by the Canadian government through its National Research Council (NRC).

The NRC is the Canadian equivalent of our National Bureau of Standards but with the added mandate of performing research that helps Canada be competitive in world markets. The research results are made freely available to anyone through a national information network, technical journal articles, and NRC research publications.

The NRC also provides facilities for hire that any company in the audio industry would be proud to call their own. These facilities include anechoic and reverberation chambers with sophisticated computer-controlled measurement equipment and an IEC (International Electrotechnical Commission) Standard listening room for conducting listening tests.

The NRC Acoustics Department is headed by Dr. Floyd Toole, who is well known in the U.S. audio community because of his involvement in the Audio Engineering Society and the Acoustical Society of America. Dr. Toole has written a

number of AES papers describing the results of his research in the area of subjective loudspeaker testing and the correlation of a speaker's measured performance with listener preferences. (See "Testing at Canada's NRC" for more detailed information on the NRC and Dr. Toole's research.)

Paradigm has drawn heavily on the work of Dr. Toole and the facilities of the NRC to optimize the 7se. The design objective was to come up with a moderately priced system that emphasized those loudspeaker design features which directly improve its subjective sound as verified by extensive double-blind listening tests.

Dr. Toole's research has found that experienced listeners prefer a loudspeaker that has wide bandwidth, flat and smooth amplitude response, and uniformly wide dispersion (again, see the sidebar for more details). These were just the areas concentrated on in designing the 7se.

The 7se is a rather conventional-looking, two-way vented system of modest appearance. The one striking feature is made evident when the grille is removed: The front panel is light gray and looks somewhat metallic in nature. The outside of the box is walnut vinyl covered with the ¾-inch (19-mm) particle board used in all of this box's construction. An internal brace connects the front and rear of the box to minimize front and rear panel vibration. Good workmanship was evident throughout.

The rear is painted flat black and contains recessed, double-banana, five-way binding-post connectors. No tweeter level control is provided. (I personally don't like driver level controls because they change the system's frequency/time-directional characteristics in a nonlinear manner. It's best to change the tonal balance with a good line-level minimum-phase equalizer in the feed to the power amplifier.)

The flush-mounted tweeter, woofer, and port are centered horizontally in the cabinet, with the tweeter over the woofer and the port below. The port is roughly 1.8 inches (48-mm) in diameter by 3 inches (76-mm) long and tunes the 1.2-cubic-foot (34-liter) box to approximately 35 Hz (see the "Measurements" section of this review).

Paradigm completely designs and manufactures their own woofer and midrange drivers, including all crossover networks. The tweeter is custom-manufactured for Para-

TESTING AT CANADA'S NRC

The National Research Council was established by the Canadian government in 1916 to promote scientific and industrial research that would help Canadian firms be competitive in Canadian and world markets. It now employs over 3,000 people at 11 locations and operates with a budget of over half a billion dollars.

The NRC maintains several world-class laboratories dedicated to pure and applied research in many diverse disciplines, including biotechnology, robotics, space sciences, advanced manufacturing, physics, and chemistry, among others. The NRC also develops and provides standards as an active part of national and international standards organizations and systems.

The NRC's heavy research emphasis and its mandate to provide technology and research information to private industry is paralleled by organizations in many other countries, including France, Great Britain, Germany, Japan, and Australia. The U.S., however, has no equivalent to the NRC's research-promoting activities.

Dr. Floyd Toole is a Senior Research Officer in the Acoustics and Mechanical Standards department in the NRC's Division of Physics. He heads the Sound Reproduction and Psychoacoustics project in the Acoustics section, where acoustic and subjective research has led to well-defined technical design requirements for loudspeakers. Several Canadian loudspeaker manufacturers have taken advantage of the Division's know-how and facilities to design loudspeakers for both the consumer and professional audio markets.

Under Dr. Toole's direction, research was undertaken to determine the relationships between loudspeaker measurements and listener perceptions. The method used was that of identifying the perceived dimensions of sound and relating them to the corresponding technical attributes of the loudspeakers. In addition, extensive research was done on the measurement and perception of resonances.

In the study, several different types of measurements were made on a relatively large number of domestic-style loudspeaker systems with forward-facing radiators. These speakers were then auditioned by many listeners with normal hearing, and the resultant data was statistically analyzed to yield a perceived fidelity rating.

It was found that, among other measurable attributes, listeners "like the sound of loudspeakers with a flat, smooth wideband on-axis amplitude response that is maintained at substantial angles off axis" and loudspeakers which "had phase responses that were smooth and only gently undulating in contour" (F. E. Toole, "Loudspeaker Measurements and Their Relationship to Listener Preferences: Parts 1 and 2," *Journal of the Audio Engineering Society*, April and May 1986).

High ratings were given to those systems that, in particular, had smooth midrange responses with no sharp peaks or dips. These local aberrations are indicators of both the presence and severity of resonances which may cause audible colorations. Dr. Toole goes on to point out the importance of high-resolution free-field measurements with sufficient spatial averaging (not frequency averaging) to remove the visual clutter of acoustical interference effects on the measurements. Interested readers may order a collection of Dr. Toole's papers, entitled "Subjective and Objective Measurements of Loudspeaker Performance," for U.S. $3.75 (including postage) from the National Research Council, Div. of Physics, Ottawa, Ontario, Canada K1A 0R6. *D.B.K.*

The 7se is optimized for design features Canada's National Research Council has found can make speakers sound better.

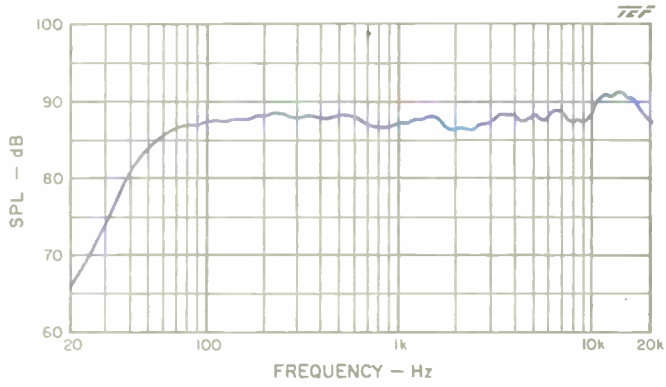

Fig. 1—One-meter on-axis frequency response, with an input of 2.83 V rms (equivalent to 1 watt into the rated 8-ohm impedance).

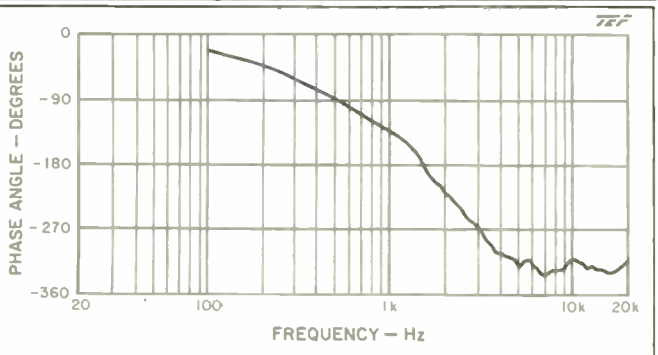

Fig. 2—One-meter on-axis phase response, with delay adjusted for the tweeter. An additional 0.17 mS was required to achieve a flat phase curve in the woofer's upper range.

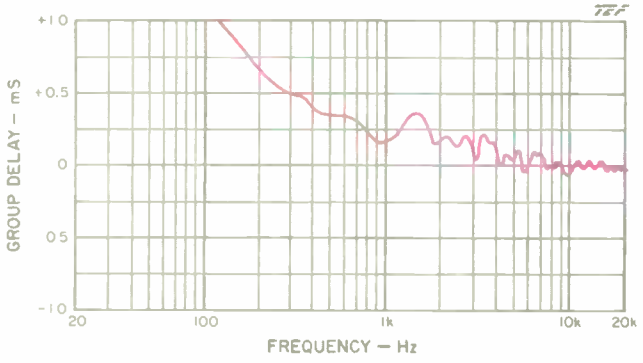

Fig. 3—Group delay corresponding to phase response of Fig. 2. The woofer lags the tweeter by about 0.17 mS, an equivalent distance of 2.3 inches.

digm by an unnamed European maker. The woofer has a die-cast aluminum frame with a forged, single-unit, backplate/pole-piece assembly. The cone is clear polypropylene with a butyl surround. A Kapton voice-coil former is used in the 1-inch (25.4-mm) diameter, long-excursion voice-coil. The tweeter uses a 1-inch polyamide soft dome with ferrofluid cooling and damping. Both drivers have sizable ferrite magnet assemblies.

The internal passive crossover is of quasi-Butterworth design (in the manufacturer's words) with a second-order high-pass filter (shunt inductor and series capacitor) feeding the tweeter and a first-order filter (single inductor) feeding the woofer.

Measurements

Most of the measurements were made using the Techron TEF System 12 Plus analyzer, which uses the Time Delay Spectrometry (TDS) technique. The measurements were mostly done inside my employer's (Crown International) large microphone-production test facility, using elevated free-field measurements and near-field measurements. Some of the tests were done outdoors, using ground-plane measurements.

The system's on-axis frequency response was measured at a distance of two meters, directly on axis of the tweeter. The input level was 2.83 V rms, which corresponds to a level of 1 watt into 8 ohms. The on-axis response was corrected to the standard distance of 1 meter for display of the data. The parameters of the measurement were set so that the data was essentially smoothed with a tenth-octave filter.

Figure 1 shows the on-axis 1-watt, 1-meter frequency response of the 7se with the grille off. The speaker exhibits a commendably flat response (±2 dB) from roughly 60 Hz to 10 kHz, with a moderate rise of about 4 dB covering roughly two-thirds of an octave between 10 and 16 kHz. In the important bass-midrange region between 100 Hz and 1 kHz, the system is even flatter, staying within about ±1 dB. This measurement reveals a sensitivity of approximately 87.5 dB SPL over the range from 100 Hz to 10 kHz, which essentially confirms the manufacturer's rating. A separate test, comparing the axial response of both the right and left speakers, yielded a commendable match of ±0.5 dB over the frequency range from 50 Hz to 15 kHz.

Note that this on-axis frequency response represents a free-space measurement taken without the effects of any reflective boundaries. It represents essentially the frequen-

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Frequency response is commendably flat from 60 Hz to 10 kHz and is flatter in the important bass and midrange regions.

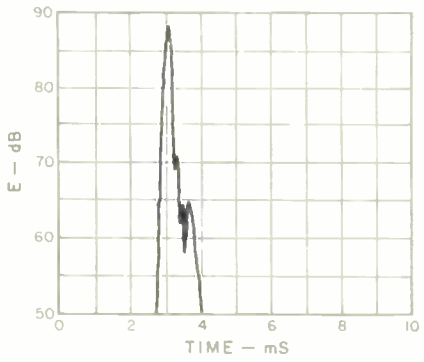

Fig. 4—One-meter on-axis ETC for test signal swept from 200 Hz to 10 kHz. In this range, most of the response shown is from the tweeter.

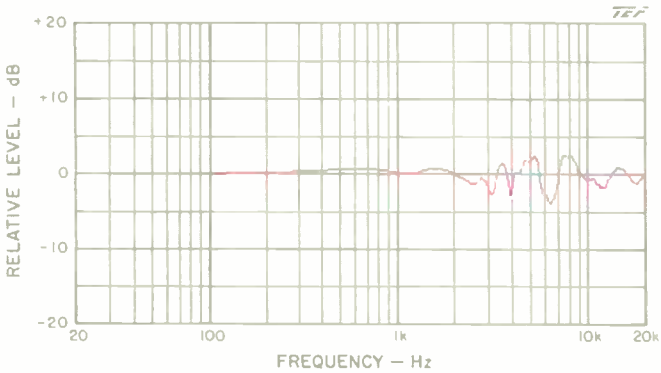

Fig. 5—Effect of grille on axial 1-meter frequency response. (The graph is normalized to show only differences from grille-off response of Fig. 1.) The grille adds fairly severe response aberrations in the range from 3 to 10 kHz.

cy spectrum of the first arrivals you hear when listening to the system in its normal listening environment. The balance between low and high frequencies will change when the system is placed near reflective boundaries in an actual listening situation.

Figure 2 shows the on-axis phase response of the system, corrected for the time arrival of the tweeter. Figure 3 shows the related group delay versus frequency for the phase curve of Fig. 2. This group delay indicates that the woofer follows the tweeter by about 0.17 mS (170 μS), which corresponds to a relatively low offset distance of 2.3 inches (58 mm). At the crossover (2.3 kHz), this offset represents approximately 0.4 wavelengths, or 140° of phase. Although this is not a linear-phase system, most available research indicates that this amount of mid-high frequency all-pass (flat frequency response) delay is not readily audible. The increase in delay below 500 Hz is due to the normal minimum-phase delay caused by the high-pass characteristic of the speaker's low-frequency response.

The 1-meter on-axis energy/time response (ETC) is shown in Fig. 4 for a test signal swept over the range of 200 Hz to 10 kHz. In general, the ETC looks good, except for a broadening of the response at levels greater than 20 dB below the first arrival peak. Be aware that this ETC represents essentially the tweeter's response only, due to the specific frequency range swept.

Figure 5 reveals the grille's effect on the on-axis frequency response. The grille produces moderate frequency response anomalies of about ±3 dB in the range above 2 kHz. I suggest removing the grille for serious listening; most of my own listening was done with the grille off.

The system's off-axis frequency response was measured in two different ways. The first method displays the data in a three-dimensional format similar to the one seen in *Audio* equipment reviews for the last few years. The second method essentially follows the way the on- and off-axis response curves were measured and derived at the Canadian NRC's test facilities, which were used extensively in the design and development of the 7se.

Figures 6 and 7, respectively, show the 3-D horizontal and vertical off-axis frequency response curves of the 7se in the frontal hemisphere. These curves were derived from frequency-response measurements made at 5° increments along the major horizontal and vertical planes in the front of the system. No additional smoothing was done on these curves except for the fairly high resolution, 200-Hz, constant-bandwidth smoothing that results from the TDS data-gathering process.

Note that these plots differ from the usual *Audio* format, in that the frequency scale is logarithmic rather than linear and that all curves have been referenced (normalized) to the on-axis frequency response. The on-axis response curve in each of the displays is easy to find because it is a straight line. The normalized format is beneficial in that it clearly depicts the differences between the on- and off-axis curves. The same display would result if the system's on-axis frequency response were carefully equalized flat over the range from 200 Hz to 20 kHz.

The 3-D horizontal off-axis curves in Fig. 6 indicate a fairly well behaved off-axis response, with extension up to 10 kHz out to about 30° off axis. Beyond 10 kHz, the response rolls off quite rapidly with increasing off-axis angle. The response ripple which appears in many of the off-axis curves above 4 kHz is actually a localized aberration of the near *on-axis* response. The normalization of the response curves displaces this ripple to the off-axis curves, making it more noticeable than if normalization were not used.

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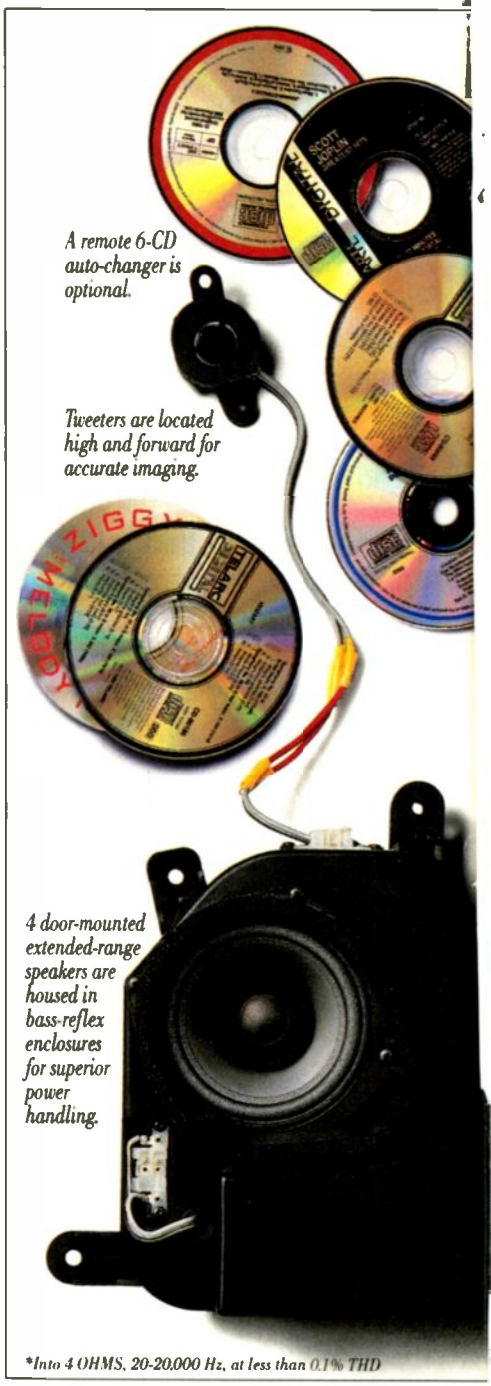

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Car audio without compromise: the Lexus/Nakamichi Premium Sound System. Lexus is the first to offer Nakamichi as original equipment.

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The LS 400 audio system is pre-equalized to the interior's unique acoustics.

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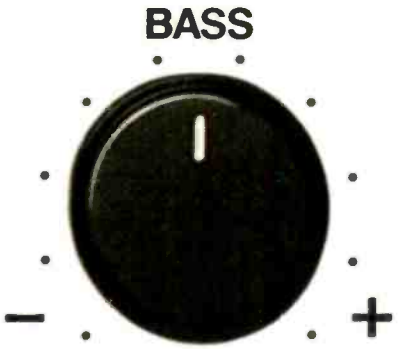

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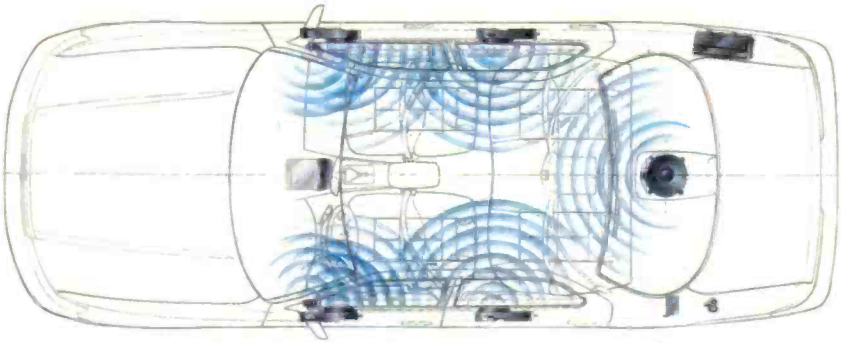

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The flat off-axis response implies that the Paradigm 7se speakers should image quite well over a broad horizontal listening area.

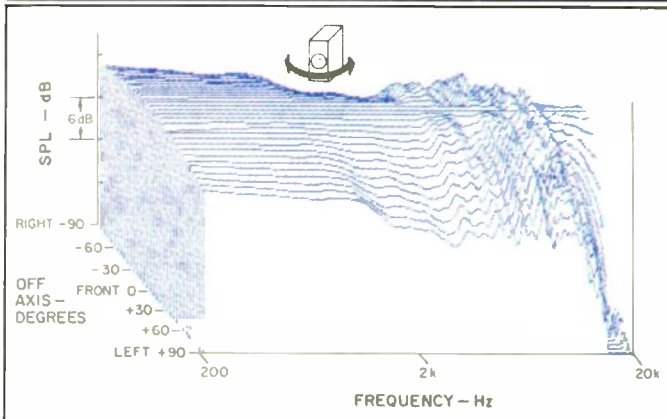

Fig. 6—Horizontal off-axis response plots taken from the left side, around the front, to the right side of the system. Note that frequencies are shown on a log scale and that all curves are normalized to show differences from the on-axis response.

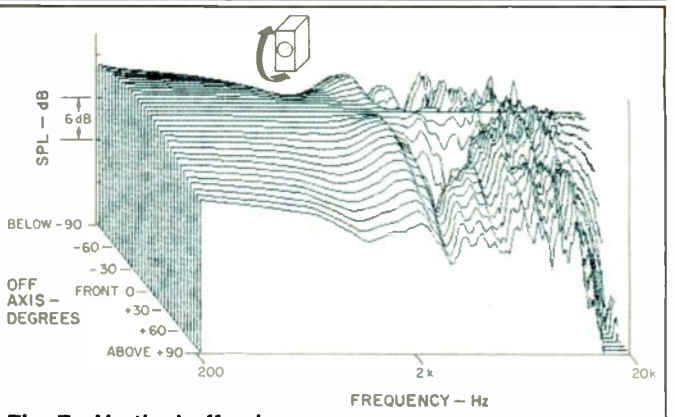

Fig. 7—Vertical off-axis plots taken from above to below the system. Note log frequency scale and normalization of all curves to the on-axis response. Also note crossover response irregularities between 1.5 and 3 kHz, at roughly 20° to 40° off axis up and down.

The vertical off-axis curves in Fig. 7 denote clearly the effects of the crossover in the domain from 1.5 to 3.5 kHz. Off-axis null regions exist at angles about 30° up and down. The 6.5-inch (165-mm) center-to-center separation of the tweeter and woofer corresponds to about 1.1 wavelengths at the 2.3-kHz crossover frequency. The symmetrical up and down positions of the vertical off-axis nulls indicate that the woofer and tweeter are approximately acoustically in phase throughout the important crossover frequency area. This very desirable behavior minimizes the "lobing error" of the system. An independent confirmation of the driver acoustic phasing was done by running a response curve on the system with the connections of the tweeter reversed. This resulted in a sharp 15-dB dip in the frequency response at the 2.3-kHz crossover frequency.

The curves also show that the response is significantly rougher off axis vertically than horizontally. I suggest listening to the system no farther than about 10° vertically off axis, for best results.

Figures 8 and 9, respectively, show the mean horizontal and vertical on- and off-axis response curves of the system, measured and derived in the manner of the NRC tests. These response curves were derived from the previous 3-D data by calculating response averages of several adjacent curves in specific on- and off-axis angular regions. This spatial averaging, rather than frequency averaging or smoothing, tends to suppress the effects of localized response aberrations due to diffractive effects, without minimizing overall frequency response problems exhibited over broad angles. The mean axial response was calculated by averaging all the individual responses in a ±15° window, both horizontally and vertically. The mean off-axis responses were computed separately, in both the horizontal and vertical directions, from the ±30° to ±45° and the ±60° to ±75° off-axis curves.

The mean horizontal response curves are shown in Fig. 8. The mean axial response curve is quite flat and extended, within a ±2 dB envelope out to 19 kHz. Surprisingly, except for a roll-off above 10 kHz, the off-axis curves over the range from 800 Hz to about 11 kHz are actually flatter than the on-axis curve. This smooth, wide-angle response trait implies that the 7se speakers should image quite well over a broad horizontal listening area.

The mean vertical responses are shown in Fig. 9. These curves are somewhat similar to the horizontal curves, except for a 2-kHz, octave-wide hole in the response at the crossover frequency in the 30° to 45° angle range.

Figure 10 shows the input impedance of the 7se, plotted over the range from 20 Hz to 20 kHz, with a logarithmic vertical scale covering 1 to 100 ohms. A minimum impedance of 5 ohms at 150 Hz and a maximum of 28 ohms at 1.5 kHz were measured in the operating range of the speakers. Though this system is rated at 8 ohms, the 5-ohm mimimum reached in the upper bass range makes paralleling two sets of these speakers a possible hazard for some amplifiers—especially at high levels.

The double-humped impedance characteristic of the vented-box (bass-reflex) cabinet was apparent at low frequencies. The Helmholtz-resonance tuning frequency of the box occurs at the impedance dip—about 32 Hz. At this frequency, most of the acoustic energy is radiated by the port, with the displacement of the woofer cone minimized.

The complex magnitude-phase (Nyquist) polar plot of the impedance is shown in Fig. 11. The curve nicely rotates clockwise with increasing frequency, which it ought to, as pointed out by the late Richard Heyser, *Audio*'s former

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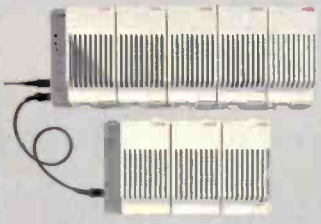

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The polar impedance curve is extremely well behaved, with no minor loops—proof that there are no spurious higher order resonances.

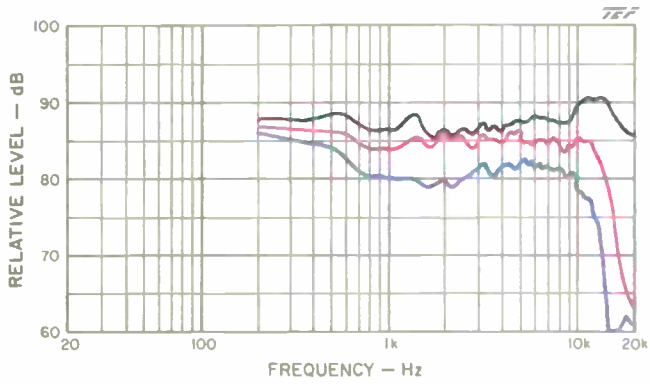

Fig. 8—Mean horizontal on- and off-axis frequency response curves above 200 Hz; see text. Top curve is mean on-axis curve, an average of response measurements made within ±15° of vertical and horizontal axes. Middle curve is average of measurements between 30° and 45° either side of axis; bottom curve is average of measurements 60° to 75° either side of axis. Note the very smooth off-axis response, even at angles out to ±75°.

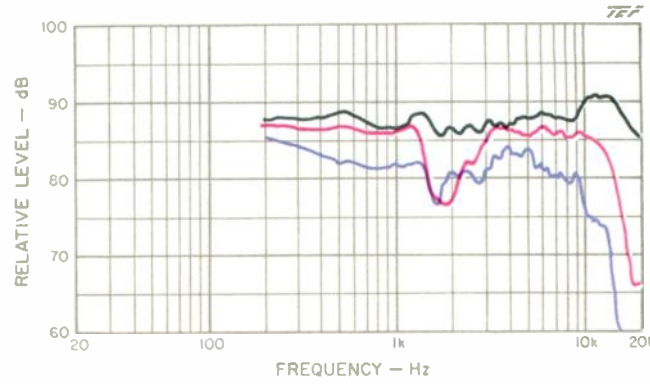

Fig. 9—Mean vertical on- and off-axis frequency response curves. Top curve is mean on-axis curve, an average of response measurements made within ±15° of vertical and horizontal axes. Middle curve is average of measurements between 30° and 45° above and below axis; bottom curve is average of measurements 60° to 75° above and below axis. Note the off-axis response dips in the crossover region (1.5 to 2.5 kHz); see text.

senior loudspeaker reviewer. The polar curve is quite well behaved, with no minor loops exhibited; this indicates that there are no spurious higher order resonances in the cabinet or woofer moving system. When looking at polar impedance plots, remember that simple second-order resonant humps show up as circles on the display. The circular, looping nature of the three impedance humps is clearly shown in the plot.

The distortion characteristics of the 7se were measured in several different ways. These included three single-frequency distortion spectra versus power level, IM distortion versus power level, and swept second- and third-harmonic distortion measurements versus frequency.

Figures 12, 13, and 14, respectively, show the single-frequency harmonic-distortion spectra versus power level at the musical notes E_1 (41.2 Hz), A_2 (110 Hz), and A_4 (440 Hz). These curves indicate how much harmonic distortion is generated by the system with the application of a single-frequency sine wave at power levels covering the range of 0.1 to 50 watts (−10 to +17 dBw, a 27-dB dynamic range). The power levels were computed assuming the rated impedance of 8 ohms. The curves show the second to fifth harmonics of the input sine wave—except at E_1 (41.2 Hz), where the sixth harmonic is also shown.

The curves were run by successively increasing the sine-wave input level in 1-dB increments (each step about 26% higher in power than the previous level). At each power level, a swept spectrum analysis was done over a frequency range covering the desired harmonics. Two precision, 1-dB-per-step attenuators were used in the setup—one in the send path and one in the receive path—to ensure that the power level steps were accurate. The receive attenuator provides a constant fundamental level to the spectrum analyzer so that distortion percentages can be read directly from the plotted data scales.

Figure 12 shows the E_1 (41.2-Hz) harmonic data. Data collection was stopped at a power level of 50 watts (20 V rms into the rated 8-ohm impedance) because the distortion levels were getting excessive (35% third harmonic at 50 watts). The actual power accepted at this voltage and power level was about 70 watts, due to the measured 6-ohm impedance. At most power levels, the third harmonic was found to predominate. At this frequency, most of the distortion was generated by the high excursion of the system's woofer. Third-harmonic distortion is generated from a symmetrical nonlinearity, which, in this situation, corresponds to the woofer's running out of excursion capability in both directions equally. The distortion levels reached in this E_1 test, although quite high, are not unreasonable for an 8-inch (200-mm) woofer when it is operated at these fairly high acoustic levels.

The 7se speaker's vented-box tuning provided only a moderate amount of cone-excursion reduction at 41.2 Hz. This was due primarily to two factors. First, the test frequency did not coincide with the box resonance frequency of the vented enclosure; at the box resonance frequency, the loading of the tuned box provides the maximum cone-motion reduction. Second, the Q factor of the vented box was not very high, which limited the amount of reduction available.

As stated previously, the manufacturer describes the 7se loudspeaker's vented-box enclosure as having a "critically tuned resistive port." In the context of the 7se, this means that a relatively large amount of damping material was used inside the box (none was found in the port). This increases the internal box losses and, hence, decreases the box Q.

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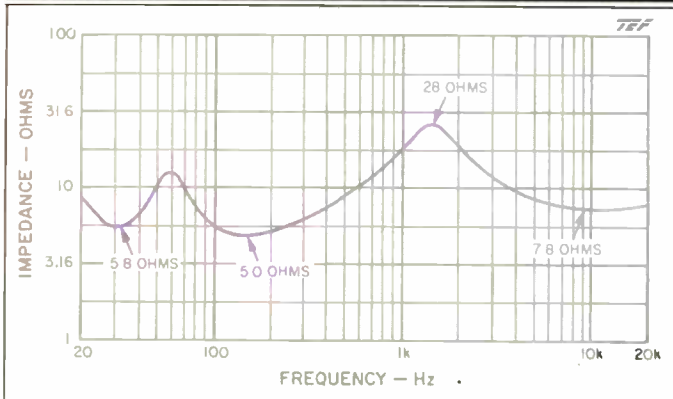

Fig. 10—Magnitude of impedance. Note the logarithmic impedance scale.

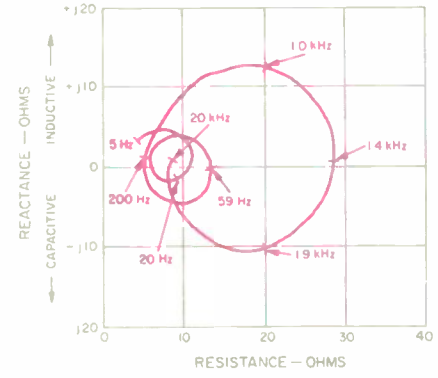

Fig. 11—Complex impedance. The system is quite well behaved; see text.

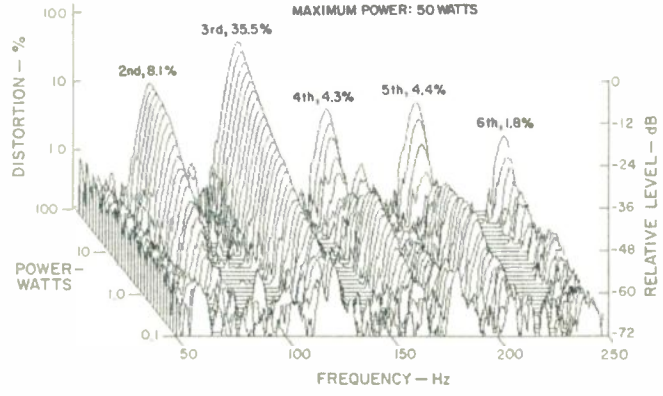

Fig. 12—Harmonic distortion for the musical tone E_1 (41.2 Hz). Note relatively high third-harmonic level at high powers; see text.

Considering only low-frequency behavior, the vented-box enclosure works best with a minimal amount of internal damping material. However, in the case of the 7se, a two-way design, the low-frequency loudspeaker is used all the way up into the midrange. In this range, standing waves and reflections inside the box can potentially color the midrange reproduction through radiation or re-radiation via the port and cone. Using a relatively large amount of damping material inside the enclosure will decrease the effect of these internal waves and, hence, their effect on the midrange response. In most vented-box enclosure designs, deciding how much damping material to add to the inside of the box involves a real engineering trade-off. It is quite clear that the designers of the 7se put more weight on smooth midrange response than on attempting to achieve the absolute lowest low-frequency distortion.

Even though this system's enclosure Q was somewhat lower than it could have been, separate tests revealed that this vented-box enclosure provided a very usable reduction of cone motion in the frequency range from 23 to 58 Hz. In the range from 30 to 40 Hz, the reduction was approximately 50%. This test was accomplished by alternately covering and uncovering the port while driving the system with a 10- to 20-V rms sine-wave signal. Above 10 V rms (12 watts), in the range from 30 to 40 Hz, windage (air movement) noises were quite noticeable from the port. This type of noise is usually not very audible with normal wide-range program material.

The A_2 (110-Hz) harmonic data is given in Fig. 13. The data essentially shows that only the second and third harmonics were significant. The nonharmonically related spikes in the graph are byproducts of the measurement setup environment and are not generated by the loudspeaker. The third harmonic was found to increase gradually with power level, reaching only 1.5% at 50 watts. The second harmonic was very low, up to a power level of about 10 watts where it quickly increased to 7% at 50 watts. The significance of this sharp increase in second-harmonic distortion just about slipped by me until I removed the system's woofer and ran an excursion test on it.

Second-harmonic distortion is caused by a one-sided, asymmetrical nonlinearity. The specific cause of this nonlinearity in the 7se speaker's woofer was found to be an effect that occurs quite commonly in long-excursion, overhung-motor (voice-coil longer than top-plate thickness) woofers. The effect is called "dynamic offset," "oil canning," or sometimes "self-rectification" (see "The Oil-Can Effect"). It occurs only in specific low-frequency ranges where the motional impedance (back EMF due to the movement of the voice-coil/cone assembly) is a significant part of the total impedance and only where the impedance is falling rapidly with increasing frequency.

The effect causes the cone to actually displace outward or inward at high drive levels. In the case of the 7se woofer, the cone always moved out of the motor assembly in the range from 50 to 115 Hz, at drive levels above approximately 12 V rms (10 watts). At 20 V rms (50 watts) at 100 Hz, the net outward displacement actually exceeded the peak-to-peak alternating displacement. This sudden outward shift in cone displacement caused the sudden increase in second-

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The IM distortion measured for mixed tones of 41.2 and 440 Hz was fairly low for a woofer of this size up to 50-watts input.

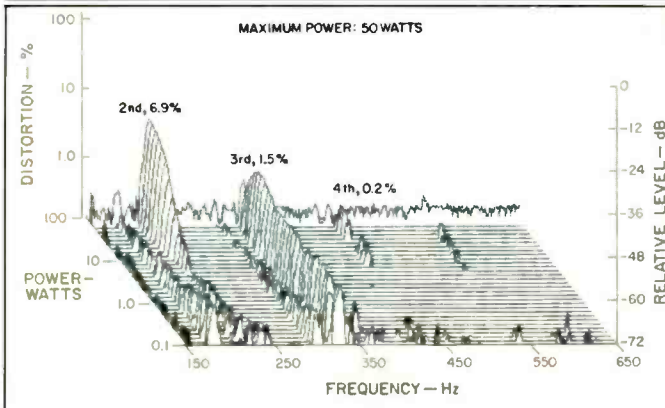


Fig. 13—Harmonic distortion for the musical tone A_2 (110 Hz). The second and third harmonics were the only significant ones in this power range. Note the rapid increase in second harmonic at power levels above 10 watts; see text.

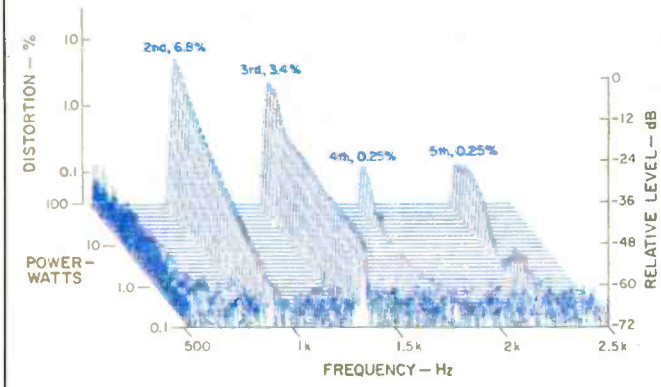


Fig. 14—Harmonic distortion for the musical tone A_4 (440 Hz). Only moderate amounts of second and third harmonics are evident.

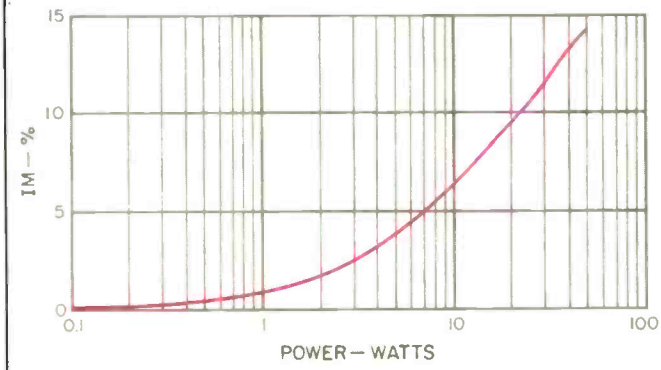


Fig. 15—IM produced by mixing A_4 and E_1 in equal proportion.

harmonic distortion exhibited in Fig. 13. Research has shown that dynamic offset also increases transient distortion and hangover for short-term, low-frequency signals. Research also indicates that vented-box (bass-reflex) systems are more susceptible to transient distortion from dynamic-offset effects than are closed-box (acoustic-suspension) systems.

Figure 14 shows the A_4 (440-Hz) harmonic measurements. Again, the predominant distortion is a moderate amount of second- and third- with only small amounts of fourth- and fifth-harmonic distortion. The third-harmonic distortion is seen to stay at roughly the same distortion percentage, a low 1%, over a fairly broad range of input powers.

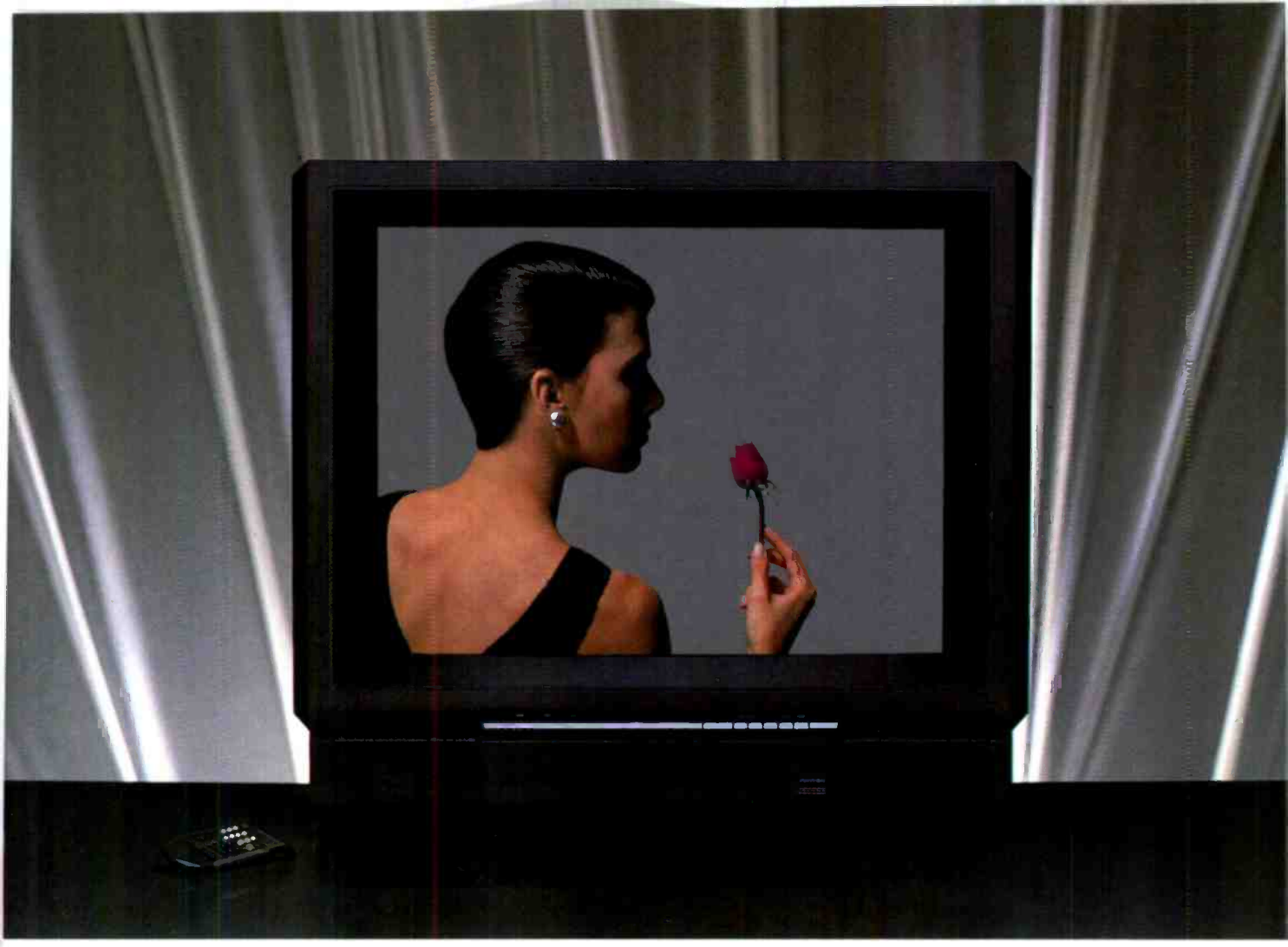
Figure 15 shows the IM distortion on a 440-Hz (A_4) tone created by an equal-level (input power, not output acoustic level) 41.2-Hz (E_1) tone. Again, power levels in the range from 0.1 to 50 watts were measured. The IM distortion gradually rises with power, reaching a level of about 10% at 20 watts and 14% at 50 watts. Only intermodulation products out to the third order ($f_2 \pm 3f_1$) were significant in these measurements. These IM levels are fairly low for a woofer of this size at these power levels. At 440 Hz, 50 watts gener-

THE OIL-CAN EFFECT

Dynamic offset is a nonlinear effect exhibited by drivers having a long-throw voice-coil moving assembly coupled with a very linear suspension system. The effect comes about because the magnetic field decreases as the voice-coil moves out of the magnetic gap. At points where the motional impedance is falling with increasing frequency (the upper slope of impedance peaks), the phase relationships are such that the cone tends to speed up as it leaves the gap. This is because the magnetic field weakens as the cone moves out of the gap, which reduces the back EMF generated by the voice-coil's motion; on this slope of the impedance peak, the reduced motional impedance causes the speaker to draw more current, raising its speed.

For those who may have taken a class on d.c. electric motors, the effect is very similar to the speed of a d.c. motor increasing (not decreasing, as you might predict!) when the current through the field winding is decreased. For constant-voltage drive, the motor has to increase its speed of rotation so that the back EMF again roughly equals the voltage applied to the rotor. The back EMF generated by the rotor is directly proportional to the product of the speed of rotation and the strength of the magnetic field generated by the field coil. As the field current decreases, thus decreasing the magnetic field strength, the motor has to go faster in order to maintain its equilibrium.

The dynamic-offset problem in woofers can be minimized by designing the suspension system to actually push back *more* with increasing displacement than a perfectly linear suspension would. This added suspension nonlinearity compensates for the nonlinearity of the magnetic field. *D.B.K.*



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The Paradigm's good vocal separation and clarity on choral music shows smooth response in the upper-bass and midrange regions.

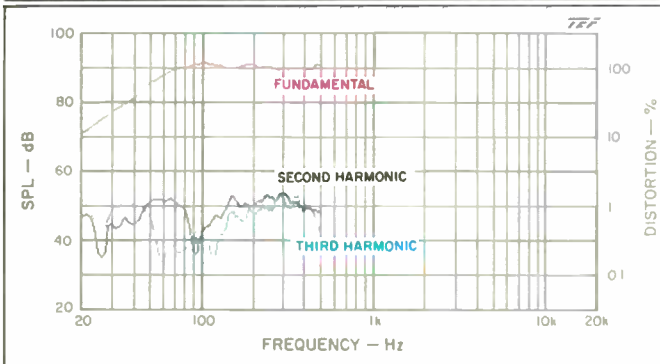

Fig. 16—Second- and third-harmonic distortion levels vs. frequency for 90 dB SPL mid-band output at 1 meter on axis; input signal is 3.6 V rms (1.6 watts into 8 ohms).

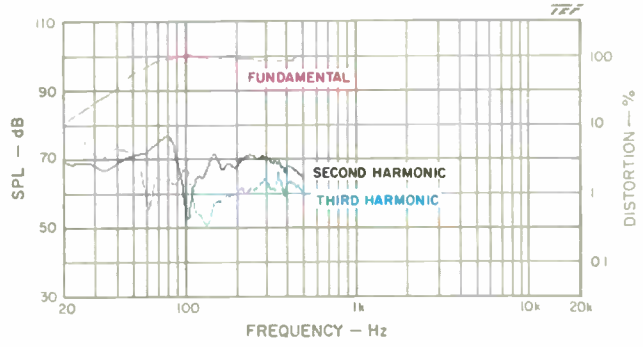

Fig. 17—Same as Fig. 16 but for 100 dB SPL mid-band output, using input signal of 11.3 V rms (16 watts into 8 ohms).

ates a respectable 105 dB SPL at 1 meter, measured on the system's axis.

Swept sine-wave second- and third-harmonic distortion tests were also made on the system at axial 1-meter levels of 90 and 100 dB SPL (Figs. 16 and 17). The purpose of running these curves, in addition to the previous measurements, was to show the harmonic content at a fixed-output mid-band sound pressure level and to display the second- and third-harmonic levels over a continuous interval in the low-frequency range. Using fixed sound levels of 90 and 100 dB SPL facilitates comparison with measurements made on previous systems. Note that in the low-frequency range below 60 Hz, where the system starts to roll off, the actual distortion percentage is higher than shown on the scale to the right of the graph because the fundamental is lower in level.

The swept harmonic tests at a level of 90 dB SPL are shown in Fig. 16. The distortion stayed below 2% at frequencies above 60 Hz and rose to about 5% at 35 Hz (mostly third harmonic). The corresponding measurements at 100 dB SPL are plotted in Fig. 17. The distortion above 60 Hz stays below 3% except for a second-harmonic peak of 8% at 85 Hz. The input level of 16 watts (11.3 V rms), required for the 100-dB midband level, is just below the point where the cone starts to move out due to the dynamic-offset effects noted earlier. The second harmonic is seen to predominate between 50 and 90 Hz. At 20 Hz, third-harmonic distortion actually rises to 100%, primarily due to the suspension's running out of excursion capability to the same degree in both directions.

Overall, the distortion measurements on the 7se are quite low for a system of this size. The windage noises in the vent at high power levels in the low-frequency range will fortunately be masked by most program material. The dynamic-offset problems observed could potentially be a problem with program material such as loud rock music, which contains high-power narrow-band material in the region of 50 to 100 Hz. However, the added second-harmonic levels may make some types of program material sound better rather than worse. (It ain't high fidelity though!)

Figures 18 and 19 show the short-term peak-power input and output capabilities of the system, plotted as a function of frequency. The tests were run by applying a shaped tone-burst test signal consisting of 6½ cycles of a sine wave shaped using a Hamming raised-cosine envelope. The resultant test signal covers a one-third-octave bandwidth with a time duration that increases as the frequency goes down. The burst is presented at such a low duty cycle that the long-term thermal characteristics of the speaker under test are not exercised. The test consisted of evaluating the maximum peak-input power-handling capacity and maximum peak-output sound pressure levels, at all the one-third-octave center frequencies, in the range from 20 Hz to 20 kHz. A very powerful amplifier that can generate 5,500 peak watts (+37 dBW, or ±210 V into an 8-ohm load!) was used to drive the system.

The test sequence began with determining how much of the special test signal could be handled by the speaker, at each frequency, before either the output sounded audibly distorted or the acoustic output waveform *appeared* distorted, whichever occurred first. At each frequency, the maximum peak-input voltage and the corresponding generated peak-output sound pressure level at 1 meter were recorded.

Figure 18 shows the maximum peak-input electrical power-handling capacity of the 7se. The peak-input power-handling capacity is seen to rise with frequency until 6.3 kHz, where the amplifier's power capacity of 5.5 kilowatts was reached! Above 125 Hz, the system can handle more than 600 peak watts. From 40 to 100 Hz, the peak power handling is limited to the range of 50 to 100 watts. Below 25 Hz, the power should be limited to 10 watts or less, so as not to cause any intermodulation of the higher frequencies. The 7se can actually handle more power than the curves show but at the expense of much greater distortion.

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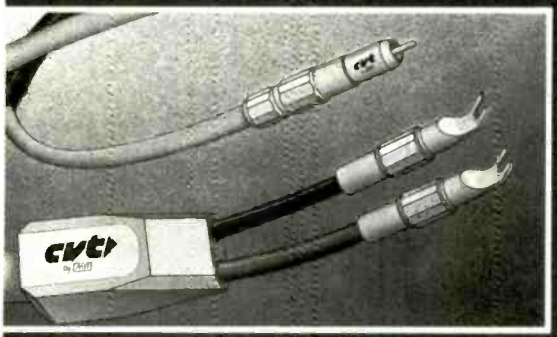

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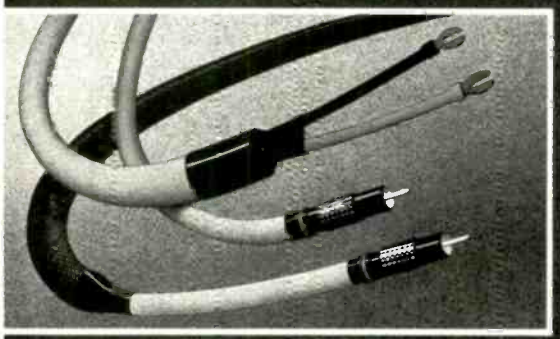

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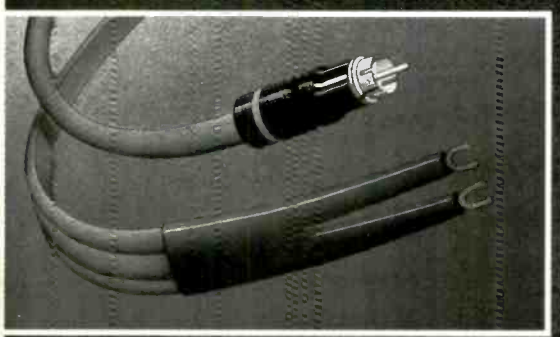

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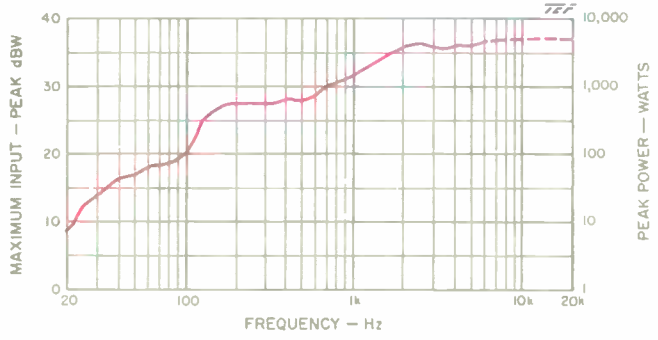

Fig. 18—Maximum peak-input power for moderately clean output. Above about 6 kHz (dashed portion of curve), limitations are imposed by clipping of 5.5-kilowatt amplifier, not by the speaker. Input signal was a shaped tone burst; see text.

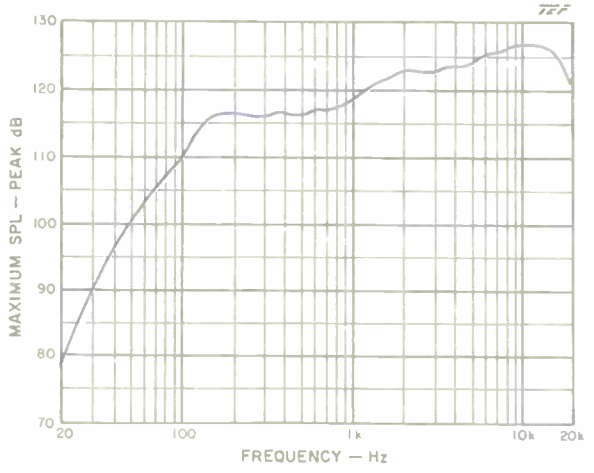

Fig. 19—Maximum peak SPL output at 1 meter, on axis, for input levels shown in Fig. 18. The system can generate peak levels in excess of 115 dB SPL above 150 Hz.

Figure 19 illustrates the maximum peak sound pressure levels generated at a distance of 1 meter on axis for the levels shown in Fig. 18. The graph shows that the 7se can generate very respectable levels in excess of 110 dB SPL at frequencies above 100 Hz. Between 20 and 100 Hz, the maximum output rises at about 15 dB per octave. Of course, two of these systems operating in a typical listening room will be able to generate much higher levels in this critical low-frequency range. due to mutual coupling and boundary effects. The room will provide some 5 to 10 dB of low-frequency gain, while a pair of speakers increases the level some 3 to 6 dB.

Use and Listening Tests

The listening tests were conducted in my basement listening room, which is somewhat small with a volume of about 1,500 cubic feet (43 cubic meters). The systems were located 20 inches (0.5 m) away from the rear wall and separated by about 8 feet (2.5 m), with most near reflective objects removed. The 7se speakers were placed on the supplied stands, which elevated them about 13 inches (0.33 m) off the floor, placing the tweeter 33 inches (0.84 m) high. At my seated listening position, my ears were within 2° of the tweeter axis. Most of my listening evaluation was done before the measurements were made.

My first listening impressions of the 7se were quite positive. I was impressed with how well the system did overall, in comparison to my reference. Later, more serious, evaluations did not change this impression. My listening tests conducted after the measurements revealed no perceptible changes in the sound, even though by then the system had been subjected to some rather abusive power testing!

The supplied speaker stands were made of ⅛-inch (3-mm) thick metal sheet stock, with 1-inch (25-mm) long spikes on the bottom of a 13½-inch (340-mm) square base. The 10-inch (250-mm) square speaker mounting surface was separated from the base by four 1-inch (25-mm) square by 12-inch (305-mm) long metal tubes. My initial impression of the stands was somewhat negative, due to some high-Q resonances in the metal structure. After the speakers were set up in the normal configuration, with the systems in place and the base (with spikes) on the carpet, the resonances were much diminished and did not cause any discernible effects during the listening tests.

Input connection was made at the rear of the system, through double-banana red/black, five-way binding posts separated by the standard ¾-inch (19-mm) distance. However, the wire insertion hole in the post was not large enough to handle any reasonable-sized stranded speaker cable. I suggest that you use spade lugs or solid wire extensions (that will fit the hole) and solder these to your cables.

Listening to some pop/rock material (*The Nightfly*, Donald Fagen, Warner Bros. 23696-2) revealed a somewhat bright high end that emphasized instruments such as top-hat cymbal and tambourine. The emphasis was not at all objectionable, however.

Reproduction of female vocalists was quite realistic, with no sign of harshness on vocal peaks (*Love Songs*, soprano Arleen Augér and pianist Dalton Baldwin, Delos DCD-3029).

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**All quotes by noted audio critic Rich Warren, Chicago Tribune, May 12, 1989*

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The 7se was very accurate and revealing—a pleasure to listen to. At its low price, I might consider buying a pair myself.

The reproduction of male vocalists with acoustic guitar was also quite good, with no upper-bass or lower-midrange tubbiness (*Folk Era's Live Sampler*, Folk Era FE2066CD and *Depth of Image*, Opus 3 Test Record 1, Track 7).

A capella choral music was also reproduced well, with good clarity and vocal separation (*Depth of Image*, Track 10). Smooth response through the upper-bass and midrange response regions is required for good results on choral music. Mozart's Piano Concerto No. 13 (*Midsummer Mozart Festival*, Bainbridge BCD-6273) was reproduced with a good sense of space and realism.

Off-axis vertical and horizontal high-frequency coverage was subjectively quite adequate, with good response out to about ±40°. The system's delivery of high-level mid-high frequency transients, such as explosive sound effects, was very effective. (You can clean your ears out on Track 4 of *Ein Straussfest*, Telarc CD-80098!)

Program material containing high-level bass transients played at high levels, such as rock kick drum, was reproduced with a moderate amount of muddiness when compared to my reference system (*Sheffield Drum and Track Record*, Sheffield Labs). After making the measurements, I attributed this muddiness to the dynamic-offset problems exhibited by the woofer in the 7se. To check this out, I searched for program material containing low-frequency information that would cause the cone assembly to travel appreciably out of the gap, in one direction, on loud passages. (This movement was determined by viewing the cone at close range while playing the material.) One disc that did this consistently contained the cannons on Beethoven's "Wellington's Victory" (Telarc CD-80079). An outward deflection of the cone resulted even when the speaker leads were reversed, because dynamic-offset problems relate only to the amplitude, not the polarity, of the low-frequency signal. Even with appreciable offset, the cannon reproduction was still quite impressive. (I made sure my wife was out of the house when I listened at the levels required to generate the offset effects!) Reproduction of other types of low-end material, such as pipe organ pedal tones and concert bass drum, was quite adequate and was consistent with the system's size.

To sum up, I am quite pleased with the overall performance attained by these speakers, considering their relatively low price and moderate size. The smooth bass-midrange response contributed to a very accurate and revealing system that was a pleasure to listen to. Except for some low-end muddiness exhibited infrequently on very high level bass passages, the system did a very good job. I would recommend the 7se loudspeakers for anyone who wants a very cost-effective speaker for use as a main system or for use in a secondary situation. At their price, in fact, I might even consider buying a pair for myself. *D. B. Keele, Jr.*

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2

SOUNDCRAFTSMEN PRO-POWER TEN AMPLIFIER

Manufacturer's Specifications
Power Output: Four-channel mode, 205 watts per channel into 8 ohms from 20 Hz to 20 kHz, 300 watts per channel into 4 ohms; two-channel mode, 600 watts per channel into 8 ohms.
THD: 0.05%.
SMPTE-IM Distortion: 0.05%.
Frequency Response: 20 Hz to 20 kHz, ±0.1 dB.
S/N: −105 dB.
Slew Rate: 50 V/μS.
Dimensions: 19 in. W × 5¼ in. H × 12 in. D (48.3 cm × 13.3 cm × 30.5 cm).
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Company Address: 2200 South Ritchey, Santa Ana, Cal. 92705.
For literature, circle No. 91

This new amplifier from Soundcraftsmen uses Class AB MOS-FET power output stages and the manufacturer's phase-controlled power supplies. Soundcraftsmen chose to use a rather stiff power supply—one that adjusts its supply voltage to match the demands of the loudspeaker. Thus, you won't find much "dynamic headroom" in this amplifier—but then again, you won't need much, in view of this unit's continuous power rating.

The Pro-Power Ten is actually two separate stereo amplifiers, each with its own massive power transformer and ultra-high-storage filter capacitors. Each of these stereo amplifiers can be "bridged," allowing four-, three-, or two-channel operation. Unbridged, the amplifier is especially suited for use in surround systems. When operated in the three-channel mode, with one pair of channels bridged together, the amp lends itself to driving a pair of satellites with a power-hungry common subwoofer.

I have always admired Soundcraftsmen's straightforward designs, and the Pro-Power Ten is no exception. After first subjecting the amplifier to the FTC preconditioning test for one hour at one-third its rated power, I removed the cover. There were no great surprises inside—just high-quality components, well located, and a prominently visible pair of huge power transformers. During the course of my tests, I confirmed the fact that the two halves of the Pro-Power Ten are completely independent—from the primary windings of their respective power transformers down to the speaker output terminals. The Pro-Power Ten amp is completely protected against short-circuits, open circuits, and input overloads. Thermal protection is provided by multi-sensor phase-control regulation.

Control Layout

The Pro-Power Ten's front panel features four independent 12-segment LED power output meters calibrated from 0 to 800 watts, referenced to 8-ohm loads. Clipping indicators for each channel are also found on the front panel. As is true of many other Soundcraftsmen power amplifiers I have tested over the years, this unit incorporates a rack-mountable front panel, but optional hardwood side panels are available to "dress up" the unit for domestic use The folks at Soundcraftsmen tell me that a Pro-Power Nine model will be available and will be similar to the Pro-Power Ten I tested, except the LED power meter displays will be omitted. It will carry a suggested price $100 lower than that of the Pro-Power Ten.

The rear panel is equipped with color-coded five-way binding posts on standard ¾-inch centers for connecting speaker cables. Channels are indentified "A," "B," "C," and "D," rather than "Left" or "Right," and the unbalanced phono-type input jacks are similarly labelled. Separate slide switches for each pair of amp channels are used for switching to the bridged mode of operation.

Measurements

Except where stated otherwise, I hooked up the Pro-Power Ten as a four-channel amp for all my tests and measurements. When testing the amp in this mode, I drove all four inputs and connected separate loads (first 8 ohms, then 4 ohms) to each output.

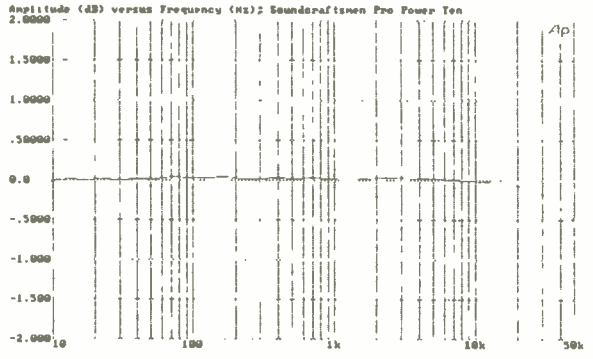

Fig. 1—Frequency response of the Soundcraftsmen Pro-Power Ten amplifier.

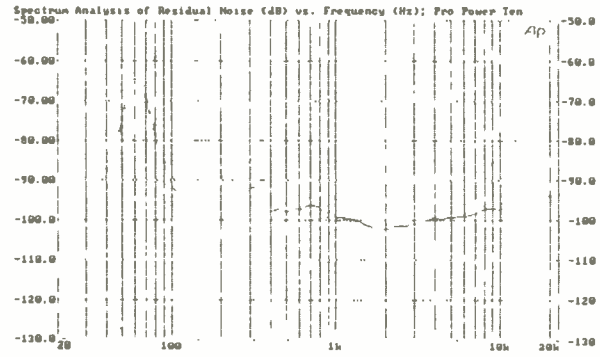

Fig. 2—Spectrum analysis of residual noise for left channel (solid curve) and right channel (dashed curve).

Figure 1 shows the frequency response of one channel of the amplifier. Response was flat to within +0, −0.1 dB from 10 Hz to 20 kHz. At 50 kHz, response was down only 0.5 dB. I measure the S/N ratio of an amplifier with respect to 1 watt output, as mandated by the EIA Amplifier Measurement Standard. Soundcraftsmen and others continue to publish S/N specifications referred to rated output. I guess the desire to come up with higher numbers outweighs the need to follow an industry-accepted standard. In any case, where there is no volume control involved—as with the Pro-Power Ten—it's easy enough to translate one form of S/N reading to the other. I measured an A-weighted S/N value of 82 dB, referred to 1 watt output. Now 205 watts of output is slightly more than 23 dB greater than 1 watt, so the S/N referred to rated output would be very slightly greater than 105 dB—exactly the value claimed by Soundcraftsmen in their published specifications.

I also used the spectrum-analyzer, or bandpass, function of my Audio Precision System One test gear to analyze the nature of the residual noise (again referred to 1 watt output

Soundcraftsmen's products invariably meet all their published specs—and then some. The Pro-Power Ten is no exception.

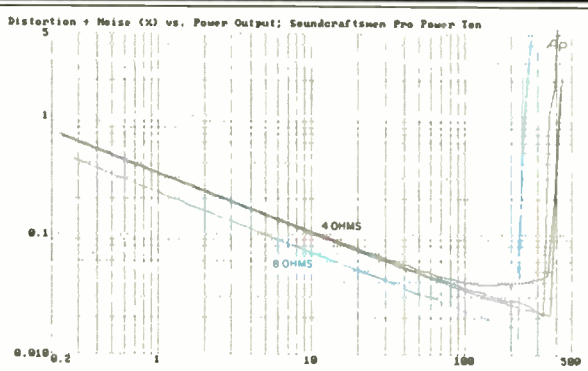

Fig. 3—THD + N vs. power output into 8- and 4-ohm loads. Just before curves slope upward, top curve is 20 kHz, straightest curve is 1 kHz, and remaining curve is 20 Hz.

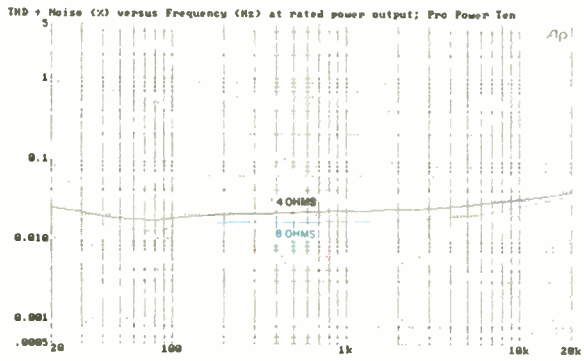

Fig. 4—THD + N vs. frequency, at rated power, for 8- and 4-ohm loads.

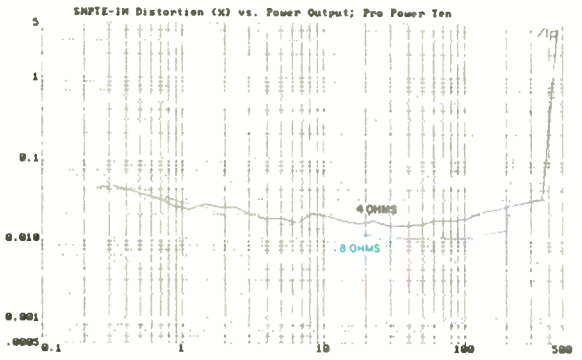

Fig. 5—SMPTE-IM distortion vs. power output for 8- and 4-ohm loads.

but with no weighting curve). I discovered that much of the residual noise that contributed to the previous A-weighted overall measurement of S/N was caused by some residual power-supply hum and its harmonics, as shown in Fig. 2. Still, an A-weighted S/N of 82 dB below 1 watt—or 105 dB below 105 watts—is no cause for concern or criticism. Few amplifiers I have tested do much better than that.

Figure 3 is a plot of THD + N versus power output into 8- and 4-ohm loads. Each plot was repeated three times for three different reference frequencies: 1 kHz, 20 Hz, and 20 kHz. At 205 watts per channel into 8 ohms, THD + N was only 0.017% at 1 kHz, 0.02% at 20 Hz, and 0.038% at 20 kHz. At the rated output of 300 watts per channel into 4 ohms, THD + N was 0.023% at 1 kHz and 20 Hz. For a 20-kHz test signal, THD + N was somewhat higher, 0.042%, but still well below the 0.05% claimed by Soundcraftsmen. At 1 kHz, the amp was able to deliver nearly 370 watts per channel into 4-ohm loads, with all channels driven. While the plots of Fig. 3 are for one channel only, measurements at the outputs of the other three channels revealed that distortion levels were substantially the same at rated output.

Figure 4 shows how THD + N varied with frequency at the rated power output values of 205 and 300 watts per channel into 8- and 4-ohm loads, respectively.

I also measured SMPTE-IM distortion versus power output for both load conditions (Fig. 5). Once again, this type of IM distortion was well below the published figures: 0.03% at 205 watts per channel for the 8-ohm load and 0.03% at 300 watts per channel for the 4-ohm load.

Although Soundcraftsmen does not specify CCIF (twin-tone) distortion, I feel this is an important performance characteristic of any amplifier, and so I measured it using equal-amplitude 18- and 19-kHz signals (Fig. 6). With 8-ohm loads at a level equivalent to rated output, CCIF IM was an insignificantly low 0.0059%, while for 4-ohm loads, CCIF-IM distortion measured an even lower 0.0032% at 300 watts per channel.

Damping factor, referred to 8 ohms and using a 50-Hz signal, measured 210. Sensitivity for 1 watt output into 8-ohm loads measured approximately 90 mV, which translates to very nearly the 1.23 V of input Soundcraftsmen specified as required to produce rated output. Finally, I measured the dynamic headroom of the amplifier. Because of the Pro-Power Ten's stiffly regulated power supplies, dynamic headroom was only 0.7 dB, but as I indicated earlier, dynamic headroom is not a measure of the sound quality or performance of an amp if that amp can deliver enough continuous power to meet the demands of the speakers with which it is used. The Soundcraftsmen Pro-Power Ten is just such an amplifier.

I made a few spot measurements of this unit's performance when it is operated in the bridged mode. Under those conditions, the amplifier's THD + N measured just over 0.01% when output levels were increased to 600 watts per stereo channel. I could not accurately plot graphs of distortion versus frequency for this operating condition, simply because of the power-handling limits of the variable auto transformer I use to maintain my line power at an accurate 120 V. When the Pro-Power Ten's two halves are operated in the bridged mode at full rated power, it demands more

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No matter how hard I drove the Pro-Power Ten, it always seemed to coast along, with a reserve of extra power on tap.

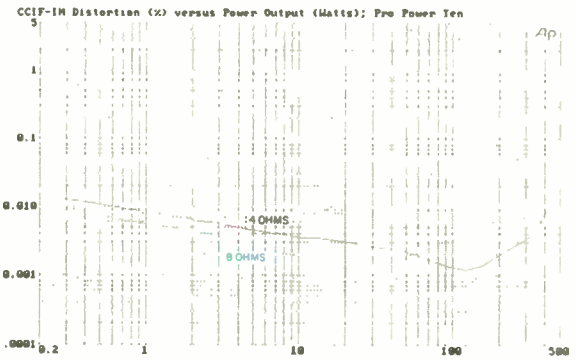

Fig. 6—CCIF-IM distortion vs. power output for 8- and 4-ohm loads.

current than this variable auto transformer can supply for any length of time. However, based on the spot measurements I made for this high-power operating condition, I have no reason to suspect that the Soundcraftsmen would not make its published specifications in the bridged mode with plenty of room to spare. The one thing I've found true about Soundcraftsmen is that they invariably meet all of their published specifications—and then some.

Use and Listening Tests

It's always a pleasure to listen to music via an amplifier that you know is not going to run out of power when you really want to let go with some wide dynamic range music. No matter how hard I drove the Pro-Power Ten as it powered my reference KEF 105.2 speakers, this amplifier always seemed to coast along, with an extra reserve of power available if I needed it. There wasn't the slightest bit of strain, nor was there any evidence of clipping—even at the loudest listening levels and when using CDs with extremely wide dynamic range.

While I have tired of the well-known *Straussfest* (Telarc CD-80098) demon disc, I couldn't resist using it with this amplifier as a test of just what kind of peaks the Pro-Power Ten would be able to handle. Of course, adequate power in an amplifier doesn't begin to tell its whole story. There is an inherent quality of ruggedness, reliability, and sonic integrity that has always impressed me favorably when I have had an opportunity to test and listen to Soundcraftsmen products. The engineers are serious people whose primary goal is to create audio products that will give years of trouble-free service, deliver accurate signal amplification, drive most any speaker load, and provide all of this performance at prices that are fair and reasonable. The Pro-Power Ten joins a distinguished group of Soundcraftsmen products which fulfill all of these goals. *Leonard Feldman*

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3

CAMBRIDGE SOUNDWORKS ENSEMBLE LOUDSPEAKER

Manufacturer's Specifications

System Type: Four-piece stereo system; acoustic suspension, sealed-box woofers.

Drivers: 8-inch (203-mm) woofer, 4-inch (102-mm) midrange, and 1¾-inch (44-mm) tweeter.

Crossover Frequencies: 140 Hz and 1.9 kHz.

Impedance: 6 ohms nominal.

Recommended Amplifier Power: 25 watts minimum.

Dimensions: Low-frequency units, 4½ in. H × 21 in. W × 12 in. D (11.4 cm × 53.3 cm × 30.5 cm); satellites, 8⅛ in. H × 5¼ in. W × 4 in. D (20.6 cm × 13.3 cm × 10.2 cm).

Weight: Low-frequency units, 16 lbs. (7.3 kg) each; satellites, 5 lbs. (2.3 kg) each.

Price: $499 per speaker system.

Company Address: Cambridge SoundWorks, 154 California St., Newton, Mass. 02158.

For literature, circle No. 92

The Cambridge SoundWorks Ensemble loudspeaker was designed by Henry Kloss, a man whose name is synonymous with audio revolution. Is revolution too strong a word? Consider that, in 1954, about the only way an audiophile could get clean 30-Hz bass was with a refrigerator-sized cabinet in the listening room or a concrete horn built outside the room. However, in the fall of 1954 at the New York Audio Fair, Edgar Villchur and Henry Kloss unveiled the Acoustic Research AR-1, a 2-cubic-foot speaker with astounding 30-Hz bass.

Villchur and Kloss battled the "refrigerator" technology for several years, slowly gaining acceptance for the radical acoustic-suspension design. The stereo LP, introduced in 1957, gave audio enthusiasts three choices—mono, two refrigerators, or acoustic suspension. The giant speakers died like dinosaurs. The makers of the mighty Klipschorn even introduced a bookshelf model which they defiantly named the "Heresy."

Kloss later founded KLH, which specialized in smaller speakers and integrated high-fidelity systems. In 1967, he started Advent and developed large-screen television as well as some good small speakers. This was the birth of the home video theater. Today, the Kloss three-tube design is used by every home projection system. Kloss introduced the Advent loudspeaker to help finance the expanding video business, but it became the largest selling speaker of all time. Another "side" project was the development of the first cassette deck with Dolby B NR. After starting Kloss Video and later selling it to Ampro Corporation, Kloss returned to speakers, teaming with former Advent and Kloss Video associate Tom DeVesto to form Cambridge SoundWorks.

Naturally, one wonders if Cambridge's Ensemble loudspeaker will further the Kloss legend by kindling another revolution. History will probably not honor it as another acoustic suspension, video projector, or Dolby cassette type of audio breakthrough, but it could set new standards for value and marketing savvy. It might even replace the Advent as the best-selling loudspeaker ever.

The Ensemble is sold direct from the factory in a 50-pound box for $499 plus shipping. It is a four-piece stereo system: Two woofer and two satellite enclosures. Plenty of speaker wire and detailed setup instructions are included. You can send a check or phone Cambridge's toll-free number (800-252-4434) and put it on your credit card. You'll receive the package in one to five days, depending on how far you are from the Boston area. An Ensemble can be air shipped in the U.S. overnight or to any place in the world in three days and still look like a bargain. Cambridge will accept the system back within 30 days and give a full refund. You are only out the shipping—one way.

Hassle-free home listening, Cambridge believes, is the only way to find out if a speaker system is right for your room. Given this, the factory-direct route seems to be as good as lugging a system home and back to a stereo store. Of course, a good stereo store has other models for you to sample as well as qualified advice. At this writing, Cambridge offers only the Ensemble, but they take pride in their toll-free telephone advice, available seven days a week.

"Value," which means a high performance-to-price ratio, is stressed by Cambridge. Direct-mail selling helps keep the price low; performance is advanced by using a woofer/satellite format and by concentrating on factors Kloss believes to be perceptually important.

The satellites are tiny, so it is easy to place them for best soundstage and imaging. The woofers operate up to 140 Hz, so they should be located in the same end of the room as the satellites, to avoid hearing upper bass coming from a strange direction. Still, this gives great ability to acoustically match the system to the room. For more bass, you move the woofers closer to room boundaries and to each other. The effect can be very strong. A recent paper in the *Journal of the Audio Engineering Society*, Glyn Adams' "Time Dependence of Loudspeaker Power Output in Small Rooms" (April 1989), predicts 20-dB, position-dependent variations in low-frequency response. The small Ensemble woofer cabinets are designed to tap this "free" bass, which translates to "value" by increasing performance.

Henry Kloss has long espoused the concept of "octave-to-octave balance" as the most critical element in perceived loudspeaker quality. This means that the frequency response measured in the room and averaged over an octave bandwidth must be uniform. Another way of saying this is that an octave-band equalizer can be used to fix many bad-sounding loudspeakers. It's not that gross nonlinearity or extreme narrow-band peaks can be ignored—Kloss just believes these are not the problems usually encountered. The portability of the four Ensemble components allows the user to acoustically equalize the loudspeaker for best octave-to-octave balance.

Another Kloss tradition embodied in the Ensemble is the acoustic-suspension sealed-box woofer. The driver's cone suspension is made extremely compliant, with 90% of the necessary stiffness being provided by the very linear air spring of the sealed enclosure. The most popular alternative is the vented design, which uses an acoustical resonance to load the driver and extend bass response. Although vented systems have been around for at least 50 years, they suffered from a poor reputation for "boomy" bass until the early '70s. That was when the work of Thiele and Small simplified

The portability of the four Ensemble components lets you acoustically equalize this system for the best octave-to-octave balance.

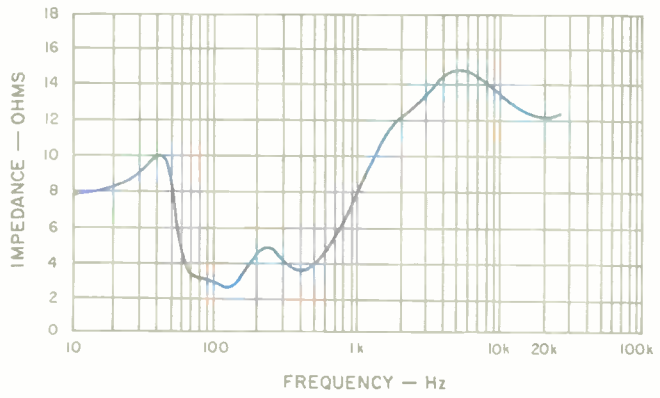

Fig. 1—Magnitude of impedance.

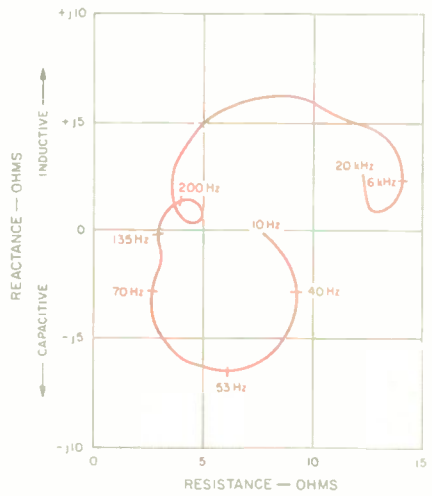

Fig. 2—Complex impedance.

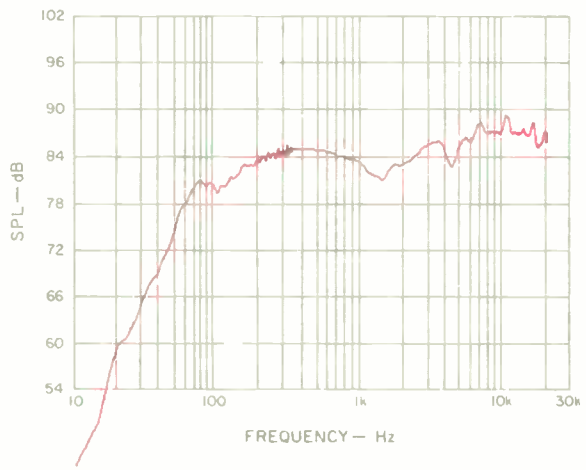

Fig. 3—One-meter on-axis anechoic frequency response with an input of 1 watt into 4 ohms (2.0 V).

proper design to equations which could be evaluated on a hand-held calculator. Their work started the vented-box era, which dominates in today's designs. The "vented boxers" claim a lower −3 dB point, increased efficiency, and a smaller cabinet. The "acoustic suspenders" counter that there is too high a price to be paid for these advantages.

The price paid for the vented box's lower −3 dB point is a fast roll-off—typically 24 dB per octave—below that point. My own experience indicates that listeners perceive bass "cutoff" to occur when the response is about −10 dB. Other things being equal, an acoustic-suspension system, with its 12-dB/octave roll-off, might be perceived as extending lower in frequency, even though its −3 dB point is higher than the vented design's. In addition, the vented box's faster roll-off results in more ringing on transients.

The vented boxers point out that their system's acoustic resonance at cutoff results in greatly reduced cone motion and reduced distortion. The acoustic suspenders counter that, in the range below the acoustic resonance, vented-box cone motion increases dramatically and will cause even more distortion. In addition, they say that a large vent is necessary for low distortion, and this can add significantly to the cabinet volume.

The arguments go on endlessly, leaving one with the feeling that there is no free lunch, only a choice of restaurants. I feel that the choice is only difficult for systems whose goal is response to between 30 and 40 Hz. I would tend to go sealed for classical purity and vented for maximum rock punch. For small systems not aspiring to extend below 40 Hz, I prefer sealed for transient response and for protection from below-band frequencies. For big systems intending to do damage below 30 Hz, I say you might as well take the advantages of vented, because 25-Hz ringing is not a musical or audible issue. Also, there are few signals low enough in frequency to cause below-band overexcursion. (These simplified recommendations are subject to other design options, such as the use of high-pass filters.)

The Ensemble uses a woofer enclosure for each satellite, as opposed to the popular single subwoofer module. Although I can accept the common-subwoofer concept at very low frequencies, the Ensemble's 140-Hz crossover frequency is a little high for the common-bass assumption. Also, be it necessary or not, two small woofers are easier to place than one double-sized driver. The Ensemble woofers are especially easy to position because of their flat slab cabinets, finished in dark gray laminate on all six sides.

The tiny satellites, each housing a 4-inch midrange and a 1¾-inch tweeter, are solid, dense, and precisely machined. The box has a perforated black metal grille, rounded corners, and a gray Nextel finish which makes it feel a little wet. Whether this modern styling appeals to you or not, the satellites are so small and neutral in appearance that they are unlikely to conflict with any decor.

There are no controls on the woofer or the satellite. Because there is a crossover in both the satellite and the woofer, connection can be made from the amp to either the woofer or the satellite, with another cable connecting the two boxes together. It is easier than hooking up Christmas-tree lights. Terminals are gold-plated, five-way binding posts on standard ¾-inch centers, with big holes that will

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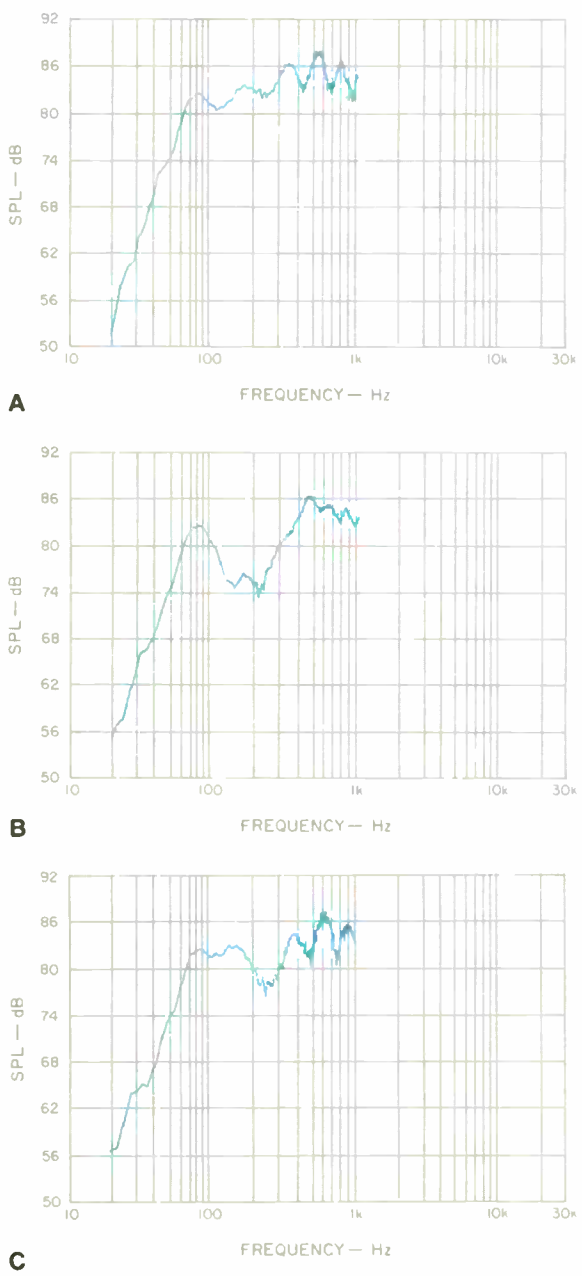

Fig. 4—Effect on system amplitude below 1 kHz of placing low-frequency module at same distance from microphone as satellite (A), 24 inches closer than satellite (B), and 24 inches farther than satellite (C). At the 140-Hz crossover frequency, 24 inches is ¼ wavelength.

directly accept large-diameter specialty speaker cable. If you are into the exotic, the speakers can easily be bi-wired to a single amp.

Cambridge recommends initially hooking up the full 100 feet of 18-gauge zip cord supplied, so you can experiment with speaker position. When you find the best location, you can cut the cable to size or, if you want, purchase the exact lengths of specialty cable. If you need additional cable, call the toll-free number, and Cambridge SoundWorks will send it free of charge. Although the Ensemble manual is the best I've seen for installing speakers, additional phone help is always available. I was told that the manufacturer's goal is not merely to satisfy but to delight the customer; they figure 25% of their business comes from referrals by such "delighted" owners.

Measurements

Input impedance magnitude as a function of frequency is plotted in Fig. 1. A peak at 40 Hz is followed by a broad low area averaging 4 ohms between 60 and 500 Hz. This low area qualifies the Ensemble for a 4-ohm nominal rating. Figure 2 shows the impedance in terms of reactance and resistance. A large reactance (vertical) with little resistance (horizontal) is difficult for an amplifier to drive. The Ensemble is most difficult around 60 Hz but should not prove a problem for any 4-ohm-rated amplifier.

Achieving a reflection-free or anechoic measurement of the Ensemble required a modification of *Audio*'s usual technique because of the woofer and satellite being in separate enclosures. The satellite, which operates above 140 Hz, will suffer a response modification from reflections off of the woofer cabinet if the two are too close together. I moved them apart for this measurement; this is how they very often will be used in the home. The satellite was measured in the usual manner, one meter away along the axis of its front panel. The woofer was also placed one meter away from the omnidirectional microphone, but off to the side to avoid reflections. This TDS measurement geometry provides nearly anechoic data from the satellite combined with in-phase woofer output.

The anechoic measurement is made in two parts: An indoor, time-windowed measurement from 200 Hz to 20 kHz, and an outdoor, ground-plane measurement from 10 Hz to 1 kHz. The overlapping range from 200 Hz to 1 kHz serves as a calibration check; the curves are spliced together somewhere in this overlap range.

The combined plot of Fig. 3 is spliced at 350 Hz. The lower range does not have reflections windowed out, so a slight roughness is visible. Some of this is due to the interfering reflections between the two cabinets of the Ensemble.

The response shows bass roll-off below 60 Hz, a fairly smooth midrange, and slightly elevated highs extending to 20 kHz. This measurement does not reflect the bass boost and extension available by placing the woofer enclosure near room boundaries. These effects would depend on exact placement and the specific room.

In practice, the length of the air paths from the woofers and satellites to the listener will most likely differ. One effect of this is phase shift and the possibility of cancellation near the crossover frequency of 140 Hz. As a rule of thumb,

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Even at 41.2 Hz, the SPL of the distortion is not all that great, and at 440 Hz, the distortion becomes exceptionally low.

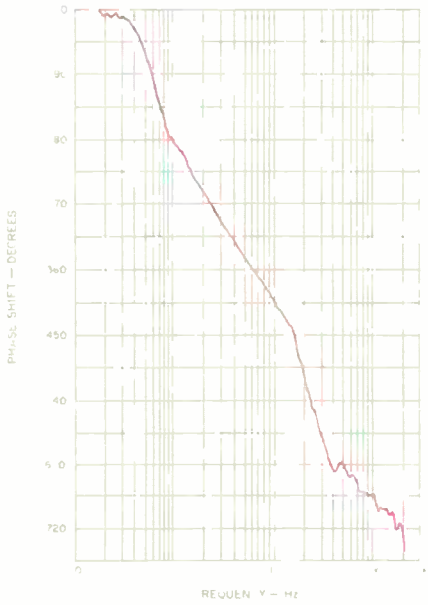


Fig. 5—One-meter on-axis anechoic phase response.

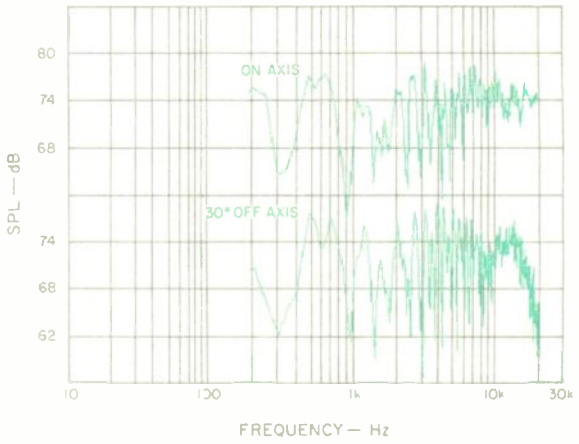


Fig. 6—Three-meter room response measured on axis and 30° off axis; off-axis curve has been lowered for clarity.

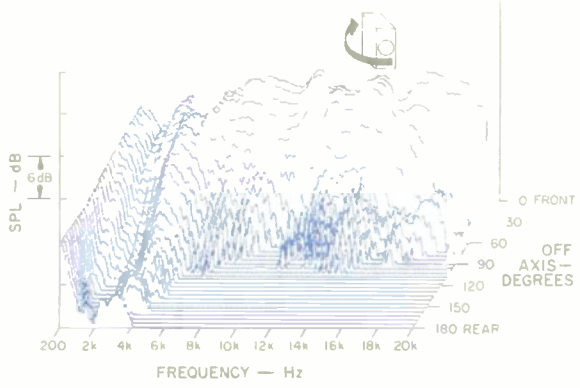


Fig. 7—Horizontal off-axis response plots taken from the front, around the side, to the rear of speaker.

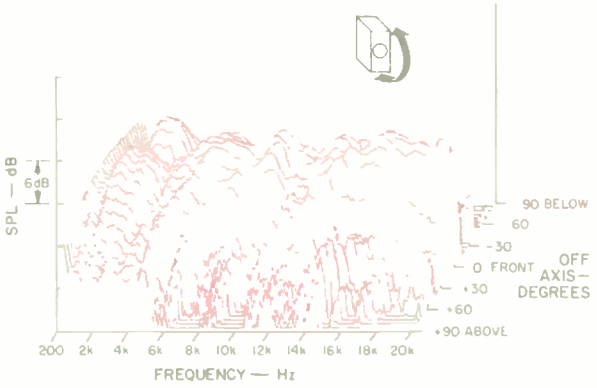


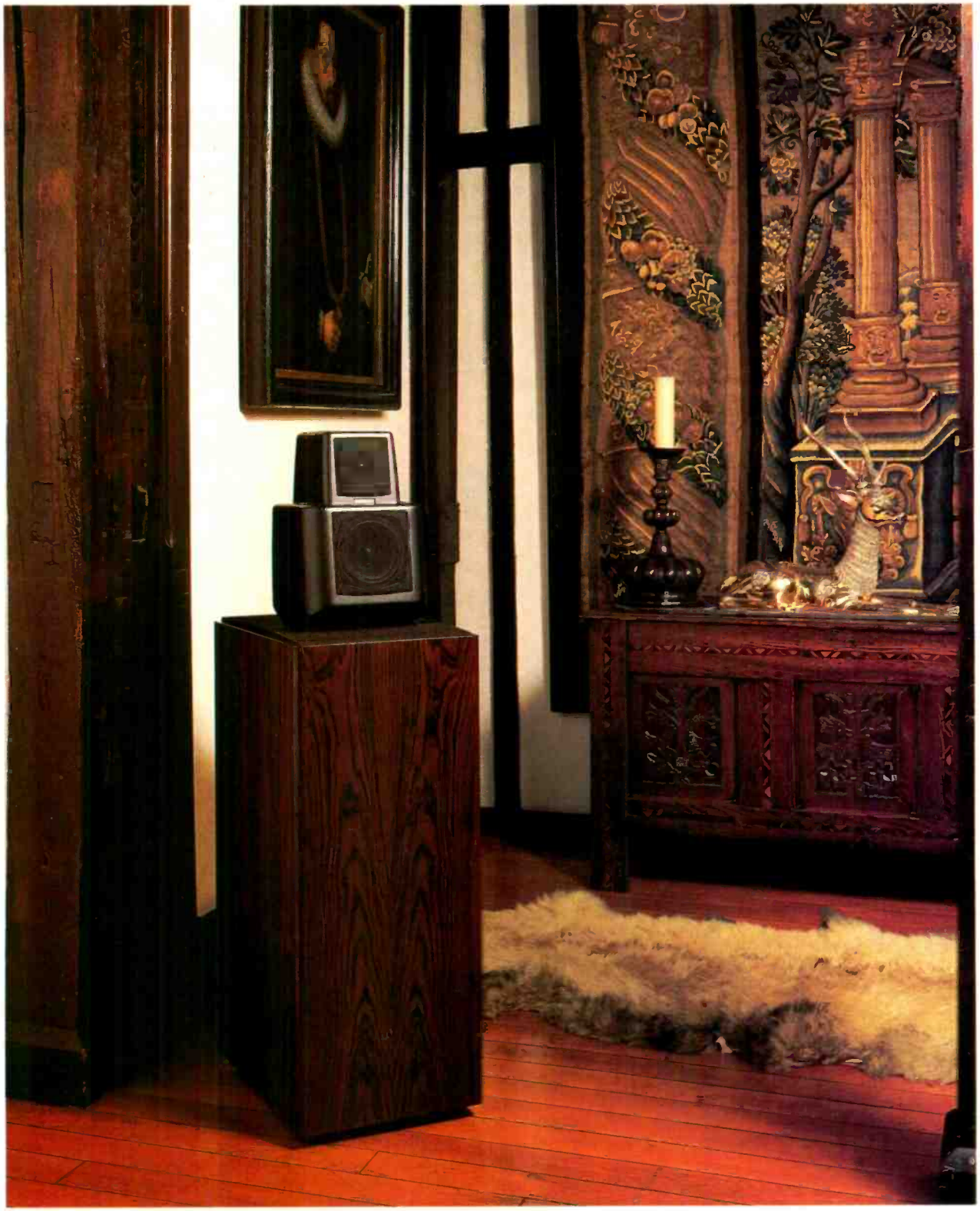
Fig. 8—Vertical off-axis plots taken from below, up the front, to top of speaker.

holding phase shift to less than 90° should prevent cancellation. This translates to holding the distance between listener and woofer to within 24 inches of the distance from listener to satellite. Another source of interaction is the reflection of satellite radiation off the woofer enclosure or any other nearby object. Both these effects are shown in the three frequency response plots of Fig. 4. The lumpy curves should not be too distressing, as this is just a glimpse of the real world instead of anechoic measurement. Here, a frequency response notch indicates that this range of sound is radiated in a direction other than toward the microphone. In a real room, this sound will arrive at the listener after one or more reflections, which does not sound nearly as bad as never hearing the sound.

Psychoacoustic studies reported by Jens Blauert in *Spatial Hearing* (MIT Press, 1983, p. 206) indicate that time shifts of 1 mS or less can cause an image shift of 10° for frequencies as low as 100 Hz. For this reason, one should keep the woofers an equal distance from the listener, if possible. What all of this means is that despite Cambridge SoundWorks' wide range of recommended woofer location possibilities, the sound will probably be best if the woofers are the same distance away from the listening position as the satellites.

Anechoic phase response of the system is shown in Fig. 5. Having 720° of phase shift over the audio band is common in well-designed three-way systems. While it is not cause for concern, it makes one think twice about laying out a couple hundred dollars for speaker cable that promises 0.5° improvement at 20 kHz. The fact that the phase shift nears 0° below 50 Hz indicates that the Ensemble system's woofer polarity is the reverse of normal.

THE ULTIMATE REFERENCE



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It's not that the Ensemble is unusually sensitive to its location—just that using separated woofers allows fine tuning.

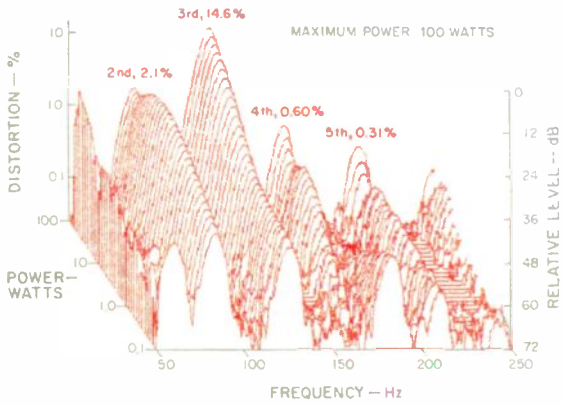


Fig. 9—Harmonic distortion for the musical tone E_1 (41.2 Hz).

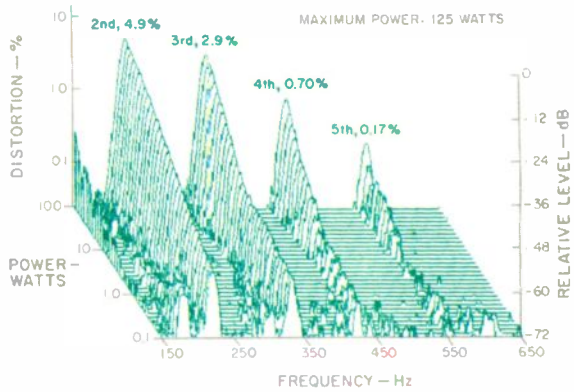


Fig. 10—Harmonic distortion for the musical tone A_2 (110 Hz).

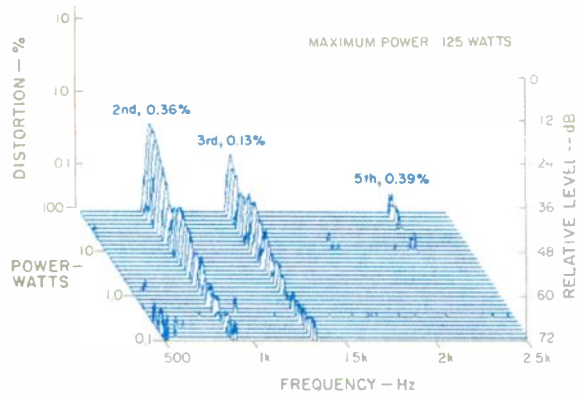


Fig. 11— Harmonic distortion for the musical tone A_4 (440 Hz).

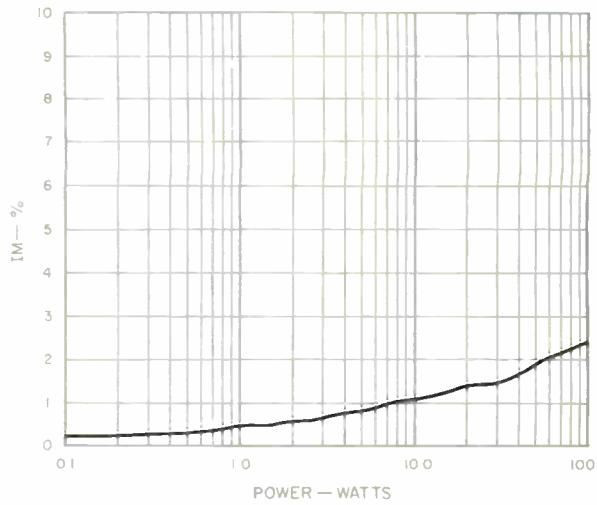


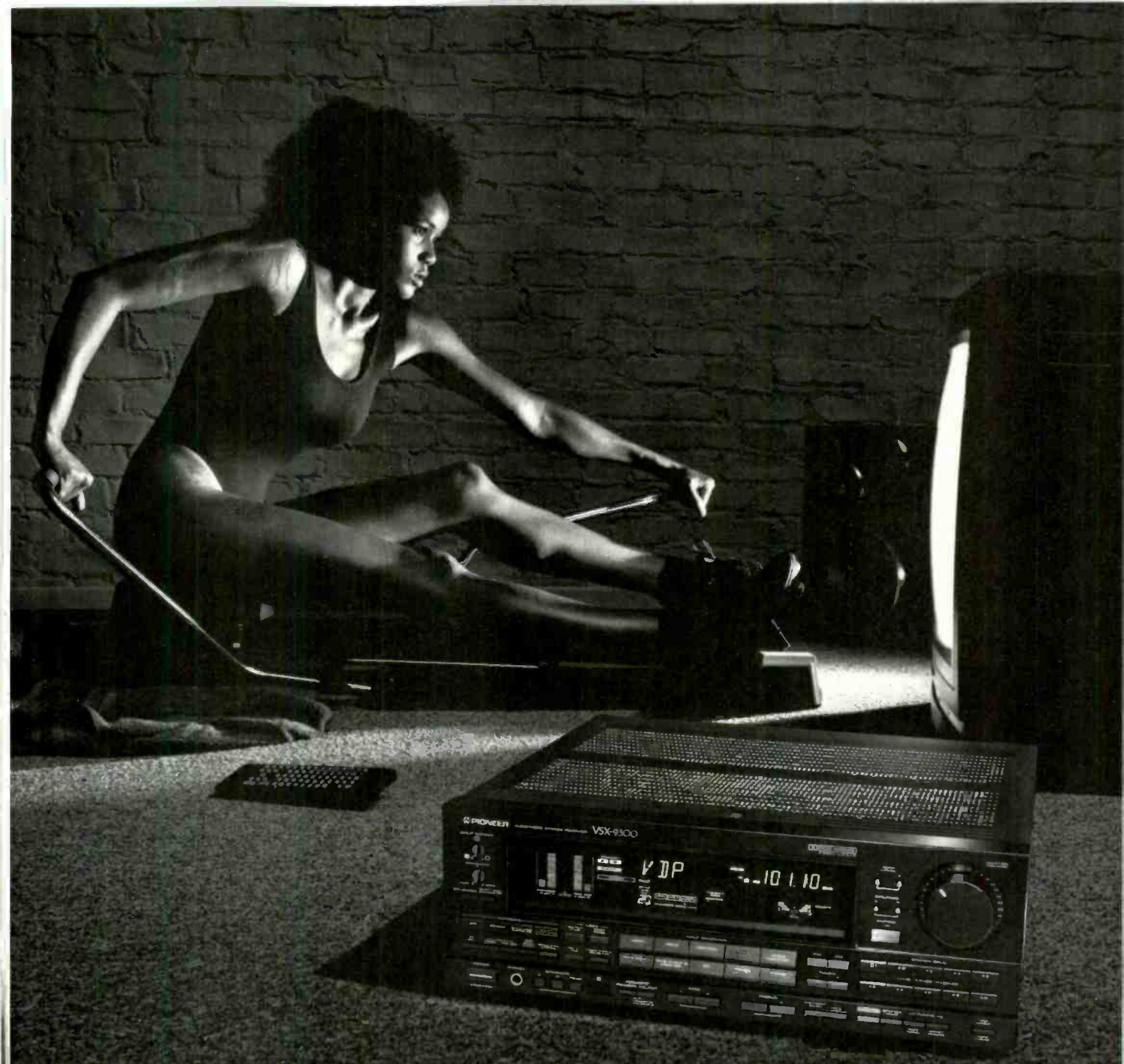
Fig. 12—IM produced by mixing A_4 and E_1 (440 and 41.2 Hz) in equal proportion.

The Ensemble's interaction with the walls, ceiling, and floor of a real listening room, during the first 10 mS, is plotted in Fig. 6 for on axis and 30° off axis. The reflections add to and subtract from the speaker's direct sound in a normal manner. Tweeter directivity is only evident at frequencies above 15 kHz.

Horizontal and vertical off-axis anechoic plots are shown in a 3-D presentation in Figs. 7 and 8. The Ensemble exhibits the omnidirectional radiation expected from any small speaker at low frequencies. The fairly narrow yet uniform directivity above 5 kHz is surprising. This could be used to widen the stereo "sweet spot" around the center line between the two speakers by rotating the satellites inward so their axes cross in front of the listener.

Figures 9, 10, and 11 show the level of harmonic distortion products for power inputs from 0.1 to 125 watts, for frequencies of 41.2 Hz (E_1), 110 Hz (A_2), and 440 Hz (A_4), respectively. The percentage of distortion at 41.2 Hz, for all power inputs, is on the high side because it is shown as a percentage of a rolled-off fundamental. Up to the 100-watt limit, distortion SPL is not great. Distortion at 110 Hz is reasonable, and at 440 Hz, distortion is exceptionally low.

When a speaker simultaneously reproduces two tones, they may interact or modulate each other. *Audio* uses two musical tones, E_1 and A_4, 41.2 and 440 Hz, to test for this. Results for the Ensemble, plotted in Fig. 12, are the lowest IM readings I have yet found in testing speakers for this magazine. The reason is that the 140-Hz crossover point assigns the tones to two separate drivers, so there is almost no interaction. This is not a trick of the measurement; the Ensemble will have little modulation of highs due to low bass notes in music.



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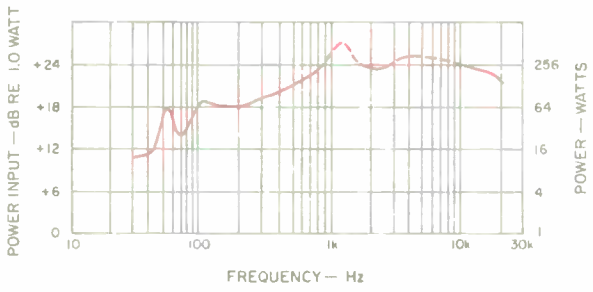


Fig. 13—Power linearity (input power handling vs. frequency for 1 dB compression of the output).

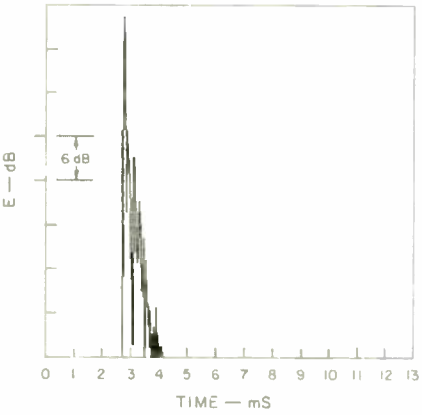


Fig. 14—One-meter on-axis energy vs. time.

Power linearity, plotted for the Ensemble in Fig. 13, is a full-range test of power handling. Power is increased at each frequency, until the acoustic output fails to increase along with it. The Ensemble accepts only moderate power in the bass, but it is linear in most of the upper range, with the maximum 256-watt input I use for these tests. It is evident that using amps with more than 150 watts output would be of little benefit with the Ensemble.

Dispersion of acoustic energy in time is plotted in Fig. 14. The Ensemble behaves in an excellent manner, showing synchronized midrange and tweeter arrivals and freedom from diffraction, reflection, and resonance.

Use and Listening Tests

The Ensemble is efficiently packaged and well protected for shipping, and I was amazed at the sheer amount of stuff you get for $499. In addition to the four fully finished speaker boxes, there are four lengths of wire with the ends stripped, solderless wire nuts, two sizes of stick-on rubber feet (the large ones didn't stick too well), and even screws and plastic anchors for hanging the satellites on a wall. The 13-page manual, as I mentioned, is excellent.

As Cambridge suggests for initial setup, I ran the full length of supplied wire between the four cabinets and a 200-watt-per-channel amplifier. I positioned the satellites where small speakers generally sound best in my 18 × 25-foot room, centered along the short wall, about 8 feet apart, 30 inches off the floor, and well out from the wall behind them. Initially, I placed the woofers below the satellites on the floor. The sound was spacious yet retained a seamless stage of instrument locations. This told me that the satellites were in a good starting location. The bass was too thin, however, so I searched for more.

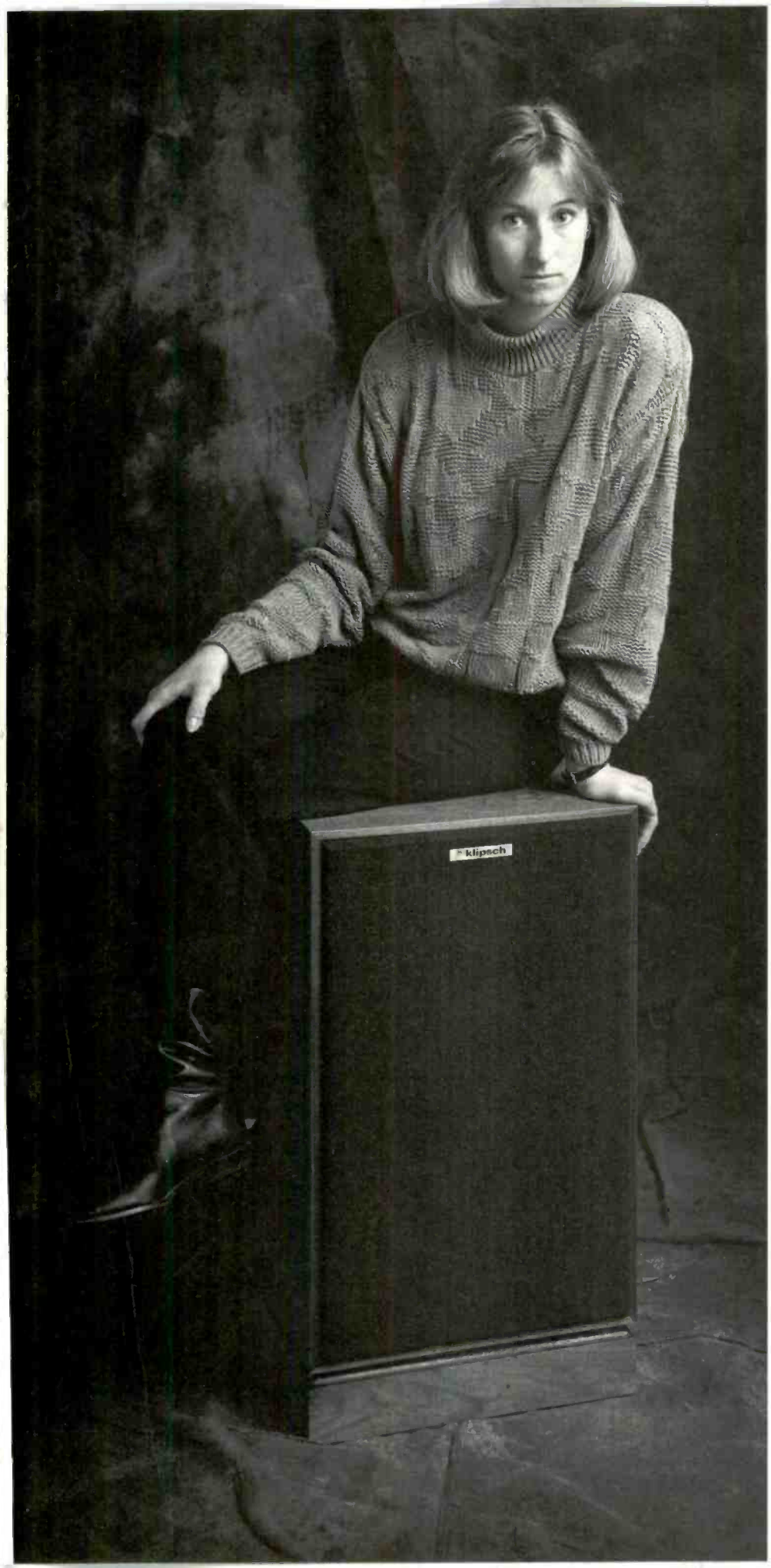
The next position of the woofers was in the corners behind me. "Bass is nondirectional, so it doesn't matter where the woofers are—right?" If you believe that, I've got a great deal for you on some beach-front property in Phoenix. Maybe rear placement works for true subwoofers most of the time, but with the Ensemble woofers going up to 140 Hz, it sounded weird—especially when I turned my head. The corner location did increase the bass, however. Next, I tried woofers along the walls at my sides and got separated lows and highs on male voice. Front corner placement provided too much bass, giving a woolly sound.

To save time, I used a third-octave real-time analyzer to position both satellites and woofers for smoothest response. Room response with woofers at the side walls, but forward, ended up being impressively flat: About ±2 dB from 80 Hz to 16 kHz. However, a peak at 63 Hz remained, with fast roll-off below that. I think a careful listener can also accomplish optimal placement while listening to music, but it will take longer. Optimum locations will, generally, be different for different rooms, but I do recommend keeping the Ensemble's woofers in the same end as the satellites and approximately the same distance from the listener as the satellites. But don't get the impression that the Ensemble is unusually location sensitive; it's just that the separated woofer allows the option of fine tuning.

Longer term listening confirmed the Ensemble's spacious, airy quality and accurate soundstage. Spectral balance, however, was a little too bright on the top end for my taste. This was corrected by angling the satellites inward so that I was slightly off axis. I was also bothered by a bass resonance when listening to the massed strings in the Third Movement of Schubert's Symphony No. 9 (Telarc CD-80110). This was probably due to the 63-Hz peak. I preferred this and other pieces of classical music with the woofers farther away from room boundaries.

The satellites have flat response and almost no distortion in the midrange. Their crossover is seamless, and directivity is excellent. Detail and focus, however, were not as good as I expected on some music. For instance, the title song from Jennifer Warnes' *Famous Blue Raincoat* (Cypress YD-0100) can be so detailed and intimate that it sounds like you are inside Jennifer's mouth. With the Ensemble, she was singing from the other side of the room. That's okay too, but for me, the communication of this gloomy piece comes from its intimacy.

So the Ensemble is not the best speaker system in the world. (I'll bet Wilson Audio and Infinity are breathing a sigh of relief, knowing that their $50,000 systems survived the challenge.) What Cambridge SoundWorks had in mind, however, was the best value in the world, and they may have it. Henry Kloss will have to settle for less than an audio revolution this time—just a winner. *David L. Clark*



Old Records, New Life

I wanted a better cassette deck. So one Saturday I dropped by a hi-fi store. The salesman took me into one of the sound rooms for a demonstration. Racks of equipment were everywhere. He started to make a recording and I immediately fell in love with the music. It was so clean, so rich, so dynamic.

"What CD is that?" I asked.

He didn't hear me over the music but it didn't matter because I quickly saw that I wasn't listening to a CD at all. It was a record.

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4

JVC XP-A1010 DIGITAL ACOUSTICS PROCESSOR

Manufacturer's Specifications

Digital Inputs: Optical, coaxial, and DAT play (coaxial) with automatic selection of 32-, 44.1-, or 48-kHz sampling frequency.

Analog Inputs: Line in and tape play.

Digital Outputs: Optical and coaxial line out, coaxial DAT record.

Analog Outputs: Main, front DAP (Digital Acoustics Processor), and rear DAP out, and tape record.

Input Sensitivity: 500 mV.

Maximum Output: 5 V.

THD: Main, 0.002%; DAP, 0.004% from digital sources and 0.005% from analog sources.

Frequency Response: Main, 5 Hz to 100 kHz, +0, −3 dB; DAP, 5 Hz to 20 kHz, +0.5, −1 dB (digital) or +0.5, −3 dB (analog).

S/N: Main, 110 dB analog and 100 dB digital; DAP, 94 dB.

D/A Converter: 16-bit linear with four-times oversampling digital filter.

A/D Converter: 16-bit with 64-times oversampling, left and right independent.

Sound-Field Patterns: 20 programmed and 20 manual.

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

Power Consumption: 25 watts.

Dimensions: $18\frac{3}{4}$ in. W × 4 in. H × $14\frac{3}{16}$ in. D (47.5 cm × 10.2 cm × 36 cm).

Weight: 15 lbs. (6.8 kg).

Price: $1,200.

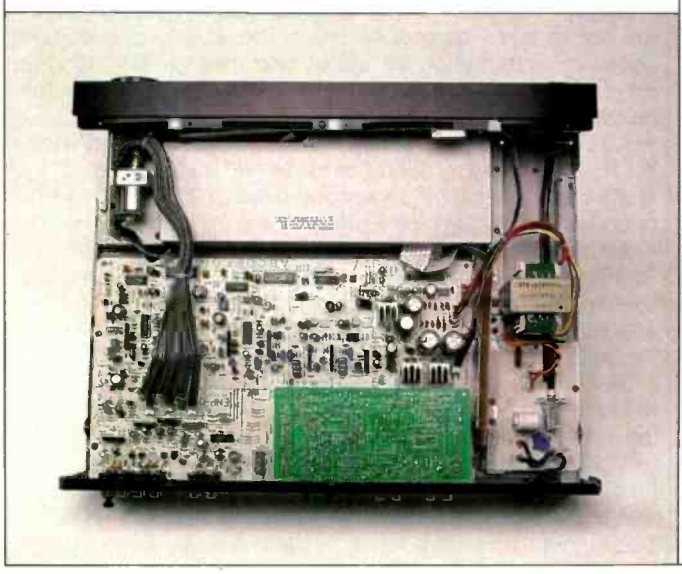
Company Address: 41 Slater Dr., Elmwood Park, N.J. 07407.

For literature, circle No. 93

The XP-A1010 is the digital acoustics processor part of JVC's Super Digifine line of digital-ready audio components. Its digital circuits simulate the sound fields of live music performances by digitally replicating directions and levels of reflections and reverberation. The processor contains ROM (read-only memory), where a vast amount of data from actual sound-field measurements is stored. A newly developed digital acoustics processing LSI (large-scale integration) device synthesizes the early reflections with proper direction, timing, and reverberation, in accordance with the stored data. The digital processing is performed in 16-bit quantization at a sampling rate of 48 kHz, using a four-times oversampling D/A converter and a 64-times oversampling A/D converter. The entire process operates independently in the left and right channels to ensure accurate re-creation of the sound fields.

Twenty sound-field patterns are stored in ROM and 20 user-programmable sound fields can be stored for one-button recall. Several acoustical parameters can be adjusted, including room size, liveness, and reverberation level. Ambience compensation can be set for both the source and the listening room. The system can be configured for either four- or six-channel operation and the six-gang volume control adjusts all channel levels simultaneously. Figure 1 is a block diagram of half (left or right) of the XP-A1010. The front-panel fluorescent display is programmable. The unit is finished in titanium but is also available at the same price in black, with wood end panels, as the XP-A1000.

In any performance hall, reflections from the room surfaces create a sound field unique to that particular site. The acoustical characteristics of the hall can be analyzed by measuring these reflections. JVC uses a pulsive source located on the stage and an array of six microphones placed at the best listening position. These measurement microphones are located on X, Y, and Z axes, as shown in Fig. 2. Each microphone pair is spaced a distance "d" apart, and each microphone is ½d from the origin "O." Usually, there are many peak signals among the impulse responses of the microphones. For accurate analysis, it is necessary to identify the peak signals caused by the same reflection of the pulsive sound source.



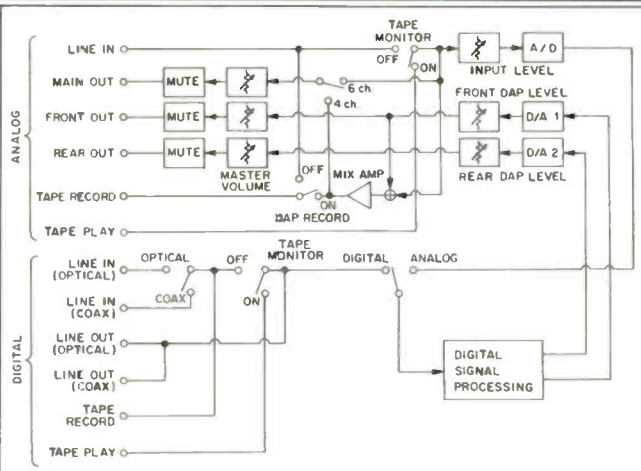


Fig. 1—Block diagram of one set of channels (left or right) of the XP-A1010 processor.

Three relationships lead to correct identification. The first is that the arrival times to each pair of microphones are different but symmetrical for each pair, relative to the arrival time at the origin (Fig. 3). Second, the arrival angles X, Y, and Z are related, in that the sum of $\cos^2 X$, $\cos^2 Y$, and $\cos^2 Z$ is equal to 1. Finally, the peak signals from the same reflection are very nearly equal in amplitude at all six microphones. The advantage of this measurement system is that virtual images can be obtained with reasonable accuracy by identifying individual reflections—even when more than one reflection is received in the same time span.

Control Layout

At the left end of the front panel are large pushbutton switches for, top to bottom, "Digital Direct," "Power," and "Remote Sensor." To the right are three orange status lights for "Sampling Frequency": "48 kHz," "44 kHz" (actually 44.1 kHz, for CDs and some prerecorded DATs), and "32 kHz." With a digital source connected, the unit automatically switches to the correct frequency and illuminates the corresponding LED. "Digital Direct" is a light-touch switch; if its small orange status light is on, this indicates that the analog inputs are disconnected. When the switch is off, the analog inputs are connected and the 48-kHz LED is on.

Further to the right are red status indicators for "Tape Monitor" and "DAP Recording." (Although "DAP" stands for "Digital Acoustics Processor," the "P" can also stand for "Processed" or "Processing," depending on the context.) The two associated switches, which will be described later, are interlocked so they cannot both be on at the same time; their circuit positions can be determined from Fig. 1. When "DAP Recording" is selected, the front DAP signal is mixed into the main-channel feed to "Tape Rec." "DAP Recording" is not available with the digital input.

The XP-A1010 offers 20 preset programs, lets you store 20 more, and allows adjustments for listening room and source material.

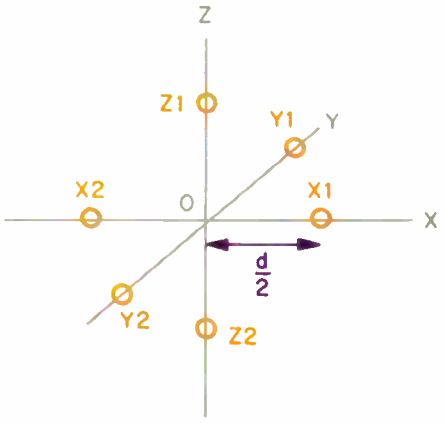


Fig. 2—Two-dimensional representation of the three-dimensional array of measurement microphones used in developing the XP-A1010. The "Y" axis, shown here as a diagonal, would actually be at right angles to this page; see text.

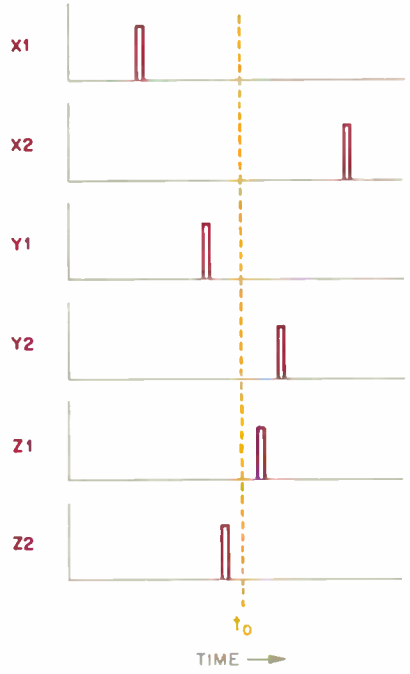


Fig. 3—Symmetry of sounds' arrival times at measurement microphones, relative to arrival time at origin; see text.

The amber, multi-mode display covers a good part of the panel, and its large size and the contrast of its characters make the display easy to read at a good distance. Operating modes, parameters, and other information are shown in various combinations, depending upon choices made with front-panel and remote-control switches. For example, the top line might show "P10: Church" and the second line "High-Ceilinged Space." The "P10" indicates that this is the tenth programmed preset. I will describe more of what is shown when the switching is discussed. The "Master Volume" control, with its really large knob and helpful white index, is at the far right. The knob's side is smooth, but its large size makes this control easy to turn. It is motor-driven when the remote is used. A small, orange "Mute" indicator is just above the knob.

A fold-down access cover extends from the remote sensor on the left to the volume knob on the right. Behind it are a total of 15 small, light-touch buttons. The first two, "Tape Monitor" and "DAP Recording," are electronically interlocked, as mentioned before. The next three, to the right and slightly separated, are "Spread/Point," "Source Reverb," and "Listening Room"; all three buttons are on the remote control as well. Pushing any of these switches changes the display. "Spread/Point" selects either a mode for spread sources, such as orchestras, or a mode for point sources, such as piano. A push of this button shows the present mode, "Spread" or "Point," on the bottom line of the display; a second push changes to the other mode, with the display reflecting this change. About 5 S after "Spread/Point" is pressed or a change is made, the display returns to its original content.

Pushing "Source Reverb" changes the display's second line to "Source Reverb = M.Ns" ("M.Ns" is the time in seconds and tenths). Up and down buttons toward the right end of the row can be used to set the time anywhere from 0.0 to 5.0 S in 0.1-S steps. A single push of either button gets a one-step change. After the button is held in for about 0.5 S, the time changes continuously at about 10 steps per S. One limitation of the XP-A1010, in my view, is that any change in this parameter is applied to all programs, not just the one in use. The second line of the display continues to show this information for about one minute after "Source Reverb" is pressed or after a change is made, then switches back to its original content.

A push of "Listening Room" changes the second line to "L. Room Reverb = M.Ns," and "M.Ns" can be set in 0.1-S steps from 0.2 to 0.6 S. A second push of "Listening Room" changes the display to "L. Room Size = " and one of the three selectable room sizes: "<10 m^2," "10 - 16 m^2," or ">16 m^2." Being able to adjust these two parameters, listening room reverb and size, is certainly unusual, and JVC argues persuasively for how important this is in obtaining the best listening conditions.

Next on the right is a simple but important LED input-level meter, with only three LEDs for each channel. The first two of the three are yellow LEDs for "15 Bit" and "16 Bit" levels; the last LED in each channel's row is red and is labelled "Over." Pressing the "Input Level" button, just to the right, causes that legend to appear on the top line of the display, with a 13-segment level meter on the line below. The meter is

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JVC persuasively argues the importance of being able to adjust for the size and reverb time of your listening room.

calibrated from "−24" to "0," and its bottom segment remains illuminated even when there is no input. The first step down is about 1.5 dB, followed by a series of 2-dB steps to −16.6 dB, a 1-dB step to −17.6 dB, and two 2-dB steps to −21.7 dB. This range and resolution is quite acceptable for setting the levels into the DAP A/D converters. It is best to set the input level high enough for a 16-bit indication, but if you switch to a higher level source, be careful. In case of doubt, always check the level indicator to make certain that "Over" is not turning on.

Pushing "Input Level" again resets the display to show "Input Balance," with a 13-position balance scale running from "L" through "C" to "R," and a balance-indicating cursor block. When the block is right on the center, it blanks out "C." The six steps each way from center are roughly 2 dB each, with a total reduction of 11 dB when all the way left or right. Correct balance is indicated when the L and R bit indicators in the little level display flash equally. This balance adjustment affects only the surround outputs, not the main ones.

"Character," the next button on the right, is for titling manual-preset programs. A push of this button starts a cursor flashing under the first available position in the second display line. Pushing the up and down buttons at the right steps through the alphabet (upper and lower case) and the digits 0 to 9. When the desired letter or number is on the screen, pushing the "Character" button again enters your choice and steps the cursor one position to the right, for your next entry. The result can be saved in memory.

The next button, "Parameter," selects the processing parameters to be adjusted for the 20 user-programmable sound fields. For the first 15 programs, successive pushes of this button select "Room Size," "Liveness," "LPF" (low-pass filter), "Reverb Level," "HF Reverb," and "Offs Delay" (offset delay—more on that later). For programs 16 to 19, "Rear Delay" is added between "HF Reverb" and "Offs Delay"; only "Rear Delay" can be adjusted for program 20. The parameter being adjusted and its current setting appear on the second line of the display—e.g., "Room Size = 1.0"—and remain there for one minute. "Room Size" and "Liveness" have a range of 0.5 to 2 in arbitrary units. The program preset values are 1.0, and adjustments can be made in steps of 0.1 units, using the up/down buttons. The low-pass filter ("LPF") can be set anywhere from 1 to 16 kHz in 1-kHz steps or to "Thru" (flat). Program preset values range from 3 to 16 kHz, depending on the particular program selected.

"Reverb Level" is adjustable over an arbitrary scale from 0 to 2 in 0.1-unit steps, starting from an initial value of 1.0. The calibrations for "HF Reverb" are the ratios between the signal's high- and low-frequency reverberation and range from 0.1 to 1 in 0.1-unit steps. The initial preset values for this parameter range from 0.3 to 1.0, depending on the program.

According to the manual, offset delay is used only when the stereo system's main amplifier is JVC's AX2911BK operating in its Digital Pure-A mode. In this mode, digital input signals are delayed while the amplifier's circuits assess the signal, predict the output level it will require, and adjust the power supply's voltage so the amp will be able to stay in

Class-A operation when the signal finally reaches it. "Offs Delay" on the XP-A1010 processor adds an extra delay to the surround channels to compensate for this delay in the amp; it's a unique feature and a sign of the times.

"Rear Delay" has an adjustment range from 15 to 30 mS in 1-mS steps. Its initial value is 20 mS for programs 16 through 20.

To the right of the "Parameter" button are the "F/DAP Level" and "R/DAP Level" buttons. A push displays the parameter name and a horizontal, 13-segment level meter. Each attenuation step down from maximum level is about 2 dB, for a total of close to 22 dB when the first 12 bars are turned off. A 13th push turns off the 13th bar and mutes the front and rear outputs. The DAP level display stays on for 5 S after the last change.

The next two buttons are for "Programmed Preset" and "Manual Preset." The first of these selects the supplied programs stored in ROM (read-only memory). When the XP-A1010 leaves the factory, its 20 manual preset programs have all the same parameter settings as the equivalent programmed presets. But in "Manual Preset" mode, these parameters can be changed, and the second line of each program's title display can be edited.

Just to the right are the "Down" and "Up" buttons, each marked with an open-V arrowhead; the many functions of these switches have already been discussed. The last button to the right, "Memory," is for entering modified programs when in "Manual Preset" mode.

I removed the wood side pieces, then the top and side metal cover. The power transformer is in a relatively narrow section along the left of the chassis. It was just warm to the touch after some hours of operation. Electronic circuitry covers the remainder of the chassis area. The front portion, just behind the front panel controls and display, has a metal

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J. Peter Montcrieff
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Neil Levenson
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"Pure musicallty is the only way I can adequately describe what I heard: no sensation of electronics or speakers, with believable sound staging and tonal accuracy... I think it would be safe to say that this represented the most 'music for dollar' at the show."
Lewis Lipnick
"Stereophile" Vol.10, No.5 Aug. 1987

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Michael Fremer
"The Absolute Sound" Vol.13, Issue 52, page 250

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As soon as I began fooling around with the XP-A1010, I was struck with the smoothness of its sound.

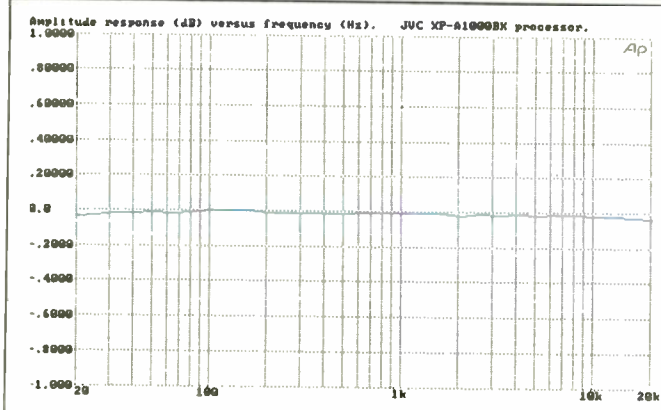

Fig. 4—Frequency response of main outputs.

cover which I did not remove. The p.c. board is large and of very good quality. It extends from the covered portion to the back panel and has high-quality parts in a neat, ordered layout. Parts are identified, and adjustment pots and function areas are labelled. I noticed with favor the generous heat-sinks for a number of transistors.

The soldering, in general, was excellent. There were a few spots with flux remaining—some apparently from last-minute changes. Interconnections were made with multi-conductor cables, most with plugs. The multi-section master level control and its motor drive are at the right front, with a shaft extension to the front-panel knob permitting direct manual adjustment. A horizontal, medium-sized p.c. board is mounted to the back panel. The board is light, but I thought it would benefit from additional support. The back panel itself is springy, but the rest of the chassis is fairly rigid—more so with the cover in place.

From the left, the rear panel has gold-plated stereo jack pairs for "Line In," "Main Out," "F/DAP Out," "R/DAP Out," "Tape Rec," and "Tape Play." A pushbutton farther to the right selects "DAP Mode" ("4 Ch" or "6 Ch").

Close to the center of the panel are six jacks and a slide switch for "Digital" connections. The "Line" connections include both optical and gold-plated coaxial jacks for digital-signal "In" and "Thru Out." The latter simply feeds the signal on to other components with digital inputs. The slide switch selects either the optical or coaxial connections; a fiber-optic cable is supplied with the XP-A1010. Gold-plated coaxial "DAT" record and play jacks complete this connection array.

The remote control, like those for most sound-field processors, is somewhat complex, with a total of 41 buttons. However, the remote's light-gold labels are easy to read against the black background.

The four buttons at the transmitting end of the control select either programmed or manual presets, enable manual preset changes to be stored in memory, and control display modes. Pressing the "Display" button once turns off the input-level indicator, pressing it again turns off the panel display, and a third push turns both back on again.

The 20 numbered keys in the next five rows select individual programmed or manual presets. Having only numbers for these preset buttons frustrated me at first, until I had used the remote control long enough to remember the names of the associated programs. The first six programs are all named "Symphony Hall" and are numbered the same as their memories. Numbers 1 to 3 are labelled "Shoebox Type" on the second display line; numbers 4 to 6 are "Vineyard Type," which indicates a fan-shaped layout with tiered seating. The seventh program is "Recital Hall," subtitled "Small Musical Space"; next come "Opera House," with "Tiered Seating," and two churches: "Cathedral/Gothic Style" and "Church/High-Ceilinged Space."

The rest of the preprogrammed sound fields are oriented more toward pop music. First come two "Live Club" programs ("Jazz Club" and "Discotheque"), "Pavilion/Live Concert," "Gymnasium/Hard-Floored Hall," and "Stadium/Outdoor Live Concert." Last come the five "Movie Theater" sound fields, subtitled "Small Space," "Medium-Sized Space," "Large Space," "Extra-Large Space," and "Standard."

The remaining 17 buttons fall into two main groups. The first group includes buttons for "Character," "Parameter," "Source Reverb," and "Listening Room," as well as buttons ("+" and "−") for adjusting these functions and "Spread/Point" and "Main Mute" buttons. All of these duplicate front panel buttons except "Main Mute." When "Main Mute" is pressed, the main stereo channels are muted, the orange LED above the volume control flashes, and "Main Muting" is shown in the second line of the display until another button is pressed. A second press of the muting button turns off the mute, stops the flashing, and returns the second line to its original content.

The final three rows, which control "F/DAP Level," "R/DAP Level," and "Master Volume," have identical layouts. Each has, from the left, a "Mute" button, the control title, and "Down" and "Up" buttons. When the front or rear DAP channels are muted, the LED above the front panel volume control flashes and either "Front Muting" or "Rear Muting" appears in the display. The "Master Volume" muting button turns off all six channels. Therefore, there is no display readout when this mute is activated—although the orange LED goes on steadily. Either the F/DAP or the R/DAP horizontal, 13-segment bar graph appears whenever an associated "Down" or "Up" level button is pushed.

Measurements

All measurements were made after the listening and viewing. As Fig. 4 shows, the right main-channel response was very flat, down only 0.04 dB at 20 Hz and 0.02 dB at 20 kHz. The −3 dB points were at 4.1 Hz and close to 200 kHz. The left-channel results were almost exactly the same. Figure 5 shows the comb-filter-type response of the F/DAP output with a mono input and one of the preset programs; another program would have a different response.

Input sensitivity was 362 mV, the input level which just turned on the level indicator's "16-Bit" LEDs; the maximum acceptable input level (red LEDs just on) was 768 mV. I did

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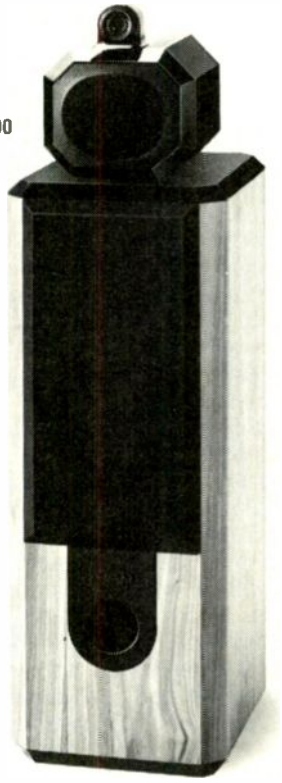

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Dialog centering turned out to be better than I had expected, despite the lack of a center channel.

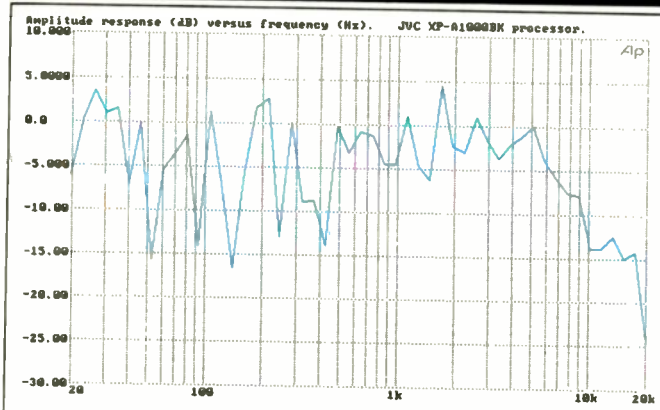

Fig. 5—Frequency response of left F/DAP output with mono signal input using modified version of the "Symphony Hall 5" preset program. Response for other programs would differ.

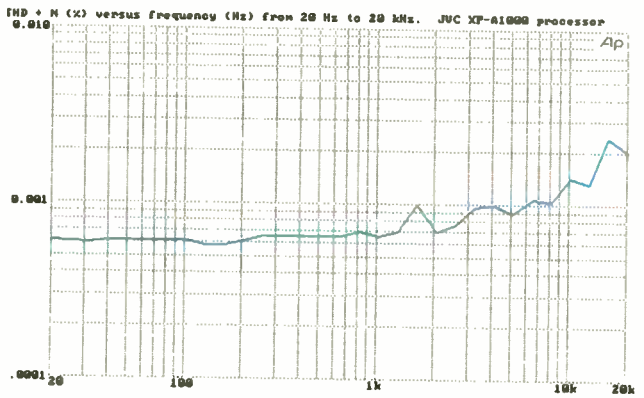

Fig. 6—THD + N for right main channel at 1 V.

not find anything I could call input clipping for the DAP channels, but waveform distortion was obvious at 600 mV, which is actually below the level where the red LEDs turned on. The maximum, no-clipping input level for the main channels was 6.5 V; output clipping did not appear at the 6-V output obtained with "Master Volume" at maximum. The S/N ratio, with a 1-V reference, was 118 dBA for the main channels and close to 99 dBA for the DAP channels. The right R/DAP channel, however, measured 95.3 dBA, which is still excellent. Figure 6 shows THD + N across the band for the main channels at 1 V input. The excellent figures are less than 0.001% over most of the band, reaching only 0.0025% or so near 20 kHz.

The output/input level difference was −0.7 dB on the left main channels and −0.6 dB on the right, with the "Master Volume" at maximum. Input impedance was 42 kilohms; output impedance was very close to 660 ohms on all channels. The two sections of the input-level attenuator tracked well within 1 dB over the control's complete range. All six sections of the "Master Volume" control tracked within 1 dB over a range of nearly 70 dB, which is outstanding. Fairly exact balance with a mono input—null in the R/DAP outputs—was achieved with the input balance set to "C." The 40-dB null at 1 kHz might have been better if balance were set with a trim pot rather than in 2-dB steps.

In the "Movie Theater" modes, the rear-delay adjustment range was from 16 to 32 mS, in accurate 1-mS steps. With the "Master Volume" at maximum, the 48-kHz residual was more than 100 dB below 1 V in the main outputs, 88 dB in the F/DAP outputs, and 99 dB in the R/DAP outputs. With the volume at a more normal 1 o'clock position, the residuals were down another 10 dB. Separation between the main left and right channels was 80 dB or better across the band. Figure 7 shows the DAP outputs in manual preset, with the "Symphony Hall 5" program, when a 2-cycle, 300-Hz tone burst with a 100-mS period was fed to the inputs. Two periods, a total of 200 mS, are shown. Other programs produced other patterns in the four channel outputs.

Output polarity was the same as input; this was true for both the main and DAP channels.

The red "Over" LED was triggered by a 10-mS burst of 5-kHz tone only 1 dB above the continuous signal level required for indicator turn-on. This is good peak detection, but the user should still adjust levels for minimum flashing of this LED, even on peaks. The decay time for turn-off of the 15-bit LED was about 150 mS, which is slightly short.

Use and Listening Tests

The reference processor for the listening/viewing tests was the Yamaha DSP-1. A Yamaha AVC-50 amp was used for switching the various sources: A Yamaha TX-900U AM/FM tuner, a Magnavox 1041 CD player, a Sanyo VCR-7200 Beta VCR, an Akai VS-555U VHS VCR, and a Yamaha LV-X1 videodisc player. I adjusted responses of the various channels with a Soundcraftsmen DC2214 octave-band equalizer and a TEAC PE-40 four-channel parametric equalizer. For power amplification, I used the second section of the AVC-50 for the main stereo channels and a Yamaha four-channel MX-35 amp for the surround channels. The speakers were two JBL 4301s (main stereo), a self-powered Triad Design HSW-300 (subwoofer), and four Dynaco A-25s (front and rear surround).

The Akai VS-555U VCR was used as the stereo-TV decoder. I connected a two-channel oscilloscope across the left and right inputs and operated it in X/Y mode to show the existence or lack of stereo and surround information. As Fig. 1 shows, the JVC processor has no center or subwoofer channel outputs. I have always considered a center output to be essential for the best results with movies, but the proof would be in the viewing and listening. Self-powered subwoofers, such as my Triad Design HSW-300, can be connected across the main speaker lines, so this lack is not a fundamental limitation on subwoofer use.

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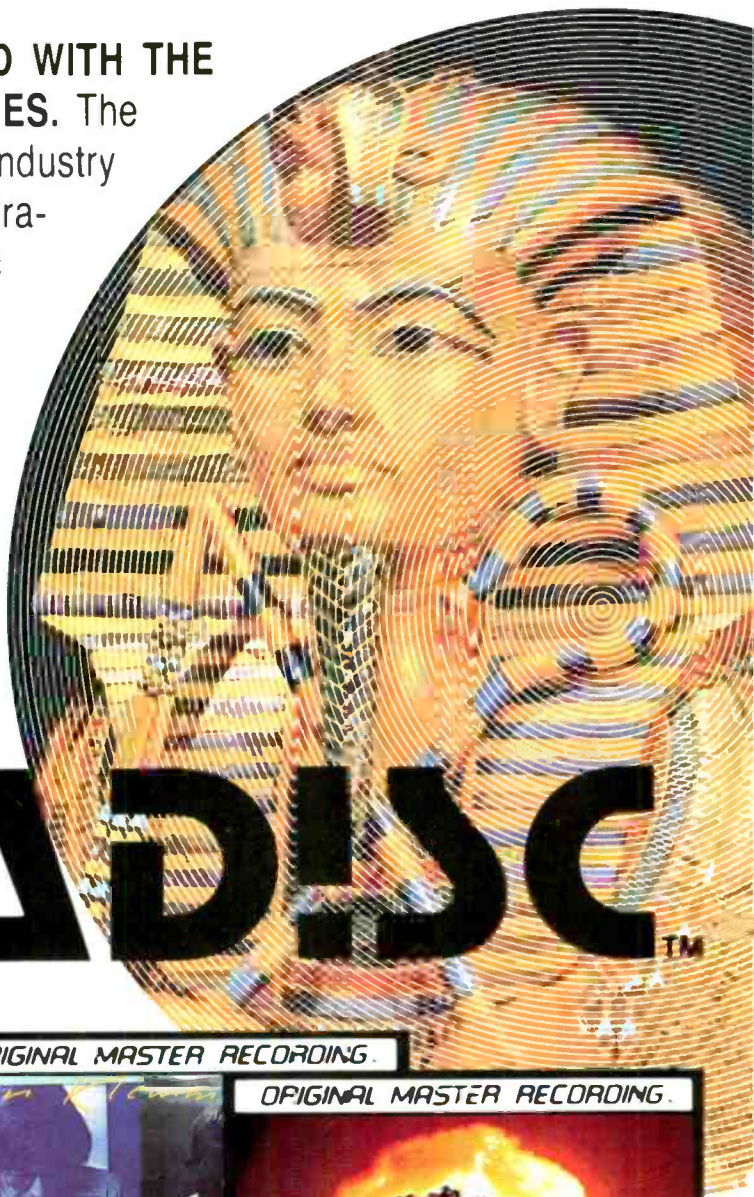

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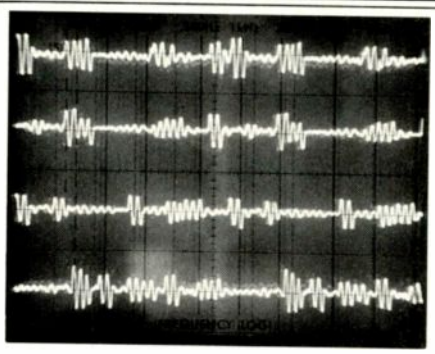

Fig. 7—Surround outputs for modified version of "Symphony Hall 5" preset program, with 2-cycle, 300-Hz tone burst fed to input. Results shown are, from top to bottom, for left F/DAP output, right F/DAP output, left R/DAP output, and right R/DAP output.

The owner's manual is fairly good, with considerable detail on combining and interconnecting associated equipment. The descriptions of panel and remote control functions and the instructions on balancing are well written. I do feel, however, that there should have been more details on the acoustics of the programs and on what parameters to change for particular sonic modifications. The manual states that the remote control is effective up to 23 feet on axis. I got response at 30 feet, which was confirmed by the flash of the front panel "Remote Sensor" red LED. At great distances, the control must be pointed accurately, and the sensor's reception angle is narrow. At short distances, reliable operation is possible with much wider angles.

I spent some time just fooling around with the XP-A1010, trying various sources. Immediately, I was struck with the smoothness of the sound. I also felt that a number of the programs sounded very close to one or more others. The default balances provided too low a level of surround sound—at least with my equipment—and I increased F/DAP and R/DAP levels for all of the programs to meet my preferences. I changed parameters for most of the programs to get combinations that produced what I felt were more realistic illusions, and set the parameters for listening room reverberation and size which matched my room. I could not set individual source reverberation times for each program, which was a little frustrating. I programmed a value of 1.2 S but ended up changing it for some programs.

Although the JVC processor does not have a center-channel output, I concluded that movie dialog required that center source. Roman Polanski's *Frantic*, with Harrison Ford (Warner Home Videodisc), had excellent overall sound quality. I tried "Spread/Point" to see its effect on dialog; there was little change between settings, and I sometimes preferred the results with "Spread." The presence of the dialog was noticeably better than I had expected, but it was not a match for the results I would have gotten from a center speaker. The character of the surround was very good, and the sound quality was excellent. One puzzlement: There was no surround sound during scenes inside the movie's disco-like Blue Parrot Cafe; there could have been more than an occasional pan of dialog or effects. Among the movie theater programs, I preferred "Medium-Sized Space" or "Standard."

Indiana Jones and the Temple of Doom, also with Harrison Ford (Paramount Home Videodisc), had very good music and effects for surround sound. I found that I could set the R/DAP level quite high and at twice that for F/DAP. I preferred the "Large Space" movie theater program, but the surround was so good at points that "Extra Large Space" was a better choice. "Spread" was better for dialog than "Point" in a number of places. *Top Gun*, with Tom Cruise and Kelly McGillis (Paramount Videodisc), really needs surround sound to be effective. I could set the F/DAP and R/DAP levels quite high without speaker localization. The positioning of effects, especially jet flyovers, was very good by ear and in the oscilloscope X/Y display. Once again, the quality of dialog without a center speaker was better than expected.

Stevie Nicks—In Concert (Pioneer Artists Videodisc) puzzled me at first, in that I couldn't find any program I really liked or disliked. This source had very strong in-phase information and little that could be called "surround." I found that some preferences emerged at higher levels: "Live Club 1/Jazz Club" and "Live Club 2/Discotheque." The source, however, remained a disappointing one.

The first thing I tried on TV was a CBS broadcast of a Georgetown versus Pittsburgh basketball game. There were stereo signals, and it was curious to watch the considerable out-of-phase information during the announcing—stereo synthesis anyone? I did get much more of a "you are there" feeling, though, with modified "Live Club 1/Jazz Club," "Live Club 2/Discotheque," "Pavilion," and "Gymnasium." I turned the TV speaker on at a low level at times, and I did prefer that.

I also liked the increased sense of being there during the ABC *Wide World of Sports* coverage of the U.S. Figure Skating Championships and the World Alpine Ski Championship. In this case, my preferences were for "Live Club 1/Jazz Club," "Gymnasium," and the movie theater programs subtitled "Small Space" and "Standard." I know some of these choices sound odd, but that's the way it turned out. *B. L. Stryker*, with Burt Reynolds on ABC, had all dialog centered, according to the oscilloscope; announcements during the commercials, however, had some "stereo." The background music and effects had good, worthwhile surround elements. Preferred programs were the movie theater programs subtitled "Small Space" and "Standard."

For each of the CDs, I chose between "Spread" and "Point" as well as whether to lengthen or shorten the reverberation time. I had previously made modifications to each of the programs and stored them in the manual presets. Unless noted otherwise, these presets and "Spread" were

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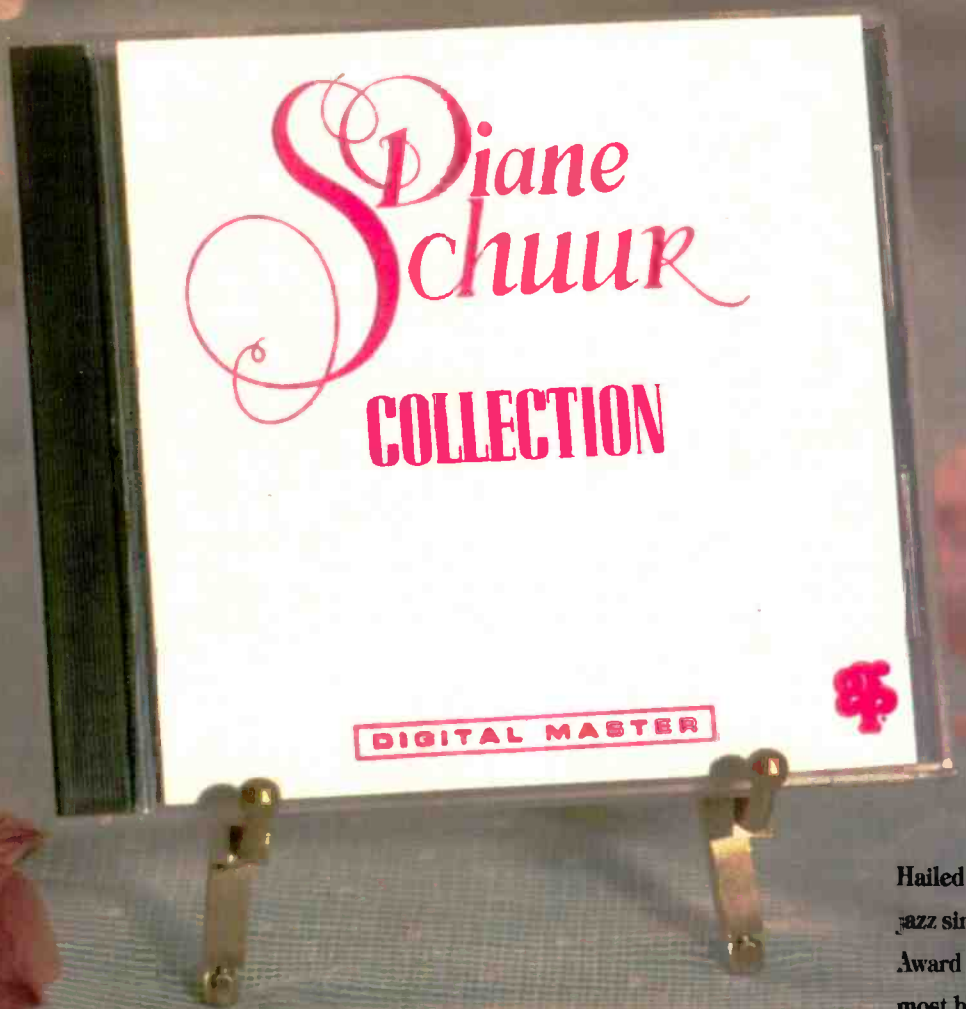

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used for orchestral works. The first CD I tried was Beethoven's "Quintet for Piano and Winds," with André Previn and the Vienna Wind Soloists (Telarc CD-80114). Although I thought I might prefer "Point" for the small group, "Spread" was definitely better. I enjoyed the results with "Recital Hall" the most, and a slight increase in reverb time made it better. My second choice was "Symphony Hall 3," with the same increased reverb. Vivaldi's "The Four Seasons," with Seiji Ozawa and the Boston Symphony Orchestra (Telarc CD-80070), also was best with "Spread." I preferred "Recital Hall" and "Symphony Hall 3" again, but I found others that were nearly as good. I used slightly longer reverberation for this music: It seemed to fit the mental image of the larger group in a larger space.

I increased the reverb time further, to about 3 S, with "Cathedral" for Handel's "Dettingen Te Deum," with the Westminster Abbey Choir (Archiv 410647-2). The surround sound was just right for the music, but I did not greatly prefer this program to using "Church" with the reverb time set to about 2 S. When I tried Berlioz's "Symphonie Fantastique," with Dutoit and the Montreal Symphony Orchestra (London 414203-2-LH), I had to reduce the reverb time to about 1.6 S. In the early parts of this music, I preferred "Symphony Hall 1" or "Symphony Hall 4," but with more listening time, I came to select "Symphony Hall 5" as the best. On the other hand, Tchaikovsky's Symphony No 4, with Maazel and the Cleveland Symphony Orchestra (Telarc CD-80047), seemed best to me with "Symphony Hall 1," and I didn't pick out any others as very close.

A number of programs delivered very good sound for Stravinsky's "Firebird" Suite, with Robert Shaw and the Atlanta Symphony Orchestra (Telarc CD-80039). I really thought "Symphony Hall 2" was best over a good listening period and "Symphony Hall 5" and "Symphony Hall 6" were close, as were "Opera House" and a couple of others. I retained my preference for "Symphony Hall 2" for the early portions, but I liked "Symphony Hall 5" for the later parts. I certainly would have enjoyed either program for the entire piece. I then tried some overtures from *William Tell & Other Favorite Overtures*, with Erich Kunzel and the Cincinnati Pops Orchestra (Telarc CD-80116). My choices varied a bit from one piece to the next, but my preference was quite strong for "Symphony Hall 4" when playing Hérold's overture from "Zampa." It was a good choice in general and was especially good on the bass drum beats in one spot.

Beethoven's Piano Concerto No. 3, with Rudolf Serkin, Seiji Ozawa, and the Boston Symphony Orchestra (Telarc CD-80063), got me switching back and forth between "Spread" and "Point." The sound was good with either choice, but I concluded that I liked the concentration of the piano sound that went with "Point." To my ears, "Symphony Hall 3" was best, with "Symphony Hall 6" not far behind. I mentioned before that I had modified all of the programs and stored the changes in the manual presets. However, when I tried Saint-Saën's Symphony No. 3, with Michael Murray, Eugene Ormandy, and the Philadelphia Orchestra (Telarc CD-80051), one of the original programs sounded best. At first, I thought that modified "Symphony Hall 1" was superior, followed by "Symphony Hall 4," also modified. Then I tried "Symphony Hall 2" unmodified and had to conclude that it was better—less muddy sounding, for one thing. I increased the reverb time a little and got one of the best sonic results in the entire listening period. I tried "Point," but the emphasis put on the organ made for poor sound.

Creedence Clearwater Revival's *Chronicle, Vol. I* (Fantasy FCD623CCR2) benefited from modified programs "Live Club 1/Jazz Club," "Stadium," and "Live Club 2/Discotheque." Although "Point" was best many times, the choice varied from number to number. I found that the modified "Pavilion" and "Gymnasium" programs just didn't work at all; the unmodified "Pavilion" and "Gymnasium" presets were certainly better. The two "Live Club" presets and the one for "Stadium," however, were not a match for the modified versions. I was a bit surprised when *Star Tracks*, with Erich Kunzel and the Cincinnati Pops Orchestra (Telarc CD-80094), was best with my modified "Pavilion." The music did sound very good with a number of other programs, both modified and unmodified, all with "Spread."

Jennifer Warnes' *Famous Blue Raincoat* (Cypress 661111-2) seemed best to me with modified programs, especially "Live Club 2/Discotheque," mostly with "Point." "Live Club 1/Jazz Club" was better for a couple of numbers, and "Stadium" was also good. I found "Pavilion" good for a surrealistic effect, particularly with "First We Take Manhattan." *Spirituals*, with Simon Estes and the Howard Roberts Chorale (Philips 412631-2-PH), sounded very good with several modified programs. "Recital Hall" and "Church" seemed best to me, and "Opera House," "Live Club 1/Jazz Club," and "Pavilion" were also good. "Cathedral" was not a good choice, which seemed sensible, considering the music, but "Gymnasium" was quite good and that was a bit confusing. Well, the name of the surround-sound game is what gives the best illusion, not what the program name is.

Conclusion

The XP-A1010 did quite well with broadcast and videodisc movies—better than I thought it would without a center-channel output. With this type of source, however, it was no match for the reference Yamaha DSP-1 processor and even less of a match for the units designed primarily for home theater use. The stereo on TV broadcasts remains a rather poor thing in most cases, and the JVC processor did fairly well with the programs tried. With music sources, the XP-A1010 could generate many very satisfying, even exciting, sound-field illusions. I would have preferred being able to store different source-reverberation times in each of the programs, as is possible with the DSP-1. With much of the music, however, the JVC processor produced a more appealing smoothness in the surround sound.

The XP-A1010 has admirable responses and low distortion and noise. It has many worthwhile features, including the input-level bit meter, front panel control of functions and parameters, inputs for listening room characteristics, the excellent display, and a remote control with much flexibility, including control of channel and overall volume. The price of this unit is high, but it is in the same range as other processors. When the emphasis is on listening to music, the JVC XP-A1010 deserves serious consideration.

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THETA DS Pre PREAMPLIFIER

Company Address: 6360 Van Nuys Blvd., Suite 5, Van Nuys, Cal. 91401. For literature, circle No. 94

I suspect few readers think of *Audio* as a "religious" magazine. First, audio really isn't quite *that* serious. Second, anyone who reads *Audio* has to share a common and pragmatic interest in the finest in music and sound quality. At the same time, it seems there are three schools of opinion regarding audio reviewing. These sometimes are taken far too seriously and are then pushed to the point of becoming cults. One school holds that only technically measurable differences matter in judging the quality of audio equipment; the second holds that only subjective differences matter, and the third holds that some technical and subjective differences do matter but can only be validated through controlled listening tests.

As a largely subjective reviewer, I have to confess to belonging more to the second school than the first or third—although I read my more technically inclined colleagues with considerable attention and take their results very seriously indeed. I also pay close attention to the ongoing debate over whether controlled listening tests really work. My interest in audio equipment, however, is largely in what it can deliver in terms of providing a more convincing illusion of a live performance—not in its terms or technology. I also believe that sound quality can only be determined by weeks or months of careful listening to a wide range of performances, and I believe in the kind of comparative listening that takes hours, not minutes or even moments.

Now, all of this introduction would be little more than a statement of personal philosophy if the value of the product I am about to review was not so dependent on subjective sound quality. The Theta DS Pre is one of the most sophisticated consumer audio products now available, but it does not necessarily measure any better than many other units which perform a similar function. The Theta's whole purpose is to produce subjectively superior results in the process of digital-to-analog conversion. It also is only fair to point out that D/A conversion is an area where experts and reviewers are still sharply debating whether any serious differences are audible and what aspects of digital sound, if any, need further improvement.

Let me preface my remarks on the sound of the Theta DS Pre by estab-

lishing that it is not merely the result of a minor "tweak" or improvement in existing D/A systems. The Theta DS Pre is based on some major innovations in technology—as might be expected with any unit that costs $4,000. The DS Pre is the equivalent of a sophisticated computer system and uses a proprietary, composite algorithm produced with the aid of a supercomputer. According to the manufacturer, this allows digital decoding to be optimized for time domain, group delay, transient ability, and frequency response. In contrast, virtually all other decoders optimize only for frequency response.

The digital-to-analog conversion process in the DS Pre is programmable. It can be used with both CD players and DAT machines, and its performance can be steadily upgraded or optimized by changing the ROM chips in each channel. The design also minimizes the amount of analog circuitry involved. Rather than try to correct or alter the sound once conversion has taken place—which is what goes on in many CD players—the DS Pre does this during the actual digital conversion process.

The unit's main designer, Mike Moffit, describes the design philosophy behind the Theta as follows: "All oversampling, digital playback devices—and recording devices—utilize digital filters to filter the signal at half the sampling rate, as well as to actually generate the oversampling itself. It takes a microprocessor to compute the necessary interpolated samples. All microprocessors need some kind of program or software to run.

"So far, all of the CD players and R-DAT machines available to the public have utilized a simplified digital filter, which consists of a simple processor with a program masked onto a memory portion of a chip. The only way to change the performance of the digital filter, which is critical to the sound of the decoded music, is to replace the CD player or the R-DAT machine. When the best CD players cost over $5,000, this is a less than ideal way to deal with progress, as better and faster filters are developed.

"My research has indicated that different methods of processing in the digital domain of the filter have more impact on the final decoded sound than what can be achieved by the relatively trivial improvements to be gained in the analog section of what has to be a flawed medium.

"The Tneta DS Pre uses a separate, digital signal processor for each channel, which is programmable by the user or the dealer by simply changing ROM chips. There are at least 50 different ways to design and optimize digital signal processors or filters. They all sound different. They all perform wonderfully when measured on normal test equipment. The Japanese and European companies which produce digital audio devices all use the same filter design, simply for the reason that it was one of the latest methods published in the Bell Laboratories and IEEE references. Unfortunately, it is the one that sounds the worst."

The Theta preamp also has a number of other technical features worthy of note. The unit uses nonswitching eight-times-oversampling filtration and conversion with only a single-pole filter. There is said to be less than 5° of phase shift from 20 Hz to 20 kHz. Interference from digital control signals is prevented by an exceptionally heavy solid-steel chassis, which is plated with copper and then with zinc. There are seven power supplies, to prevent current draw in one area from affecting another.

The DS Pre has a wide range of control features that have practical value and greatly improve the flexibility with which this preamp can be used. The rear panel has two switchable digital inputs, and a source-monitor switch on the front panel can be used to directly compare the decoded output of the Theta with that of the original signal source or of some other digital input. The channels can be reversed, and there is an absolute-phase switch.

While the DS Pre is not a true preamplifier, it has a number of analog controls which allow it to perform some of the functions of a preamp. The audio output is switchable between a fixed line output and a volume control with right- and left-channel trim pots to provide control of balance. There is a "Mute" switch, and a "Normal/Thruput" switch makes it extraordinarily easy to compare the sound of the Theta with that of the D/A and analog circuitry in any CD player or R-DAT unit which the DS Pre is used with. In other words, this unit has all the controls needed for it to be used to drive power amplifiers directly. In a truly simple audio installation, you could combine CD and R-DAT units with a high-level source such as a tuner and do without a conventional preamp entirely.

All of this technology and the features would be unimportant if the Theta did not produce impressive sound quality. "Gilding the lily" has no more benefit in audio than in any other art form; neither, for that matter, does "gilding the ear." A unit such as the Theta preamp only has meaning to the extent that it is capable of producing audibly superior and more enjoyable music reproduction.

The DS Pre does this in spades! It not only reproduces music far better than the D/A conversion stages of any CD player or R-DAT unit I have yet heard but also promises that digital sound, in addition to its own benefits, can surpass any of the claimed benefits of analog. In fact, this Theta preamp provides such superior reproduction of the finer details in recorded music that we may not be able to tell what digital can do until the producers and manufacturers of CDs and R-DAT cassettes begin to use equally good equipment during studio monitoring and production.

Let me be more specific. I have used the Theta DS Pre with over a dozen top CD players and two R-DAT units. Given the rapid change in digital products, there isn't much point in naming names, but the units I used have had very favorable mention in this and other top audio magazines. In every case, the Theta improved the depth and imaging of the soundstage. With the exception of a few CDs that were one- or two-dimensional to the point where the recording engineer appeared to have performed an act of malice, this improvement in the soundstage was clearly perceptible, and in many cases, it was striking. For example, in listening to the Proprius recording, *Jazz at the Pawnshop* (PRCD-7778), I found for the first time that the CD could equal or surpass the analog record in revealing the details of the soundstage.

The Theta preamp also added to many recordings a degree of subtlety

Used with 12 top CD players and two R-DAT units, the Theta DS Pre improved both the depth and the imaging of the music's soundstage.

and transparency that was sadly lacking in virtually all the CD players I auditioned. Audiophiles may disagree as to whether or not phonograph records have an added degree of "air," or mix of soft harmonics and overtones, that is lacking in CDs. I doubt, however, that most audiophiles who hear the Theta preamp will argue about whether or not it reveals more "air" than the D/A conversion stages in virtually all competing CD or R-DAT units. You can hear the difference on everything from Willie Nelson to Gregorian chants, and it is particularly impressive in choral works, opera, and complex vocal music. There is a consistent improvement, ranging from slight to immediately impressive, depending on the recording and on the competing D/A circuit.

I am not a supporter of those who claim that most digital equipment's upper octaves drive you out of the room, are lacking in musicality, or somehow produce a consistently unpleasant edge. A bad recording is a bad recording, and the better high-frequency performance of CDs can scarcely be blamed for revealing this. Nevertheless, I often do find that many digital recordings seem to have upper octave information which is slightly amusical, and they sometimes contain smeared or hardened music. The DS Pre does not save bad recordings, but it does do a great deal to show that many recordings actually have far better and more musical upper octave detail than I had previously believed. The Theta preamp often makes a particularly impressive improvement in the reproduction of violin, piano, vocal sibilants, and upper octave woodwinds.

Finally, I found that this preamp produced a more convincing and dynamic mix of bass, upper bass, and lower midrange. I had previously found this part of the musical spectrum to be a bit flat on many CDs, and to lack natural musical life and interest. The Theta may not always produce more powerful bass, but it consistently produces more musically detailed bass. It also reproduces the natural richness of the transition from bass to midrange—something I find critical to enjoying live music but often miss in recordings.

At this point, I have to return to the three cults, or schools, of audio reviewing discussed at the beginning of this review. If you already believe in subjective listening, you can test the validity of my praise of the Theta simply by auditioning it at any high-end dealer who carries it. The benefits of the DS Pre are not all that subtle. They should show up clearly after listening to a few of your favorite CDs on any system that is set up to provide a revealing soundstage and that is quick and extended enough to be called transparent. Further, if your CD player has a digital output, you can plug it into the Theta and immediately compare the improvement it makes in sound quality. Few products provide an easier way to

The Theta DS Pre does not save bad recordings but does show that many CDs have far more musical top ends than I had believed.

make sure you do not get carried away with reviewer claims or technical hype.

If you sincerely believe that only technical measurements matter, you've got a problem. There is no way I can possibly prove that the DS Pre really sounds better, although the summary of its design philosophy and technical features may at least persuade you that it *could*. You may then have to compromise your beliefs a bit to enjoy this preamplifier.

Similarly, if you only believe in controlled listening tests, I am afraid my proof of the Theta's merits is equally lacking. It is easy to "A/B" this unit—it has A/B switching built in. I also ran enough blind tests to confirm that after extended auditioning, non-audiophiles hear a real improvement when listening to carefully chosen passages and to their own favorite CDs when comparing the Theta DS Pre to their favorite player. What I cannot offer, however, is a statistically valid sample to show that the Theta is better—if for no other reason than that I know of no way to determine how to structure an experiment in which the exposure to given lengths and types of music would really determine what is statistically relevant in terms of perception. This review is not the place to get into statistics, but it is very easy to measure the statistical validity of a large sample from a given experiment. What is difficult is to structure the experiment so that the actual test is relevant. All my experience with audio equipment indicates that controlled or blind listening to short periods of music does little to tell most people about the sound character of a given piece of equipment, and it quickly confuses most listeners. Similarly, tests of large numbers of listeners—to determine what levels of distortion and frequency can be perceived—have tended to produce results that minimize hearing abilities and maximize the levels of distortion that matter. This occurs, in part, because the tests often are not relevant to the results of prolonged listening to music.

All I can suggest is that, even if you do firmly reject subjective, open, long-term listening as a major criterion for selecting equipment, you should still audition the Theta preamp so you can play the role of devil's advocate. At least you will be able to say that you personally tried to figure out why subjective reviewers get so enthusiastic about "nonexistent" differences in sound quality, and that you cannot see any reason why there is a debate about digital sound. Further, if you *do* hear the benefits I claim for the Theta DS Pre, this may prove an occasion for joining one of the few cults that are harmless. You give up nothing, and you may well find that the sport of audio becomes far more enjoyable—and that your system can reproduce far more musically convincing sounds.

Anthony H. Cordesman

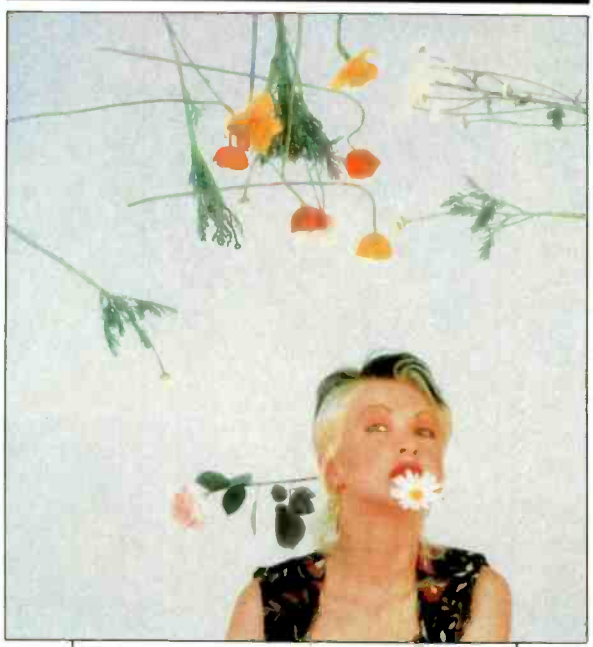
GOLDEN GIRLS

Something Real: Phoebe Snow
Elektra 60852-1, LP.

Sound: B Performance: B+

For over eight years, the only new recordings we've heard of Phoebe Snow's singular vocal instrument are those from guest appearances on other musician's albums and on advertising odes praising retail stores or coffee beans. It's taken all this time to escape from a fortress of personal, creative, emotional, and legal problems and get back to doing what she does best. Ironically, some of the singers that owe Phoebe a debt—among them Suzanne Vega and Tracy Chapman—are also responsible for creating the present musical atmosphere that makes Snow's latest release, *Something Real*, possible. The cynic in me wants to think that only when it seemed most profitable did a label come out of the shadows and do the right thing, but let's just say that Phoebe simply wasn't ready to get back to work . . . for a long time.

And back she is, with a 10-song collection of pop/jazz/rock hybrids, delivering varied moods and musical feels. There are touching, straightforward pop songs such as the three written by Snow—"Something Real," "I'm Your Girl," and "Touch Your Soul"—anchored by Snow's particular acoustic guitar playing, and there are reworked uptempo numbers such as Maurice White's "Best of My Love" and Peter Anders' "If I Can Just Get Through the Night." David Frank provides a quality, electronic, dance-club-type arrangement to "Best of My Love." Unfortunately, Phoebe Snow's more languid, legato style of phrasing never seems to catch up with it. In an attempt to get control of the tune, she seems at times both to be caught behind the beat and anticipating the beat. Individually, the arrangement and Snow are excellent; together, they don't work.



Photograph: ©1989, Michele Clement

Four separate producers were involved with *Something Real*: The highly talented Warner Bros. exec Russ Titelman on three tracks; Rob Fraboni and Ricky Fataar (Fataar also plays drums, percussion, and bass on several tunes) on six, and long-time Snow supporter Phil Ramone on one. Ramone was the engineer and co-producer of Snow's first album release in 1974. His track, Rhonda Schuster's "We Might Never Feel This Way Again," is the strongest bid for commercial success. The song could have been even stronger, however, if Snow had developed the vocal, taking time to build it as she progressed. As it stands, Phoebe delivers the goods in toto by the middle of the first chorus, thus leaving the remainder of the song somewhat static.

Something Real is, in many ways, a continuation of Snow's early musical period—the one which gave us "Poetry Man" and "I Don't Want the Night to End." It was this period which meant so much to a now-older, CD-buying crowd. This audience likes variety in its musical diet, and since Phoebe Snow has always been and always will be a musician without a category, expect these music lovers to once again latch onto Phoebe. Don't for one moment, though, think that this is some kind of nuevo-retro album. This is a musical move forward. Snow definitely has changed over the years. Her songwriting is neater, and her voice has grown a ton. It is now stronger, more fluid, more capable. She does resort to more vocal "tricks" (slides, falsetto climbs) than in the past—and perhaps does so more often than she needs to—but I assume this is due to her years of jingle singing, where you need to sell the point in 10 to 30 seconds or you're nowhere. Slow down, Phoebe. You're good enough to wait for.

Phoebe Snow's *Something Real* is not a great album. It lacks the continuity and strength of a great album because it does not have the six or seven excellent songs necessary to give it sufficient staying power. However, it is a good album with some remarkable highlights. More importantly, *Something Real* marks the return of a rare musician—one we haven't had the pleasure of listening to for eight years.

Hector G. La Torre

A Night to Remember: Cyndi Lauper
Epic EK-44318, CD; ADD; 39:53.

Sound: B Performance: C+

Whoever recorded this album looks like Cyndi Lauper, sounds a little like Cyndi Lauper, and is even named Cyndi Lauper—but it must be a different Cyndi Lauper than the one who became our darling by cutting through the pin-striped '80s with humor, irreverence, and a Queens accent thicker than anything in *Working Girl*. On this, her third album in five years, it's clear that Cyndi Lauper has gone through the makeover machine. The songs are listenable if not inspiring, and the craftsmanship is impeccable. But this record could be anybody's.

It doesn't start out that way. The opening track gives us a nice bit of kitsch that promises good things: A scratchy, old-radio-style song with Oakie overtones. Then Cyndi suddenly disappears, replaced by someone who has a very good voice but is missing the emotional range from kewpie-doll cute to powerful anguished belter—and, most sadly, is missing that sense of humor and individual style that set Lauper apart from the clones.

The material itself is a big problem. Lauper has gotten hit-makers Billy Steinberg and Tom Kelly ("Like a Virgin") to write or co-write half the songs here, and they're by-the-numbers torch jingles. She's also retained producer Lennie Petze of her mediocre previous album, *True Colors*. (Petze was also executive producer of her spectacular debut album, but Rick Chartoff—sorely missed and needed—was the actual producer there.)

What results from all this high-priced talent is a slick, anonymous record that, with a few alterations, could be fitted onto Madonna, Belinda Carlisle, or any number of singers in that school. On "I Drove All Night," she gives us, on cue, Rickie Lee Jones-sensitive phrasing; on "Insecurious," she makes with Dolly Parton tremolos. Why such obvious swipes? Where's Cyndi? Her voice can still punch through walls and do acrobatics, as she demonstrates on "My First Night Without You," but her singing here shows technique without soul, programmed and calculated.

So is most of the playing, which by any technical standard, is world-class. But the credits list no less than Eric Clapton among the seven guitarists here, and aside from my suspicions about a couple of guitar solos, I couldn't pinpoint where his characteristic style appears. On this record, even Eric becomes part of a smooth, slick machine lacking in personality.

By coincidence, I suppose, the two best cuts—the uptempo ballad "A Night to Remember" and the muscular, swirling "I Don't Want to be Your Friend"—are co-produced by Lauper and Phil Ramone. He's as slick and high-priced as anyone, but on these two songs, he does seem to help Cyndi relax. You can hear a coloration in her voice, a sadness—something ineffable, perhaps, but nonetheless there.

Unfortunately, there is a sound like a soft wind between many of the tracks—not exactly tape hiss but close. I hate that on CDs. And in this case, it's one more reason why *A Night to Remember* is an album to forget.

Frank Lovece

Touch: Sarah McLachlan
Arista ARCD-8594, CD; 47:50.

Sound: A Performance: B+

Sarah McLachlan is only in her early 20s, but she has already been trained in classical piano, guitar, and voice. She has been influenced by many of the rock greats—Peter Gabriel, Kate Bush, and Jane Siberry, to name a few—and she wears these influences as if they were badges. Like these artists, McLachlan makes music which is arty and precious in the best sense of each word. And her work is very, very serious.

McLachlan's songs are ever intense, often nearly florid, but they have a fierce beauty. Her training gives her the savvy and confidence to take risks in shaping and styling songs, and she usually brings them off. Her voice has a passionate yet cool sound that is similar to Enya's, and she uses similar wordless vocal washes, too. But McLachlan does not work with the kind of enforced distance which Enya seems to need.

"Vox," the first single, is sleek and modern, deceptively simple melodically, and extremely seductive. Small thing that the lyrics are little more than psychobabble. They hardly matter in the fullness of the sound. The title track is all layered keyboards and voices with no words. "Out of the Shadows" offers a wafting 6/8 meter and lovely classical guitar work. "Steaming" is the punchiest song here, with a mighty drum part that virtually serves as lead instrument. "Trust" is at once dreamy and disturbing.


Sarah McLachlan

Producer Greg Reely engineered, mixed, and played percussion on several tracks. He has crafted a lovely sounding record which is particularly fine on that most crucial element, the piano. The CD adds one bonus track, an expanded, remixed "Vox" that may be unnecessary but not unwanted.

Michael Tearson

Oranges & Lemons: XTC
Geffen GHS-24218, LP.

Sound: B+ Performance: B+

Ever since XTC managed to generate some controversy via "Dear God" (from 1986's *Skylarking*), their records have been taken more seriously. They're not seen as just another British band of post-punk leftovers but (gasp!) as neo-Beatles with progressive ideas. This group is now the darling of college radio rather than a non-touring band stuck in the quandary of being just a bit over the hill. They have offended; therefore, they are important. But let's get one thing straight: XTC already said everything it had to say on *Black Sea*, and nobody gave

Tex Ritter is one of many well-known greats whose songs appear on Capitol's entertaining collection of hillbilly classics.

them the time of day. The albums XTC has made since then have been delightful in their own ways, but nothing approaches the consistency and sonic breakthroughs of "Towers of London" or even "Burning with Optimism's Flames." Not to begrudge XTC any success—it is well deserved—but Andy Partridge and Colin Moulding had their pop epiphany early in the decade and have since been making records which are more timely than timeless.

Oranges & Lemons is the latest exploration of pop music to use jazz chords, clever and often adult-oriented lyrics, and inventive melodies. Yet a new drummer joins the band for this record—Pat Mastelotto, of Mr. Mister—who obviously has listened to XTC's early records and has tried for a Terry Chambers-type feel. Although he is in sync with what the other three members of the group are trying to do, it is very difficult to slot a drummer into a band and have things anchor firmly. The musical textures are guitar-heavy, and the bass is mixed very upfront. These problems only accentuate the lack of a "live feel" rhythm section. Still, even measured against its own yardstick, XTC manages to come across with plenty of gems this time around. The first single, "The Mayor of Simpleton," coasts along nicely—even though it could groove more in the "B" sections of the verses—and "Pink Thing" will probably raise an eyebrow due to its lyrical content, which is full of double-entendre. But if this is what excites the 15-year-old record buyer, wail on. "Hold Me My Daddy" is about as poignant as we'll ever see Andy Partridge get, and "Merely a Man" shows that even when he condescends, the man maintains a high aesthetic level. "King for a Day" is the best of the Colin Moulding compositions, and isn't it time for his solo LP?

Compared to the rest of the releases we've seen so far this year, *Oranges & Lemons* is a singular masterpiece. But XTC's finest moments (check out the *Singles Going Steady* anthology) continually remind one of the greatness the group achieved when it was a real working unit with a permanent drummer. We keep hoping they will get over their allergy to live performances and once again go out and visit the real world, where playing in front of a live audience teaches you things that no recording studio ever can. Good is good, but in this case, it's not good enough. *Jon & Sally Tiven*

Hillbilly Music . . . Thank God! Vol. 1: Various Artists
Bug/Capitol CDP-91346-2, CD; 60:33.
Sound: B+ Performance: A–

This is a highly entertaining collection of hillbilly music from the Capitol Records archives. The material dates from the '40s through the '60s, and every selection is top rate. Marshall Crenshaw compiled songs from well-known greats like Merle Travis, Faron Young, Rose Maddox, Tex Ritter, The Louvin Brothers, and Buck Owens side by side with some wonderful obscurities from the likes of The Farmer Boys, Skeets McDonald, and The Milo Twins.

Leslie Ann Jones' engineering and Larry Walsh's mastering make it all sound much cleaner and better than anyone would have a right to expect, given the age of these performances. The only serious flaw is the lack of annotation. Original recording and release dates and sidemen should have been part of the package. However, as Crenshaw notes, the session files of these tracks were destroyed in a fire in '65. That one carp aside, this is a highly recommended release.

Michael Tearson

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Hindemith: Mathis der Maler. San Jose Symphony, George Cleve.
Bainbridge BCD-502, CD; DDD; 26:57.

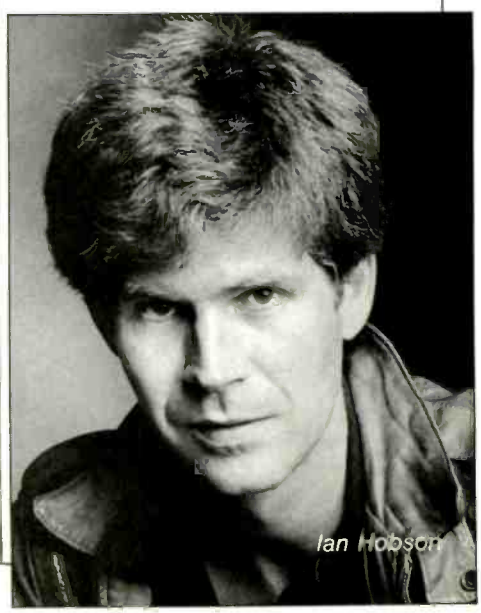
Here's a stunning version of the one really outstanding symphony among the prolific orchestral works of the late German composer, Paul Hindemith. The Mathis der Maler is significantly the very first of its genre, built out of an opera banned by the Nazis in the early '30s. The CD is a reworking of a 1984 Sonic Arts recording via the Colossus system. The performance, actually, is a bit on the heavy side, but Hindemith was always so inclined himself, both in music and in body. Also, in the live performance, with audience, there are a few strangled string noises here and there, indicating less than total assimilation of the music by these players. Nevertheless, there is power and conviction. The Third Movement, "Temptation of St. Anthony," indeed becomes quite terrifying.

The recording is the real stunner here, even with a live audience and a few mild coughs. It is a vivid, super-real symphonic sound, huge and forceful, about as convincing as anything I've ever heard. This is the work of Leo de Gar Kulka who, if I am right, founded the Sonic Arts label for his own work and is instrumental in these Bainbridge reissues on CD. The early Sonic Arts products, as I've noted before, were naïve to the point of absurdity in their "direct-to-something [disc or digital]" live concert format: Great stretches of audience noise, music begun and hastily faded out, lots and lots of musical boo-boos. Not so this recording, nor any so far put out by Bainbridge. Kulka, who came to L.A. from musical Central Europe, obviously has lived and learned in the classical field. The huge, fat brass chords that characterize so much of Hindemith's orchestra are simply awesome in sound here. I have heard leaner, faster, more precise versions of the music but none ever had *this* sort of audio! A real showpiece.

You will note the length of the CD. You can buy it for less—it's one of those new "shorties," 20+ minutes, now arriving in the stores. It's also one of the "longies" in the packaging—double size and all cardboard. We *knew* the CD was too long (that is, for many a listener's limited attention span) and too small (for the proper eye-catching sales appeal). Hence the frantic search for better sizes on both counts, to supplement the real longies in length. Maybe we should package the three-inch CD in leftover LP covers? That might sell. Just punch a hole in the center and put in a three-inch blister. . . . *Edward Tatnall Canby*

Saint-Saëns: Le Carnaval des Animaux (original instruments); Septet; Allegro Appassionato; Bagatelles. Sinfonia da Camera, Ian Hobson; Claude Hobson and Ian Hobson, pianos.
Arabesque Z-6570, CD; 60:09.

Familiarity doesn't always breed contempt—more often, contentment. Almost everybody knows this "Carnival of the Animals" in the alternative format for orchestra with two pianos. This is the original, kept out of circulation for decades by Saint-S., though often played privately for friends. It is chamber music, music-room music, for two pianos neck to neck and a group of nine instruments surrounding them, audience a few feet away. Very loud, of course, in that situation, and you can make it as loud as you want for your own listening.



Ian Hobson

The unfamiliar format will probably jar and jolt you a bit with its very different sound, but it will also intrigue you to listen further. Instead of a whole string orchestra, there's a string quintet with one instrument on each part, plus the wind and percussion instruments you hear in the larger version—flute, clarinet, celesta, xylophone. The real difference in the listening is proximity. Everything is very close to you, instead of way off at concert stage distance.

Ian Hobson, the prime mover here (two Hobsons, Ian and Claude, play the two pianos), is an indefatigably communicative pianist. (Listen to his monumental and fascinating set of three CDs, *The London Piano School*.) He is the nominal conductor, presumably via head and eyebrows since his hands are decidedly busy. Nevertheless, the sprightly playing stems from his leadership, without a doubt—also in the accompanying works, all with piano or piano solo (himself).

There is a yet later posthumous version of the Carnival which really sews it up to perfection: The little verses by Ogden Nash, summing up each animal in a few choice and wonderful words. (Nash himself spoke the lines, deadpan, in an early recording.) The perfect companion to "Peter and the Wolf," this combination of Saint-Saëns and Nash beats "Peter" all out, for everybody from adults to children.

Now listen to me, Arabesque Recordings. You *must* do an Ogden Nash version of *this* Carnival! Just jettison some of the other music, do some digital editing, and insert an appropriate voice. Not Nash—he is no more—but somebody, preferably elderly and fatherly, with a benign sense of humor and a good close-up voice (for the chamber music surround). Walter Cronkite? Betcha he'd do it. It could be a winnah—for Christmas maybe, whichever Christmas comes next.

Edward Tatnall Canby

Dvořák: Concerto pour Violoncelle; Tchaikovsky: Variations Rococo. Boston Symphony Orchestra, Seiji Ozawa; Mstislav Rostropovich, cello. **Erato ECD-88224**, CD.

The Dvořák Concerto in B Minor for Cello and Orchestra is one of the great seminal works for this instrument, and it is widely used as a benchmark to evaluate the technical prowess and artistic and musical capabilities of a cellist. Thus far, there are some 23 CD recordings of this work, ranging from recordings by Du Pré and Feuermann (mainly of interest in a historical context) to modern digital recordings by such artists as Lynn Harrell, Yo-Yo Ma, and Mstislav Rostropovich.

While taking nothing away from the excellent recordings of Harrell and Ma, it is Rostropovich (affectionately known in musical circles as "Slava") who has been most closely identified with this work. In fact, he is represented on CD

Mstislav Rostropovich may be getting along in years, but there is no sign of a decline in his technical or interpretive artistry.

with recordings under Giulini and the London Philharmonic and von Karajan and the Berlin Philharmonic, as well as this latest effort with Ozawa and the Boston Symphony. However, Rostropovich also has made quite a number of analog recordings of the Dvořák Cello Concerto, dating back to those done in his native Russia. Musicologists endlessly argue which represents his best performance of this work.

The recording of the Dvořák Cello Concerto under review here was made with Seiji Ozawa and the Boston Symphony Orchestra in December 1985. Although Rostropovich is getting along in years, there is certainly no evidence of a decline in his technical or interpretive artistry. His tone remains firm, yet his expressive vibrato really makes the instrument sing. In the great vaulting arches of glorious melody in the First Movement, no other cellist quite equals the emotional intensity of his performance. The Second Movement is equally compelling, while the last part of the Finale conveys a sort of world-weary resignation that is really heart-wrenching, even though the work ends in the uplifting fortissimo fanfares of the orchestra.

The familiar Tchaikovsky Variations Rococo for cello and orchestra are equally well played and make an appropriate filler for the Concerto. Seiji Ozawa and the great Boston Symphony Orchestra have obviously established a fine rapport with Rostropovich, and they furnish him with an unusually perceptive and sympathetic accompaniment. Add a splendidly clean recording by John Newton, with a most natural balance between cello and orchestra, and it all contributes to an outstanding sonic and musical experience. *Bert Whyte*

Pops Britannia. Boston Pops Orchestra, John Williams.
Philips 420-946-2, CD; DDD; 54:43.

John Williams and the Boston Pops offer an engaging program of some familiar British folk-song-inspired pieces, such as "Londonderry Air" ("Danny Boy") and "Greensleeves," along with Delius' haunting "Brigg Fair" and Davies' sprightly "An Orkney Wedding." The CD is rounded out with excerpts from John Williams' film score for *Jane Eyre* and Walton's stirring "Orb and Sceptre." The last number, "Scotland the Brave," is replete with the skirl of bagpipes and the rattle of field drums. Add a nice, clean recording with the usual superb Pops musicianship, and this is a CD to delight the heart of any Anglophile. *Bert Whyte*

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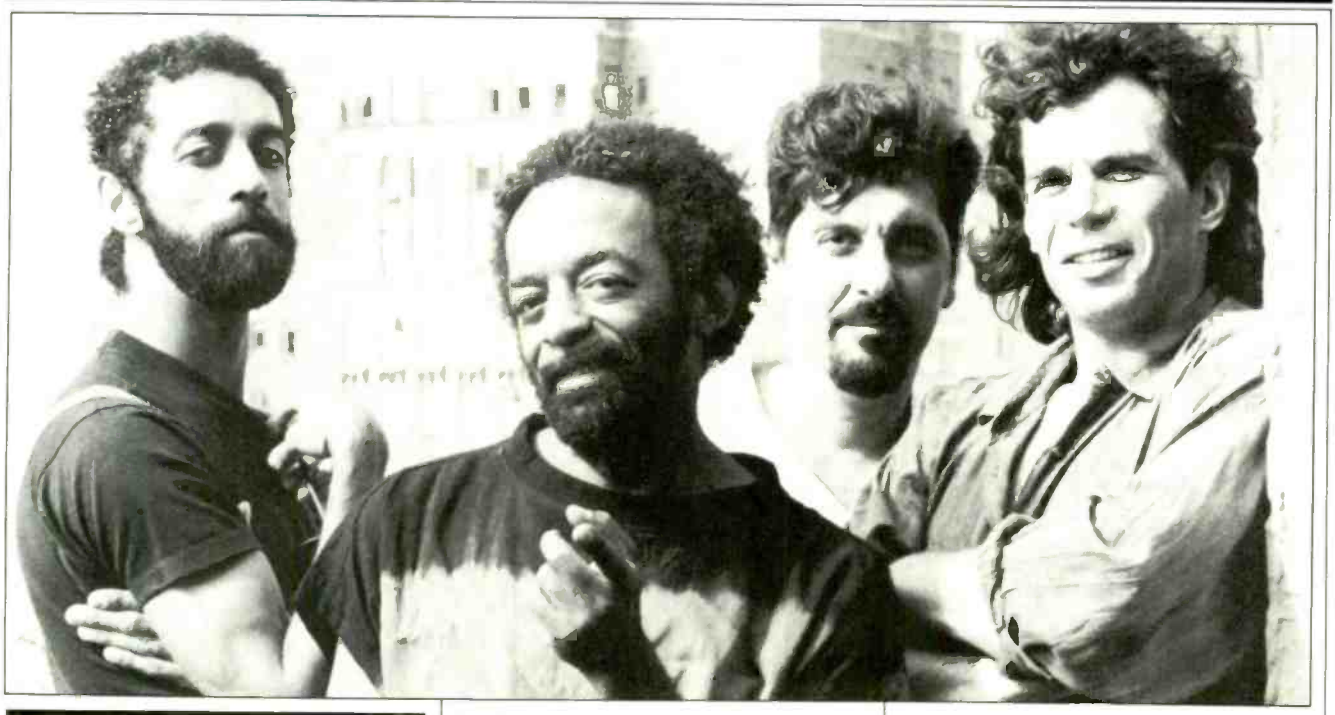

Rain Dance: Nana Vasconcelos
Antilles 91070-2, CD; AAD; 47:07.

Sound: A Performance: A–

Nana Vasconcelos is a Brazilian percussionist who gained fame playing with avant-garde jazz artists Don Cherry and Gato Barbieri in the late 1960s. Although Brazilian, his music is an amalgam of African and Latin American instruments and rhythms. He is especially known for playing the berimbau, a one-stringed African lute played with a stick.

The metallic rhythms of the berimbau are still in evidence on *Rain Dance*, where Vasconcelos continues to reach beyond the traditional percussionist's role, finding the melodies implicit in his rhythms. He has composed world music improvisations with the collective Codona; on his own, his 1980 album *Saudades* (ECM) and 1983's *Zumbi* (Europa) were lush, sensual excursions into rhythm and percussion. With *Bush Dance* (Antilles), he began getting involved with synthesizers and more contemporary rhythmic motions. This is carried farther and done more successfully on *Rain Dance*.

Vasconcelos and the Bushdancers orchestrate a propulsive, sensually volatile rhythmic landscape mixing synthesizers, acoustic percussion, and chanting vocals that sound like a tribal dance for the world. They've found a sound space where electronics take on earth tones and acoustic percussion takes on new dimensions.

Rain Dance opens with the simple, childlike themes of "Bird Boy," with Vasconcelos singing the plaintive call over a lazy rhythm that soon explodes into a heavy-metal African crunch. On the title track, Vasconcelos creates a push-pull sensation in the rhythm, while flutes and bird-like synthesizer sounds chirp and gurgle in melodic communication.

Throughout, Vasconcelos and his ensemble sprinkle fragmented melodies with breathy synthesizer sounds and Sergio Brandao's earthy, gut-grabbing bass melodies. Recorded and mixed in analog formats, the *Rain Dance* Compact Disc erupts from the speakers with crispness and visceral punch.

There are references to Weather Report, with the Zawinulesque synthesizer lines of "Batida," and nods to African percussive giants such as King Sunny Ade and Babatunde Olatunji. But few have achieved the kinetic and sensual mix of technology, rhythm, and percussion as successfully as Nana Vasconcelos. *Rain Dance* is a tribal celebration for the techno-age—a joyous yet intelligent romp into a new world music groove. *John Diliberto*

I Ain't Beggin' Nobody: Larry Davis
Pulsar PUL-1001, LP. (Available from Pulsar Records & Publishing, Suite 11, #1880, Bogey Hills Plaza, St. Charles, Mo. 63302.)

Sound: B+ Performance: B–

No less a blues authority than B. B. King picked Larry Davis as a future star when he signed the St. Louis bluesman to King's own short-lived Virgo Records. King's foresight was proven when Davis won a Handy Award for contemporary blues album of the year for his 1982 debut, *Funny Stuff* (Rooster Blues). *I Ain't Beggin' Nobody* is the long-awaited followup, cut with many of the musicians heard on *Funny Stuff*.

The title track, which opens the album, forecasts another success. Producer/engineer Oliver Sain's overdubbed horns and piano provide a pulsating backdrop for a strong solo and Davis' polished vocals. The dynamics that propel "I Ain't Beggin' Nobody," however, are too often absent elsewhere. Without brass or an aggressive rhythm guitar on most of the album, the songs never build up a head of steam. The absence of drum-

Larry Davis is a polished, affecting blues singer and guitarist with a claim to a much wider audience.

mer Billy Gayles, a key member of Ike Turner's Kings of Rhythm who helped give a spark to *Funny Stuff*, is readily noticeable. To compound the lack of tension, Davis' vocals are rarely answered by his band, let alone his own busy, clipped guitar runs. Most tracks end with a fade-out rather than anything decisive, as if to acknowledge their own lack of focus.

Davis is a polished, affecting singer, but he tends to an ethereal approach reminiscent of former band mate Fenton Robinson, rather than the guts-and-gravel attack of gospel singers. Davis' singing and the meandering arrangements work best on the B. B. King ballad "Sneaking Around," which highlights Davis' wonderful falsetto.

I Ain't Beggin' Nobody isn't a bad album, merely a disappointing one. Davis, a former member of the bands of blues Kings B. B. and Albert, is a mature bluesman with a claim to a wider audience. Both Davis and the newly launched Pulsar label bear watching.

Roy Greenberg

Pardon Me!: The Bruce Forman Quartet
Concord Jazz CCD-4368, CD; AAD; 47:45.

Sound: A Performance: A

If the new Bruce Forman Quartet album were an audio textbook instead of this blowing record, its title might be something like *A Survey of Traditional Jazz*. Guitarist Forman is totally in control, with a smooth, fat, liquid tone that races, soars, and brakes all over tunes ranging from a no-holds-barred jamming of Coltrane's "Count Down" to original hot be-boppers like the title cut, one-take improvised standards like "Autumn Leaves," the daring harmonic contrasts of David Liebman's "Once Again," and a stunning, octave-technique tribute to the master, "Blues

Photograph: Frank Driggs Collection

Peggy Lee's new album is all but flawless. She is utterly convincing in this set of blues standards.

for Wes." Billy Childs is no slouch in the ivory area, and you can't find fault with Jeff Carney's bass or Eddie Marshall's drumming. If you like the classic sound of a very talented, enthusiastic, be-bop-style combo, check out The Bruce Forman Quartet's *Pardon Me!*

Michael Wright

Miss Peggy Lee Sings the Blues
MusicMasters CIJC-60155, CD; DDD; 48:27.

Sound: A Performance: A

To anyone who has ever attended a Peggy Lee event or just heard her sing on record, the enduring quality inherent in her latest work will come as no surprise. She has remained a peerless interpreter of American song throughout a career which spans several decades.

Renowned for the meticulous excellence with which her artistry is consistently portrayed, Lee projects an honest emotion and unique personality into a song, and she does so with seemingly effortless, witty, impeccable style. As a vocalist and accomplished songwriter, she instinctively feels and understands the subtle distinctions and variations of timing and meter in a song. Peggy Lee never fails to bring to a lyric and melody a totally distinctive point of view.

The blues is one of the oldest forms of American music. It is rarely expanded beyond its specific harmonic structure, and its interpreters, considered perhaps too generic, seldom cross over. Similarly, very few mainstream vocalists would attempt to essay the art. That Peggy Lee is so utterly convincing in this collection—which includes Fats Waller's "Squeeze Me"; W. C. Handy's "Beale Street"; two Billie Holiday tunes, "Fine and Mellow" and "God Bless the Child," and the more recent Leiber and Stoller R&B classic, "Kansas City"—is testament that the singer's power has not diminished. The material may be old, but Peggy Lee brings it to life anew. The superlative accompaniment is supplied by Mike Renzi, piano; John Chiodini, guitar; Jay Leonhart, bass; longtime associate Grady Tate on drums, and Mark Sherman on percussion and vibes.

The sound has been beautifully digitally recorded at New York City's Clinton Sound by the uncredited Andrew Milano. Produced by Gregory K. Squires, the result is all but flawless. The mellifluous elements of a stellar performance have been perfectly captured in a studio setting, with Peggy Lee sounding as intriguing as ever.

Michael Aldred

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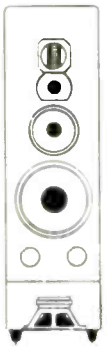

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ANNOUNCEMENTS

AUDIO CLASSICS

Precision Stereo Components Bought-Sold-Traded-Repaired-Modified-Updated-Appraised. AMPLIFIERS: conrad-johnson Premier 1B ($5950) $3900; Eagle 2 $595; Hafler XL280 Demo ($675) $575, XL600 Demo ($1195) $995; Krell KMA100 II ($6000) $3500, KSA100 II ($3650) $2500; McIntosh MC 30 $2-300, MC40 $400, MC50 pr. $500, MC60 $550, MC225 $700, MC250 $350, MC2100 $500, MC2105 $650, MC2120 $850, MC2125 $1050, MC2002 ($1895) $1600, MC2250 ($2495) $1700, MC2300 $1700, MC2500 ($3495) $2200, MC7270 ($2195) $1800; SAE A201 ($650) $300; Threshold S200 ($1950) $1200. **CD PLAYERS:** Magnavox; McIntosh MCD7000 ($1399) $8-900, MCD7005 ($1599) $1200, MCD7007 ($1995) $1600. **EQUALIZERS:** Audio Control Octave ($179) $149, Ten $229, Ten Plus ($329) $295; dbx 20/20 ($1700) $800; Cello Pallette ($12,864) $7,500; McIntosh MQ101 $99-175, MQ102 $60, MQ104 ($500) $99-285, MQ107 ($650) $400; SAE E101 ($650) $300. **HEAD AMPS:** audio-research MCP33 ($1395) $700. **INTEGRATED AMPLIFIERS:** McIntosh MA230 $399; MA5100 $400, MA6100 $500-600. **PRE-AMPLIFIERS:** Cello Etude ($1200) $800; conrad-johnson PV1 $375; Hafler Iris Demo ($800) $679; Krell KRS1A ($8200) $5900; McIntosh C11 $700, C20 $600, C24 $250, C26 $400, C28 $500, C30 $1200, C31V ($1895) $1500, C34V ($2195) $1800. **PROCESSORS:** Audio Control Phase Coupled Activator ($279) $239; dbx 110 NEW ($99) $49; Lexicon CP1 ($1295) $1050. **RECEIVERS:** McIntosh MAC1700 $450, MAC4100 $1050, MAC4275 ($1798) $1200. **SPEAKERS:** Acoustat Spectra 33 ($2250) $1999; Apogee Duetta Signatures ($3735) $2585; Dahlquist DQ10 $600; JSE Infinite Slope Demos .6 ($599) $475, Used 2 ($2295) $1200; McIntosh ML1C $550, ML2C ($1598) $800, ML4C ($2400) $1000-1800, XL1 ($525) $375, XL1W ($549) $375, XL10 ($858) $350, XR5-19 $900, XR6 $800, XR16 $800, XRT20 $3200; Velodyne ULD 12" ($1195) $1095, ULD 15II ($1795) $1669, ULD 18 II ($2595) $2395. **TAPE DECKS:** Kyocera New D811 ($750) $545; Tandburg TCD330 $300. **TEST EQUIPMENT:** Audio Control SA3050A 1/3 Octave Real Time Analyzer ($965) $877; Sound Technology 1000A $1500, 1701A ($4950) $3250. **TUBES:** Many major brands. **TUNERS:** Magnum Dynalab FT101 Demo ($698) $599, 205 Demo ($229) $199, FT101A Demo ($1195) $995, FT11 Demo ($449) $425; McIntosh MR55 $100-350, MR65B $200-500, MR66 $350, MR71 $600, MR73 $450, MR75 ($1349) $800, MR80 ($2495) $1500; SAE T101 ($650) $300. **TUNER PREAMPS:** McIntosh MX110 $250-500, MX112 $450, MX117 $1200. **TURNTABLES:** Ariston Forte ($625) $569, Icon ($520) $439, Q-Deck ($365) $289; Dual CS5000 ($569) $399. Audio Repairs-Updates-Modifications by Richard Modafferi and Clif Ramsey. Over 55 years combined experience. **AUDIO CLASSICS** invites you to visit our new retail location at the United States Post Office Building in Walton, NY. FREE Catalogue. Layaway Program. Major Credit Cards accepted. 8AM-5PM EST Mon.-Fri., POB 176, Walton, NY 13856.

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ANNOUNCEMENTS

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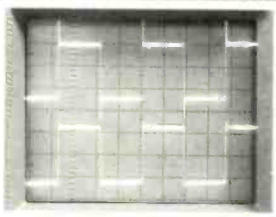

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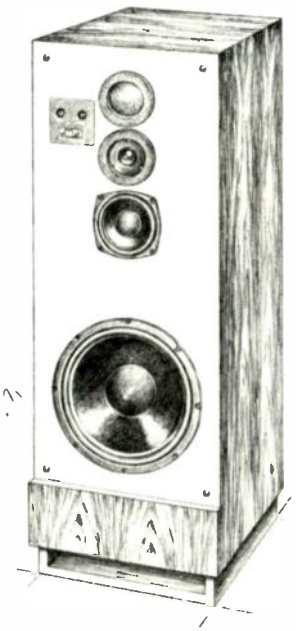

The VMPS MiniTower IIa, $369ea kit, $479ea assem in oak or walnut. 39"x12"x 15" (HxWxD), 65lbs.

The VMPS MiniTower IIa is a dual 10", compact floor standing system with many of the features and much of the performance of our highly acclaimed large speakers, at a very attractive price. Sensitivity (92dB/1W/1m), power handling (200W rms/8 Ohms), maximum undistorted output levels (122dB SPL/1m) and bass extension (-3dB at 28Hz) are outstanding for a system this size. The MiniTower IIa shares the same mid and high frequency complement as the VMPS **Tower II** (a "Recommended Component" of **Stereophile** magazine, April 89).

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Hear VMPS at the dealers listed below, or write for brochures and test reports. Kits are supplied with fully assembled cabinets and all prices include free shipping in 48 US states.

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div. Itone Audio

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Now you have got a simple choice when it comes to upgrading your car stereo. Instead of paying a few thousand to a good high-end dealer, you can pay only a few hundred. With a good in-dash unit in place, you need only follow author Dan Ferguson's instructions for buying and replacing your front speakers, main speakers, and adding the killer—a subwoofer with enclosure, power amp and crossover.

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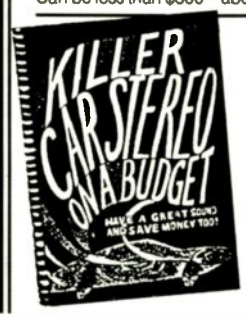

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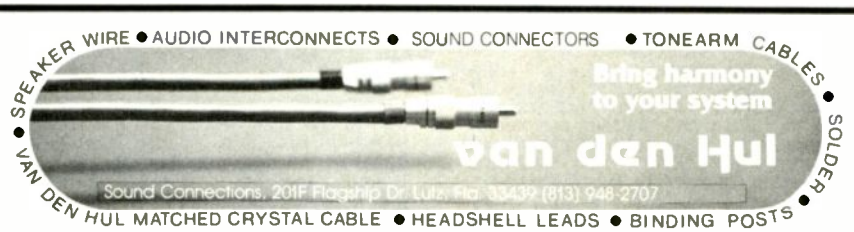

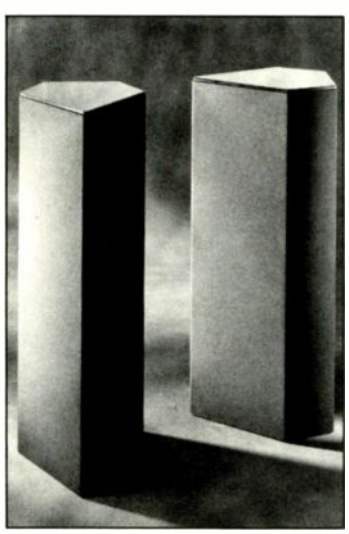

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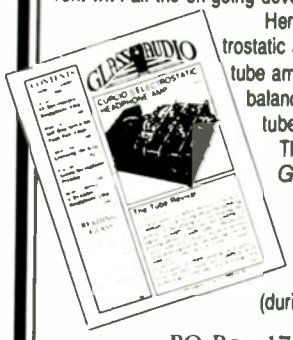

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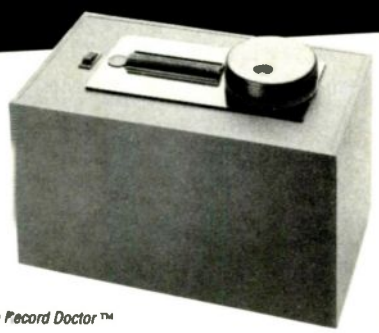

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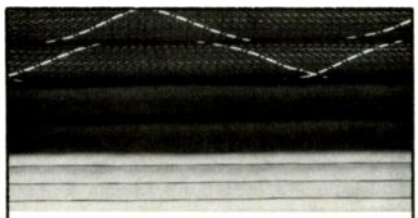

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