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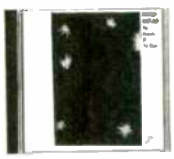

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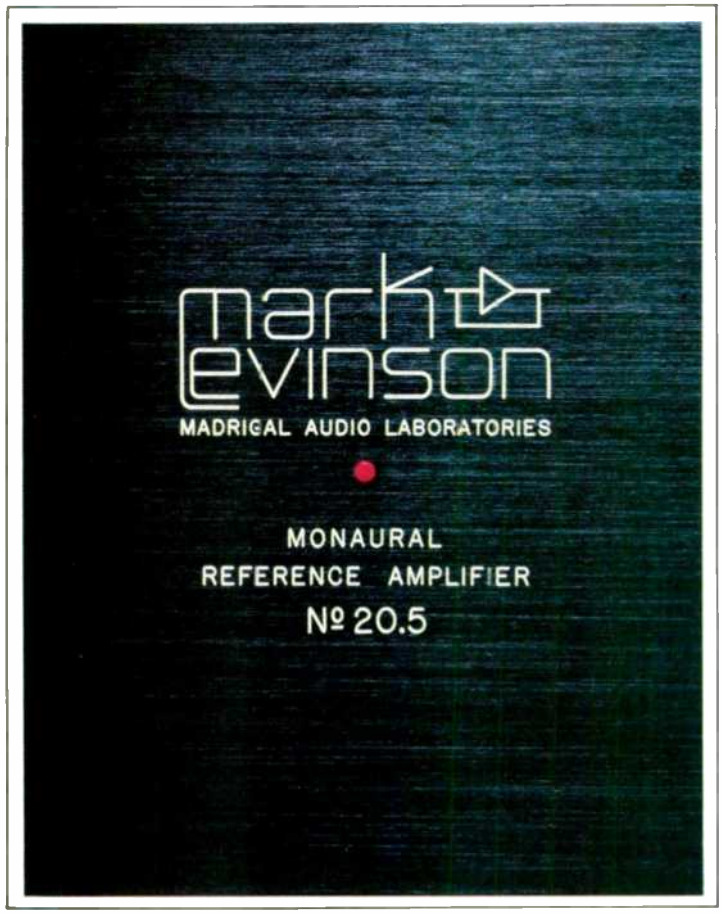

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SIGNALS & NOISE

Foresight Forsooth

Dear Editor:

Concerning my fanciful piece in this issue's "Audio ETC" on "What hath God wrought," and the first Morse code message, allow me to stave off a number of indignant letters by noting that I am quite aware of the improbability of the "testing-testing" messages I manufactured for the story.

Not, however, their impossibility. If I am right, the Washington-to-Baltimore demonstration line was one wire, with earth return, and thus subject to plenty of nature's interruptions. A couple of thunderstorms in the general region could have set off quantities of spurious dots and dashes, like the clicks I hear today in my rural phone when there is lightning around. An imaginative and excited mind might well interpret these literally. *Spqrfcc?* Maybe.

I trust that those who set up audio communications will attest to the validity of the testing-testing concept—Mr. Murphy, Sr. included.

Edward Tatnall Canby
West Cornwall, Conn.

Help Wanted

Dear Editor:

I wonder if I might make an appeal through the pages of *Audio*. Older readers will remember that in the pre-tape era, the very best disc recorders were made by Presto Corp., last located in Paramus, N.J. Of course, they have long been out of business.

I have a Model 8D Presto recorder which I would like to restore, and I am seeking any information regarding servicing, etc. If anyone can send me photocopies of schematics and brochures, I will happily reimburse the costs. I also have a Model 85E recording amplifier, and again, photocopied information would be welcome.

Peter Newbrook
"Applecross"
185A Newmarket Rd.
Norwich, Norfolk NR4 6AP
England

Ins and Outs

Dear Editor:

In regard to the article "Too Many Signal Sources" (June), while switchboxes can be useful in multiplying the number of inputs and outputs of audio equipment, it has been my experience that they also can degrade the signal. It is important how the switches are made. For example, some low-current switches employ an armature that simply touches the different contacts as it is switched. These switches can seriously degrade the signal. On the other hand, in most switches, the armature is grasped between spring contacts; these transfer the signal with better fidelity. Probably the closer a switching mechanism comes to being a continuous wire, the better. In other words, the best switches will have heavy armatures and heavy contact gripping springs.

Another factor that can degrade the ability of a switch to conduct an audio signal is oxidation. Switches made of copper, bronze, or silver will tend to become less efficient as they age. The best switches will have armatures and contacts made of gold alloy or gold-plated materials. Spraying with TV tuner cleaning fluid helps reduce oxidation and improve the signal conduction of all switches.

In view of these considerations, it seems important that audiophiles study the construction of the switches that they are thinking of using. Since many switches are mounted in boxes it may be difficult to see the armatures and contacts or to reach them easily with cleaning fluid. Also, it is wise to test switches before buying them.

Bradford Lyttle
Chicago, Ill.

Erratum

In my article, "Cables and the Amp/Speaker Interface" (August), the discussion of a transmission line's characteristic impedance, on page 48, should have read:

The characteristic impedance of a transmission line is given by:

$$Z_0 = \left(\frac{R + j\omega L}{G + j\omega C}\right)^{1/2}$$

where R is the line resistance per unit length, L is the series inductance per unit length, C is the shunt capacitance per unit length, and G is the shunt conductance per unit length. Of the two constants, j is the square root of -1 and ω is equal to 2π times the frequency.—*R. A. Greiner*

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TAPE GUIDE

HERMAN BURSTEIN

Test-Tone Anomalies

Q. My cassette deck has the Dolby symbol marked on its meters midway between the 0 and +4 dB points. A few months ago, I acquired a cassette containing some test tones, including a Dolby 400-Hz calibration tone and left- and right-channel 400-Hz tones recorded 3 dB below Dolby level. When this cassette is played on my deck, the meter reading for the Dolby calibration tone is at the 0-dB point on both channels; meter readings for the left- and right-channel tones are at −4 dB, and readings on both channels sometimes fluctuate—for example, from −4 dB to midway between −4 and 0 dB.

What is the correct interpretation of the meter readings I have described? What, if any, are the undesirable audible consequences of these readings? I find it hard to believe that such readings are normal. It seems that a problem exists, or will exist, but I am uncertain if I have encountered it. Is my deck in need of alignment or other servicing?—Victor S. Zupancic, Kirkland Lake, Ont., Canada

A. Your deck may be slightly—about 2 dB—misadjusted with respect to Dolby level. The meter markings, too, seem slightly off—about 1 dB. Alternatively, the test-tone levels may be off. A high-quality, accurate test tape is expensive, costing up to $100; inexpensive test tapes can easily be somewhat inaccurate. The variations in the recorded tones' levels also seem to be an artifact of the test tape, particularly since they vary *upward*. If they were downward, this would suggest momentary loss of good contact between the tape and the tape head.

If the meter readings, instead of the tape, are at fault, they are too minor to be of real consequence. If you follow these readings, you may fail to achieve as high an S/N ratio as is theoretically feasible, but not by much. On the other hand, you'll get added protection against recording at excessively high levels, which can cause noticeable distortion and treble loss. In the case of the meter fluctuations—if these are slight, brief, and not particularly audible—again, you have nothing important to worry about. Even if they are audible on single tones, keep in mind that such imperfections tend to disappear on normal program material. Also, as I said before, these fluctuations may be due to the test tape rather than your deck.

Your ears are an excellent measuring device. If your deck can produce a good aural facsimile of the original source, it is working properly. Remember the maxim: If it ain't broke, don't fix it.

More on Hi-Fi VCR Recording

Reader John H. Markell has more illuminating information on high-fidelity recording with a VCR:

I agree with Brent Jessee ("Tape Guide," January) that operation at the highest speed on a Hi-Fi VCR is desirable in order to minimize dropouts. This is the only reason for operating at the highest speed, because frequency response and S/N are not affected by tape speed. Also, for Beta Hi-Fi, L-500 tape is recommended over L-750 because the former is thicker and therefore less subject to dropouts.

However, it appears that the theory of dropouts should be examined. It seems to me that a tape dropout's duration is too short to be heard directly through the audio decoding system. Dropouts longer than the sync pulses could cause loss of synchronization, turning on the muting circuit. Thus, what would actually be heard would be the dropping in and out of the muting circuit, which has time constants in the audio range. If this is indeed the case, the type of modulation (PCM or FM) would make no difference in the number of dropouts heard, inasmuch as the problem is in the sync circuits. I suspect that differences in dropout susceptibility between various VCR brands are due to differences in their muting circuits.

I have tried Hi-Fi recording without a sync pulse, using the simulcast setting of the VCR with no TV station tuned in. Needless to say, this resulted in many dropouts as well as inconsistent tape speed.

The character of the internally generated sync pulses, when recording audio, may also have an effect on frequency of dropouts. I seem to have fewer dropouts when recording a TV signal, which uses the TV sync, than when recording an audio-only signal, which uses the internal sync. It could be that the TV sync is better than the VCR's internally generated one. Differences in the internal sync generators might be why audio-only tapes made on one brand of VCR sometimes will not play properly on another brand, even though videotapes will. There may also be incompatibility between VCRs if the relative azimuth positions of the audio and video heads aren't maintained.

Dolby for Dubbing

Q. Should I use Dolby noise reduction to record CDs onto tape? If so, should I use Dolby B or C NR?—Alex Ly, Pasadena, Cal.

A. Definitely use Dolby C NR rather than Dolby B NR to copy a CD. Dolby C NR will provide greater noise reduction than Dolby B NR, better enabling you to cope with the wide dynamic range of many CDs. Also, it will better guard against tape saturation in the treble spectrum.

Skew, Torque, and Speed-Up

From his vantage point as service manager and then owner of an audio service shop over a period of eight years, reader Daniel E. Mull of San Luis Obispo, Cal. illuminates some interesting tape problems:

I have run across skew and related speed aberrations on a variety of cassette machines, ranging from minor skew problems (primarily on dual-capstan decks) to major skew and speed problems on cheap units. My experience has been very frustrating at times. Typically, when a deck has excessively high take-up torque along with worn or glazed pinch rollers or inadequate pinch-roller pressure, the fact that most Type II tapes have very highly polished coatings and backings will cause the tape to skew. If the take-up torque is great enough in this situation, the tape will be pulled past the capstan and pinch roller, causing tape speed-up. If a Type I tape of medium to poor quality is used, these symptoms occur far less often.

Recently we serviced two high-end dual-capstan decks that exhibited ma-

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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Even though the meters of two decks read the same, the decks' output levels can differ appreciably. It's a question of gain.

jor skew problems, with resultant tape damage, but only when using Type IV tape; cassette behavior was perfect with Type II and Type I tapes. In both decks, the problem was eliminated by increasing pinch-roller pressure on the supply side and decreasing the take-up torque back to the unit's original specifications.

Conversation Piece

Q. I have some questions about tape recording and equipment for the purpose of transcribing conversations. Presently, I am using an old Realistic tape deck, a Numark equalizer, and an old self-amplified Ampex speaker. My objective is to hear as much conversation detail as possible. What do you recommend?

I also transcribe microcassettes. Would it be best to copy these onto a C-60 or C-90 cassette, or would you recommend just hooking the microcassette deck directly into the equalizer?—Herbert Joe, Houston, Tex.

A. It seems that your best option is to take advantage of the facilities provided by your equalizer. Treble emphasis, starting in the range of about 2 or 3 kHz, would enhance the clarity of taped conversations. Trial and error will help you optimize the equalizer settings. If you use excessive treble boost, you may get objectionable ringing. Also try bass reduction below 200 or 300 Hz to improve clarity.

I see no advantage in copying microcassettes onto compact cassettes before transcription; that is, simply go from the microcassette deck into the equalizer.

A better speaker system might also help, particularly if the tweeter level is adjustable.

Variations in Output Level

Q. I have a JVC deck and an Akai deck. The output level of the JVC deck is very low compared with that of the Akai, even though, according to the record level indicators, they are recording at the same level. Why?—Robert G. Nicolella, Scotia, N.Y.

A. The output of home decks tends to vary considerably, roughly from 0.33 V to 1 V or slightly more on signal peaks. Even though the meters of two decks read the same in playback, their output levels can differ appreciably, owing to different gain in the stages following the point at which the playback signal is fed to the meter. A 2:1 voltage ratio—say, 1 V versus 0.5 V—is a 6-dB difference in level, which is quite distinct. A 3:1 ratio is a 9.5-dB difference, which is even more profound.

Just Plain Dolby

Q. If a prerecorded tape just has the words "Dolby System," does this mean Dolby B or C NR or HX Pro?—Nelson Chin, Wollaston, Mass.

A. If a prerecorded tape just says "Dolby," this signifies that it was recorded in Dolby B NR. The reason is that many low-price decks still provide only Dolby B NR and not Dolby C NR. HX Pro probably was not used, but this has no relationship to the Dolby decoding required in playback.

High-Frequency Outage

Q. I have a new deck with auto reverse. Every time I make a recording of 15 minutes or more, I get a very annoying dropout problem. The dropout is cyclical—about every 3 or 4 S—and the high frequencies suffer the most. The longer the recording, the worse the problem becomes, to the point where the dropouts convert to a continuous absence of high frequencies, except for an occasional moment of normal response. I take meticulous care of the deck, with regular cleaning and demagnetization. Please help me with this problem.—Douglas J. Bayne, Huntington Station, N.Y.

A. When high frequencies suffer the most, I am inclined to suspect an azimuth problem or poor contact between the tape and the heads. Inasmuch as your difficulty is intermittent, at least early on, poor azimuth alignment would also have to be intermittent. This could be caused by skewing of the tape within the cassette shell, due to a defect in either the cassette or the deck. Poor contact between the tape and the heads could be due to failure of the cassette's pressure pad to operate properly; perhaps something in the deck's mechanism prevents the pad from fully exerting pressure. Other possibilities are improper adjustment of the torque of the take-up and supply reels, or a spot of dirt which cleaning hasn't adequately removed from the tape head.

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A five band program equalizer adjusts and improves the loudness contrast of the five most important frequency ranges. Musical balance can be adjusted to compensate for listener preferences.

A precision volume control is electronically trimmed during manufacture to maintain channel balance accuracy to a fraction of a decibel (dB). This high order of accuracy assures continuing program balance as the volume is changed.

The C 35 SYSTEM CONTROL CENTER has many useful features to enhance your listening and video enjoyment. They include: High level imputs 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 hand-held 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.

The McIntosh MCD 7007 COMPACT DISC PLAYER moves performance to a new pinnacle of technological achievement producing the highest quality music reproduction. Every aspect of performance is improved: focusing and tracking, decoding, error correction, digital filtering, digital-to-analog conversion. Even with dirty or damaged discs, even when the player is bumped or knocked, the music retains its surpassing purity. The full integrity of the sound is preserved from the first readout of the compact disc straight through to the gold-plated connectors on the output.

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McIntosh has earned world renown for its technological contributions for improved sound. The FM/AM McINTOSH MR 7082 TUNER is continuing evidence of McIntosh technological superiority and integrity and the McIntosh reputation for durability, long life, and best sound. In a McIntosh you get user-oriented facilities and appearance, and a design that provides for ease of maintenance or repair. These fundamental elements are incorporated in the McIntosh MR 7082 FM/AM Tuner, the easiest to operate yet with extensive useful features.

The MA 6200 combines McIntosh's amplifier and preamplifier technologies into one chassis. This feature packed integrated amplifier is another fine expression of stereo engineering, hand craftsmanship and quality manufacturing by McIntosh.

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- Sophisticated-Versatile-Complete IR Remote Control.
- Use hand-held IR Remote Control to select sources-FM or AM- up to three speakers-tape or video (audio) record or playback adjust volume.
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- McIntosh POWER GUARD* protects the quality of the sound.
- Five band tone equalization controls.
- Three pairs of stereo speakers may be played independently or together.
- 6 FM and 6 AM pushbuttons with electronic memory for programming.
- Manual Tuning
- Scan up or down either the FM or AM band.

McINTOSH MAC 4280 FM/AM RECEIVER

- Three band tone equalization controls.
- Two pairs of stereo speakers may be played independently or together.
- McIntosh digitally controlled linear phase FM tuning system which tunes in 100 kHz increments.
- McIntosh AM digitally controlled precise center tuning system.
- 5 FM and 5 AM pushbuttons with electronic memory for programming.
- Scan up or down either the FM or AM band.
- Separate RECORD and LISTEN input switching, introduced and perfected by McIntosh.
- Use the hand-held IR remote or front panel controls to select the listened-to sound source and volume desired.
- Add a McIntosh R607 Remote Sensor to provide remote control from a second area.
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- McIntosh POWER GUARD protects the quality of the sound.

McINTOSH CR7/CR8 REMOTE CONTROL SYSTEM

The McIntosh Infrared Remote Control System provides unusual versatility with operating simplicity. It is a system which provides remote control in one listening area, yet can be expanded to provide individual source selection with independent volume settings in up to five additional areas.

The McIntosh MQ 107 custom environmental equalizer is a fourteen channel (seven per side) third octave room equalizer. The MQ 107 is designed specifically for the McIntosh speaker owners who wish to go further in refining their systems. The MQ 107 has adjustments for room standing waves, extended bass response, different room gains, and high frequency balance.

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Coherence of sound imaging
Definition of musical instruments
Musical balance
Musicality of expression
Absence of typical loudspeaker sound

Each member of the McIntosh family of music reproducing instruments is designed to meet these demands.

Each McIntosh loudspeaker is conceived in total dedication to the pursuit of excellence, the time required to develop the research program to meet these criteria has spanned at least two decades. The elusive combination of variables required to yield a uniform field has been tantalizing researchers for many years. Finally, after McIntosh built one of the most advanced and best instrumented acoustical laboratories in the world was it possible to follow the many theoretical leads to their conclusion. Then, after this extensive effort of analyzing so many different approaches to uniformity of field, was it possible to synthesize all of this knowledge and in one flash of intuitive genius the director of our acoustical laboratory saw a seemingly simple solution in the correct matching of diameters, masses and compliances and what evolved is a new measure of accuracy and realism. The intellectual and emotional experience of listening to a McIntosh is something you simply must enjoy in your own home.

The McIntosh XRT 22 is the purest expression of the loudspeakers scientist's endeavors. It is the one *right combination* of component parts that has eluded the diligent searcher for the loudspeaker bridge to the dominion of reproduced musical reality. The high-frequency radiator column is an illustration of the *right combination*. The 23 tweeter elements can reproduce 300 watts sine wave input power at 20 kHz, with the lowest measured intermodulation distortion. Because each tweeter mechanism handles a small quantity of the total power, extremely low quantities of distortion are developed. The total columnn radiates the energy in a half cylindrical time co-ordinated sound field. The low distortion, transparency of sound, coherence of sound images, defintion of musical instruments, and musical balance is simply a revelation that you must experience.

Sound images are amazingly lifelike in the McIntosh XRT 18 system. To reproduce the power, the clarity, and the pure musical expression of a triple fortissimo, the XRT 18 transforms the electrical energy to acoustical energy through 32 one inch dome tweeters, two six inch midrange drivers and two twelve inch bass mechanisms.

The design objectives for the XR 1052 uniform field loudspeaker are directed precisely to satisfy the requirements for the maximum in musical performance. The XR 1052 is a four way system with exceptionally uniform dispersion. It has a one inch dome tweeter, a precisely matched five inch midrange, supported in the bass range by a high power handling ten inch woofer and a twelve inch passive radiator.

The McIntosh XD 717 is a three way speaker system which uses a one inch dome tweeter, a six inch midrange and a low distortion twelve inch woofer. In a loudspeaker system of this size it is amazing how the sound you hear corresponds to the message carried by the electrical signals that drive the loudspeaker.

Excellent dispersion is only one of the many quality characteristics of the XD 715 system. The choice of materials and the acoustical, mechanical and electrical characteristics of each speaker element are adjusted for optimum performance. These high quality elements make the XD 715 the outstanding loudspeaker in its price class.

Two active and one passive driver are the elements of the XL 10. You will hear a three dimensional sound space and smooth response. The McIntosh anechoic chamber provided the ability to adjust response, amplitude and arrival time to the optimum in a loudspeaker of this size. The XL 10 can recreate stereo sound for you with full depth and spaciousness.

The two way compact loudspeaker system, XL 1, has a power handling six inch polypropylene woofer, a complex, true 1 kHz crossover network, and a one inch dome tweeter. With the XL 1 you get depth and spaciousness and low distortion, high quality sound that has challenged the industries for a loudspeaker of this size.

The XL 1W bass loudspeaker system is a dual voice coil stereo sub woofer system, designed to complement and smoothly extend the performance of a loudspeaker system, not merely cold unrealistic bass thumps. Here's high quality music you can enjoy and not see the source.

The McIntosh WMS 1 wall mount loudspeaker, is a two way in-wall mounted loudspeaker system designed to reproduce with great accuracy for a wall mount system, the sound from today's digital sound sources. The WMS 1 has a six inch long throw polypropylene woofer and a one inch dome tweeter made of woven polyester fabric which is sealed to present a rigid merging surface.

XL 10 XL 1

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Adding a Single Speaker

Q. My receiver will accept two pairs of speakers. I'd like to use an 8-ohm stereo pair in one room and a single 8-ohm mono speaker in another. Can I run the single speaker from one channel, push the balance control to that channel, and press the mono button? Can I leave the second channel of the "mono" room unterminated?—Marc Richman, Washington, D.C.

A. Yes, you can use a single speaker, and you have two options: One option assumes you will have all three speakers running at once, and the other assumes you'll just have the mono speaker running.

First, let's consider the case of all three speakers operating at one time. Set your mode switch to mono and your balance control to center, just as you normally have it for stereo. Thus, the listening room serviced by two speakers will get the benefit of both speakers and the added "feeling" which two speakers provide—even when you are listening monophonically. There is no problem about terminating the unused channel; it is effectively loaded by one stereo speaker.

If you are mainly interested in having the single speaker operating, connect it to one channel and move the balance control to favor that channel. Again, you don't need to be concerned about terminating the unused channel because the balance control probably kills all signal to that channel. If not, I suggest you terminate it with an 8-ohm resistor of suitable wattage.

Even here, one speaker will be "live" in the stereo room. If the balance control does not completely kill the unneeded channel, some sound will also be produced by the other speaker in this room. If you want silence in the stereo room, add a switch which will open the "hot" leads to both speakers in the stereo location.

Removing Vocals

Q. I am looking for a device or at least a way to remove or muffle the lead vocalist or instrumentalist on recorded music. What can I do to accomplish this? I am a musician and need to use these stripped tracks for practice.—Tom Tuttle, San Antonio, Tex.

A. Although I have heard of a device which supposedly strips off the vocals from recordings, I don't know anything about it. Assuming that you have the necessary equipment, you probably can do this yourself. If the program source is stereo but the lead is placed on just one channel, all you need to do is copy the recording with just the channel which does *not* contain the music you want stripped. Of course, you also lose anything else which happened to be on that channel.

If the music source is monophonic, there's nothing you can do. If the recording is stereo and the material to be removed is centered equally on both channels, you have a fighting chance of accomplishing your goal. The final recording will, however, be mono.

What you require is a mixer with at least two inputs which can be assigned to just one output. You also need a device that inverts the phase of one channel of the music source so that its output is 180° out of phase with the input signal. Although such an inverter could be made from scratch, chances are that among the equipment you have on hand, there is either a cassette recorder, equalizer, or some other unit which just happens to invert phase.

To make this system work, connect the left channel of the music source directly into one mixer input. Connect the right channel of the program source into the input of the device which will invert phase. The output of that device is fed into the second input on the mixer.

Next, send the music to the mixer. Set the two mixer pots to equal knob settings, and adjust the master gain to a suitable level. Start the music. If you hit it just right, the lead vocal will be reduced or removed. If not, move the mixer control associated with the phase-inverted signal up or down. If this makes no difference, advance the volume control on the device which inverts phase. If this device is a cassette recorder, be sure to set its selector to monitor the input. Reset the mixer control to its original position and adjust the volume control on the phase-inverting device up or down until you hear the least amount of signal from the lead which you are attempting to strip. If the lead increases in volume instead of decreasing, chances are that the device you are using to invert phase is not doing so. Try a different piece of equipment.

Once you get things straight, you'll notice a distinct decrease in the volume of the lead you are removing. You may never remove it completely because some of this sound will be found in the overall reverb, which will have random phase and hence cannot be cancelled.

Should the sound be "thin" in bass, you may be able to use an equalizer to boost the bass of *one* channel. Loss of bass is common because bass is often centered along with the lead.

If you only expect to strip sounds from phonograph records, skip the phase-inverting device and reverse the leads of one channel of your phono cartridge. Use the mixer as above.

I have been asked to do this trick many times during my years in the recording field. I hate to do it because the audible results are poor in most cases and can never be stereophonic. When possible, purchase specially prepared background tracks.

The backgrounds for many popular religious songs are often released with no vocals. These tracks are recorded stereophonically and are often of very high musical and sonic quality. There is sometimes an "alternate" provided, with a vocal which you can use for tutorial purposes.

Digital Remastering Of Old Recordings

Q. I've heard a lot lately about old recordings being remastered digitally for better fidelity. I am wondering what is done, aside from transferring the original performance from analog to digital.—Joe Mazza, Long Beach, Cal.

A. Much of the digital remastering is done to permit the performances to be recorded onto CD. Beyond this, there's no telling what happens to any given recording between the moment it is removed from the archives until the time it finds a new home.

Perhaps the safest answer I can give you is that what happens to a performance depends on what the producer

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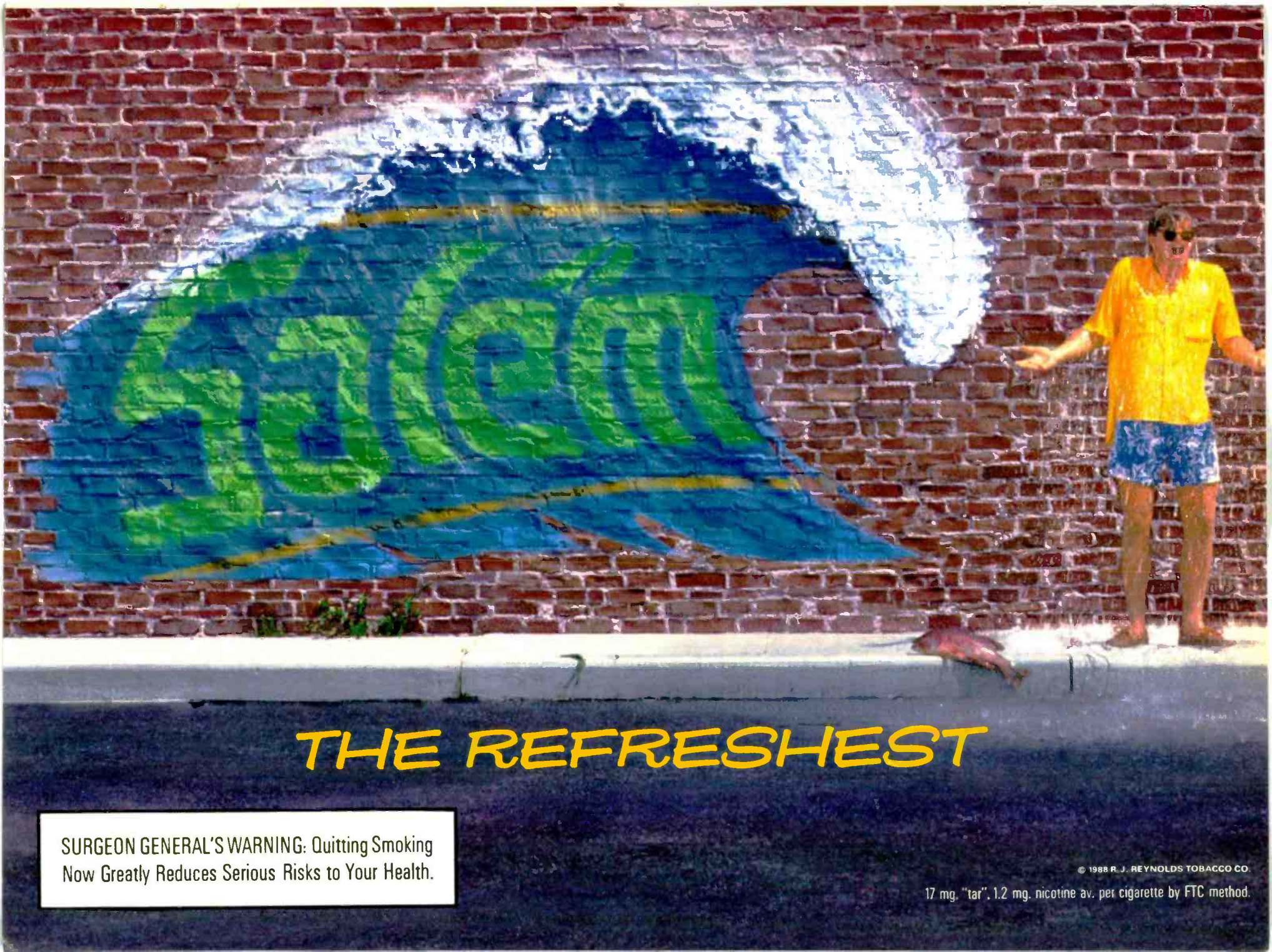
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Sadly, remastering is not necessarily the salvation of old recordings. There's nothing inherently magical about digital recording.

thinks *should* happen to it. For instance, I have recently come upon some really nice jazz trio performances which were much better sonically as analog recordings than they are after transfer to the CD format.

Sadly, I must therefore say that remastering is not necessarily the salvation of old recordings. There's nothing at all magical about digital recording. Any transfer is only as good as its engineers and producers allow it to be

Assuming that the reissue is really better than the original, the engineer may bring this about in a number of ways. He may add bass, for the original master may have been deliberately left bass-shy to fit the groove limitations on a long LP side. Or the producer may add treble if he believes that the studio session would likely have been brighter than the final master tape showed. This can happen because of the limitations imposed by tracing distortion of LPs or by treble saturation on either cassette or open-reel tapes. The producer and/or engineer may also *kill* treble via a filter or by rolling off all treble to reduce background hiss. (I'll accept hiss, so long as the music remains intact.)

Many older recordings were made in very "dead" environments. Thus, the producer may elect to add some reverberation to simulate a real concert hall, or he may like the sound and just leave it as is. I have heard many recordings ruined by overuse of reverb!

Connecting a TV Set To a Stereo System

Q. I recently purchased a stereo TV receiver, assuming that it had high-level stereo output jacks which could be used with my component audio system. Instead, it only has two tiny, tinny speakers about 14 inches apart—obviously unsuitable for stereo!

I am considering adding stereo jacks to the unit by tapping into the wires connecting the set to its speakers. I assume that the audio circuitry is all on printed circuit boards, making it difficult to tap directly into them. Do I need to match impedances somehow and, if so, how? Should I feed the signal directly into the high-level tuner or tape inputs? Will I need any additional resistors in the line?—Randy Webb, Sweet Valley, Pa.

A. I surely thought I'd received the last of letters like this once stereo TV sets came along. Like you, I figured they'd all contain line-level output terminals so the set could be properly connected to component or even "packaged" systems. Oh well. . . .

You must be careful when tapping signal from the speaker outputs. It is essential that the "low" side of the speaker be at true ground potential. I have seen many sets which were not designed that way. If your set is not usable as it is, connect an isolation transformer between the speaker outputs and the inputs of your audio system. This will prevent damage to either the TV or the audio system. You should be able to wire your cables so they will plug into the high-level inputs of your sound system.

When you use the loudspeaker terminals, the volume control setting on the TV set will affect the amount of audio which actually gets to your main system. If you set that control too low, you'll need to advance the main system's gain control too much and will risk picking up too much background noise from the electronics in the TV set. Turning it too high may lead to distortion and may also make it hard to control the volume of the main system. Experiment to find a good setting, and mark it for future reference. You will probably also want to provide a method of turning off the internal loudspeakers when they are not needed.

In some circuits, it is possible to obtain signal by connecting your cable across the volume control terminals. Again, you can't count on the designers of TV sets to use standard audio volume control circuitry. Further, with modern ICs, volume is often controlled by negative feedback. Assuming that you can readily connect to the volume control and that it is wired in a conventional manner, you may still run into problems. The volume control could be wired ahead of high-frequency de-emphasis. I think this is less likely with a stereo TV than with older sets; nevertheless, you may need to supply your own de-emphasis.

You may also find the impedance to be fairly high at this point in the circuit. If so, you may be all right if you use short, low-capacitance cable between the set and the audio system.

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Vector Research Turntable

The Model VT-320 is a programmable turntable using a linear tracking arm design. By "seeing" blank vinyl between tracks via an optical sensor in the pickup assembly, the VT-320 can be programmed to play up to eight selections in random order. A repeat function allows for multiple playback of one selection, of all programmed selections, or of an entire LP side as many as 16 times. A muting circuit prevents extraneous noise common with lifting or lowering the tonearm. An automatic speed and size selector is also featured and can be disengaged as desired. The platter is belt driven by a motor suspended in butyl rubber bushings for isolation. A moving-magnet cartridge is included. Price: $199.95.
For literature, circle No. 100

Belles Research Power Amplifier

Belles Model 450 is a high-current (over 100 amps peak) amplifier packaged on a single circuit board. A solid-state design, the 450 has a 22-lb., 1,500-VA toroidal transformer, complementary stages from input to output, power MOS-FET output transistors, polypropylene capacitors, and 1% metal-film resistors. Output is rated at 200 watts continuous power per channel from 20 Hz to 20 kHz, with no more than 0.05% THD into 8 ohms and 400 watts per channel into 4 ohms. Tiffany input connectors and gold-plated binding posts are used. Price: $1,595.
For literature, circle No. 101

Parallel Productions Storage System

Doubling as a picture frame, the Behind the Scenes storage cabinet operates like a medicine cabinet, opening via a touch-release magnetic closure. The picture frame is designed to hold posters selected by the user and can accommodate sizes from 18½ in. W × 20 in. H to 32¼ in. W × 36 in. H. The storage cabinets can stow from 36 to 96 Compact Discs or from 63 to 168 cassettes. Prices: CD cabinets, from $179.95; cassette cabinets, from $139.95.
For literature, circle No. 102

Thiel Loudspeaker

The Model CS5 is a five-way speaker using Thiel's Coherent Source design, which combines a sloping baffle and electronic correction to achieve time coherence. The baffle front is cast from a rigid, marble/polymer composite that is shaped to reduce edge diffraction. The driver diaphragms are made of either aluminum, Kevlar, or a Kevlar/foam sandwich to reduce cone breakup. The drivers include three 8-inch woofers with very long throws; the woofer and the 5-inch mid-frequency driver have special distortion-reducing magnet systems. Specifications include a −3 dB bandwidth of 20 Hz to 22 kHz, frequency response of ±1 dB from 25 Hz to 20 kHz, and sensitivity of 87 dB SPL at 1 meter for 2.8 V in. The speaker is 13 in. W × 64 in. H × 17 in. D and is available in oak, rosewood, teak, walnut, or gloss black laminate. Price: $9,200 per pair.
For literature, circle No. 103

"They Were Designed To Play Music And Make It Sound Like Music..."

This They Do Very Well, In A Most Unobtrusive Way, At A Bargain Price... It's Hard To Imagine Going Wrong With Ensemble."

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.

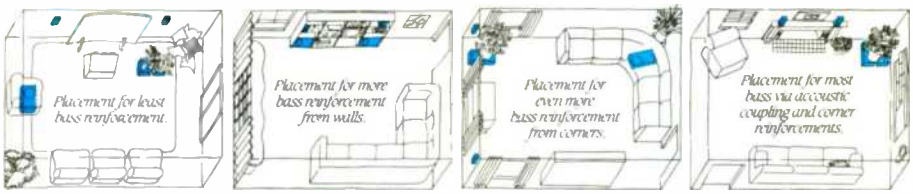
No matter how well a speaker performs, at home the listening room takes over. If you put a conventional speaker where the room can help the low bass, it may hinder the upper ranges, or vice-versa.

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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WHAT'S NEW

Advent Indoor/Outdoor Loudspeaker

Designed for indoor and outdoor applications, the weather-resistant Mini-Advent loudspeaker can handle 40 watts continuous power and 120 watts peak. The system is a two-way design, using a 5¼-inch woofer and ½-inch tweeter. Rated frequency response is 110 Hz to 21 kHz, ±3 dB. The speaker uses a high-impact black plastic enclosure and is available with brackets. Rated sensitivity is 88 dB SPL at 1 meter for 1 watt input. Harmonic distortion is rated at less than 1.5% above 200 Hz at 1 watt. Prices: Mini-Advent, $199.95 per pair; optional brackets, $59.95 per pair.
For literature, circle No. 104

a/d/s/ Cassette Deck

The Model C4 uses separate record and playback heads composed of amorphous metal, allowing for extended low-end resolution with a response curve that is nearly flat from 40 Hz to below 20 Hz. A rigid cast-alloy transport provides exact alignment of heads, guides, and other components in the tape path. The two motors are microprocessor-controlled for accurate speed, and hold-back tension on the tape is electronically controlled. The microprocessor also determines and sets bias and equalization. The C4 is remote-controllable when used in conjunction with other a/d/s/ equipment. Dolby B and C NR and HX Pro are featured. Price: $1,250.
For literature, circle No. 105

Pioneer Elite CD/LD/CDV Player

Like many of the latest CD players, the CLD-91 has an 18-bit D/A converter using eight-times oversampling and a fiber-optic digital output. Unlike most, it also plays 12- and 8-inch Laserdiscs and both 4¾- and 3-inch CDs and CD-Video discs. Its CD features include a Custom File memory for favorite tracks on up to 140 discs. On the video side, it features an alpha-turn mechanism that can play both sides of a videodisc, and S-video outputs for better picture quality. Price: $2,000.
For literature, circle No. 106

R.F. Engineering Loudspeaker Switchbox

The Model SI-2 automatic speaker switch allows two different amplifiers (i.e., a stereo TV and a hi-fi system) to be connected to a single pair of loudspeakers. The switch automatically detects which source is delivering a signal and routes the signal to the speakers. This eliminates the need for extra speakers and for running the stereo TV through the amp's auxiliary input. The SI-2 can switch up to 120 watts, while another model, the SI-3, can switch up to 900 watts. Prices: SI-2, $49.95; SI-3, $69.95.
For literature, circle No. 107

™*Ensemble* and *Ambiance* are trademarks of Cambridge SoundWorks, Inc.

Ambiance™
by Henry Kloss

An ultra-compact speaker that proves high performance, small size and low cost need not be mutually exclusive.

Ambiance by Henry Kloss outperforms many, if not most, speakers of its compact dimensions, and is outperformed by none. We think you'll find it an ideal speaker for use in many circumstances, and it is perfect as an extension speaker, in surround-sound systems, and for situations where space is at a premium.

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

Proper engineering vs. over-engineering.

Ambiance provides a level of performance that makes it comparable to the costliest small systems, which can be costly indeed. So-called "mini" speakers have developed a kind of jewel-like cachet, whereby the higher the price per cubic inch, the higher the performance is assumed to be. That this is not so with the application of proper engineering, as opposed to over-engineering, is amply demonstrated by *Ambiance*. *Ambiance* is a two-way acoustic suspension system designed to the same high standards as our *Ensemble*™ system, with much the same seamless, well-balanced response. Unlike most speakers of its size, *Ambiance's* response in the 100 Hz region has not been exaggerated at the expense of bass lower down. It has more output in the 40 Hz region than any speaker its size we've encountered. While *no* speaker of *Ambiance's* size can provide the same very low bass and total volume as our *Ensemble* system, it does provide ample weight on the vast majority of recordings. And its high-frequency dispersion permits placing it in a location that acoustically supports low bass (such as on the floor against a wall), without sacrificing treble response.

Ambiance can accept more power than most systems its size, and can be used with just about any amplifier designed for home use. While efficiency is moderately low to maximize low frequency performance *Ambiance* can be comfortably powered in many applications by low-cost receivers and amplifiers (a minimum of 15 watts/ch. is recommended). *Ambiance* is available in three finishes: gun-metal gray Nextel (a durable, suede-like finish), primed so that you can paint them, and in solid oak.

Enter No. 2 on Reader Service Card

Try Ambiance in your home risk-free for 30 days.

Ambiance is available *only* directly from the Cambridge SoundWorks factory, a method of distribution reflected in its unusually low cost (we believe *Ambiance* competes *directly* with "mini" speakers retailing for hundreds of dollars more). *Ambiance* is only $109 per speaker in Nextel or primed for painting; $129 in solid oak (shipping extra), and comes with a 30-day money-back guarantee. For literature, expert advice, or to order call 1-800-AKA-HIFI Mon–Sat 9AM–10PM, Sun 9AM–6PM (ET). Canada 1-800-525-4434 Fax: 617-332-9229.

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- ☐ Send me more information on *Ambiance*.
- ☐ Send me_____(qty.) *Ambiance* spkrs. (Nextel) for $109 each.*
- ☐ Send me_____(qty.) *Ambiance* spkrs. (Primed) for $109 each.*
- ☐ Send me_____(qty.) *Ambiance* spkrs. (Oak) for $129 each.*

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MA residents add 5% sales tax.
*Plus freight ($2–$12). Delivery time is usually 2–7 days.

Nakamichi Car Head Unit

The TD-560 has a full-logic auto-reverse cassette transport using a Crystalloy play head with a narrow, 0.6-micron gap, said to deliver flat response from 20 Hz to 20 kHz in both tape directions; wow and flutter is rated at less than 0.08%, wtd. rms, in both directions. The tuner section features a multipath-suppression circuit. The unit includes a slide-out chassis, for anti-theft installation, and a wireless remote control. Both the front-panel and remote controls can also be used to operate Nakamichi's CDC-101 car CD changer; the changer has analog and digital outputs, permitting use of the DAC-101 car D/A converter. Prices: TD-560, $895; CDC-101, $895; DAC-101, $495.

For literature, circle No. 108

Shure Phono Cartridge

Commemorating the 25th anniversary of Shure's introduction of the legendary V15 series of phono cartridges, the company is offering a limited-edition version of the V15 Type V-MR, called the V15 Type V-MRLE. In checking the specifications of each V15 Type V-MR before packaging with a computer printout of the test results, Shure is selecting units which offer optimum performance for the new limited-edition model. These preferred cartridges come in a plush-lined, solid wood box with a nameplate bearing the signature of founder S. N. Shure; also included are installation tools and an alignment gauge. Shure anticipates that the collector's Model V15 Type V-MRLE will appreciate in value. Price: $337.

For literature, circle No. 109

Jackson Loudspeaker

The Auralight AU-6 is a three-way, stand-mounted loudspeaker using a 6½-inch woofer and an 8-inch passive woofer. The passive woofer is externally damped by a pressure slot and is internally damped by a passive network across its terminals. The 1-inch aluminum dome tweeter is used in conjunction with a ⅝-inch polycarbonate supertweeter. A 26-element crossover is used. Rated frequency response is 48 Hz to 20 kHz, ±3 dB. Sensitivity is 87 dB SPL for 2.82 V input at 1 meter. The Auralight's cabinet stands 17½ inches tall and is finished in textured satin enamel in ivory or black; faux-stone and other custom finishes are available. Price: $1,799 per pair.

For literature, circle No. 110

Soundcraftsmen CD Player

A CD's full dynamic range can be excessive for background listening or when making tapes for use in the car; the Pro-CD 750 therefore includes a compressor circuit which can provide a reduction in dynamic range of up to 35 dB. Other features include a switchable Spectral Gradient circuit to reduce high-frequency harshness, an oversampling D/A converter, and a remote control. The unit is available with a white or a black front panel, in the rack-mounting version shown and in a version without rack mounts. Price: $599.

For literature, circle No. 111

American Acoustics®

No other loudspeaker offers these advanced features and a 10-year warranty.

From the initial research and development to finished product, we're dedicated to providing the very best in sound to our listener.

For instance, our new Dual Source Format Loudspeakers, a stunning culmination of technical excellence and pure auditory emotion by people who love music just like you do. Features like dual bass transducers for high level bass clarity. Symmetric rear port apertures for quick bass reflex at near zero distortion. Geometric baffle cover configuration that minimizes sound diffraction and improves high frequency dispersion. Midrange driver positioning (above the tweeter) for improved time arrival over the entire sound spectrum. Discrete high-slope crossovers for smooth frequency transition.

And, like all American Acoustics Loudspeakers, an industry-leading 10-year warranty! A full decade of listening confidence. Because we're confident about what goes into every American Acoustics product. Superior componentry, advanced materials and construction techniques along with quality conscious, old-fashioned American craftsmanship.

Whether you choose the exciting new DS-Series, our popular D-Series, or our value-priced AAL Series, you'll hear the pride. Today, tomorrow, and for years to come.

DS Format Series

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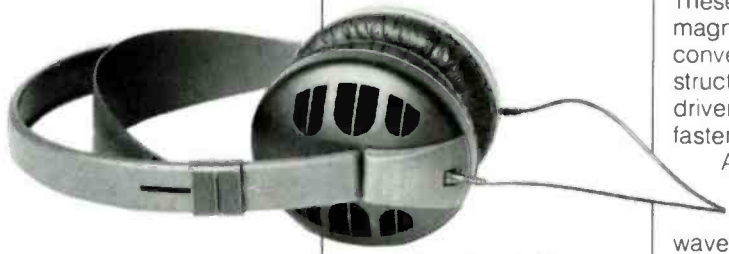
When calling, please refer to number 10977

BIC Loudspeaker

The Venturi V830 is a bass-reflex loudspeaker with a 1-inch soft-dome tweeter, 6-inch midrange, and 8-inch woofer. The cabinet is segmented into two sections, one for midrange and tweeter units, the other for the bass driver. This bass section features horizontal cross-bracing to diminish resonance. Base spikes are also included for optimum stability. The Venturi V830s measure 10¼ in. W × 40 in. H × 11½ in. D and are available in medium oak or black ash laminate finishes. Price: $799 per pair.

For literature, circle No. 112



Sennheiser Headphones

The Model HD 520 headphones use a transducer constructed with neodymium-iron magnets. These provide a stronger magnetic field than do conventional magnet structures, allowing the driver element to react faster to signal changes.

A new Open-Aire housing design prevents standing waves. Rated frequency response is 18 Hz to 22 kHz, and sensitivity is 94 dB SPL at 1 meter for 1 watt input. Price: $149.

For literature, circle No. 113

Scosche In-Car Portable CD Player Mount

While there are many ways to connect portable CD players to car stereo systems, finding secure places to rest those players is a problem. The PDS-1 (portable disc shuttle) is a swivel-mounted platform with cushioning suspension that secures a portable player in place. Price: $29.95.

For literature, circle No. 114

Kenwood Surround-Sound Receiver

The KR-V9010 is a 130-watt audio/video receiver with a number of interesting features. Among them is Dolby Pro-Logic surround-sound circuitry, enabling proper decoding of the principal type of theater multi-channel movie sound. In addition, the KR-V9010 is capable of simulating "Theater" and "Hall" environments, thus enhancing standard stereo programs. A built-in test-tone generator greatly simplifies the volume adjustment of surround and center channels. This receiver can store preset information for 20 AM or FM stations, together with 10 equalization settings. The video section offers S-VHS inputs and outputs, video dubbing with audio overdubbing, video-through dubbing, and on-screen dot-matrix display of source, function, surround mode, etc. Also included is a 160-function remote control, which can operate almost any remote-controllable component via its learning function. Price: $850.

For literature, circle No. 115

JVC SUPER DIGIFINE AUDIO SERIES

JVC Super Digifine Audio Series — In full view of the possibilities

SUPER DIGIFINE

Digital Technology is no longer a shimmer on some distant horizon. We are now in full view of the possibilities that the technology affords us. The Super Digifine Series from JVC turns these possibilities into reality.

RX-1010VTN Audio/Video System Control Center

CSRP — Getting control over the possibilities

Audio/Video Inputs and Outputs on Back
(S-Video Terminals Included)

With technologies as advanced as Digital Acoustics Processing, Dolby Pro-Logic, electronics equalization and digital delay processing plus the variables of front and rear channel levels, balance, loudness compensation and even room compensation, the RX-1010VTN is an engineering marvel. It can quite literally recreate any acoustic experience, whether it be a movie in your neighborhood theater or the sound of a choir in a great cathedral. But how does one control the over 10 million possible settings necessary to achieve this?

CSRP — or COMPU LINK Source-Related Presetting — does the chore completely and automatically. Touch a single button and all the parameters change to a setting that is appropriate for the source you've selected.

Then if your listening determines that some fine tune adjustments should be made, make them. One more button updates the memory with your changes and from then on recalls all the settings everytime you return to that source.

For example: When you turn on your hi-fi system and listen to a CD, you get response specially customized for CD listening. Level and channel balance are properly adjusted, a customized equalization is recalled, and parameters for JVC's sound field processor — the Digital Acoustics Processor — are all optimized for the size and acoustics of your listening room.

Or, as you switch to video, settings you've preset for the Dolby Pro-Logic decoder, such as the center-channel mode and center and rear levels, are automatically recalled.

This also holds true for all program sources — records, tapes and even individual radio stations. Since the RX-1010VTN accepts connection of up to eight audio and video programs, and provides presets of 40 FM/AM stations, this means it can handle customized control settings for a total of 48 different program sources or stations. That's control.

Example of Fluorescent Display with CSRP Preset (VCR-1 as a source)

(1) Source selected

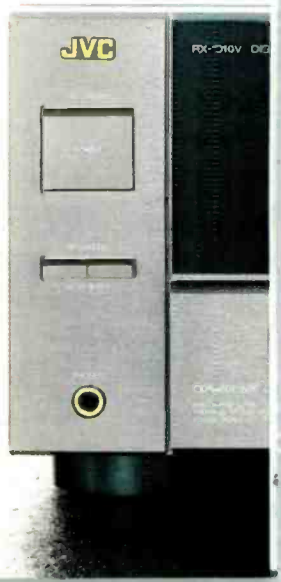
(2) Volume, balance, loudness setting

(3) S.E.A. graphic EQ setting

(4) Dolby surround setting

(5) DAP setting

(6) Normal setting

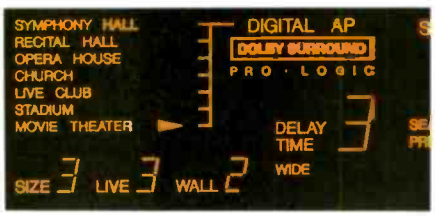


DAP — Digital Acoustics Processing

In the RX-1010VTN, there's a ROM (Read-Only Memory) that stores the sound field patterns we measured at famous halls and theaters all over the world. Seven patterns, from symphony hall to movie theater, are programmed in memory for instant recall.

And you can fine-adjust these patterns to suit the size, "liveness" and wall type of your listening room. This ensures that the ambience of your listening room is completely compensated for so that you enjoy the reflections and reverberations of only a desired hall.

Dolby Pro-Logic



With sound steering, active matrix and center channel output, Dolby Pro-Logic Surround provides you with an enhanced sense of direction and sharply centered dialog. When watching videos, it will make you feel as if you were sitting in a first-class movie theater, especially since the digital acoustics processor is already at work.

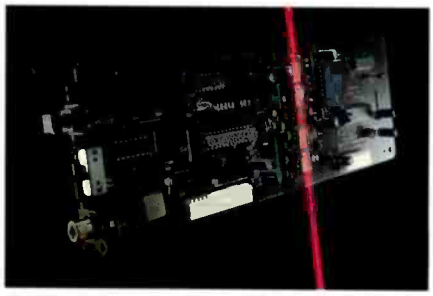
The remote is a convenient LCD touch panel. The amplifier is a state-of-the-art Super-A design.

Our RX-1010VTN simply does everything and keeps everything simple.

*"Dolby" and the double-D symbol are trademarks of Dolby Laboratories Licensing Corporation.

XL-Z1010TN Compact Disc Player

K2 Interface — Revealing possibilities at the source



The K2 Interface optically decouples the digital from the analog section

Changing the digital code on a CD into music requires that a digital-to-analog converter choose 1 of 65,536 possibilities every 1/44,100th of a second.

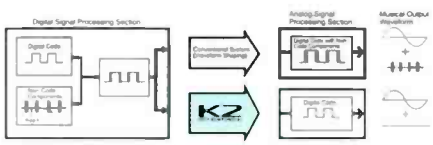
It's commonly assumed that digital signal is composed of 1's and 0's, each represented by the presence or absence of a square-shaped pulse. But the fact of the matter is, a digital signal contains ripple — a type of distortion that changes the shape of a waveform — and jitter, components that move the timing of a pulse forward or behind.

These "non-code" components can result in a sound that differs from the intent of the digital source. The K2 Interface solves this problem by completely regenerating the digital signal. At the heart of the K2 Interface is essentially an ultra-high-speed camera with a shutter speed of 20 nanoseconds (20 billionths of a second). Based on these quick snapshots, it recreates the digital signal as a perfect square wave.

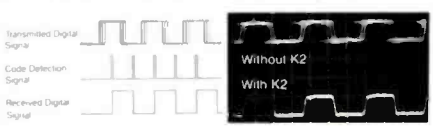
Providing a perfect signal to the D/A converter allows for accurate reproduction of all the nuances such as sound staging and depth.

As a matter of fact, in many ways both frequency range and dynamic range are expanded. High frequencies sound clearer. There is a heightened sense of the power in the mid- to low-frequency range.

Comparison of K2 Interface and Conventional Transmission System
The JVC K2 Interface strips the transmitted signal of ripple and jitter as it travels from the digital to analog processing circuit.



Data Transmission Waveforms
The clean shape of data transmission waveforms indicates that the K2 Interface has removed ripple and jitter.



Music seems to acquire more depth and width, providing clear images of instruments and voices. Overall, sound is smoother and more natural across the audio spectrum.

Precision D/A Converter System Using Four D/A Units

The XL-Z1010TN features two D/A converter units for each channel — four in all. There is a 16-bit converter for the most significant bits and a 2-bit converter for the two least significant bits. Since the least significant bits have greatest bearing on the sound quality at low level, JVC uses an elaborate discrete D/A converter system for these bits to ensure higher precision. All four converters operate with 18 bits "full time" whether the level is high or low. Our "quadruple full-time linear 18-bit combination D/A converter" allows you to enjoy digital sound at its most delicate and dynamic.

XP-A1010TN Digital Acoustics Processor

Bringing new possibilities to the home

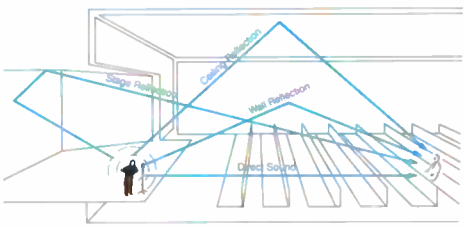
Symmetrical 6-Point Sound Field Measurement Microphone Set

Many of us have already invested in fine audio systems for our homes. Even the best, however, sound like music being played in a home environment.

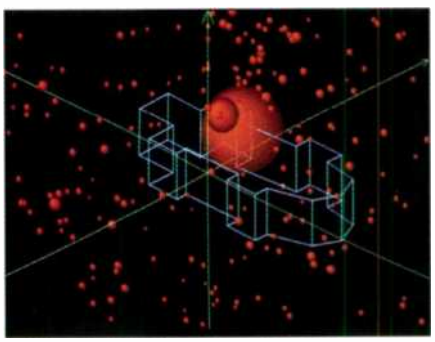
A new age is dawning in audio realism, thanks to the vast advancements in digital engineering. Now it is possible to simulate the acoustic ambience of a live music space — concert hall or movie theater — and recreate it right in your own listening room.

The new JVC XP-A1010TN Digital Acoustics Processor is the key. No other component available today so accurately brings concert hall ambience to the home.

The processor features a ROM (Read-Only Memory) containing a huge amount of data on reflections and reverberations — "sound field patterns" — our engineers measured in actual halls and theaters throughout the world.



Acoustic Response of a Musical Space



CHURCH

Sound Field Analysis Pattern

JVC's Unique Advantages of Acoustics Synthesis

The JVC XP-A1010TN offers a number of unique advantages. One, excessive reflections and reverberations added by your listening room can be compensated for, and so can reverberations contained in the source program. This means a precise sense of the size and shape of a simulated space is accurately recreated in any listening room.

Two, the entire process, from input to output, is performed channel by channel independently. Therefore, critical time-related information contained in music is retained, providing a natural sound field ambience.

Three, the size of the sound source — a point, like a solo or a spread, like an orchestra — is precisely reproduced.

The XP-A1010TN comes with sound fields from 20 actual concert halls, jazz clubs, theaters and stadiums. You can customize an additional 20 patterns of your own. With the XP-A1010TN, the possibilities now include the recreation of the concert halls around the system in your home.

AX-Z1010TN High-Power Class-A Amplifier

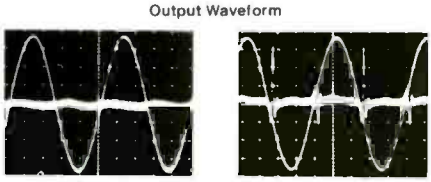
Digital Pure-A — New possibilities for class-A

There's no doubt that an amplifier operating in class-A mode provides lower distortion and cleaner sound than those in popular class-B or class-AB. Their inefficiency, however, makes class-A amplifiers require elaborate heat sinking, and still the amps waste much of their power in the form of heat. This results in inflated cost and relatively low power output. But to enjoy the dynamic sound of digital programs, you need a lot of power.

How to combine the low-distortion sound of class-A with efficiency and power demanded by digital audio?

Class-A vs. Class-B Operation
With class-A, combined output from the paired transistors looks very close to that of the input. With class-B, this is not so, leading to crossover and switching distortion.

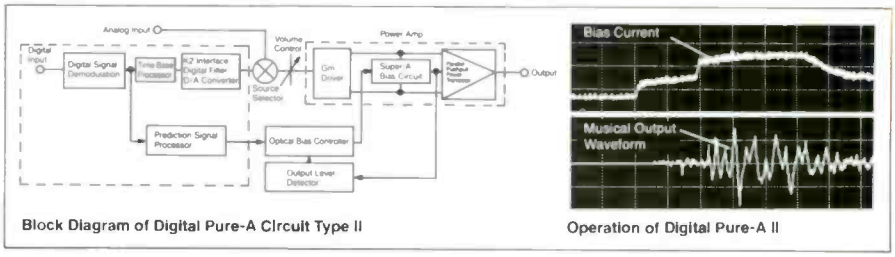
Output Waveform



Class-A Class-B

Enter the Digital Pure-A Type II

JVC has the solution — the Digital Pure-A Type II circuit featured in the AX-Z1010TN "Digital" Integrated Amplifier.



Block Diagram of Digital Pure-A Circuit Type II

Operation of Digital Pure-A II

This ingenious design takes the advantage of the fact that digital signals can be stored in memory temporarily without changing their frequency response or phase response.

In the Digital Pure-A Type II, digital signals fed directly from digital equipment are split into two: the main signal and the "prediction" signal.

The main signal is sent to a time base processor where it's stored in memory for a fraction of a second before it goes to the D/A converter. The prediction signal is sent to the bias circuit to optimize bias applied to the power transistors depending on dynamics of the upcoming signal. What you get out of this is low-distortion class-A sound with high efficiency and high power.

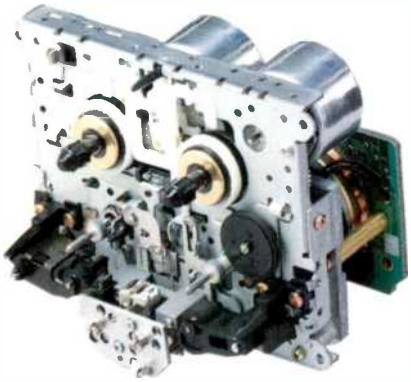
The AX-Z1010TN is a "digital" integrated amplifier incorporating a D/A converter system complete with the K2 Interface, 8-times oversampling and quadruple D/A converters.

And the amp features a special design for analog programs too — Opt Super-A, another JVC exclusive combining low distortion and high efficiency.

FINE

TD-V1010TN Discrete 3-Head Cassette Deck

The world's finest cassette deck? A distinct possibility!



Closed-Loop Dual-Capstan Drive Mechanism

When it comes to specifications for cassette decks — such as wow & flutter, frequency response and signal-to-noise ratio — we can safely say today there is only marginal room for further improvement. This is because of the steady but sure advances over the years in mechanical design, heads, noise reduction designs and tapes.

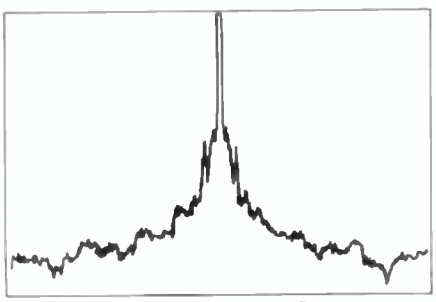
We have isolated "dynamic" response as one of the final steps in ensuring taped sound that's as pure and transparent as can be. We even developed a new specification to measure the degree of purity and transparency a cassette deck can provide:acoustic modulation noise.

In this measurement system, the test deck is subjected to a high 100-phon sound pressure during recording and playback. More rigorous than conventional modulation noise tests, this new method better simulates a real-world situations where the deck must operate while speakers are playing music.

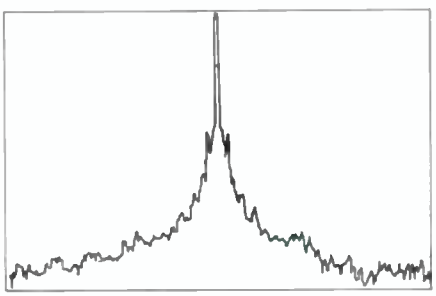
Taped Sound Free of Acoustic Modulation Noise

Based on what we discovered from our test, we've developed solid mechanical designs in order to suppress resonance and vibration. The result of our efforts is taped sound that rivals digital.

"Acoustic Modulation Noise"



Response of Conventional Deck



Response of Rigidly Built Deck

Moreover, there are other ways we've improved clarity and purity of the taped sound of the TD-V1010TN. A "CD DIRECT" switch lets you route the signal from your CD player direct to the cassette deck. We've cut down wiring to a minimum length using remote rods and controls. We use the time-proven closed-loop dual-capstan tape transport to suppress modulation noise. "Fine" amorphous heads, highly pure PCOCC copper wire and high bias frequency also enhance the purity and transparency of the taped sound.

If you think that taped sound cannot compare with digital programs, you owe yourself a listen to the TD-V1010TN.

SUPER DIGIFINE

FX-1010TN Computer-Controlled FM/AM Tuner

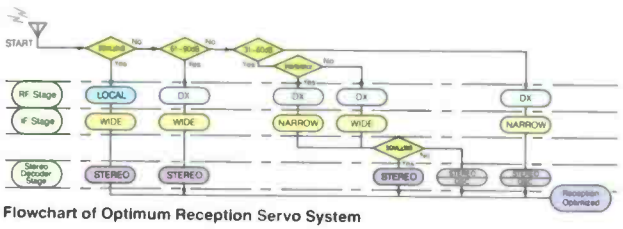
Self-adjusting to the possibilities

The FX-1010TN is a smart tuner that adjusts itself to the endless possibilities in the capture of radio signals.

Our reception servo automatically selects the optimum operating mode — front-end gain, IF bandwidth, stereo mode, etc. — after checking the degree of interference and the strength of the station you're tuned to. It guarantees you get the best reception anywhere and from every station. And yet the digital noise, which a computer could create to muddy sound, is cut down by the "Opticalink" system separating the digital section from the analog.

The computer is put to use for special conveniences, too. You can preset up to 40 FM/AM stations for one-touch recall, and give a name to each preset station. You can let the tuner automatically preset all 40 FM/AM stations for you. You can "shop" for stations one by one. Also you can set the muting level to tune all stations in your area or only a few powerful ones.

Add circuitry designed for low distortion and wide dynamic range and you'll see that the FX-1010TN is the tuner that addresses the practical world of radio reception.



Flowchart of Optimum Reception Servo System

We are no longer at the threshold but have passed well into the world of digital technologies and their applications. In full view of the possibilities, we have endeavored to develop products that will endure the test of time and stand as small reminders that technology can advance while remaining sensitive to the needs of its users.

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WROUGHT IRONY

Illustration: Russell O. Jones

Browsing at random through my alma mater's fancy published voice, *Harvard Magazine*, I stumbled third-hand on what must have been the first communications snafu by electrical transmission in all history, as well as maybe the first *official* public message sent over a long distance by the same. I burst out laughing and have been chuckling ever since—*so* typical! I'll get to that. It was an astonishingly long time ago, 145 years and some months, on May 24, 1844. In a small but important way, things were not so different then from right now.

This was, as you may guess, the inspiring telegraph message pronounced by the fingers of Samuel F. B. Morse to inaugurate a new age of communication. In his *Harvard* column, John Train quotes a young grad student, Edward Widmer '84 (Harvard, obviously) who dug up, shall I say, the amplified version of the famous text plus the ancillary confusion that went along with the well-known official words, "What hath God wrought?"

Somewhere deep in my ancillary brain, a bell rang. I once read a very detailed account of Morse's slightly eccentric telegraphic development and, more important, the publicizing of his new invention at a place where it would count—among the influential figures of the Federal government in Washington. From which place, of course, Morse tapped out his famous question, carefully chosen ahead of time for maximum impact.

The other end of the line was in Baltimore, a lot more than a stone's throw away from the capital; so this was indeed a miracle, wrought by Morse and his teammate, God.

You'll pardon me if I amplify a bit on this Harvard story. It does have great implications for us in our several special media and numerous submedia for the transmission as well as storage of information. And it's funny, too. . . .

Not Morse's humor, you can be sure. He knew better than to crack jokes in selling his telegraph to Washington. This dignified, even professorial character (New York University) was a splendid portrait painter and general experimenter who was in communication (via pen and ink) with most of the scientific leaders of his time concerning his own and their ideas. In fact, because of this, Morse was the very first man in the world to set eyes on an actual *photograph*—other than, perhaps, the family of his friend Daguerre. They had exchanged accounts, in Paris, of their respective inventions, and Daguerre had given Morse a look at a stack of the new Daguerrotypes at a time when they were still top-secret. An absolutely effervescent, if sometimes rather fuzzy, thinker, Morse was also an excellent publicist in terms of his own day. (Otherwise, we probably would not have known the telegraph as an American invention—a number of Europeans were hot on the trail, too, if not with Morse's brilliant simplicity.) To launch his new invention and, of course, to raise cash for further expansion—hopefully from the government—a "do" had to be put on, with invitations to all the proper bigwigs (or, rather, tall hats) with plenty of pomp and circumstance. A show, as we might put it in public relations.

Morse had to be weighty but also terse. *What to say* on this first public exhibit of electrical communication at a distance?

After all, speaking show-wise, there would be nothing heard at his demo but the faint clicking of his little machine, quite meaningless to all present. And not even very convincing, when you come down to it. A few choice words then, *very* short but also very big, to match the dignity of all those tall funereal top hats that, I think, were already becoming the obligatory mark of every big shot from the President down to the boss of the tiniest local business enterprise.

Official language was then flowery and deadly serious, if often inspiring, as, say, the Declaration of Independence 60-plus years earlier. By 1844, what we call the Victorian age was rapidly getting underway (Victoria herself came on stage in 1837), and bright colors everywhere were converting to black—from formal dress and top hats all the way to the grand piano. This had nothing to do with the Civil War, the coming War Between the States, as you might think; it just happened. The already feeble instinct for a good joke in a public speech, which might have tempted Jefferson or Washington, was ruthlessly suppressed. No sense of humor—or so it seems today.

Morse and, presumably, his friends must have worked a long time on "What hath God wrought?" It's a top-hatted masterpiece of pompous brevity, even unto the Biblical "hath!" If God were about to pass a miracle, then this was the perfect message. So like another, more modest message less than 20 years later, when good, honest Abe Lincoln (in tall black hat) would speak quietly, in public, something inaudible about "Four score and seven years ago, our fathers brought forth . . ." (instead of the much more prosaic "87

When Morse tapped out his famous question, chosen in advance for maximum impact, it was a miracle wrought by Morse and his teammate, God.

years ago"). It is the flavor of the age. Practically nobody could hear Abe, by the way. No mikes.

Solemn, if brief. We can easily imagine the assemblage of 1844 dignitaries clustered around Morse and his machine, the insignificant wire out of it going forth in the general direction of Baltimore. The famous four words were about to be transmitted for all to see, if not to hear—unless Morse proclaimed them in a loud voice (as he surely did) while wielding the telegraph key. *Somebody* had to unveil them.

So here is my fanciful amplification of the conventional story that comes down to us in all its typical lack of detail. Who among us hasn't heard those words, and that they were the first words transmitted by telegraph? Inspiring thought; totally fuzzy in terms of detail! Like Washington and the cherry tree—though that, I understand, is pure myth whereas our Morse event actually did happen. Most famous stories of the sort—legends in the making, even if basically true—tend to shed all sorts of detail and nobody ever notices. Read up on the Liberty Bell; that's an interesting one. Even more, Ben Franklin and his lightning. That man was remarkably lucky not to get fried. Another man did, who was grounded. As I see it, Ben was out in the rain with his umbrella and its pointed iron tip; thus, he was well housed in reasonably good insulation to match the bumbershoot. He got the spark but was spared the funeral. Later, of course, he figured it all out and invented the lightning rod—a brilliant bit of deduction, you'll admit.

Famous first words? They became less fancy, more prosaic, as time meandered on through the late Victorian. Mr. Bell, whose telephone went merely from one room to another, spoke that famous but flatfooted remark, "Mr. Watson, come here immediately. I want you." (If I remember it right.) As for the emperor of Brazil, when Brazil actually did have an emperor, he came to the big show, Exposition, at Philadelphia and was given a telephone to put to his ear. He, at least, had the dignity to invoke the deity, just like Samuel F. B. "My God, it talks!" he said.

In this vein, I suppose it is inevitable to bring in old Thomas Edison—actually, he was fairly young in 1877—and his famous First Words ever to be recorded—though to be sure, not electrically. He was a showman too, and when he wanted to be, also a bit of an old-fashioned humorist. His First Words were not uttered at some big publicity thing, just in his own lab, along with his familiar co-workers. So out came nothing godly at all but, instead, "Mary had a little lamb, its fleece was white as snow. . . ." Some comedown from those words that God had wrought for Morse only one score and 13 years before.

In my estimation, the bottom was reached when Thomas A. Edison, in his old age, was fêted upon the phonograph—was it a "do" put on by Henry Ford?—and was persuaded solemnly to repeat, in a shaky voice, those same fateful words into—yes, as I remember—a battery of mikes (1927). Edison made it into the age of electronics that we know, but his interest was gone and, indeed, had departed after his only electronic discovery, the "Edison effect," which in the end led to the vacuum tube, amplification, and onwards. Edison developed a dismal ability to go into the wrong thing at the wrong time after his final really big invention, the moving picture. In his later days, he barely escaped ruin in a disastrous coal-mining venture—just as oil was coming to the fore. (Like Ford himself, who went heavily into natural rubber plantations with synthetic rubber on the horizon.) You may have heard Edison's later "Mary." It is, in a way, almost pathetic. So old and tired. Again, audio history.

And so to the payoff. If you will return to my imagined (but mandatory) 1844 scene when Morse introduced his telegraph with "What hath God wrought?" I will complete the story. *Click-click* goes the telegraph instrument under Morse's hand, supposedly sending its famous message all the way to Baltimore right at that very instant, defying time, distance, even common sense.

Now, any audio person will understand, following my reasonable reconstruction, that long before this vivid moment, there was the period of fabrication. Not the words, not the telegraph itself, but the remarkable trail of wire all the way from Washington to Baltimore. And then, the installation complete—not the formal opening! Far

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Most famous stories of this sort—legends in the making, even if basically true—tend to shed all sorts of detail, and nobody ever notices.

from it. Obviously, there would have to be what I can easily call the testing-testing period. For that breathtaking moment when Samuel F. B., minus dignitaries but probably surrounded by assorted assistants, first tried the line out at, we suppose, a preset time, with watches carefully synchronized.

Our Harvard graduate student says the man at the other end, in Baltimore, was Alfred Vail. Not having my own former source of Morse material at hand (I filed it somewhere), I am inclined to accept his info. Why not? He's out for a Ph.D. and this is a scholarly part of it. So, at a given moment in time, Mr. Vail taps out—no, not anything like "What hath God. . ." More likely, "Testing. Testing."

If anything at all came out of Morse's instrument, 30 miles away, on that first test, I would expect it to be more like "Qrzzzfx mbzzt." Like the tests on the first transatlantic cable. (They forgot about capacitance.) You understand that Mr. Murphy's great-great-great-grandfather was on hand as a matter of course. So Morse taps frantically back: "Hey, try that again. I can't read you." "Ztrsvt," says Vail. "It must be that section over the stream. Remember? Send Joe to fix it." "Psx," replies Vail from Baltimore.

Eight days later (we can guess), Mr. Morse, tired and dishevelled, is back testing again. Aha! "What hath God . . . ," he taps hastily and gets a quick answer, "Gotit! You on the wire tryegin." So Morse, once more in Washington, "What hat. . ." and back from Vail comes, "My God, it talks. Congratsxsv." Mr. Murphy is still busy.

So, inevitably, the big day comes, all serene, and all looks well with Mr. Morse himself, but his heart is jumping. Last-minute test. "Okay up there?" Morse sneaks in as the dignitaries begin to arrive. Right back comes, "Yessir getting signal just fine sqgks all set to grf."

Too late. The show is on. Remember, folks, those famous words made a question, more or less, and the proof that God had indeed "wrought" would be a dignified and suitable answer from the instrument, all by itself, out of Baltimore. Presumably translated into spoken words by a reputable code man. No fakery, please. So we may imagine a breathless silence as the multitude waited for the rhetorical indication as to what God had accomplished, all the way from Baltimore. For a moment, nothing. Then the machine chattered, briefly. What it said was, "Yes."

Was this an answer to a previous testing question, Vail having missed the big message while, perhaps, tightening a connection or some such? The dignitaries were surely confused. Yes *what*? But it seems that was all there was to say. The first public communications snafu in history—electrically speaking—and thanks, Harvard, for tipping me off.

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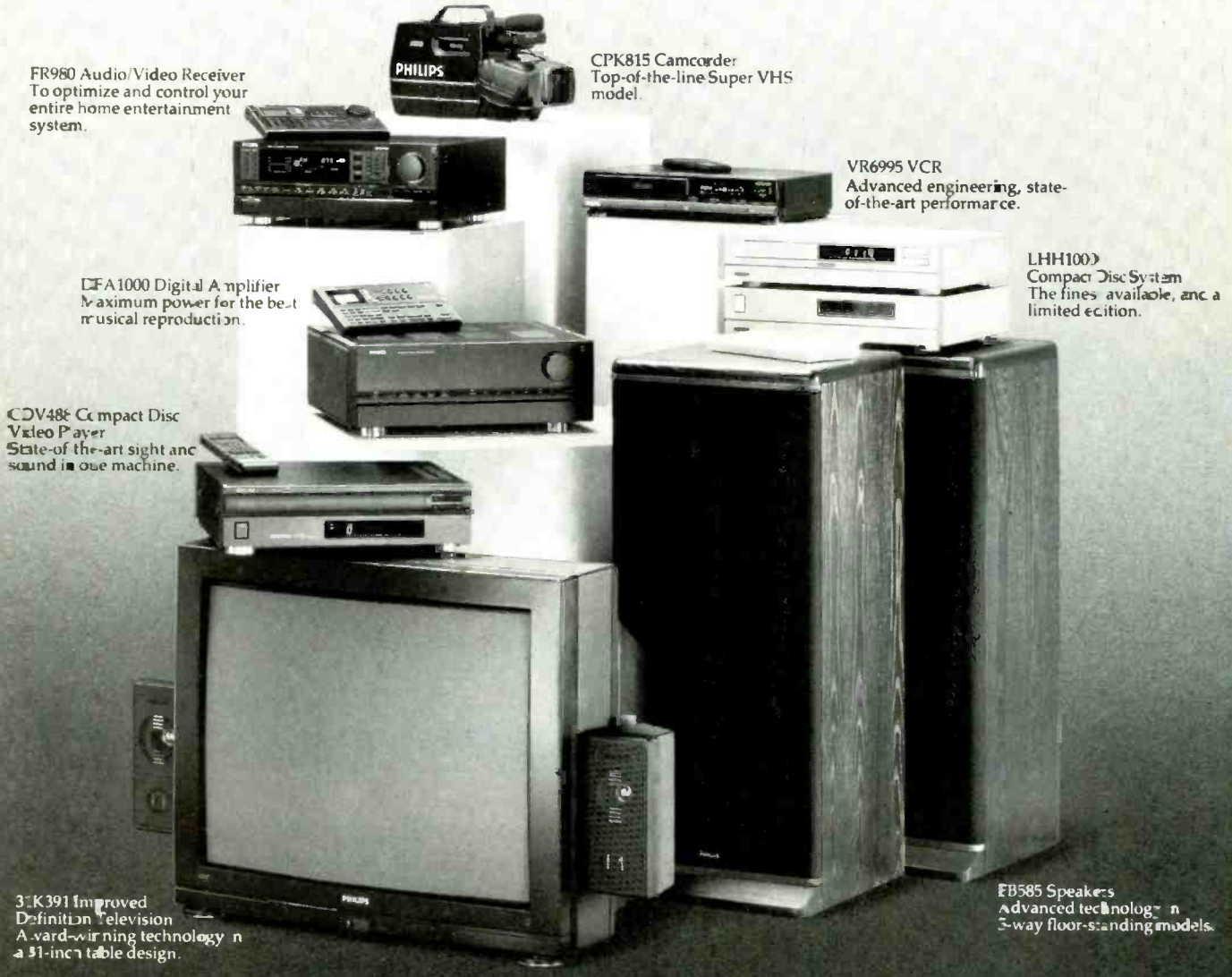

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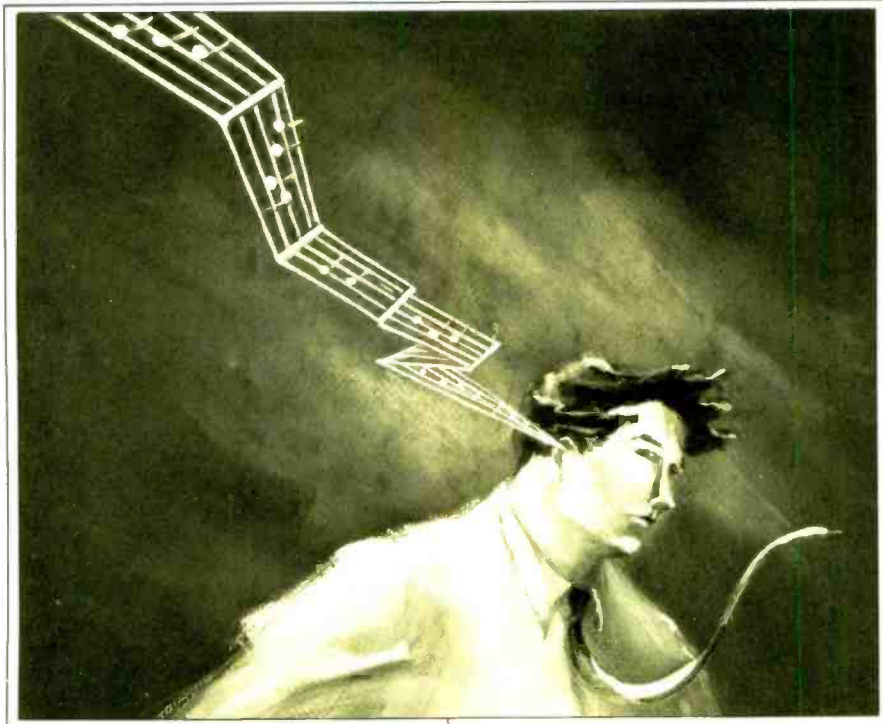

Illustration: Karen Stolper

Obviously, *Audio* is a specialized journal, and the people who read it are often graced with the designation "audiophile/music lover." For these people, audio is not so much a hobby as a way of life. The dedicated audiophile yields to no one in his zealous pursuit of music reproduced with ever-increasing faithfulness to the live experience. Some people like to denigrate audiophiles, claiming they have no real sensitivity to music and are bedazzled by the technology, performance, and appearance of their audio components. No doubt, there is a certain amount of truth in this—we all know the guy who has a half-dozen demo discs that he plays endlessly, to compare components.

Audiophiles know that music is the cornerstone, the raison d'être, of their endeavors. Moreover, it is quite natural that audiophiles have an avid interest in obtaining recordings of the highest quality for demonstrating the performance of their system and for maximum enjoyment of a particular piece of music. This is why I receive quite a lot of mail asking me how I evaluate recordings and which recordings I use to demonstrate my audio system.

Of the prodigious number of CDs issued every month, I receive only a modest amount, which nonetheless represents quite a few recordings. I freely admit that I cull quite a few CDs purely on the basis of musical content, along with the standing and reputation of the artists and performing groups and the track record of the recording company with respect to sonic quality.

Even after this preliminary sorting, there usually are still quite a number of CDs to audition. With CDs averaging 50 to 70 minutes of playing time these days, that's a lot of listening! So much, in fact, that it is necessary to ration time. Listening for a few minutes usually provides enough information as to balance, dynamic expression, and acoustic perspective to judge the basic fidelity of the recording. If everything makes a good sonic impression, I may skip to other passages to reinforce my views. Of course, there are those recordings which have such glorious music, along with a compelling performance and outstandingly realistic sound, that I get mesmerized and play every note from start to finish!

The factor that carries the most weight in my decision to fully review a CD is usually the sonic quality of the recording. If the playing is of high caliber and the performance gratifying, that is icing on the cake. I believe most readers of *Audio* who prefer classical music enjoy their Beethoven Fifth, Dvořák "New World," and Tchaikovsky Piano Concerto, but they may not have the abilities required for musicological evaluations of recordings. Even if these readers never hear their favorite works in the concert hall, they have the aural acuity to differentiate the sonic attributes of a recording. Needless to say, people have widely varying tastes in music, and perhaps some of this is reflected in their choice of audio components. Someone who is fond of chamber music might prefer the openness and smoothness of an electrostatic speaker, while pipe organ buffs would probably opt for a subwoofer to reproduce the pedal fundamentals. Those who like large-scale orchestral works want a system that will handle the great dynamic peaks of the music and will have the power-handling capability to reproduce the music in all its awesome grandeur.

Once a person has established that a certain recording is of very high quality, an opinion bolstered by favorable reviews from several critics, he can feel confident that it is a reliable music source for component evaluation. When an audiophile has acquired a modest library of high-quality recordings in various music categories—string quartets; piano, violin, and cello concertos; organ pieces, and large-scale symphonies—he can use them to test specific sonic parameters in his system. If this demo library is on CD, there is the added advantage that no matter how often the music is played, the sonic quality will remain the same.

I have been accumulating a library of demonstration CDs for some time. These discs cover a very wide range of music, and I must say that in addition to choosing them for their sonic veracity, I have, whenever possible, chosen them for emotional impact as well.

As you might expect, I am visited by many people in the audio business: Recording engineers want me to hear their latest triumph, while equipment manufacturers want me to check out a prototype of a new product—as do marketing and PR people, and "visiting firemen" of all stripes. Depending on their interests and affiliations, I usually manage to present a music demonstration that blows them away.

Before I select music for a demo, I try to ascertain the preferences, musical knowledge, and intellectual level of my guests.

I am a great believer in establishing a mood, an emotional climate, at the beginning of a music demonstration. You've greeted your guests, exchanged pleasantries, and indulged in small talk, aided by a stimulating libation; you've seated them comfortably in the listening room, and then you let fly, full-bore, with the electrifying brass fanfares and gut-thumping bass drum, the bright, upbeat ebullience of John Williams' "Olympic Fanfare" on Telarc's *Pomp & Pizazz* (CD-80122). Believe me, this gets the juices flowing!

The follow-up selections are equally important in sustaining a mood. After the "Olympic Fanfare," I might play Ravel's "Piano Concerto for the Left Hand" (London 410230-2-LH). This starts off with an extremely low-level passage for contrabassoon and gradually builds up to tremendous fortissimo piano chords, abetted by full orchestra. There is much brilliant pianism, with ultra-fast, clean transient response, lovely melodies, and a rousing finale. Guests are usually wowed by the low-level resolution and huge dynamic impact—to say nothing of the fact that they love the piece.

If your guests are of a more intellectual type and are more deeply involved with music, you can rivet them to their seats by playing passages from the Shostakovich 13th Symphony ("Babi Yar") on London (417261-2). In the Fourth Movement largo, they'll hear the huge subterranean rumbles of the Concertgebouw Orchestra's bass drum, with muted brass, followed by great, menacing sounds from the contrabasses. Next is a terrifying ascent of the dynamic scale, with massive chords from full orchestra, punctuated by the chilling tolling of bells. This has, quite probably, one of the widest dynamic ranges of any CD, and it usually raises the hair on listeners' arms!

After the terror of "Babi Yar," the group becomes more relaxed when I play the wonderful Ashkenazy recording of Rimsky-Korsakov's "Scheherazade" (London 417301-2). They are impressed with the smoothness of the strings and woodwinds, and they like the forward thrust and brilliance of the brass; the pulse-pounding excitement of the finale leaves them breathless.

When my guests are organ buffs, I start them off with Bach's famous Toc-

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I'm a great believer in establishing a mood, an emotional climate, at a demonstration's start.

cata and Fugue in D Minor, which I recorded with Virgil Fox (Bainbridge BCD-8104). They are always impressed by the weight and clarity of the 32-foot pedals. I follow with the Saint-Saëns Third Symphony (Philips 412619-2-PH). It is exceptionally well recorded, and the great, shuddery pedal tones in the Second Movement are difficult to reproduce on most systems. I follow this with Mendelssohn's Organ Sonata No. 6, as played on the Rieger organ in Ratzeburg Cathedral in West Germany (London 414420-2). It has huge sonorities in a fine reverb that doesn't cloud the sound, and there is a gargantuan 19-Hz pedal tone that will shake your innards if you can reproduce it.

For more pop-oriented guests, I see their startled reaction when I play Tom Jung's razor-sharp recording of the Thom Rotella Band (dmp CD-460), especially tracks one, three, and 10, where percussion transients are virtually explosive! Another dmp recording, *The Pugh-Taylor Project* (dmp CD-448), provides avant-garde scoring with ultra-sonorous bass trombone and super-sharp percussion on track seven. In stark contrast, I next play the creamy voice of Barbra Streisand from *One Voice* (Columbia CK-40788). Her miraculous phrasing and almost palpable presence are especially notable in "Send in the Clowns."

Guests who want grand-scale orchestral music are awed by the huge brass fanfares and visceral bass drum, with awesome organ-pedal counterpoint, of John Eargle's Delos recording of Respighi's "Feste Romane" (Delos D/CD-3070). Following this is London's monumental recording of Stravinsky's "Rite of Spring," with Chailly and the Cleveland Symphony (London 417325-2-LH). This incredible recording, which probes the stratosphere and plumbs the depths of extravagant dynamics, is one of the most severe tests for the best high-powered systems.

For guests who want to hear voice, I play the wonderful Handel "Messiah" highlights on Oiseau (400086-2-OH). Recorded in Christ Church Cathedral, Oxford, the familiar music manages to combine an extreme sense of depth perception with good articulation.

If, after some orchestral blockbuster, a guest says, "It sure is impressive, but how does it handle chamber music?" I put on a Denon recording (C37-7830) of Ravel and Debussy string quartets. They are exquisitely recorded, with realistic balances and ultra-clean sound. The immediacy and presence of the pizzicati in the Second Movement of the Ravel must be heard to be believed.

On a practical note, remember that it is important to place self-adhesive labels on your CD boxes. By indicating track numbers or the timing of passages, as well as volume settings, you'll save time when guests next gather for a sonic demo.

THE NEXT PLATEAU

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Our reputation...

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J. Peter Montcrieff
"International Audio Review", Hotline #43-45

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"Their KCD-20A puts other CD players in the shade musically... it is a clear first-choice recommendation among CD players."
Neil Levenson
"Fanfare", Vol.10, No.4

CES — Summer '87
"Pure musicality 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

CES — Winter '88
"The Death of Mid-Fi: The Big Chill in Vegas"
Michael Fremer
"The Absolute Sound" Vol.13, Issue 52, page 250

CES — Summer '88
We weren't there.

CES — Winter '89
"...I am pleased to note that the sound in the Kinergetics room was stunningly true to the sound of the original Steinway. Nice one, Ken and Tony!"
John Atkinson
"Stereophile" Vol.12, No.3, Mar. 1989

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RTA 8t

In a slightly smaller package, the RTA 8t offers the same driver complement as the larger, more expensive RTA 11t, and thus shares its benefits of superior imaging, musicality, and detail.

Both Polk RTA series loudspeakers achieve the extremely rare combination of good looks and state-of-the-art performance. The tall, elegantly slender and deep "tower" design cabinets allow for substantial internal volume for high efficiency and powerful bass, but only require less than one square foot of floor space! The small baffle surface area around each driver minimizes diffraction (sonic reflections), thereby insuring outstanding imaging and low coloration.

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Polk RTA speakers have an uncanny ability to perfectly reproduce the human voice, pianos, guitars, and every other instrument whose faithful reproduction demands superlative midrange and high-frequency performance. Bass and percussion instruments are accurately reproduced with full visceral power and realism, without the heaviness, boominess, or lack of detail that plague lesser designs.

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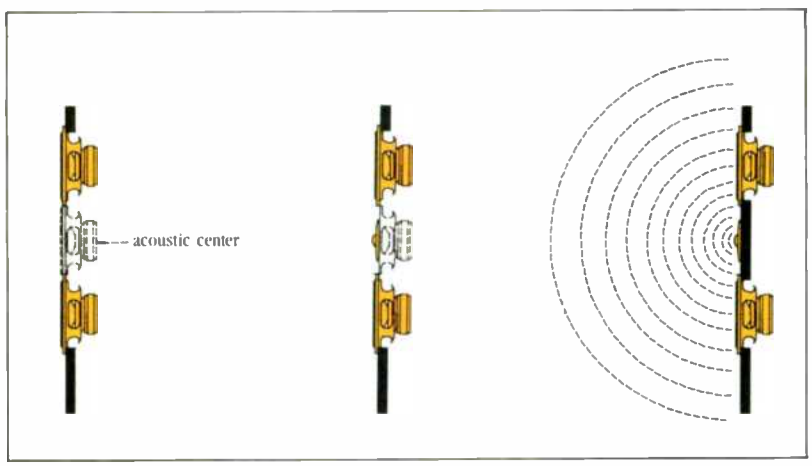

The perceived source of sound of two identical drivers is centered in the area between them.

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Soundcraftsmen Power Amplifiers...

Perfect Mates for our new Pre-ceiver on next page...

Pro-Power Four

DESCRIPTION: The New PRO-POWER amplifiers are especially designed for the extended Dynamic Range requirements of today's Compact Disc players and Hi Fi VCRs. The ULTRA HIGH CURRENT design offers you incredibly high power without sacrificing distortion-free performance, superb reliability, and the utmost in sonic purity. These new amplifiers operate flawlessly under all operating conditions. It is well known that most of today's highly regarded loudspeakers exhibit impedance curves which drop to 1 or 2 ohms at some frequencies, and in conventional amplifiers this results in severe clipping and the triggering of protective circuitry. However, our new PRO-POWER Phase Control amplifiers continue to operate even under those extremely low impedance conditions. Current limiting had been eliminated entirely by the use of the latest POWER MOSFET technology, thus avoiding the sonic degradation typically found when limiting circuitry is employed.

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..."

"In my view, you can spend five times as much as what this amp costs, but you won't get a better, more reliable, or more musical unit."

FEATURES: MOSFET amplification stages provide the utmost in sonic purity, rivaling that of vacuum tube amplifiers...Precision-Calibrated LED power meters (0-400 watts at 8 ohms)...Speaker switching for two pair of stereo speakers...

SPECIFICATIONS: CONTINUOUS RMS POWER: 205 watts per channel @ 8 ohms, 20Hz-20kHz, 300 watts per channel @ 4 ohms, 20Hz-20kHz, 450 watts per channel @ 2 ohms, 1kHz...THD—less than 0.05%. 19"Wx5¼"Hx12"D, 30 pounds.

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.

The PCR800 amplifier is similar to the PRO-POWER ONE, rated at 205 watts per channel @ 8 ohms, but with plain overlay front panel.

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Pro-Power Ten 2/3/4 Channel 600-watt Mosfet Amplifier

TWO-CHANNEL MODE

The PRO-POWER TEN, used in this mode, is the ultimate in high current, high power amplifiers, and provides a massive 600 w/p/c @ 8 ohms.

THREE-CHANNEL MODE

This mode provides 205 w/p/c for a stereo pair of satellite speakers for mids and highs, plus 600 watts to guarantee optimum sub-woofer bass performance.

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The ultimate in audio/video systems is the Surround Sound system, where the Theatre environment is recreated by stereo front and stereo rear speakers.

Introducing our new Pre-ceiver© . . .
. . . the Pro-PT TWO Preamplifier/Tuner

Soundcraftsmen, America's leader in separate components, introduces the new PRO-PT TWO PRE-CEIVER. This new Control-Center/Preamplifier/Tuner combines the outstanding performance and features of our separate tuner and preamplifiers. The PRE-CEIVER offers the sensible alternative to the "all-in-one" receiver, by allowing the freedom to choose a separate power amplifier to match the needs of the speaker systems. This intelligent PRECEIVER approach allows you to avoid the inherent problems and compromises found in today's receivers, and still enjoy the cost-saving of combining the compatible preamplifier and tuner stages on a single chassis.

Due to space and technical design limitations, ordinary receivers cannot be ecuipped with the high-current, high-voltage power stages found in even modestly-priced separate power amplifiers. In a receiver, these heavy-duty power stages, necessary for high dynamic range amplification, would generate levels of heat, hum, and noise unacceptable to the tuner and preamplifier's low level, sensitive circuits. The new PRE-CEIVER eliminates all of these compromises by keeping the low-level preamplifier and tuner stages completely separate from the incompatible high-level power amplifier stages; thus providing a near-perfect and distortion-free output signal to drive any amplifier.

C-MOS PREAMP SECTION

The PRO-PT TWO's preamplifier section has the quality and features you need as the cornerstone of your audio system. Feather-Touch Digital C-MOS Switching for noise-free and distortion-free listening and recording. Source selections include CD/DAT, Phono, Tuner (built-in), Audio/Video, plus two Tape Monitors with dubbing. Each source has its own push-button and LED for easy selection and verification of signal source desired.

Two pairs of outputs for Surround Sound applications or Subwoofer/Satellite speaker systems. Two switched plus one un-switched AC outlets are provided for powering other audio components. Our unique Variable Contour Loudness Control allows precise and easy selection of frequency balance at any volume level.

PREAMPLIFIER SPECIFICATIONS

TOTAL HARMONIC DISTORTION: 0.008%
IM DISTORTION: 0.008%
FREQ. RESPONSE: 20Hz–100kHz ± 0.5dB
MAXIMUM OUTPUT LEVEL: 8 volts
SIGNAL-TO-NOISE RATIO: Phono: 80 dB
High Level: 100 dB
INPUT SENSITIVITY for .5 volt output: Phono: 2.5mV
High Level: 200mV
TONE CONTROLS:
Bass: ±10dB @ 85HZ
Treble: ±10dB @ 12kHz
DIMENSIONS: 19" x 3¾" x 11¼" WEIGHT: 14 pounds

DIGITAL PLL TUNER SECTION

The PRO-PT TWO Tuner section's advanced technology incorporates a digitally synthesized, quartz-referenced crystal oscillator which guarantees unparalleled tuning accuracy and drift-free reception. Multipath distortion, common in urban areas where many strong stations exist, has been virtually eliminated by a specially designed RF stage. In rural areas, where low signal levels are common, the PRE-CEIVER'S high sensitivity assures you of distortion-free and noise-free reception. A Micro-Computer memory system, coupled with Automatic Scanning allows extremely simple programming of 32 stations of your choice (16 FM and 16 AM). Direct access retrieval of any of your preprogrammed stations is as simple as pressing one or two buttons. The Scan Selector provides you with easy access to strong stations or direct access to even the weakest of stations. The Mono/Mute-Off selector allows noise-free listening of very weak stereo broadcasts.

TUNER SPECIFICATIONS

IHF SENSITIVITY: 10.3dBf
SIGNAL STRENGTH for 50dB quieting:
Mono: 12.5dBf
Stereo: 36 dBf
CAPTURE RATIO: 1.2dB
ALTERNATE CHANNEL SELECTIVITY: 80dB
SEPARATION @ 1kHz: 52dB
THD @ 1kHz: Mono—.04%, Stereo—.08%
S/N RATIO: Mono—85dB, Stereo—75dB

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JOHN EARGLE

CHOICE CUTS

The practice of unauthorized tape copying at home has been viewed with great concern by the American record industry. On the other hand, the hardware industry has downplayed the problem, stating that consumers have always had the facility to copy software and that record companies have still prospered. Last year was, in fact, the all-time high for profits in the record industry. While large-scale piracy may be a real problem for the industry, home copying probably is not. In any event, there is a major alternative to home copying, one which should make the record companies quite happy.

Personics, based in Redwood City, Cal., has come up with an interesting in-store method allowing consumers to make personalized cassette copies of a wide range of program material at reasonable cost—and with copyright payments going to the record companies! At the present time, Personics installations are in selected record stores in Los Angeles, San Francisco, and New York. The process has been up and running only since October 1988.

What you see in the store is an audition display counter where you can put on headphones and sample any item in the Personics catalog. Over the 'phones, you will hear a short segment of any item you have picked, simply to let you verify the choice you have made. When you have made your selections, you fill out a sheet indicating the order in which you would like them taped. You can also create a title for your cassette, personalizing it with your name or whatever.

You then take your desired list of songs to the main counter and give it to the attendant. The data on your list is entered via a keyboard that interfaces with a large rack of electronics. On the front of the rack is a highly modified Nakamichi cassette recorder, which does the actual duplicating.

The music, running into thousands of titles, is stored on CD-size optical discs, but not in the normal PCM format. The program material which Personics has licensed has been transferred using Dolby B NR and then converted to an adaptive delta-modulation code developed by Dolby Laboratories for greater storage density on the disc. (Each disc may hold up to 60 or 70 songs.) A complete set of encoded software is in each store, and the eventual program capacity will be 15,000 catalog items.

Selected catalog items are then transferred to a blank cassette. The copying process is carried out at an eight-to-one duplication ratio, indicating that an average-length cassette is transferred in a matter of about five minutes. A laser printer has, in the meantime, produced a neat-looking set of labels for both sides of your cassette as well as a J-card to insert into the outer box.

Each item in the Personics catalog carries a price tag from 50¢ to $1.50 for most of the pop/rock selections and up to $2 for some of the longer classical items. These are the only costs, and they include tape, labelling, and royalties for the record companies.

Some readers may wonder why there is a complete program storage system in each store. Would it not have been possible, even desirable, to have a central depot from which all program information could be sent out via fiber-optic links or some other form of data transmission? This was considered early on, but abandoned as too expensive and not as reliable as the current method.

According to Personics, the company takes extreme care when they initially transfer the licensed program material. When possible, they go back to the earliest unequalized source material available, and Personics is happy to provide a mastering engineer to supervise the transfer process. The Dolby adaptive delta-modulation process is itself a refinement of earlier methods, in that its output converter "knows" some 10 mS ahead of time any changes which must be made in order to accommodate sudden changes in signal density or dynamic range. It can thus avoid problems of clipping or "breathing." The overall duplicating process is capable of producing a cassette which maintains, at the very least, a frequency response from 20 Hz to 16.5 kHz, ±3 dB. TDK Type II tape is used for the in-store duplication.

Personics has the basic interests of the record business very much at heart; one of their shareholders is Thorne-EMI, the British parent of Capitol and Angel Records in the United States. Personics' intent is to enhance overall album sales by offering only the main cuts from a given album. This may encourage the user to buy it, since it is not possible to copy an entire album in the store.

A monthly publication lists the Personics catalog to date and contains

California Audio Labs Announces The New Tercet mkIII CD Player

From the company that builds the worldwide reference standard in CD Players.

The all new Tercet mkIII is the definitive statement in solid state CD players from California Audio Labs. At a suggested retail price of only $1,295. the Tercet mkIII is an affordable player with an exciting pedigree. The Tercet mkIII comes from the people who have the most successful high end CD players in the world. Made in America to exacting standards, the Tercet mkIII features separate eighteen bit D/A converters for left and right channel with eight time oversampling. Of course, the Tercet mkIII also features the new CAL linear drive transport

At California Audio Labs exceptional sound quality is a tradition. Now, with more than eighty dealers throughout America, California Audio Labs can be found in high quality audio dealers everywhere. Just phone or write for more information, or better yet, call your local audio dealer and ask them to let you audition the exciting new Tercet mkIII.

California Audio Labs

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Personics stores its tunes on CD-size discs that won't play on regular CD gear; the modulation system is entirely different.

articles on artists. The catalog listings are given for major categories, and there is also an artist listing. The program categories are blues, classical, country, easy listening, folk/bluegrass, heavy metal, jazz, oldies, New Age, pop, rap/dance, reggae, rock, soul, and sound effects. With mainline record companies participating, and with their catalogs dating back several decades, it is clear that Personics has quite an artists-and-repertoire job on its hands. It is interesting to peruse, for example, the easy listening section. Here we find five entries for the Andrews Sisters (going back to the '40s), three for Johnny Mathis (from the '60s), and three for Patti Page (from the '50s). That's plenty of nostalgia, and a clear indication that Personics is interested in tape enthusiasts of all ages! The jazz section is fairly large and presents the best of the past as well as current artists. The largest section by far is for rock.

The classical section is a problem. Mainly, it consists of selected movements from various works, including Bach's Brandenburg Concertos, Handel's "Water Music," Vivaldi's "Four Seasons," and Brahms' Hungarian Dances. Sibelius' "Finlandia," Mozart's "Eine Kleine Nachtmusik," and a Strauss waltz are offered for good measure. The longest work listed is Beethoven's "Moonlight" Sonata (14:36 for $2). The problem here is that the repertoire base for classical music is so broad, and the works basically so long, that the entire notion of in-store dubbing is questionable.

Personics proposes to make additions to the catalog biweekly, since this is about the turnaround time for optical disc production. At any given time, a licensor may want to change the product mix, deleting or adding items. Another benefit for participating record companies is that an accounting may be made at any time of the units duplicated on a given catalog item. Personics ultimately expects each store installation to generate 10,000 cassettes per year.

Personics' marketing is aimed both at major record distribution chains and major record companies. For the most part, the record companies have been very receptive to the concept and feel that it poses no threat to their album sales. One adverse reaction has come from A&M Records, which feels, purely from an artistic view, that the Personics approach runs antithetical to the integrity of the album concept, that an album is programmed by the artist and producer for continuous listening from start to finish.

In closing, I wish to thank Charles Garvin, President of Personics, for providing much of the information presented here. Thanks also go to Henry Brief, of the International Tape Association, for the loan of taped proceedings of ITA's technical seminar presented in May 1989.

"...enjoy heavenly sound in the most comfortable headphones ever invented!"

Rich Warren
Nationally Syndicated Audio Columnist
Chicago Tribune, December 2, 1988

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EDWARD J. FOSTER

BURST OF CREATIVITY

Illustration: Richard Aloisio

At the Summer Consumer Electronics Show this past June, NAD appealed to the audio press to support a movement for the reconvening of the Electronics Industries Association (EIA) Amplifier Standards Committee. The company's aim was the adoption of a new power rating which NAD tentatively called Musically Effective Burst Power (MEBP). The company further suggested that "a new EIA amplifier standard should also mandate that all power ratings be expressed in decibels, corresponding to the way the ear hears, rather than in linear 'watts' " and went on to say that a "dBW-based rating system would go a long way toward reducing consumer confusion and rationalizing amplifier design." Since both concepts were originated by me when I was chairman of the Institute of High Fidelity (IHF, now the EIA) Amplifier Standards Committee, I heartily approve of the concept. It might be a good idea, however, to review how the present standard came to be and what NAD's objection to it is.

During the time when the IHF was developing its Standard Methods of Measurement for Audio Amplifiers (1975 to 1978), the FTC issued its now (in)famous rules for permitted disclosures of home amplifier power in ads and spec sheets. The FTC rules stated that if a power specification were to be claimed for a home amplifier, the amplifier must be preconditioned for one hour at ⅓ rated power and the *primary* power rating must be based upon the amplifier's ability to deliver *continuous* power, measured in watts, with all channels driven, into a specified impedance, over a specified bandwidth, at a specified maximum level of total harmonic distortion. It was left up to the manufacturer to choose the impedance, bandwidth, and THD level, but all three were required to be stated as part of the power disclosure. Eight-ohm loads and a bandwidth of 20 Hz to 20 kHz were so commonly cited that many thought those numbers had been imposed by the FTC.

The FTC ruling was issued because some manufacturers on the fringes of high fidelity had been taking liberties with the existing IHF music-power rating and were making grossly exaggerated claims for their products. The committee I chaired was well aware that music is not composed of constant-level sinusoids and that the FTC, in an attempt to protect the music listening public, had neither understood nor served its needs very well. Nonetheless, the law was the law, and to write a standard that purposely flouted it did not seem appropriate. Thus, the IHF/EIA primary power rating was designed to be compatible with the FTC regulation, and a dynamic headroom specification was created that, according to the foreword of the standard, "addresses itself to the power output capability of an amplifier when that amplifier is called upon to handle music-waveform signals, rather than continuous sine-wave signals." Furthermore, the dBW (power expressed as dB, re: 1 watt) was introduced as "an alternate *recommended* logarithmic power-rating scale" (italics mine).

What we were attempting to do—or at least what *I* was attempting to do, since I can't now speak for the other committee members in this—was to avoid going to the mat with the FTC (which would have made us appear as an industry group trying to cover up deceptive advertising by our members), while leaving the door open for perceptive manufacturers to create products that had the headroom needed to reproduce real music at high listening levels without the gargantuan and costly power supplies and heatsinks that would be needed for a high FTC power rating. The committee chose *not* to call the new specification "music power" because that was what caused the FTC to intervene in the first place. Nor did we wish to use the term "dynamic power" because we feared that two "power" ratings potentially would be confusing.

Speaking for myself, I had hoped that specifying dynamic headroom in dB might convince manufacturers to start rating power (at least as a supplement) in dBW. Since human perception of the relative loudness of two sounds is approximately proportional to the logarithm of their acoustic power ratio, a dB-based power rating system seemed to me to make good sense. Certainly, if dynamic headroom was meant to indicate how much *louder* an amplifier would play music than the FTC power rating might suggest, a dB-based specification would be most appropriate. Hence, dynamic headroom was born.

The committee now needed to come up with a suitable test signal and methodology. Of all the members, only Hitachi produced experimental data that related to the duration of peak levels in music. Their studies suggested that

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C&C Computers and Communications

For more information call (312) 860-0335. NEC Home Electronics (USA) Inc.

NEC

Pre-CD studies indicated that 20 mS of increased output was reasonable for dynamic headroom. Now we're not so sure.

music peaks seldom exceed 20 mS in duration and occur no more frequently than once per second. On the basis of this, the IHF dynamic headroom test signal was established as a 20-mS burst of a 1-kHz sine wave, repeated at 0.5-S intervals, superimposed on and phase-coherent with a continuous 1-kHz sine wave at a level 20 dB below the burst. The continuous sine wave was meant to represent the average music power; the more stringent 0.5-S interval (rather than 1 S) was adopted for ease of measurement.

The dynamic headroom rating was to be established by observing the output of the amplifier on an oscilloscope and determining the level at which the output stage went into clipping on the high-level portion of the burst. The dynamic headroom rating was then defined as "the ratio of the average power of a sine wave, having the same peak-to-peak voltage [as the signal at clipping], to the continuous average power output rating . . . of the amplifier, expressed in decibels." The committee realized that the accuracy of this measurement would depend on how clearly one could establish the clipping point by visual observation. Since most solid-state amplifiers clip sharply, visual observation could be quite precise. For those that do not, the measurement would be less precise—but it was, after all, an auxiliary measurement, not a primary one, so some imprecision in some instances could be tolerated.

As is often the case—especially when a standard is developed in the United States and affects products that are, for the most part, designed and manufactured in the Far East—publication of IHF-A-202 was greeted with sublime indifference. Even now, 11 years after publication, certain significant innovations of the standard (notably the input terminations and control settings to be used when measuring sensitivity and signal-to-noise ratio) are often ignored. Dynamic headroom did seem to stick, however, and most high-fidelity amplifiers, whatever their origin, now often carry a specification for it. This is usually in the range from 1.5 to 2 dB, which is about what one might expect from a rather loosely regulated power supply that provides a higher output voltage when its filter capacitors are fully charged.

Unless the power supply is very well regulated, a dynamic headroom of 1 or 2 dB comes almost automatically. It is possible, however, to achieve much greater dynamic headroom by using a "smart" power supply—that is, one with two output levels. Normally the amplifier operates from its higher voltage supply and can deliver substantial short-term output power; as the amplifier heats up, it switches to a lower voltage supply to limit the power dissipation and thus the need to provide extra heat-sinking and power-transformer capacity. The low-voltage supply determines the continuous (FTC) power rating; the high-voltage supply establishes the short-term power output or dynamic headroom. With this type of supply, one can design for whatever dynamic headroom is desired, and one can provide that headroom for much longer periods than the 20 mS called for in the IHF/EIA standard. In fact, the designer decides how long to provide high power; a little extra heat-sinking and transformer capacity can double, triple, quadruple, or further increase the short-term power duration arbitrarily. NAD was one of the first companies to capitalize on this concept, which was, after all, the purpose of having a dynamic headroom specification in the standard. For years, NAD amplifiers and receivers have carried rather modest continuous power ratings but have had dynamic headroom specifications higher than most of their competitors. As such, they represented good value in the minds of many music lovers.

Back to the present: At the June CES, NAD made a plea to *abandon* FTC continuous power as the "primary" power rating and replace it with a dynamic power rating based on response to a test signal similar to the IHF dynamic headroom signal but of substantially different duration and duty cycle. For the time being, NAD suggested a 200-mS tone burst repeated at 2-S intervals and superimposed on a continuous tone 12 dB lower than the burst. (For the future, NAD suggested they would develop a more complex test signal.) The 200-mS burst is said to correspond to the peak durations that NAD found to be typical of music, and the test signal's 15% average-to-peak ratio is said to impose the same thermal stress on the amplifier as compressed rock music.

To demonstrate the validity of its proposal, NAD played various selections through its own 50-watt (FTC) Model 7100 "Power Envelope" receiver and through five competitive receivers that were FTC-rated from 60 to 90 watts per channel. The outputs from all receivers were matched and padded down before driving the speakers so that, even at reasonable listening levels, all devices would be driven into clipping during peaks. The square of the output voltage (which, into a resistive load, is proportional to output power) was displayed on an oscilloscope so that the attendees could visually observe clipping as it occurred. Indeed, the NAD 7100 did not clip until much higher output levels than the competitive products, and the peak duration of the musical sforzandi often exceeded 20 mS in duration. The demonstration was so dramatic that one waggish technical editor called for the Standards Committee to be reconvened there and then.

As committee chairman (I'm told one never really gets rid of the job unless one resigns from it), I am in favor of reconvening the committee to examine the NAD proposal and the data generated in support of it. The difference between a 20-mS and a 200-mS peak duration is clearly substantial and should be investigated by one or more independent parties. In observing NAD's CES demonstration, I noted that most often (but not always), long-duration clipping occurred on very low-frequency signals whose period (the duration of a single cycle) exceeded 20 mS. If those signals are present in music at sufficient level to cause clipping, the peak duration, ipso facto, will exceed 20 mS. The time at which the Hitachi study was performed implies that it was based on analog tapes or discs, so it is quite likely that very low frequencies were not present in the recordings at full level. NAD (properly) used CD recordings, which can carry arbitrarily high levels of low-frequency tones. If the above hypothesis is true, NAD is likely to be on the right track.

Nonetheless, further investigation is needed. As stated above, in NAD's demonstration all amplifiers were forced into clipping on a fairly regular

NAD has shown that power standards for amps should be reviewed but not that they must necessarily be overturned.

basis. This is fine for demonstration, but it is not the ideal way to conduct an experiment to establish the duration and recurrence of peak levels in music. (Indeed, upon questioning, an NAD spokesperson stated that the original experiments were not performed with the demonstration setup.) In my opinion, one must perform the experiment *below* the clipping point, and one must categorize the peaks *according to their duration and level*—not a simple task by any means. In the NAD demonstration, it is conceivable that short-duration peaks, substantially higher in level than the long-duration ones, were occurring and being clipped even more frequently. NAD's position, if I understand it correctly, is that short-duration clipping cannot be heard and therefore can be ignored.

Even granting that the NAD tone burst is more representative of music than the present IHF burst, I foresee problems using it as the basis of the *primary* power rating. It will be difficult to quantify distortion or bandwidth when using a noncontinuous test signal (I can conceive of ways to do it, but they are likely to be of questionable accuracy), so the NAD proposal may bring us back to the days of rating power independently of bandwidth or distortion. Many would consider this a step in the wrong direction.

Furthermore, NAD did not make clear *how* its proposed test signal would be used to rate power. The IHF/EIA dynamic headroom methodology, i.e., driving the amplifier to the clipping point on the tone burst, can be justified to establish an auxiliary rating such as headroom, but it is not appropriate (in my opinion) for a primary rating. With some amplifiers—notably those with NAD's "soft-clipping" circuit—it is very difficult to get an accurate reading using a "clipping-point" criterion.

I commend NAD's work and believe the Amplifier Standards Committee should review it to determine whether the present dynamic headroom test should be modified. At the same time, the committee can decide whether the results of such a test are or are not appropriate for use as an amplifier's *primary* power rating. Change, in this regard, would imply a change in FTC regulations, which presumably would require political action.

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ROBIN LANIER

The Blue

Some years ago, in the pre-digital era, my partner and I plunged into making a binaural recording. We built, almost from scratch, a complete binaural system, with audio quality representing the peak of the art for that time.

We used the system to make recordings of first-rank musicians playing first-rank music in different acoustic settings. These recordings amply confirmed the long-recognized virtues of binaural technique. As far as we know, they were the first, perhaps the only, binaural recordings of professional musicians playing serious music that were made by independent audio experimenters. We believe that the audio community will be interested in the story of our project, told here in full for the first time.

Our story is in two parts. The first tells how we built the system, with intense efforts to reach a truly state-of-the-art level of audio performance. Our master tape still exists, and it can hold its own for high quality, even in this digital era.

Of course, the audio experimenter who follows our lead will have a decidedly easier time of it today: Digital is here at moderate cost. But the user must learn how to employ digital equipment for truly top performance. He can learn the importance of top audio performance by listening to excerpts from our master tape, which were transferred to cassette in real-time duplication (as described in the accompanying sidebar). The cassette not only demonstrates binaural technique in full application but will surprise many listeners by showing the superb quality that was possible with top-notch analog recording even then.

The second part of our story is about our experiences in making the recordings: What we learned about the system's advantages for the recordist, as well as what it brings to the listener. The benefits for the recordist are so marked that we have to remind ourselves why binaural sound has never entered the mainstream. The require-

Sculpture: Madi Lanier

Max Affair

ment of headphones for the full effect is one reason; the commercial and technical advantages of multi-track recording are others.

But the technical advantages of binaural recording have slowly resulted in a modest body of use in the music industry of late. We'll look at that trend in some detail further along.

Building the System

We built our system because we did not have, before we started, top-grade audio recording equipment. We believed we could build key elements of the system to higher performance standards than those of any equipment we could rent or find available in most pro recording studios.

Our confidence was based largely on the very high skills of my partner (anonymous here at his request), a graduate engineer with long professional involvement in advanced audio design. He was the technical leader and designer. I, as a journalist who had been an amateur builder of ham radio gear and home hi-fi systems in my early years, was a good backup with the soldering iron but was more useful to the project for alertness to sources of music and acquaintance with professional musicians. A third important skill was supplied by my wife, Madi, a sculptor with years of professional experience. Madi was the key to our production of the dummy head, the centerpiece of any binaural recording system.

Building this head was our first construction assignment. A dummy head's main requirements have long been established: Real-life size, realistic shape, and especially important, "real" external ears. We also felt that the outer material should at least approximate human skin's elasticity.

To get us started, my wife produced a realistic head and shoulders in clay, with carefully delineated external ears. This new individual quickly assumed the name "Max." His eyes were closed, and his head was slightly forward—an intent listener.

Max's metamorphosis from clay to his mature stage followed steps familiar to sculptors. Around his head, he received a coating of plaster that closely followed the contours of the clay. The plaster coating was divided into sections so it could be removed after it hardened; the sections could then be reassembled into a hollow mold with a negative of Max on the inside surface.

For the mature Max, we chose General Electric RTV silicone rubber, a wonderful material that is an inert, somewhat viscous liquid until a curing agent is added. Then, in a short time,

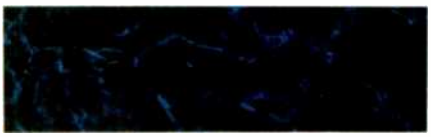
Ray Curletti

the material becomes a very tough rubber, permanently taking whatever shape the container gives it.

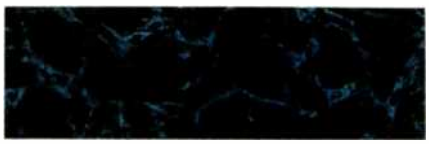
We poured the silicone rubber and the curing agent into the reassembled mold. When the rubber was hard, we took off the plaster cocoon and had our dummy, with lifelike ears and skin. The hardened rubber had a grayish-blue color, so we changed the dummy's name to "Blue Max."

The underside of the dummy, somewhat below shoulder level, got a wooden base, to which we attached an adjustable stand holding Blue Max at any height up to about 5 feet. He is still

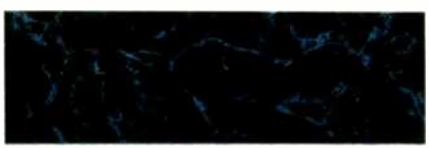
The recordings produced with the Blue Max dummy head confirmed the virtues of using binaural technique. The story of this project is told here, in full, for the very first time.



Blue Max



Why hasn't binaural sound gone mainstream? Because of the commercial and the technical advantages of multi-track and because of the need for using headphones.



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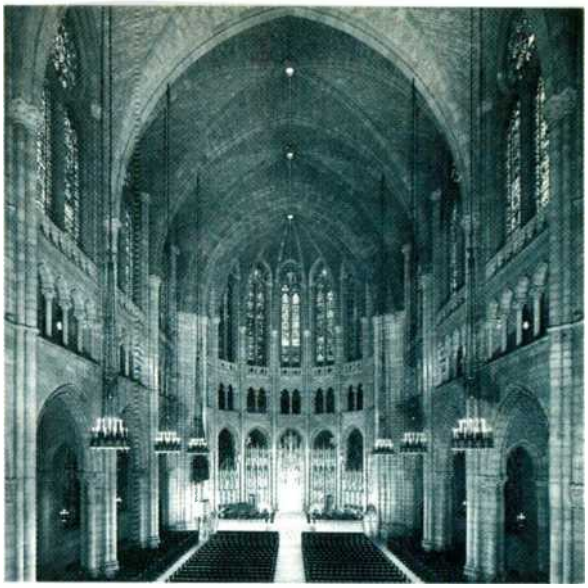

Photograph Nathaniel Lieberman

standing in my partner's laboratory, unfazed by the passage of time.

Ears for Blue Max

To complete the dummy, we had to give him ears—microphone surrogates for the real thing. We used two small condenser mikes—the brand name has been obliterated from my memory—that had been damaged. These microphones got new diaphragms of ultrathin plastic, metallized on one side, and stretched to the proper tension. We also cleaned and tightened the assemblies.

These refurbished microphones, by our careful tests, performed extremely well—above the standards of the period's commercial units. Frequency response was very flat to 20 kHz, with a slight rise around 18 kHz.

Installing the mikes required some surgery on Blue Max. We drilled holes through the representations of the ear canals, into the interior of his head. The holes were sized so that they would hold the microphones tightly. We inserted each mike so it was flush with the exterior rim of the ear canal.

This placement made it certain that sounds reaching the mikes would be subjected to all the influences of the head and external ears: The blockage and diffractions of the head, the frequency discriminations of the ears, and especially the differences between the two ears in all these factors. These differences would be preserved for the listener by feeding each mike separately to the corresponding ear via headphones, the essential delivery scheme of the binaural technique.

With these complex signals corresponding closely to those a real ear canal would get at the reception point, and delivered to the listener's ear at a point corresponding closely to the mike pickup point, the listener would, in effect, be taken back to the original musical event.

This offers distinct advantages. Stereo localization, for one, is truer and very stable. The elements in the reverb, moreover, are well reproduced with respect to frequency character amplitude, direction, etc., so the hearing system gets truer ambience and can deal with it in a "real" way, exercising its well-known power to focus on the signal through ambience and noise.

From all this, the listener gets a sense of instruments in a real space, a re-creation of reality that is one of the hallmarks of binaural reproduction. There is some variation in response to binaural sound from one individual to another, but the majority of listeners with normal hearing, including reasonable sensitivity to the high frequencies, hear the instruments as though they are "outside" the head, disposed in the space around and in front.

Home-Brew Electronics

My partner designed all the electronics for the system: Mike preamplifiers, line amplifiers, two recording amplifiers, and two playback amplifiers. The mike preamps used a very low-noise circuit developed by my partner some time before. The two preamps went into small tubular enclosures that could be clamped to the Blue Max stand, just below the base, and connected to the mikes through fittings on the base.

The two line amps went into one small enclosure that could be put down anywhere between Blue Max and the offstage position of the tape recorder. These line amps allowed us to use very long cable runs.

The recording amps incorporated several no-compromise ideas. For one, they provided recording bias at the highest frequency that could be forced through the recording heads—about 200 kHz. The distortion in the bias signal was virtually unmeasurable.

Performance of the electronics chain as a whole was up to our hopes: Dynamic range, greater than 80 dB; S/N ratio, about 83 dB; frequency response, very flat from 25 Hz to 20 kHz, with a slow roll-off at each end, and distortion in the electronics, around 0.01%. Digital recording has made such figures banal, but at that time, they were very far from common—they represented the peak.

The recording and playback heads were top-of-the-line Bogens, made for three tracks on half-inch tape. We planned to use the two outside tracks for the two stereo channels and leave the center blank. The heads performed superbly.

The tape drive evolved from a custom-built drive which we had inherited from an earlier project. The drive checked out well for the 30 ips we planned to use but had more unevenness of motion than we wanted, including flutter and some stick friction leading to modulation noise.

Reduction of the motion problems required remachining and refining a number of parts. We installed a better balanced flywheel on the capstan, eliminated stationary tape guides in the tape path in favor of low-friction, high-inertia rollers (especially on both sides of the head), and made other changes to obtain smoother tape-drive motion. For this work, my partner and I had available a high-precision machine tool (a combination lathe, miller, and drill press) which we owned jointly.

The flutter finally came down to about 0.05%, which was very low for that time period, when smoothness of motion depended mainly on mechanical refinement—not, as it does now, on the frequency stability of digital circuits. Modulation noise was also very low as a result of our work on friction in the tape path.

With the tape drive in good shape, we had our complete system, genuinely at the peak of the art for that period. The immense effort that went into the system was inspired, in part, by a delight in super-fine audio performance. It was equally a financial necessity: The total cost was a fraction of the cost of a complete top-line pro audio system. In this case, low cost and high quality went hand in hand, making our project a viable one.

Recording the Music

The accompanying sidebar, "The Blue Max Binaural Cassette," gives details on the music from our original recording which is currently included on the cassette. Described are the pieces, composers, performers, recording locations, and other relevant information.

The first job we tackled was recording the organ in Manhattan's Riverside Church, a huge interior space which houses one of the most powerful organs in the world.

While Frederick Swann, the organist, ran through soft and loud passages for us, we moved Blue Max around in the forward part of the church to find how he would react in our first for-real job. One of the great virtues of binaural technique was quickly apparent. We got a good balance of sound at any spot within a wide range of distances from the front of the church, along the main center aisle. Blue Max was at home everywhere in this area. We could hear increasing distance from the high-pitched pipes in back of the chancel, but all the music was there, pretty evenly reproduced, from the top of the scale to the bottom.

A second important asset was the handling of the tremendous reverb in the tremendous space. We could hear the reverb, but it did not overwhelm the music at any of the center area positions. Anyone who has made stereo recordings in a highly reverberant space will realize what a gift this characteristic is to a recording engineer. Getting set in large churches, for example, has usually meant moving several microphones around a lot, sometimes to odd positions, to get a reason-

The Blue Max Binaural Cassette

As noted in the main text, the equipment used for this binaural recording was then at the peak of the analog art. (*Editor's Note:* It still sounds pretty good!—*E.P.*) The electronic system had a dynamic response greater than 80 dB, distortion below 0.01%, and frequency response flat beyond the limits of hearing. Recording was on half-inch tape moving at 30 ips. The audio quality of the master tape fully reflects these high levels of performance.

The recordings have been newly duplicated by In Sync Laboratories in New York City, in real time, using the original master tape and applying the very best of today's duplication techniques. The 22 minutes of music are complete on one side of a C-60 cassette tape.

If you order the cassette by mail, as outlined below, it will bring you three interwoven audio experiences:

The phenomenal acoustic realism of binaural recording, demonstrated in three different acoustic settings—a listening experience virtually unavailable elsewhere;

The ultrafidelity of the original master tape, which can hold its own for superb quality even in the digital era, brought to the cassette listener via the transparency of today's finest duplica- methods, and

First-class music extremely well played by first-class musicians specifically for these recordings.

The music is in three groups of two pieces each. The first section features "The Sound of Change" (2:48) and "Space Virgin" (3:42). Ronnie Roullier, jazz pianist, composer, and group leader, wrote these pieces especially for the binaural project. The first is a typical rock number, the second a splendid example of mainstream jazz. The performers, in addition to Roullier on piano, are: Joe Newman, trumpet; Morty Lewis, tenor saxophone; Wayne Andre, trombone; Joe Beck, guitar; Russell George, electric bass, and Ed Shaughnessy, drums. The setting was the Rutgers Presbyterian Church on Manhattan's Upper West Side.

The second set of selections includes an excerpt from the First Movement of Beethoven's Quartet No. 1, Opus 59 (3:00) and the First Movement of Schumann's Piano Quintet (6:28). The performers are the members of what was then Hofstra University's quartet in residence: Harry Glickman and Raymond Kunicki, violin; Jack Braunstein, viola, and Seymour Benstock, cello. On the Schumann Quintet, they were joined by Jascha Zayde, piano. The recording venue was a recital hall at Hofstra University.

The third and final section of the tape features Bach's Prelude in G Major (3:04) and the Trumpet Voluntary attributed to Purcell (3:25). Frederick Swann, organist of the Riverside Church in New York City, played these two familiar organ masterpieces on the church's powerful organ. As noted in the main text, the binaural technique makes it possible for the listener's hearing system to get a clear account of the music on the recording, through the tremendous reverb in Riverside Church.

Copies of the binaural cassette are available for $11 each from In Sync Laboratories (2211 Broadway, New York, N.Y. 10024). Simply note that your check or money order, payable to In Sync Laboratories, is for the binaural cassette, and include your name and address.—*R.L.*

Blue Max

Good microphone placement ensured that every sound reaching the mikes would be subject to all the influences of the head and outer ears.

able balance between music and reverberation.

Blue Max produced a good balance by his very nature, allowing the hearing system to deal with the reverb in a "real" way—a major asset, as already noted. He made microphone placement an affair of great simplicity. We ended by leaving him about 30 feet from the chancel, in the main aisle. We could hear everything there—the voices of all the pipes and the full acoustic power of the church.

There was one unexpected result of our drive for very wide frequency response. The lower pedal notes came through with such power, as a result of their truly enormous acoustic power in the church, that we had to reduce the recording level about 10 dB to avoid overloading the tape. We did not want

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to roll off the bass substantially, relative to the higher frequencies, so we accepted a small loss in S/N ratio, which the powerful music rendered inaudible through virtually the entire recording. In the other recordings, no such reduction in signal level was necessary.

When you listen to the organ recordings, you should keep the headphones tightly sealed against your head to avoid loss of the low bass. Also, as with all our recordings, you should set the perceived volume at the highest comfortable level for the "truest" space re-creation. It should be comparable to what the listener would hear at the original performance.

In fact, we believe that listeners will discover that the volume can be very high without any discomfort, if high-quality headphones are used. This results partly from the very low distortion in the recorded signal but also from the hearing system's opportunity to deal with a "real" signal, the gift of the binaural technique.

Jazz in Church

Our second recording, of jazz and rock music, also took place in a church. One rock and one jazz piece were composed for the project by Ronnie Roullier, pianist and jazz orchestra leader. "The Sound of Change" is the rock piece, and "Space Virgin" is the jazz.

We had arranged to make the recordings in the Rutgers Presbyterian Church on New York City's Upper West Side. This space has been used for a long time by independent recording engineers who like its very smooth reverb and the resulting clarity and definition in the music. Roullier assembled the group—six men from the army of talented and skilled pop/jazz recording sidemen available in New York City. We had some of the stars.

None of them had seen Roullier's music before sitting down in the church's chancel. The composer led the musicians in unpressured run-throughs of some passages while we moved Blue Max back and forth along the center aisle of the church.

Again, Blue Max showed his mastery in a wide range of positions. We did rearrange the seating of the group somewhat, to put the powerful trumpet, trombone, and saxophone a little further back so their volume would be more even with that of the piano. The setup, from left to right, was: Piano, guitar, and electric bass; drums in the middle, and then trumpet, saxophone, and trombone.

Finally, we put Blue Max in the main aisle, about 20 feet from the raised chancel on which the musicians sat. Every instrument could be heard perfectly there. When we gave Roullier the signal that the tape was moving, he and the group took off in a display of superb musicianship. They played with a verve and give-all to the music that I still remember with intense pleasure.

In the recording, all the virtues of binaural technique work especially well for the music. If the volume is set high, the result is just very strong, very clear sound, with the musicians seeming "right there." (Of course, if you like a lower volume, follow your inclinations but try the high volume first.) Being "right there" is exciting when listening to this group. The work by trumpeter Joe Newman, for example, is moving and strong. Ronnie Roullier's piano is splendidly in the spirit of mainstream jazz in "Space Virgin"; note especially his solo break about two-thirds of the way through the piece.

Max's Third Triumph

We made our final recording, of chamber music, in a recital hall at Hofstra University, using musicians who were then the quartet in residence. The room is quite large but without the very high ceiling that gives churches their strong reverb. Getting a good "live" tone could have been problematic with separated microphones and probably would have required a good bit of moving mikes around.

Yet there was absolutely no problem for Blue Max. He gave us a decent sound from anywhere in a wide area in front of the musicians, who were on a raised platform at one end. We settled on a position about 15 feet from the front of the platform. The string players were in standard quartet positions—first violin to the left, cello to the right, etc. For the Schumann Piano Quintet, we put the piano a little back and to the right, to get it in reasonable balance with the strings.

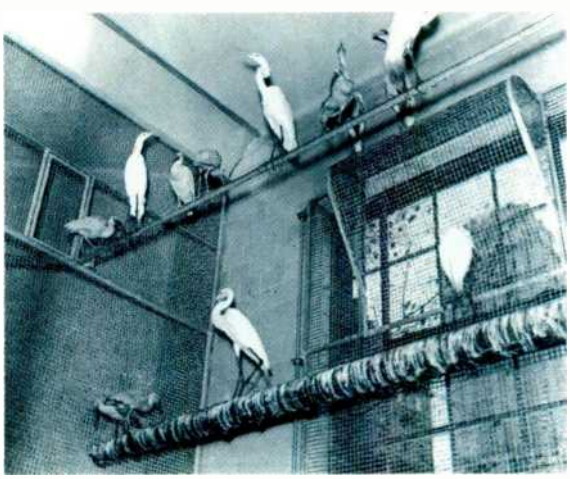
Again, the performances seemed to us totally first-rate, with complete commitment to the music and high skill. To double-check my decade-old high assessment of the work these musicians did, I recently compared their Schumann with the same music performed by Leonard Bernstein on piano with the Juilliard Quartet (Columbia MS-6929). My judgment is that our players did just as well and maybe a little better. Moreover, with no fuss at all, Blue Max produced a satisfying room tone, with all the performers in proper position. The Columbia recording is no better on these counts—the room tone is maybe a little thinner. We can assume it was made in a megabuck studio with controlled acoustics, artificial reverb if that was wanted, and plenty of mikes carefullly disposed to get the performers front and center.

By raising the volume to a high but comfortable level, the listener will move close to the actual scene. He can get the thrill of being right next to highly skilled professionals giving an all-out account of fine chamber music. Of course, it is not as good as really being there, but it will make an excellent substitute for those many nights when a close approach is not possible.

Current Use of Binaural Recording

The strengths of binaural technique are evident in these three examples of recordings made more than a decade ago. Recently, there has been a growing interest in binaural technique, especially in Germany, where the Neumann company has developed a series of dummy heads which they use and sell commercially. Called "Fritz," the Neumann head is a near cousin of Blue Max but uses a somewhat different approach to microphone placement. The mikes are deeper in the simulated ear canal and work with an elaborate acoustic filter for needed equalization.

Neumann says their latest filter has made the recordings fully usable on loudspeakers as well as on headphones. This has evidently opened the way to the use of dummy heads in commercial music recordings—especially those made in highly reverberant spaces (for reasons this article has made clear). Our own recordings seemed to us, from the beginning, very effective on loudspeakers, though the full space and reverb effects were obviously lacking. Present in both modes of delivery are great dynamic range, very low distortion, and extra-wide frequency response. The recordings seem excellently balanced on speakers, and the performances are completely enjoyable.



Courtesy of Central Park Zoo

Masquerading as Blue Max

In addition to music, our original recording included a full side of demonstration material—city sounds, moving voices, etc. For these recordings, we used an entirely different system in which studio-grade electronics and fast tape recording were abandoned in favor of portability.

We did search for the best small portable recorder we could find at the time, which turned out to be a Uher. This unit recorded two tracks on the full tape width of ¼ inch, at 7½ ips. For that tape speed (and that time), the quality was excellent, though obviously not up to the studio quality of our larger recording system.

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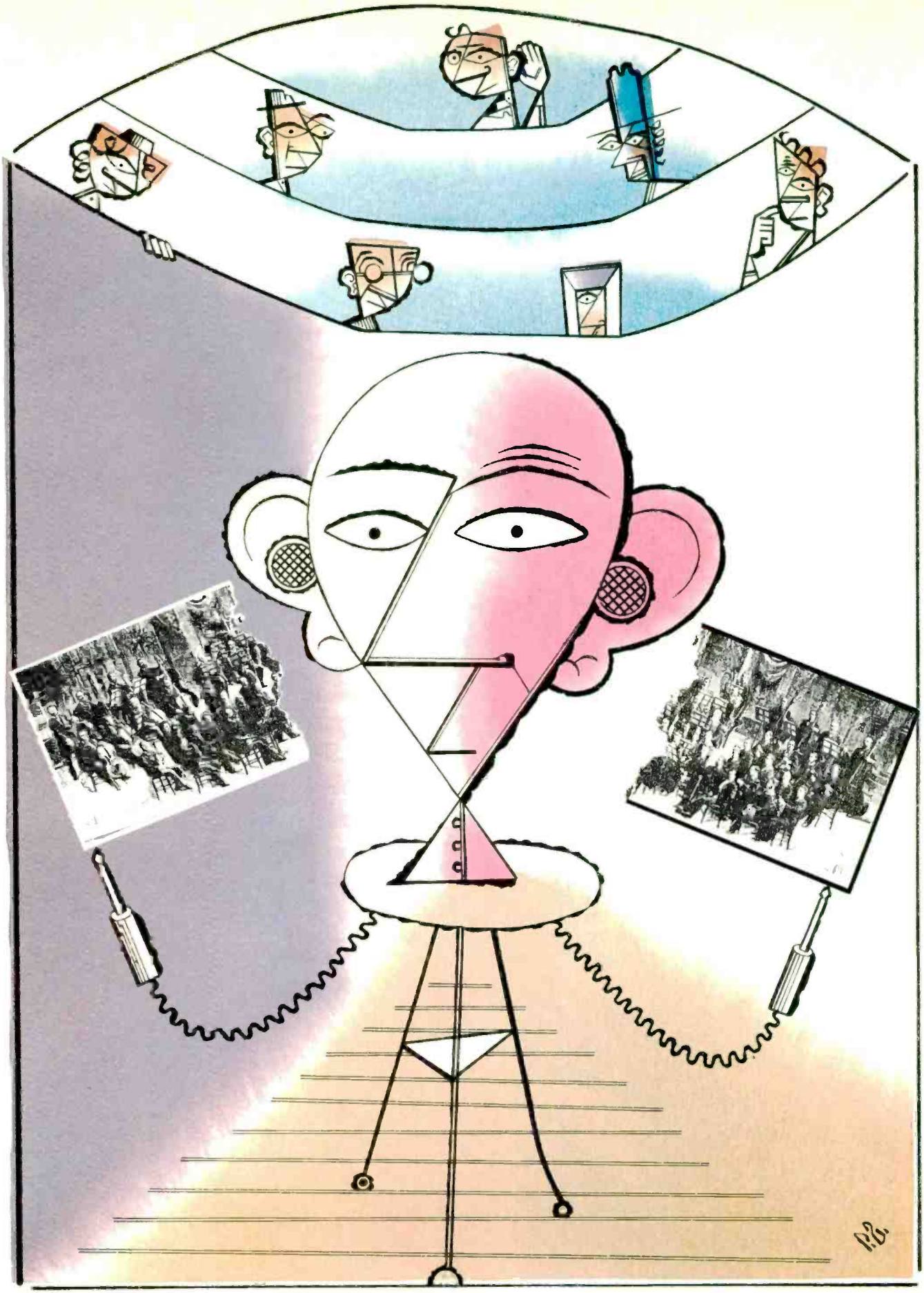
To get binaural input, we used my own head as the dummy head (no coarse humor, please). I spent about two months going around Manhattan with small condenser mikes in my ears and the recorder under my coat. Though the resulting recordings lack the appeal of the ultrafidelity on the music recordings, they do further illustrate binaural technique in action.

The demos on the original recording included: A college basketball game in an enclosed arena whose tiled walls turned the crowd's roars into oceans of reverb (through this din, the binaural system pulled nearby voices, referees' shouts and whistles, and other individual sounds); the bird house at the Central Park Zoo, gently echoing with a mixture of children's voices and eerie bird calls; an exuberant crowd watching New York City's Puerto Rican Day Parade, with many far and near voices around my position and the marching band's music passing in front; a beautiful antiphonal service in a Greek Orthodox Church, with the sonorous priest high on the left, the excellent choir high on the right, and the congregation's responses all around; and rush hour in the Times Square subway station, with loudspeaker announcements competing with massive train noises, voices in the crowd, and shuffling feet.

These and other demo recordings capped our experiment with binaural technique, a most satisfying voyage in so many ways.



EARS WHERE THE MIKES ARE

PART I

JOHN SUNIER

In the last decade, more than 200 million stereo headphone sets have been sold in the U.S. alone. While the majority of these 'phones are attached to Walkman-type portable cassette, CD, or FM units, improvements in larger, home-type stereo headphones have made headphone listening an important part of many home music systems. Yet none of the source material being listened to by these headphone wearers was recorded for proper playback via 'phones! Standard recordings usually suffer from an exaggerated separation which concentrates sounds at the two ears and *inside* the head, rather than providing a natural placement *outside* the head, across the stereo stage. Further, ordinary two-channel recording fails to take into account the complexities of human hearing, especially the transfer function characteristics of the pinnae—i.e., the frequency-response and arrival-time differences caused by the outer ears.

For those unfamiliar with the concept, I'll start by defining binaural sound. It is a system employing two microphones, preferably mounted in an artificial or dummy head but often merely spaced the same distance apart as human ears or placed on or in the recordist's own ears. Two completely independent channels are used, and the two signals are fed, at the end of the chain, to the separate sides of a pair of stereo headphones worn by the listener; the original left mike feeds the left ear, and vice-versa.

At heart, this is the simplest possible method of reproducing sound (after, perhaps, the tin-can telephone). And this may be why it was invented only a few years after the phonograph: In 1881, Clement Ader experimented with transmissions from the Paris Opera using pairs of early telephone transmitters. Lately, binaural recording has benefited from the interest in spatial aspects of psychoacoustics that has led to such developments as Do'by Surround, Carver Sonic Holography, Hughes/Sony SRS, and various ambient-surround systems.

In the March 1986 issue of *Audio*, I presented a history of binaural sound. In Part I of this article, I'll look at the inherent problems of binaural sound, research projects going on now, some still-unanswered questions, and various approaches to dummy head design, including the most recent improvements. In Part II, I'll explain the effects of differences in headphones, equalization, and noise-reduction methods (not to mention differences in listeners' hearing); new methods of achieving binaural reproduction via loudspeakers and binaural effects with ordinary, two-channel material on headphones; binaural motion-picture sound, and some suggestions for do-it-yourself improvements in binaural listening.

The biggest drawback to binaural sound is obvious—one normally has to wear stereo headphones, with their logistical problems and their limitation of the number of listeners who can hear the same source. Loudspeaker playback of standard binaural recordings results in a distant, off-mike sort of sound with a lack of stereo spatiality. There is too much ambience, which seems to muffle the original sounds, and the bass lacks fullness. A second limitation: Only recordings that have been binaurally made can be heard binaurally—and very few recordings have been made this way. Bert Whyte has pointed out how simple and inexpensive it would be for most recording companies to set up a dummy head and make a binaural recording at the same time they make the main stereo master: with multi-track sessions, it could even be placed on two spare tracks of the master tape. However, the only label that has done this, to my knowledge, is Sonic Arts.

ILLUSTRATION: PHILIP ANDERSON

THE IDEA OF BINAURAL SOUND IS TO PUT

MADE, FOR A TOTAL SOUND

A basic binaural recording, made with a standard, unimproved dummy head, poses a number of problems for a totally realistic portrayal of the sound field at the recording location. The idea of binaural sound is to put your head where the recording was made—a total sound-recollection experience. Yet direct front and rear spatial localization is not as accurate as lateral localization (Fig. 1). Frontal sounds also usually seem elevated from their placement at the original recording. These effects differ from one listener to another; many people, in fact, have difficulty locating natural sounds that are in the same plane.

The ability to distinguish locations in the vertical direction is also relatively poor with basic binaural recordings. When a moving sound—such as a person walking by in a straight line in front of the dummy head—is played back, many headphone listeners hear the sound describing an arc in front of them, rather than the accurate straight line. Discrepancies of frequency response sometimes cause not only audible deviations from flat response but also confused spatial cues. Differences in headphones, equalization, and hearing are all factors. All of this has been summed up as the problem of the compatibility of production and reproduction in binaural sound.

Standard stereo recording and reproduction are based on the theory, held for many years, that the relative positions of sound sources are cued by interaural (between the ears) differences in the time of arrival, intensity, and phase. The phase differences are used to localize sounds between about 200 and 700 Hz. Above 1,500 Hz, amplitude differences are felt to be the main contributors. Between 700 and 1,500 Hz, both phase and amplitude differences are used to determine direction of sounds. In fact, most mixing consoles work only with intensity differences to place sounds in the horizontal plane between the speakers. Work with four-channel sound, in the 1970s, made it clear that intensity cues alone were not sufficient to give proper side and rear images.

Localization cues by means of amplitude were found by investigators to be insufficient to define source positions such as "directly in front" or "directly behind," where the sounds produced at each ear have the same phase, intensity, and arrival time. Out of this came research showing that additional localization cues are created as the incident sound is reflected by the convolutions of the pinna of the ear. The theory is that these convolutions act as minute reflectors to create short time delays, causing a comb filter effect in the frequency response (Figs. 2 and 3). More information about these pinna transfer functions has been the goal of many researchers trying to fully understand auditory imaging, the cocktail party effect, the Haas or precedence effect, and other phenomena. Not all of these efforts are directed toward improving binaural recording and reproduction, but they all make useful contributions toward the recording arts.

Another discovery was the importance of the envelope of the signal as a localization cue. It was found that transients are more easily localized than continuous sounds. Some of the cues could also be omitted without serious effects on localization as long as other cues were present. The problem of in-head localization was shown to be not limited to headphones; it could also be created with loudspeaker reproduction by preventing the listener from learning the

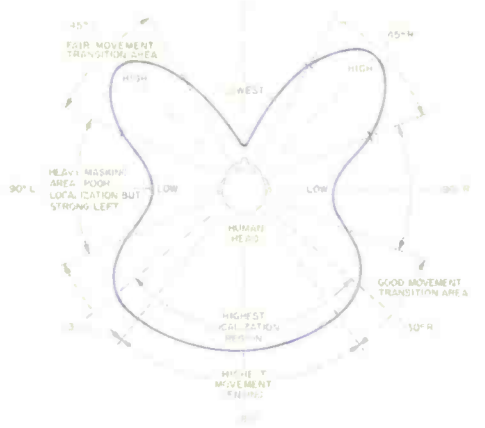


Fig. 1— Localization and movement sensitivity plot, showing asymmetry in natural binaural hearing process. (After Ron Cole.)

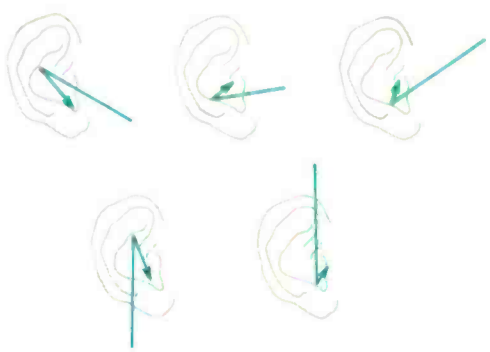


Fig. 2— Paths of first major coherent reflection in pinnae for sounds from various elevations. (After Rodgers.)

acoustics of the listening room—i.e., confusing his short-term memory. Three Japanese researchers found that this effect can be greatly reduced during headphone listening by simulation of the room's acoustic properties through delaying a portion of the input signal.

G. Plenge, at the Institut für Rundfunktechnik in Munich, found bone conduction within the head to be one of the causes of in-head localization. It occurs during recording with some dummy heads and all human heads but does not occur during playback with headphones.

Another researcher in Germany, where the greatest interest in binaural sound exists, developed what he has called the Association Model (Fig. 4). Gunther Theile, who is also with the Institut für Rundfunktechnik, assumes a two-stage function of the hearing process. His model builds on the fact that each hearing event has two different aspects: The sound source itself and the location of the source. These two aspects, therefore, have two correlates in the perception of sound: The location determination stage and the determination of the source itself (i.e., recognizing its gestalt). Without these two stages of signal processing by the brain, our sense of hearing would be unable to determine whether details of spectra are due to the transfer functions of the pinnae or to the sound source itself.

Theile found that the spectrum of a sound source changes depending on its location so that, together with the time delay between the two ears, there is a binaural correlation pattern set up. These patterns can be compared with others stored in the brain during the acquisition of hearing ability. One researcher even investigated the changes in these patterns during childhood: As the child's head grows, the distance between the ears, as well as around the head, increases, and the brain has to readjust the binaural correlation to maintain correct localization.

Theile's work is just one of many efforts during the past quarter century to demonstrate the importance of the localization cues provided by pinna filtering, as well as their role in establishing out-of-the-head character of sounds in the environment. Experimental manipulation to reduce or remove pinna cues was carried out by scientists (at some discomfort to subjects!), including filling the pinna folds with putty, covering them with blocks, and inserting tubes into the ears. All researchers, as expected, reported various degradations of localization acuity following pinna deformation. Wightman and Kistler recently conducted more precise tests simulating the free-field listening experience, using digital techniques to synthesize headphone-presented stimuli. They measured their subjects' free-field-to-eardrum transfer functions deep in the subjects' ear canals using tiny probe microphones (Fig. 5). The measurements obtained were shown to be consistent with previous data.

In addition to the pinna's frequency-contouring effect, the auditory canal, through which sound must pass on its way to the eardrum, also constantly filters the sound (Fig. 6). This gross coloring of the spectrum is common to all that we hear. Our brains make allowance for it with a sort of multiband automatic gain control.

Jens Blauert pointed out, in his 1983 book, *Spatial Hearing*, how we associate certain directions with certain timbres (Fig. 7). The

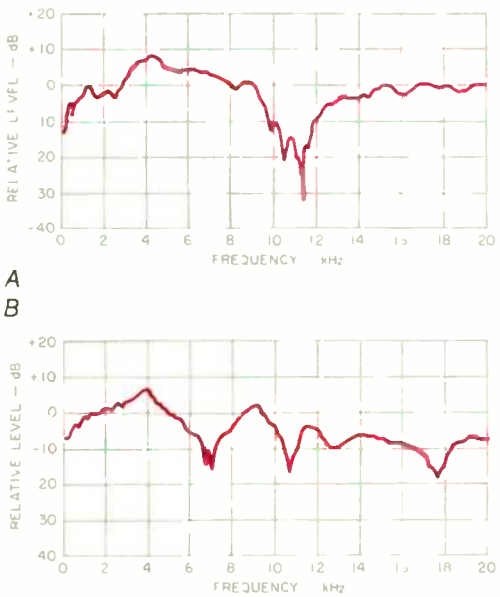


Fig. 3— Pinna response for sound source at 90° azimuth and 15° above ear level (A) and at 180° azimuth (directly behind the head) and below ear level (B). Note the high-frequency attenuation in (B). (After Rodgers.)

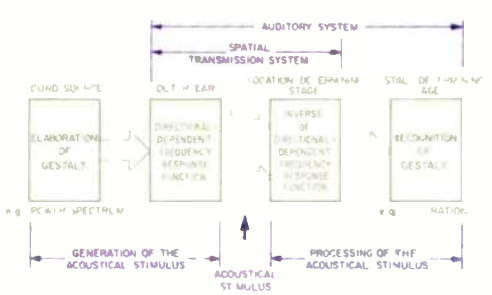


Fig. 4— Gunther Theile's Association Model of binaural hearing; see text.

perception of a sound's location can be changed just by changing its equalization. The most familiar example of this is adding "presence" to a sound by raising the frequencies in the vicinity of 2.5 kHz. The plots clearly show that the main characteristic of frontal sounds is just this peak—the strongest frequency in the sounds we perceive from the front. So a peak at that pitch increases our feeling that the sound is close in front of us—increases, in other words, its "presence." Similarly, a peak at about 7.5 kHz in the sound source will be heard as coming from above one's head, no matter where the actual sound is located.

C. A. Rodgers observed that the spectral cues from pinna filtering were probably assisting the brain in resolving difficulties in differentiating sources directly in front from those directly in back. She also states that there is much yet to understand about the decoding mechanism of the pinna transfer functions. We do not know where the "location code" is contained—in the spectral nulls and peaks, or in a gestalt of the entire frequency spectrum. Also, it has been assumed that each person learns the localization cues provided by his own ears and localizes best with those specific cues. However, one study suggests that some pinnae provide more adequate cues than others. Will high-end binaural buffs one day actually cover their outer ears with putty and put on special headphones with flexible plastic "optimum ears" attached?

The pinna transfer functions are also felt by Rodgers to be important to better understand the Haas, or precedence, effect, which states: "If two sounds that are nearly alike follow each other in close consequence, they will be heard as one sound." She points out that the key phrase here is "nearly alike." Early reflections often come to the ears from many directions, and because of the spectral filtering of the pinnae, when they reach the eardrum, they are no longer nearly alike.

One study by Plenge went beyond the usual assumption that the subject's head would be fixed in hearing tests involving loudspeakers. He concluded that the listening sense does not use all arriving acoustic stimuli but makes a reduction by an appropriate choice process. It attaches the continuous information stream to gestalts, which it recognizes by using stored/learned perception patterns in the brain. Stimuli which cannot attach to these learned and stored patterns in a plausible arrangement with other stimuli are ignored. Another researcher's theory is that an entirely different process in the brain decodes recorded or broadcast binaural sound as compared to the process used in normal hearing.

The listener's brain is merely the final stop in the chain from the origin of the sound source to the experience of hearing its transmission or its delayed reproduction. There are variables in the transfer function at every step: The room in which the original sounds are made; the microphones in the dummy head; the construction of the head, pinnae,

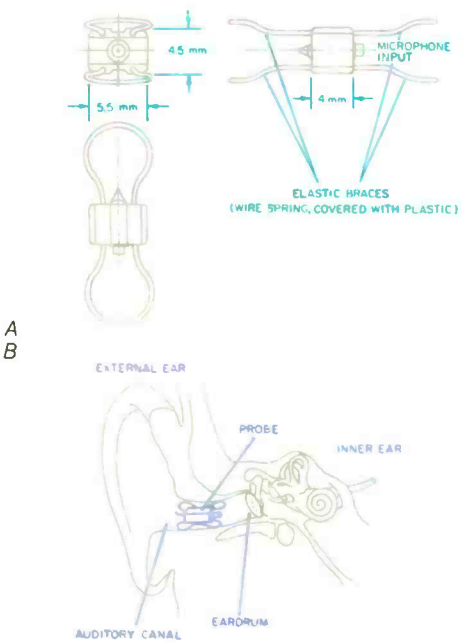


Fig. 5—
Probe using Knowles' miniature mike (A) and its placement in the ear (B). (After Theile.)

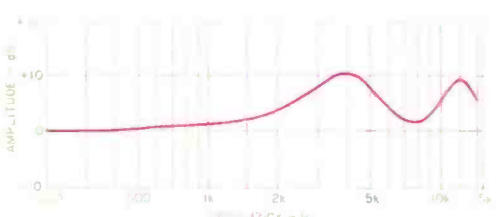


Fig. 6—
Filtering effect of the ear canal, based on mean value of canal transfer functions measured by Shaw et al. The most effective frequency bandwidth for aural localization is from 625 Hz to 2.5 kHz; the point of greatest 360° imaging uniformity is 1.25 kHz, and the most sensitive point for image perception occurs from about 2.5 to 2.7 kHz. The resonance of the ear canal is at 7.5 kHz; the reference frequency (0 dB) is 315 Hz. (After Shaw.)

BINAURAL SOUND RECORDING IS ONE POTENTIALLY ONE OF THE BEST AS WELL.

and torso (if there is one) of the dummy head; the headphones placed on the dummy head and tested with probe microphones (preferably the same model headphones to be worn by the listener), and the transfer function with the listener's 'phones, pinnae, and ear/brain processing which concludes the chain.

A number of amateur binaural sound enthusiasts have made their own artificial binaural heads by using permafoam or wooden wig heads and drilling holes in the ears to mount small omnidirectional mikes. As we'll see, these two materials are just about the least suitable because they don't have any of the physical characteristics of the human head. Others have gone the route of mounting small electret mikes in, on, or near their own ears, sometimes using a spring headband such as that found on earmuffs.

For a time, JVC and Sony manufactured stereo headphones with built-in binaural mikes. This was a compromise solution because the low frequencies had to be filtered out to prevent feedback from the headphones. However, recording binaurally with small mikes in one's own ears often can provide the greatest realism, especially when the same person who made the original recording listens to the playback via headphones.

There are a number of obvious drawbacks to actually wearing the binaural mikes. Great care must be taken to keep the head perfectly straight and still during recording. If the head is turned to the side even a little, when one later listens to the recording, the entire musical group will seem to suddenly shift position in front of the listener! One must also be extremely quiet, since whispering, coughing, even heavy breathing will be clearly picked up by the mikes. A portable recorder is, of course, a necessity for this type of recording. I use a Sony Pro Walkman; others are having success with one of the portable DAT recorders. Since the recordist has to have the machine on his person, however, it cannot be a large studio model. *If* one can keep still, some astounding recordings of shorter musical selections and sounds can be made wearing the microphones.

However, for serious use, and especially for laboratory testing of the binaural hearing experience and improvements in the recording process, an artificial or dummy head is a necessity. In Germany, this is known as a *Kunstkopf* (*Kunst* is German for "artifice," *Kopf* for "head"). A number of such artificial heads are available for experimental, acoustic research, and recording purposes.

One of the most ingenious and, at the same time, affordable to advancec amateurs, is the Sennheiser MKE 2002 (Fig. 8). Recognizing that a professional head with cuality mikes mounted in it is very expensive, Sennheiser came up with their triaxial stereo microphone, which looks something like the acoustic headphones used on airlines. The two sensitive condenser mikes at the end of the "Y" yoke fit close to the ears but do not actually enter them. The power supply is in a

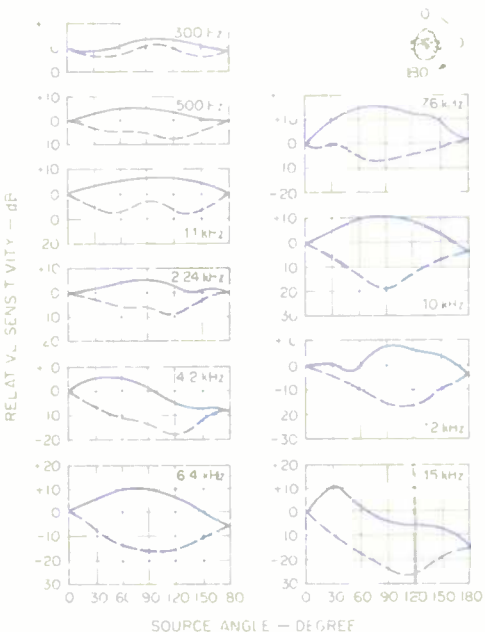


Fig. 7— The association between timbre and perceived source location can be inferred from these graphs, which show variations in the ear's sensitivity, at various frequencies, for source locations from front to back along one side of the head (top right). Solid curves represent the near ear, dashed curves the far ear. Note that the ears' responses do not mirror each other. (After Hiraga.)

Fig. 8— Sennheiser's MKE 2002 triaxial stereo mike.

small attached box with leads running to a portable recorder.

The developers of this system, which has been available unchanged for over a decade, recognized that the binaural effect would not be as good when this mike is used with the dummy head they supply for concert recording and other situations where the mike cannot be worn by the individual.

While the gray, rubbery-surfaced head with mike-stand screw mount has an appropriate consistency, the pinnae are not detailed and cannot be expected to give the same sophisticated location cues as your own ears.

To use the Sennheiser dummy head, the "Y" yoke mikes are simply fitted into the ears just as on your own head. There seems to be greater high-frequency content when recording with the dummy head as opposed to wearing the mikes; perhaps this is due to the lack of hair and finished pinnae. Sennheiser urges binaural listeners to employ open-air-type headphones for best results, but as we'll see later, equalization factors seem to affect results more strongly than differences between closed- and open-ear designs.

The Neumann KU 81i (Fig. 9) has been widely used by professionals for binaural recording, as well as some lab work, for a number of years. The original models had the condenser mikes buried deep in the head, which was split side to side to access the mikes. However, it was learned that locating the mikes at the end of the artificial ear canal, where the human inner ear would be, caused equalization anomalies: In the listening process, the sound passed through the ear canals twice instead of just once! So most dummy heads now mount the mikes with their diaphragms as close as possible to the plane of the human eardrum.

A number of improvements have been made in the Model "i" version, primarily based on Theile's Association Model. Its improved pinna forms have all the pleats and cuts of actual human ears, as well as a similar texture and consistency. The head is equalized for flattest response as measured in a diffuse field, which is a different concept from the free-field approach of some other binaural researchers.

Free-field measurements of audio transducers are frequently made in an anechoic chamber—one which is free of all reflected sound. Only direct, frontal, acoustically flat sound is dealt with. In a pinch, measurements are sometimes made outdoors, where due to the lack of reflections, the results are similar to those obtained in a free-field environment. Adherents of this approach feel that dummy heads and mikes equalized for the free field provide the correct tonal character of sound for images directly in front. They also believe that for loudspeaker reproduction, these binaural recordings are superior to those made with diffuse-field EQ.

Fig. 9—Neumann's KU 81i professional artificial head with condenser microphones.

Kalifi, an ensemble from Ghana, being recorded with a Neumann dummy head for a West German CD on the AudioStax label.

TENDS TO IGNORE THE COMPLEXITIES

THE ROLE OF THE PINNA.

Diffuse-field conditions take into account not only the direct sounds but also their reflections. The further away the mikes are from the sound sources, the more diffuse the sound is because the ratio of reflected to direct sound increases. Followers of this method point out that natural hearing conditions are nearly always diffuse-field and that this approach thus seems more realistic when listening on properly equalized headphones. A gentler equalization is required than with free-field, which means that many standard headphones are closer to diffuse-field parameters than to free-field. These 'phones require an adjustment in their high-frequency response to flatten the sound arriving from some directions.

The calibration procedure for both approaches (after calibration of the dummy head) is to insert the small probe mikes 4 mm inside the ear canals of the listening-test subjects and, without their wearing headphones, to make an equalization chart. (For free-field calibration, the sound originates from directly in front; for diffuse-field, the source speaker is rotated in various directions around the listener's head.) The probes are then left in the ear canals, and the same equalization is carried out while the listener wears the headphones. The idea is to achieve the same flat response as without headphones—the total response must be as flat as possible. David Griesinger feels that the claims of free versus diffuse fields may be moot because of the wide range of equalization in individual listeners' hearing. In other words, if an overall average transfer function is decided on as a universal standard, it will be so generalized that the smaller differences between free- and diffuse-field conditions will be unimportant. Griesinger proposes a standard somewhere between the two, with an off-axis front angle from 0° to 20° as the important direction.

The Brüel & Kjaer Type 4128 head and torso simulator (Fig. 10) is an expensive unit designed for objective measurements on audio communications devices such as telephones, headsets, and hearing aids; evaluation of hearing protectors and noise-cancelling microphones; testing of headphones; investigation of room acoustics and speech intelligibility; evaluation of stereo sound fields, and motor-vehicle noise-control work. Its proportions are said to replicate those of a median adult human. Brüel & Kjaer ½-inch condenser mikes are mounted in the realistically formed silicone rubber pinnae. The unit even comes with a low-distortion "mouth simulator," used for testing communications mikes, telephone equipment, and sound-reinforcement systems.

While some of the dummy heads I've mentioned look like body parts for a *Star Wars* robot, the Knowles Electronics Manikin for Acoustic Research (KEMAR) is scary in its nearly human appearance (Fig. 11). It is an-

Fig. 10— B & K's Type 4128 head and torso simulator.

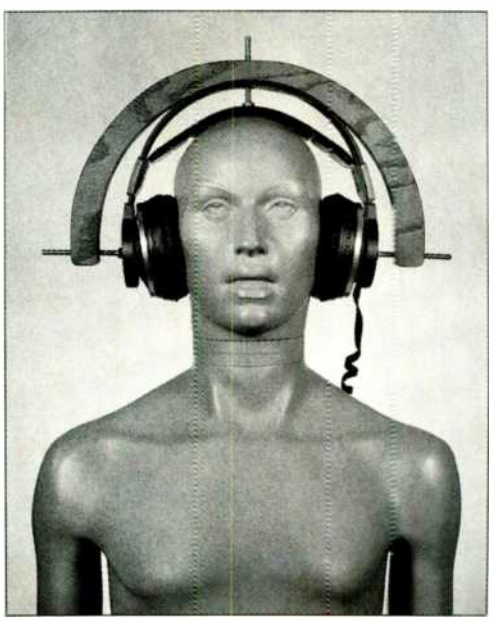
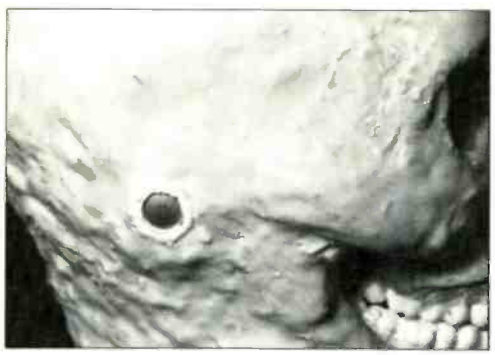


Fig. 11— The KEMAR mannequin, with a zero-static-force restraining yoke holding headphones under test. (From Russotti, Santoro, and Haskell.)

A



B

C

Fig. 12—Construction of the "Mr. Aural II" and the "Lady Aural" dummy heads. In overall view (A), the left skull has synthetic internal packing—brain, tongue, ported nostrils, and sinus cavities—in place. Right skull is plaster cast of skull on left, but with all open areas—nostrils, mouth, eyes, etc.—built up, to be used as a form for constructing an outer facial mask to be placed over head on left. The close-up (B) shows mike transducer in auditory canal area. Completed "Lady Aural" version, with microphones in place, is shown on its stand (C). (Photographs courtesy of Ron Cole.)

thropometrically proportioned in fiberglass-reinforced polyester; some of the interior is hollow to allow for cables, mikes, and other equipment, while the rest is coated with lead-pellet-filled resin to reduce resonances. The ears are removable, as with the Brüel & Kjaer unit, and there is also an ear-canal extension for tests requiring ear canal/eardrum simulation. The method of attachment permits other sizes and shapes of pinnae to be used if desired.

In 1986, KEMAR was used by researchers at the Naval Submarine Medical Research Lab in Groton, Conn. to establish testing procedures for circumaural (on-the-ear) headphones. Prior to this, the only measurement standard was specifically for supra-aural (insert) headphones. Digital conversion-function techniques were used to measure the frequency response of several popular stereo headphones from Sennheiser and Stax. Even with this highly accurate dummy head and torso, it was found that the rubber pinnae did not compress under normal headphone headband pressures, as human ears do, so bass response was less accurate than could be expected in actual use.

Ron Cole, a researcher in Southern California, has been evolving dummy head designs for some years, calling his process Biophonic Sound. Cole's desire to replicate, as accurately as possible, the softness and hardness of various skull areas, as well as the head's interior density, led him originally to experiment with actual human skulls! (At the risk of being mundane, I should point out that Cole obtained his skulls from a medical supply house.) He soon found such wide variations in the real thing that he opted to start from scratch and build his own; he now uses a proprietary latex/polymer material, chillingly fleshlike to the touch, to cover his heads (Fig. 12). The interior is packed variously with polyurethane foam and cotton to imitate the brain and other tissues—all of which Cole feels contribute to the perfection of binaural localization.

Cole's latest Biophonic design, which has resulted in "Mr. Aural" and "Lady Aural" heads, exaggerates certain facial features to compensate for faults in the microphones and for phase anomalies in the recording electronics. This has resulted in lateral frontal imaging that is vastly improved over the elevated and indistinct frontal image of some other binaural systems.

Cole identifies several conditions for achieving the most effective binaural replica of actual hearing. First, the passive response characteristic of the ear canal must exist, but

HAVE SHOWN THE IMPORTANCE OF

BY THE PINNA, OR OUTER EAR.

the real time delay of the canal cannot. Second, phase mirroring must be used to cancel out phase summing in the listener's ear canal. (Cole accomplishes this by critical tuning of the passive-equalization amplitudes and responses.) Third, the surface travelling-wave effects of the cranium, together with the resonance of the ear canal, must act as a single, unified, tuned instrument at mid- and high frequencies (Fig. 13).

He has further learned that extremely flat phase response is vital to the binaural effect. For example, a 30° phase lag at 2 kHz can shift an overhead sound source in the rear to an unnatural, overhead-in-front location, while a 30° phase lead will create the inverse. Because of such phase sensitivities, Cole feels that transformers should not exist anywhere in the signal path.

Binaural recordings often begin with identification of the left and right channels; this is much more important than with ordinary stereo. Left and right orientation cannot be reversed between the making of a binaural recording and its reproduction. According to Cole, localization processing is "a function of differential level sensitivities between the two ears and brain, plus the associated phase relationships summing to the original amplitude differentials."

His tests involved 30 right-handed subjects (response patterns are different for left-handed subjects, though their brains make the proper correction). The top-view response sensitivities create a "Big D" pattern (Fig. 14) due to the right ear being about 7 to 7.5 dB greater in sensitivity. A similar plot for a dummy head would be quite different, correlating more closely on the left side but with a major "difference region" on the right and around the back, due to the sensitivity being mirrored on both sides equally.

The Aachen *Kunstkopf* (Fig. 15) of Dr. Klaus Genuit of Aachen, Germany uses a special processor whose circuitry removes the pinna's transfer function. Genuit's processor achieves flatter response and makes playback of binaural recordings successful through speakers. With exact free-field equalization, playback through headphones is even better, but for many 'phones, results are good without additional equalization.

The Aachen head is similar to the popular ORTF stereo microphone, which places two cardioids 17 cm apart, at an angle of 110°. (The 17-cm separation simulates normal spacing of the ears, while the angle simulates the ears' directional pattern.) Thus, ORTF recordings are well suited to listening with headphones and with speakers. The Aachen head equalization results in fewer errors in the low frequencies than does the ORTF, and the actual head reproduces all the phase and surface-wave characteristics pointed out by Ron Cole.

The *Kugelflachenmikrofon* (*Kugelflachen* is German for "spherical surface," *Mikrofon* for "microphone") is a spherical dummy head system developed by Gunther Theile to improve loudspeaker reproduction. It has neither features nor pinnae, and surface mikes are embedded in it. Its response is very close to that of a standard dummy head, without need for special equalization. Even with headphones, many listeners find it difficult to tell its recordings from those of a true dummy head.

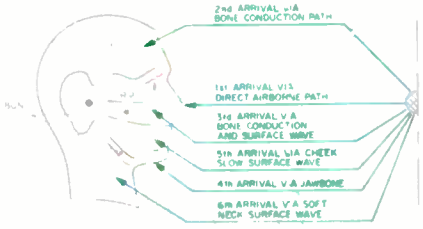


Fig. 13— Airborne and surface-wave sound paths to the ears and the order of arrival times. (After Cole.)

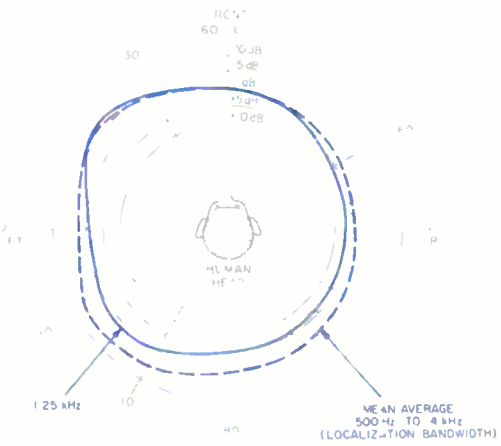


Fig. 14— Lateral-plane left/right sensitivity is shown for right-handed listeners. This curve's "Big D" shape, with the typical 7.5-dB difference in sensitivity between ears, shows why channels cannot be interchanged in binaural recording and listening. The shape would be different for a dummy head (because left/right sensitivity is basically mirrored the same on both sides) and for left-handed listeners. For this plot, from an average of 30 subjects tested in 1983 and 1984 by Cole, an acoustic source with a constant level of 0.25 watt at 1 meter was kept at a constant distance from the listener around the measurement circle. (After Cole.)

USING A PORTABLE TAPE RECORDER AND BINAURAL MIKE HEADSET, YOU CAN MAKE ASTONISHINGLY GOOD RECORDINGS.

There are several other quasi-binaural mike arrays in current use. One of these, from Crown International, was originally offered as a binaural microphone. In its latest version, however, it is referred to as a Stereo Ambient Sampling System (SASS) designed for highly localized stereo imaging in loudspeaker reproduction, with a successful summing to mono (impossible with widely spaced mikes). The SASS (Fig. 16), said to accurately convey the ambient environment, is available with either a pair of Brüel & Kjaer 4006 omnidirectional studio mikes or a pair of Crown International electret PZM mikes.

Swiss recording engineer Jürg Jecklin, the head of a small classical record label, has developed a special microphone configuration based on the dummy head concept. Jecklin calls his special mount the O.S.S. Disc ("optimal stereo signal"). He wished to achieve three things: A balanced sound source, the proper acoustical environment, and a sense that the source and the environment belong together. His configuration is designed to record the sound at the one point in the room where the balance between direct and reverberant sound is optimal. The system consists of cmnidirectional pressure-zone mikes spaced 165 mm apart to produce the proper time-delay differences between channels. They are acoustically separated by a disc 280 mm in diameter, damped on both sides to avoid reflections. A similar, but rectangular, configuration was offered by Bang & Olufsen in the 1960s, with ribbon mikes in a figure-eight pattern. Both of these types would be considered quasi-binaural. A coherent, 360° stereo signal is the result, incorporating intensity, time-delay, and frequency-response differences between the channels. Other types of omnidirectional mikes may also be used with the O.S.S. Disc. Headphone listening is excellent, though not truly binaural. This configuration has found considerable use for recording classical music and jazz in France and Switzerland. I have found that European engineers sometimes refer to such a configuration as an artificial head pickup. In fact, it is not actually a dummy head.

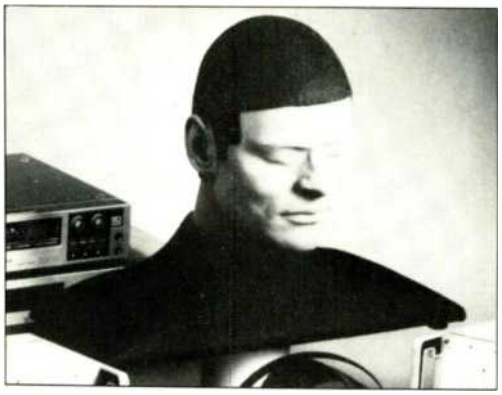


Fig. 15— The Aachen dummy head, which is compatible with loudspeakers, and its associated hardware.

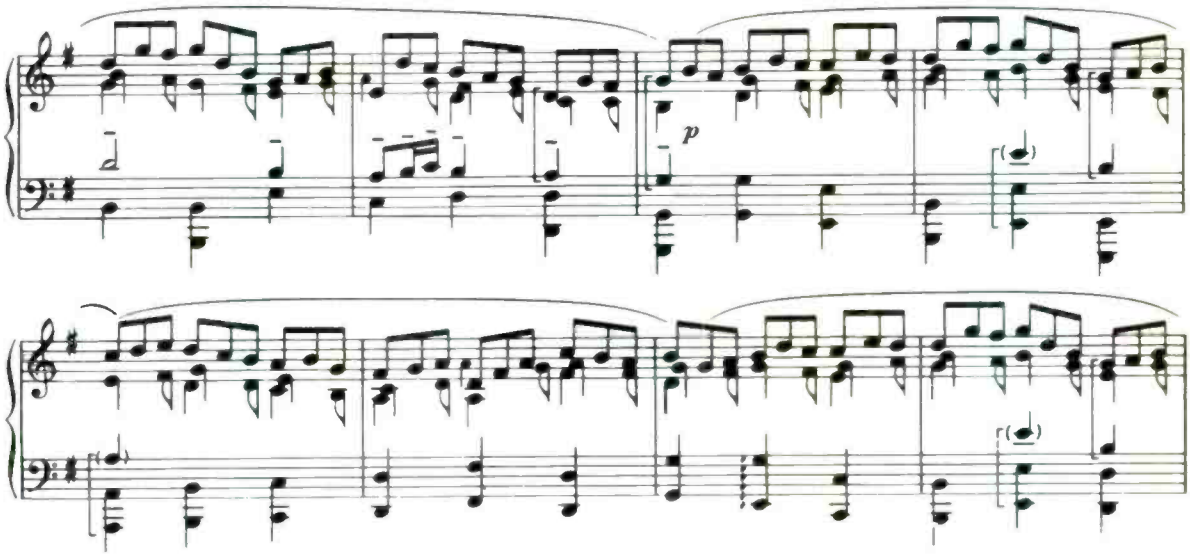
Fig. 16— Crown International's SASS quasi-binaural mike configuration, using PZM microphones.

Some years ago, the French recording engineer A. Charlin used what he referred to as a *tête artificielle*, and some of his recordings are still available on CD. This "head" is actually two convex discs, much like shallow bowls, fastened together and covered with fur. The mikes are mounted on opposing sides, protruding some distance from the fur's surface. The Charlin head was used in 1958 for recording some of the first French stereo discs. The French label, Harmonic Records, uses the Charlin head in recording CDs. Headphone listening derives very little actual binaural localization from these recordings, but they sound fine on loudspeakers. French Harmonia Mundi reports that many of their recordings of early music are made with a basic artificial head system, often with judicious use of additional spotlight mikes for certain soloists.

If the *Audio* reader is moved to try his hand at building a dummy head—or binaural microphones to fit on his own ears—I suggest two do-it-yourself articles: Gene A. Nelson's "Build a Binaural Mike Set" (*Audio*, May 1976), in which Nelson uses a headband to hold two Panasonic electret mikes, and Thomas Krehbiel's "Build a Binaural Mikeset" (*Hands-On Electronics*, April 1987). Krehbiel's unit is mounted in a permafoam wig head, which Ron Cole's work suggests is unsuitable because its density is nothing like that of the human head. I would prefer to see Sony, JVC, or others bring back their simple binaural mike/headphone systems, given the current rebirth of interest in binaural sound.

In Part II, we'll delve further into the recording end of the binaural chain.

IF YOU COULD ONLY HEAR THIS AD



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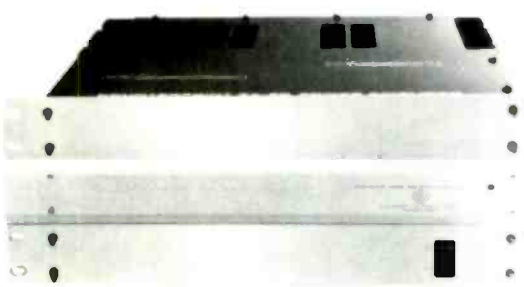

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Photograph: Michael Ochs Archives

BIRD IN FULL FLIGHT

A Charlie Parker Compilation

JON W. POSES

In many ways, the much publicized 10-CD set, *Bird: The Complete Charlie Parker on Verve* (837-142-2), defies description, rating systems, and the usual methodology we critics employ when going about our business. Based on quantity and thoroughness alone, assessment here becomes difficult. The issue is further clouded because this presentation involved a jazz cornerstone and an American musical folk hero of near-legendary proportion. Such status tends to skew opinion and to allow for excuse and rationalization in instances of less-than-perfect execution.

In the end, however, attempting to absorb what's been preserved and organized here and attempting to elucidate the magnitude of this set, which covers the years 1946 to 1954, has been nothing short of exhilarating and *fun*—as much fun as when I was a child and my mom let me run loose in F.A.O. Schwarz, the giant midtown-Manhattan toy store, or when my dad took me to Coney Island to eat Nathan's famed hot dogs and fries.

There is little doubt, what with the many partial and complete takes of individual compositions (for example, up to nine in the case of "Old Folks"), that this multiple-disc set is aimed, to a certain extent, at the Charlie Parker/be-bop fanatic. At times, the retakes and slight variations of specific cuts can become distracting; you might find yourself saying, "Let's get on with it, okay?" Still, all in all, the novice jazz listener will gain and learn much about Parker from this deep, deep investigation of his music and the work of his associates.

If you know the reputation of the project's producer/compiler, Phil Schaap, then you will know why this set is the way it is, why it is *so* complete, *so* painstakingly put together, with take after take

Photograph: Frank Driggs Collection

Birdland, 1950: Charlie Parker and Dizzy Gillespie.

Birdland, 1951: Tommy Potter, Charlie Parker, Dizzy Gillespie, and John Coltrane.

Photograph: Frank Driggs Collection

Hank Jones

Photograph: Michael Ochs Archives

of whatever was available or could be dug out of the vaults and *made* available. Schaap is an analyzer, and he has been an archivist of this music for years. As a radio announcer, first on Columbia University's WKCR-FM and then on the Newark, New Jersey-based National Public Radio affiliate, WBGO-FM, Schaap has made Parker's music a pet project for much of his career. Those listening to Schaap's five-day-a-week morning show know that they will hear at least an hour of Parker *every day*. Schaap's fixation surfaced long before the conception of this set and, clearly, this project was a labor of love. Further, Schaap is obsessive/compulsive. Consequently, he would not—or, should I say, *could not*—deliver this package without explaining his every move and decision, even to the point of self-criticism. Fortunately for us, it's all a necessary part of Schaap's *modus operandi*.

Among the materials Schaap presents in the accompanying 34-page booklet—which has an aesthetically pleasing rather than an overdone or pretentious layout—is a biographical intro written by Parker's most noteworthy cohort, John Birks ("Dizzy") Gillespie. The booklet also contains an annotated discography (including names,

Roy Eldridge

Photograph:
Michael Ochs Archives

dates, personnel, and recording sites), the players' personal recollections, and a legend—yes, a key—explaining master and alternate takes, false starts, incomplete and complete takes, previously unreleased material, etc. Additional explanations cover, if you will, potential asterisk situations—namely, one-time aberrations or quirks. Schaap wants you to understand everything *he* understands about this set and about Parker. For instance, under the heading "Audio and Editorial Notes" sits the subhead "Sound Disclaimers," which offers such tidbits as: "The superior sound source for 'Segment' was unfortunately scarred during the 1950s. Although restored, you may still hear the damage." And, "Max Roach's final cymbal 'sting' was not included in any microgroove issue of 'Star Eyes' . . . ." I could go on with more such examples, but you get the point—Schaap's need for exactitude.

Compact Discs and the ensuing technological advancements are in full swing here, and, again, Schaap lets you in on the project: "We have identified this set with the SPARS code ADD since all selections have been transferred directly from their original analog disc or tape source to the digital domain without any intervening mixing step." As musician/writer/critic Stanley Crouch correctly noted in his essay, "Bird Land" (*The New Republic*, February 27, 1989), the CBS soundtrack to Clint Eastwood's movie *Bird*, which combines the present-day work of current musicians with Parker's original solos, falls quite a bit short of what Schaap accomplishes here.

Bird: The Complete Charlie Parker on Verve is a sizable and ambitious exhibition to be viewed over and over again; simply, there's just too much to feel and touch in one visit—hell, in dozens of visits. The more you listen, the more you hear; the more you hear, the more you *want* to listen. This compilation is a museum piece, a coffee-table item, an oversized pictorial—but utilitarian, to be sure. It is presented in much the same way co-producers Michael Cuscuna and Charlie Lourie deliver their Mosaic efforts: The package is informative, manageable, and aesthetically impeccable.

Charlie Parker on Verve is a useful document. It is a compendium that celebrates the interactions of many of the world's best jazz players in their primes. Among the participants: Miles Davis, Max Roach, Johnny Hodges, Ben Webster, Lester Young, Coleman Hawkins, Roy Eldridge, Kenny Clarke, and, of course, Diz.

To delve into this set is one way to learn Parker's genuinely profound role in the development and exposition of later 20th-century music. "Charlie Parker was a pied piper," begins Diz's essay on Bird's early years. Indeed, it was Parker who brought together and served as the centerpiece for this talented cast of initially experimental and later terribly influential characters. While Parker may have been the clean-up hitter, the lineups of small combos, large ensembles, and full orchestras are to jazz what Murderer's Row, the Gas House Gang, the Reggie Jackson-led Oakland A's of the mid-1970s, and The Big Red Machine are to baseball: Multi-dimensional, all-pervasive, dominating.

The Complete Charlie Parker is sizable and ambitious. There is too much here to feel and experience in one listen or dozens of listens.

All told, the 10 discs, packaged in three groups (1-4, 5-8, and 9-10), represent a large chunk of Parker's work—not only in terms of different backdrops and collaborations but also with regard to his elongated, extended solos and his driving, relentless musical battles with colleagues. Swing, blues, be-bop, and ballad all are woven into myriad selections.

Disc 3, for instance, is a 68-minute excursion, recorded in Carnegie Hall at midnight on September 17, 1949 as part of Norman Granz's Jazz at the Philharmonic Series, which Granz emceed. The first two tracks of the eight on this disc, "The Opener" and "Lester Leaps In," jump at you as 12-minute be-bop barn burners in a septet setting that includes Eldridge on trumpet, Tommy Turk on trombone, Flip Phillips and Lester Young as tenor saxophonists, and a rhythm section that doesn't know how or when to quit (Hank Jones on piano, Ray Brown on bass, and Buddy Rich on drums). The set continues with a luscious version of the classic ballad, "Embraceable You." As raucous as this band is, they kill quietly here, with dramatic subtlety, before countering with 10 minutes of "The Closer." A truly formidable Ella Fitzgerald, whose scat and harmony underscore a rendition of "Flying Home," now enters the proceedings. The first of her three selections on this disc can only be matched, not surpassed, by Phillips and Young's voracious saxes. "How High the Moon" and "Perdido," both previously unreleased takes, close out this group of compositions.

To think that this disc represents a mere 10% of the total package boggles the mind—my mind, anyway. When the industry starts talking Grammys, *Bird: The Complete Charlie Parker on Verve* should strut its stuff and swagger proudly to the podium.

Jazz history and Charlie Parker are inseparable, and this set is invaluable to all modern jazz lovers. I don't know when I've digested a more varied and delectable multi-course meal. There's a feast here. Dig in.

1 NAKAMICHI 1000 DAT RECORDING SYSTEM

Manufacturer's Specifications

DAT Recorder

Sampling Frequencies: 48, 44.1, and 32 kHz.

Drum Revolution Speed: 2,000 rpm.

Digital Inputs: 75-ohm coaxial/optical (switchable).

Digital Outputs: 75-ohm coaxial/optical (parallel).

Power Requirements: 120 V a.c., 50/60 Hz, 40 watts.

Dimensions: 17⅛ in. W × 5¼ in. H × 14⁹⁄₁₆ in. D (43.5 cm × 13.3 cm × 37 cm).

Weight: 35¼ lbs. (16 kg).

Digital Audio Processor

Sampling Frequencies: A/D converter, 48 kHz; D/A converter, 48, 44.1, and 32 kHz.

Frequency Response: 5 Hz to 22 kHz, ±0.5 dB after A/D and D/A conversion; D/A converter alone, 5 Hz to 20 kHz, ±0.5 dB.

S/N Ratio (EIAJ): Greater than 95 dB after A/D and D/A conversion; D/A converter alone, greater than 106 dB.

Dynamic Range (EIAJ): Greater than 95 dB after A/D and D/A conversion; D/A converter alone, greater than 100 dB.

THD at 1 kHz: 0.001% after A/D and D/A conversion at 48-kHz sampling rate; D/A converter alone, 0.0005% at 44.1-kHz sampling rate.

THD + N at 1 kHz: 0.003% after A/D and D/A conversion at 48-kHz sampling rate; D/A converter alone, 0.0005% at 44.1-kHz sampling rate.

Channel Separation: Greater than 85 dB after A/D and D/A conversion at 48-kHz sampling rate; D/A converter alone, greater than 106 dB at 44.1-kHz sampling rate.

Digital Inputs: Three optical and 75-ohm coaxial (switch-selected).

Digital Outputs: Two optical and 75-ohm coaxial (parallel).

Analog Line Input Impedances: Balanced, 40 kilohms; unbalanced, 25 kilohms.

Analog Line Input Levels for −18 dB Recording Level: 50 mV, balanced and unbalanced.

Analog Line Output Impedances: 1 kilohm, balanced or unbalanced, for fixed or variable outputs.

Analog Line Output Levels for 0-dB Recorded Level: Fixed-level outputs, 2 V, balanced or unbalanced; variable outputs, 2 V maximum, balanced or unbalanced.

Headphone Output: 100 mW for 0-dB recorded level, 40-ohm load.

Power Requirements: 120 V a.c., 50/60 Hz, 70 watts.

Dimensions: 17⅛ in. W × 5¼ in. H × 14⁹⁄₁₆ in. D (43.5 cm × 13.3 cm × 37 cm).

Weight: 38½ lbs. (17.5 kg).

Remote Controller

Power Supply: 3 V d.c. (two AA batteries).

Dimensions: 12¹⁄₁₆ in. W × 1¾ in. H × 4¹³⁄₁₆ in. D (30.7 cm × 4.4 cm × 12.3 cm).

Weight: 2 lbs. (0.92 kg).

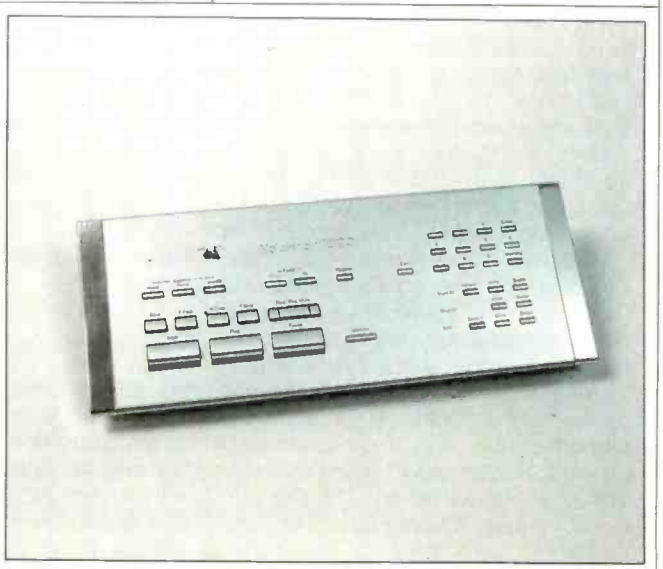
General Specifications

Price: Entire system, $11,000; recorder alone, $5,900; processor and remote, $5,100.

Company Address: 19701 South Vermont Ave., Torrance, Cal. 90502. For literature, circle No. 90

To Nakamichi must go the credit for delivering to this country the first "consumer" DAT recording system, despite the threats of litigation posed by certain record companies and the RIAA. Admittedly, it was not likely that the RIAA would sue someone who sold a DAT recording system for $11,000, but Nakamichi's dedication to technology went beyond politics. They even went beyond the interim recommendations of the DAT Conference and allowed digital input recording at 44.1 kHz.

I can remember when I bought my first Nakamichi Model 1000, the designation given to their then state-of-the-art analog cassette deck. That unit quickly became the cassette deck against which all others were compared. I suspect the same will hold true for the Nakamichi 1000 DAT recording system. By the time you read this, the three-year battle between the audio component makers and American record companies will have been resolved. The new requirements called for by this accord can probably be easily retrofitted into a Nakamichi 1000 DAT system, since the unit is constructed and designed to allow changes or enhancements to the DAT format without expensive modifications.

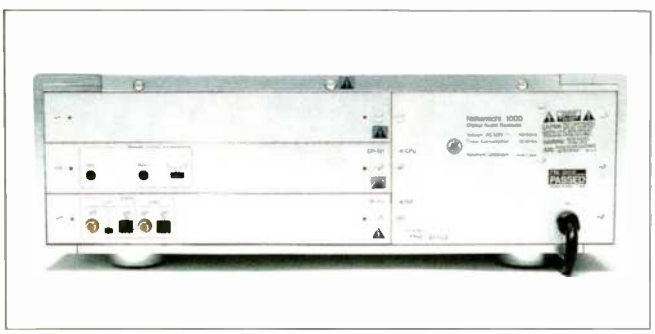


The system consists of three separate units: The Nakamichi 1000 DAT recorder, the 1000p digital audio processor, and the 1000r remote control. Because the processor and remote can control up to two recorder units, users can add a second recorder section, which can be purchased separately. You can also buy just the processor for use as a stand-alone converter with other DAT recorders or CD players equipped with optical or coaxial digital interfaces.

The consumer and professional versions of the 1000 are substantially identical, but the pro version has 19-inch rackmount handles and a wired remote. It also allows recording at 44.1 or 48 kHz from analog sources (the home version only records at 48 kHz from analog) and conforms to studio-standard analog line input and output levels. Both versions feature balanced (XLR-type) as well as unbalanced analog inputs and outputs.

There are so many unique features in the 1000 system, one hardly knows where to begin. Nakamichi's F.A.S.T. (Fast Access Stationary tape guide transport) mechanism is included. According to Nakamichi, it offers greater tape-travel precision than other DAT mechanisms which derive

This is the first and only consumer DAT deck with off-the-tape monitoring like that in three-head analog tape decks.



their tape transport systems from VCR technology, and it takes less than 2 S to load a tape. This system also permits a "half-load" position, in which the tape is lifted off the rotary head drum. This permits fast winding at 400 times normal play speed (twice as fast as with most other DAT machines) and reduces head and tape wear as well.

Perhaps the most outstanding feature of the 1000, from the user's point of view, is its four-head design. This is the first and only consumer DAT recorder to permit true, off-the-tape monitoring much like that found in three-head analog tape recorders.

The 1000p processor unit uses an eight-times oversampling, 20-bit D/A converter. There are no sample-and-hold circuits in any portion of the D/A circuitry. The required precision in the D/A converter is achieved through the use of calibration ROM chips. Two low-glitch, 16-bit converter integrated circuits are used for each channel, each premeasured at the factory, according to Nakamichi. Error data is recorded on the ROM chips, which are then installed in each 1000p along with their corresponding converter ICs to provide compensation data. Digital glitch-cancellation circuitry is another contribution from Nakamichi's design staff, as is an automatic calibration technique used with the A/D converter. This circuit compares and trims the values of successive bits through a novel additive process. Other refinements in this system will become evident as we discuss the control functions on the system's two main units.

Control Layout

A power switch, timer switch (used with an external timer), "Auto Play" switch, and "Eject" button are all at the left end of the recorder's elegantly finished silver-gray front panel. The door-loading cassette compartment accepts DAT cassettes oriented vertically, rather than by the usual horizontal drawer arrangement. When the door is closed, windows permit you to view the slowly rotating tape (a DAT moves along at a mere 8.15 mm/S) and also let you see the spinning head drum mechanism in action.

Large, light-touch pushbuttons handle "Stop," "Play," and "Pause" functions, while above these are smaller buttons used to rewind, fast forward, reverse skip, or forward skip the tape from selection to selection. Above and to the right of the cassette door are a counter display and three small associated buttons. The counter will display as an arbitrary five-digit counter, in program time (from the start of the current selection), in remaining time available on the tape, or in absolute time from the tape's start. Indicator lights above the display tell you which counter mode is currently in use. Other small indicator lights nearby show the current digital sampling rate, whether the current signal was recorded with pre-emphasis, whether it is a digital source, and whether the digital signal contains a copy-prohibit subcode flag bit. (Other home DAT decks will not go into recording mode when they detect this bit, but the Nakamichi will continue to record the entire signal—including the copy-prohibit flag and other subcode bits.)

Just below these indicator lights are "Down" and "Up" buttons for a digital fader. This allows digital signals to be faded in and out as you record them. (DAT decks' analog level controls do not affect the digital input bit stream.) Two fading speeds are available—slow if you just tap the button, faster if you hold it down—but the automated fades cannot be stopped halfway.

Moving a bit to the right, a second display window shows the number of the selection being played and, during search modes, the number selected by the numeric keys to the right of the display (or by the forward and reverse "Skip" buttons). If playing a program, this display shows how far along you are. Just below this window are a "Repeat" button and indicator light, a "Memory" LED, and a "Call" button (which is used to display the memorized program). Farther to the right are the numeric buttons for programmed playback and direct accessing of numbered tracks.

Below the display area and programming buttons are the source/monitor button and, farther to the right, three rows of controls and switches for setting and erasing start and skip IDs and end marks. The top row starts with the "Start ID" indicator LED, followed by the "Auto" switch and buttons to renumber, write, and erase ID codes. The switch sets the unit to record start IDs whenever the level falls for a time below −40 or −60 dB (not all DAT decks offer this choice), or turns the auto-ID feature off. The "Skip ID" row has a switch to enable or disable the skip-ID mode in playback, plus buttons to write and erase codes. The bottom row, controlling end marks, features an on/off switch for automatic rewind, a "Search" button which finds the end ID marking the last recorded portion of the tape, and buttons for "Write" and "Erase."

The rear panel is equipped with digital inputs and outputs but no analog connections (analog signals must go through the 1000p processor or an equivalent). A switch between the jacks selects either the optical or coaxial digital input, but both the coaxial and optical outputs are live simultaneously. Above these jacks are "Remote" input and output jacks for the pro version's wired remote, plus a "DAT 1/DAT 2"

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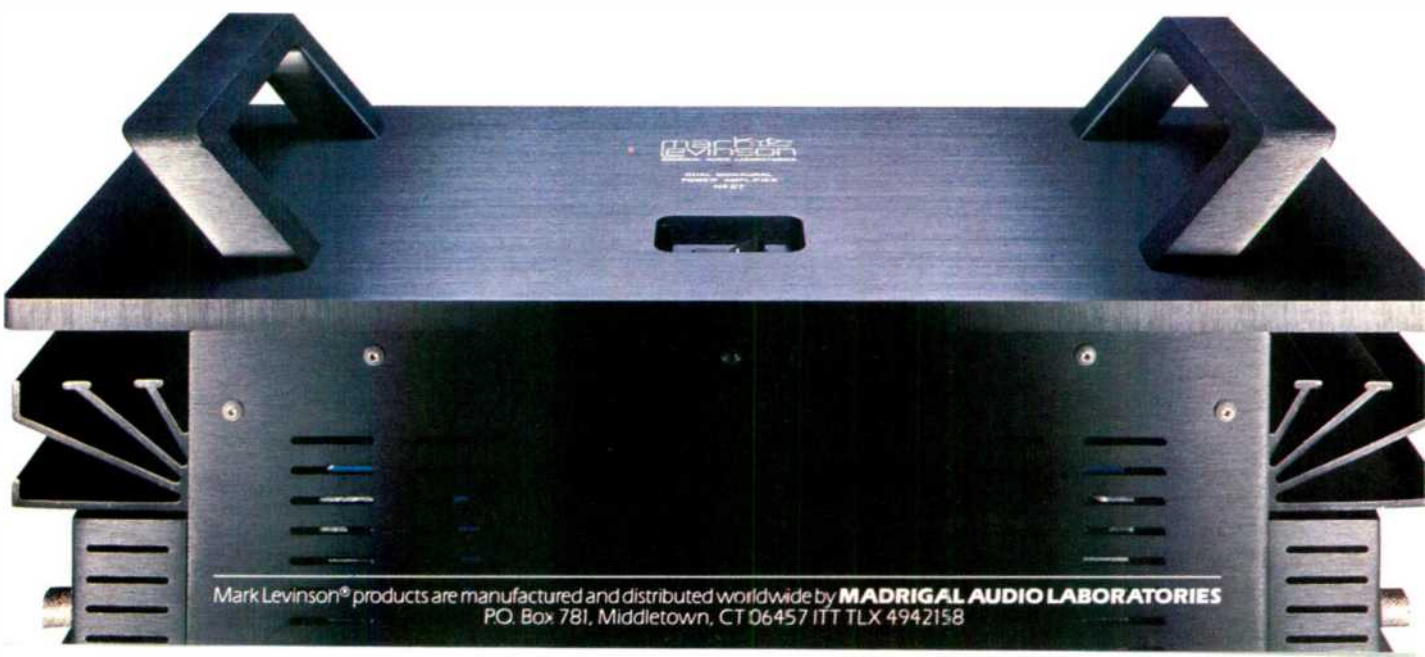

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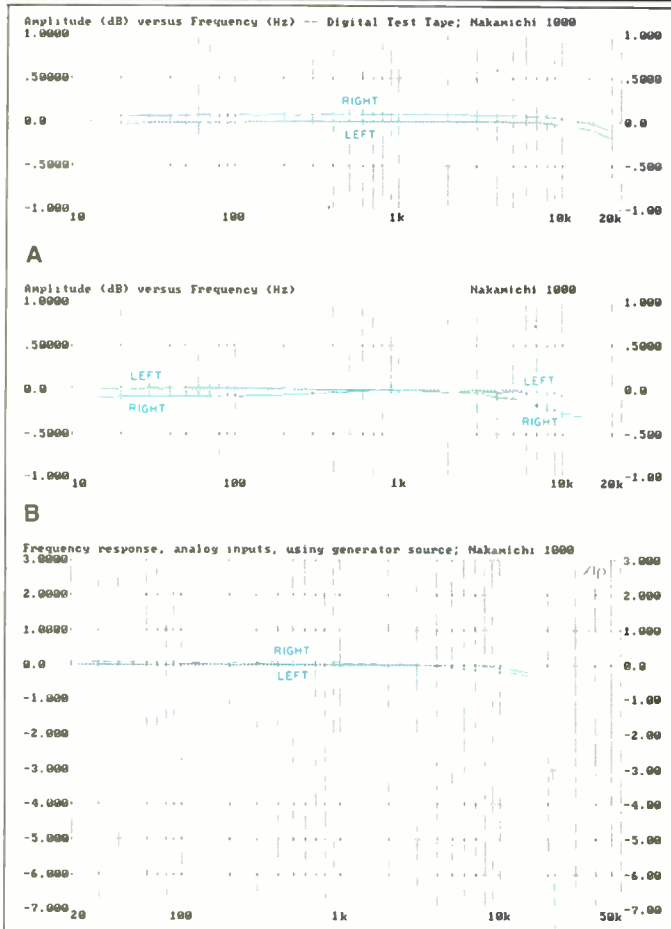

Fig. 1—Frequency response for playback of digital test tape (A) and for record/play, via analog inputs, from CD player (B) and from external test generator (C). In 1A, the right-channel curve was displaced for clarity.

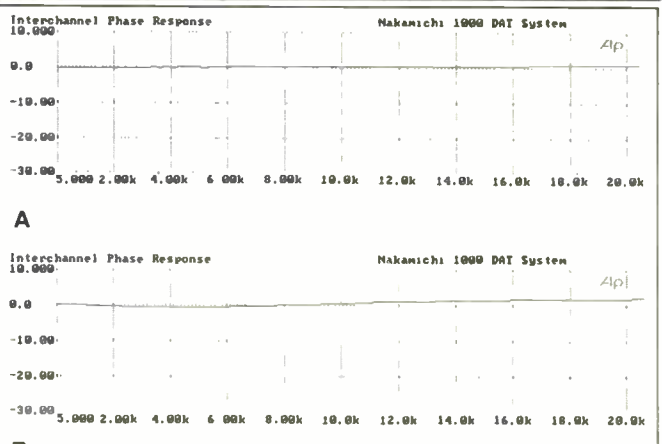

Fig. 2—Interchannel phase difference for record/play via digital inputs (A) and analog inputs (B).

address-selector switch. The 1000r remote control has a similar switch so that, when two decks are used at once, it can operate both decks together or either one separately, depending on the switch settings used. This remote control, supplied with the recorder, duplicates virtually all the control and transport functions found on the front panel of the recorder itself.

The companion 1000p digital audio processor is styled to match the recorder component. At the left are its power switch, a headphone jack, and a headphone level control. Vertically oriented peak-level LED meters (which read the signal in the digital domain) are nearby. Further to the right are sampling-rate and pre-emphasis indicator lights and toggle switches for source selection (digital or analog), DAT dubbing, meter indication (off, on, or peak hold), and pre-emphasis on/off (used when making recordings via the analog inputs). An output level control and left and right record level controls are positioned above three light-touch buttons that select "DAT 1," "DAT 2," or "Source." At the right is a large master record level control.

The rear panel carries coaxial and optical digital input and output jacks for two DAT recorders, plus optical and coaxial inputs for a CD player or other digital source; a switch selects the optical or coaxial input, in each case. On the analog side, there are both balanced (XLR-type) and unbalanced (phono) connections; a switch selects either the XLR or phono inputs. The output section has both fixed-level and variable phono jacks, plus a switch to select fixed or variable operation of the balanced connections. Also on the rear panel are two unswitched a.c. convenience outlets and the power cord.

Nakamichi supplies one pair each of glass optical cables and coaxial digital cables, and two pairs of coaxial analog cables; all coaxial cables are of linear-crystal, oxygen-free copper. A music cassette, a blank R-120, a cleaning cassette, and a cleaning cloth are also provided.

Measurements

In some ways, measuring a DAT recorder is very much like measuring a CD player. In fact, many of the same tests found on my standard CBS CD-1 test disc are useful in

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Ten factory preset combinations of digital soundfield-plus-equalization are at your disposal—ready to be adjusted for literally trillions of alternate settings.

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You can use two transports with the 1000p processor and control them together or independently with the remote transmitter.

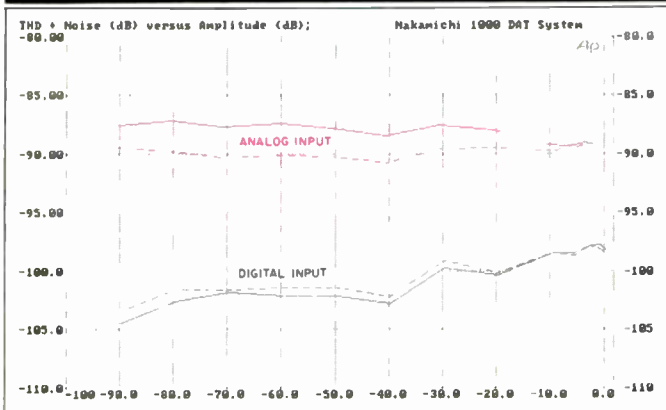


Fig. 3A—THD + N vs. recording level for record/play via digital and analog inputs, using a CD player as a source.

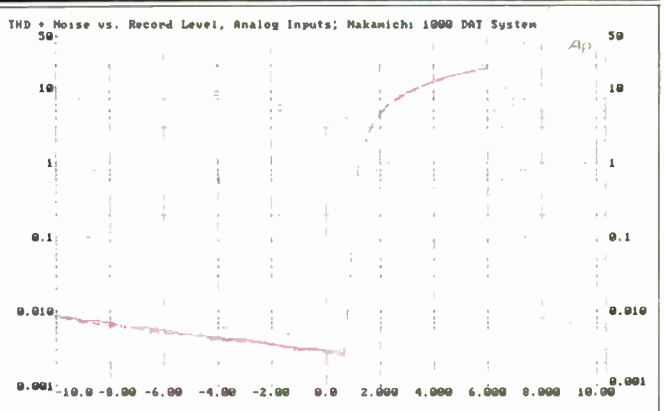


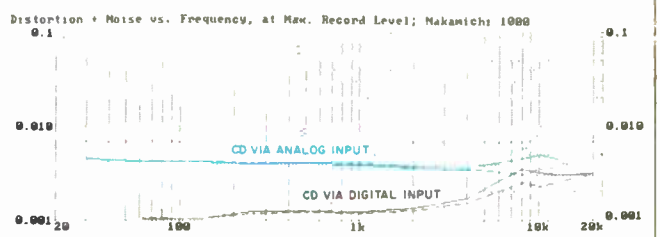
Fig. 3B—Effect of excessive level on a digital recording. Note the sharp rise in THD + N just above 0-dB recording level. Source was a test generator, recorded via the analog inputs.

measuring both. Some time ago, I managed to obtain a DAT equivalent of the CD-1 test disc and have used it in checking car DAT players. Because the Nakamichi 1000 is able to record program material at 44.1 kHz through its digital inputs, I was able to measure the performance of this magnificent system much as I would a three-head tape recorder. In other words, I was able to record the contents of my CD-1 test disc onto digital tape and, while doing so, measure the playback of that tape using the tape monitoring feature of the Nakamichi 1000. In addition, I felt it necessary to assess the performance of the system using its analog inputs. For these tests, I employed two types of program source. First, I played the CD-1 test disc on my reference CD player and connected its analog outputs to the Nakamichi's analog input jacks. Then I used the generator portion of my Audio Precision test system as a source. In each case, the 1000's tape monitor let me plot test results as the tape was being recorded.

Now, I recognize that when I taped from my CD player, I was really reading the combined performance of the D/A conversion system of my reference CD player *plus* the performance of the A/D conversion system in the Nakamichi processor. My purpose in making these measurements, however, was to show how much degradation the resulting recording would contain if users were permanently restrained from making digital-to-digital recordings. As we now know, the compromise reached between software and hardware makers a few months ago will make it possible for those of us who buy DAT recorders to make digital-to-digital recordings.

To show the analog input performance of the Nakamichi alone, ignoring the impact of any possible defects in the analog source signal, I used the test generator in my Audio Precision system to simulate an analog input source other than CD. This enabled me to illustrate the difference in quality between recordings made wholly in the digital domain and those made via the analog inputs.

Figure 1A shows the record/play frequency response of the Nakamichi 1000 system, using the digital inputs to record the contents of my CD-1 test disc, in the digital



A

B

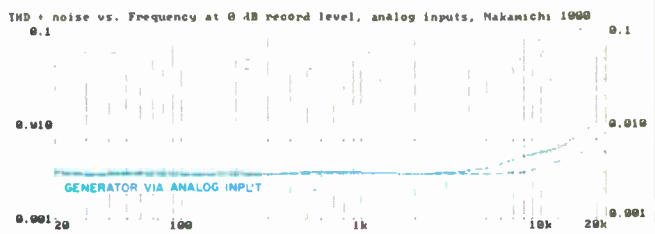


Fig. 4—Record/playback THD + N vs. frequency at 0-dB level, for CD via analog and digital inputs (A) and for the test generator via analog input (B).

For record/play via the digital inputs, THD + N was only 0.001%, which is about as low as my test system can measure.

domain, from the digital outputs of my reference CD player. Response was down −0.27 dB at 20 kHz for both channels. (Upper curve, for the right channel, was deliberately displaced for clarity.) By way of comparison, Fig. 1B shows the response when the analog line outputs from my reference CD player were connected to the analog inputs of the Nakamichi DAT system. Response, while still relatively flat across the audio spectrum, was now down a bit more than 0.5 dB at 20 kHz. A separate measurement at the output of my reference CD player revealed that much of the difference (the added roll-off) could be attributed to the CD player providing the signal.

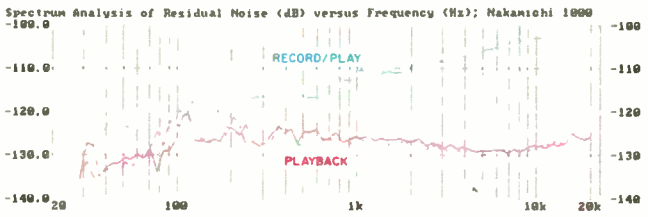


Fig. 5—Third-octave spectrum analyses of residual noise vs. frequency, for playback of digitally dubbed test signal and for record/play via analog inputs.

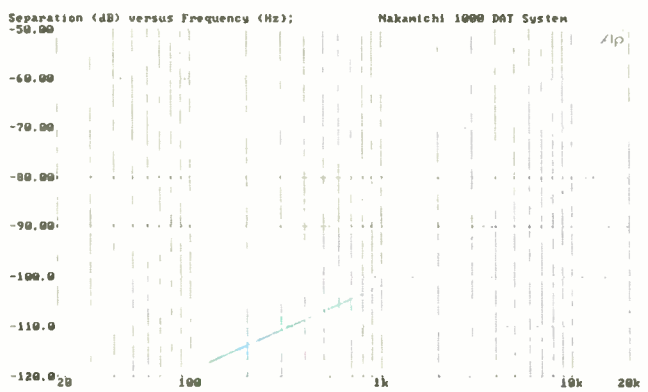


Fig. 6—Separation vs. frequency for record/playback. Separation was identical in either direction (left to right or right to left) and for recording via either analog or digital inputs.

Figure 1C was plotted using the signal generator of the Audio Precision test system. Measurements were made in much the same way as they would be for a three-head analog tape deck. Since the sampling frequency was 48 kHz in this test, you will notice that response actually extends very slightly beyond 20 kHz before the steep roll-off, which is required to prevent aliasing, occurs.

Just for the record, I measured the phase difference between the two channels, using the digital-to-digital interface (Fig. 2A) as well as the analog inputs (Fig. 2B). There is virtually no difference between the two curves, though to be precise, there is a bit of phase error (no more than a degree or two) at 20 kHz when the test was made via the analog inputs.

Figure 3A is a plot of THD + N versus recording level. Values of THD + N are expressed in dB, relative to maximum level (0 dB). For levels of −20 dB and lower, THD + N via the digital inputs measured about −100 dB or less, or 0.001%—about as low as my test system can measure. At 0-dB levels, the analog output stages must have contributed a slight amount of extra THD, so the reading increased to about −98 dB, or 0.00125%. Compare these results with those obtained when I played the test disc via the analog outputs of my CD player connected to the analog inputs of the DAT recorder: Typically, the readings were about −89 dB at 0-dB level, or around 0.0035%.

Once again, I must remind you that much of this added distortion may well be coming from the CD player and not from the record/play cycle of the DAT recorder. As proof of this, and in order to illustrate the "brick wall" limitations of overrecording in the digital domain, I used the Audio Precision test generator to plot THD + N versus recording level in Fig. 3B, from −10 dB to +6 dB. At 0-dB recording level, THD + N was 0.003%—less than when measured using the CD-1 test disc as a source via the analog inputs to the DAT recorder. But more significantly, notice what happens to THD + N at about +0.6 dB: It rises steeply as the system runs out of bits with which to describe the increased level. Here is harder clipping than you've ever seen from an audio amplifier! As professional users of digital recording equipment have learned, and as we amateurs will have to learn as we make the transition, digital recorders are completely unforgiving of any overrecording. One of the nice things about being able to transfer program material in the digital-to-digital mode is that you don't have to worry about level setting; the "zeros" and "ones" of the original recording are simply dubbed to the copy.

Figure 4 shows how THD + N varied with frequency for recordings made at 0-dB level when feeding digital to digital, taping CD via the analog inputs (Fig. 4A), and recording from an external generator via the analog inputs (Fig. 4B). The reading obtained for the digital-to-digital recording is the lowest I have ever measured for this test, whether for a CD player or a DAT machine. As expected, THD + N was a bit higher when the analog inputs were used, but it was still so low at all audio frequencies as to be audibly insignificant.

My biggest delight was being able to monitor my taped results. I should have known Nakamichi would figure out how to do that.

Measurements of S/N proved particularly interesting. With the "silent" track of my CD-1 test tape recorded digitally and played back by the Nakamichi 1000, I obtained A-weighted S/N figures of 113.4 dB for the left channel and 114.0 dB for the right. When the "silent" recording was made via the analog inputs—again combined with any noise delivered at the analog outputs of the reference CD player—the readings dropped to 94.5 dB for the left channel and 93.6 dB for the right. Spot measurements of EIAJ dynamic range yielded similar differences between digital-to-digital and analog-to-digital tests. For the all-digital tests, EIAJ dynamic range measured between 101.4 and 101.7 dB. When I fed the test signal from the analog outputs of my CD player to the DAT's analog inputs, dynamic range decreased to between 87.1 and 89.1 dB. I measured SMPTE-IM distortion of 0.0029% on both channels for digital-to-digital record/playback; using analog-to-digital record/playback, SMPTE IM increased to 0.01%.

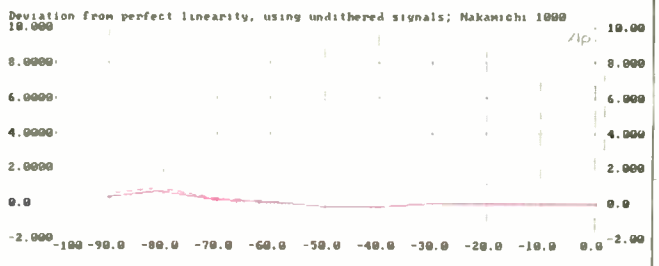
Some interesting data is revealed in Fig. 5, which shows spectrum analysis plots of residual noise versus frequency. In the lower plot, for playback of a digitally recorded test tape, you can see that noise level hardly varied with frequency and was generally better than 120 dB below maximum recorded level. By contrast, a recording of the CD-1 test disc's "silent" track, with the digital outputs of a CD player hooked into the Nakamichi's digital inputs, yielded a noise characteristic which increased with frequency, reaching the −100 dB level at 20 kHz (top curve).

Figure 6 is a plot of separation versus frequency and was actually plotted two ways: While making (and monitoring) a digital-to-digital recording and while feeding signals into the DAT machine from my CD player, using analog outputs and inputs. I was somewhat surprised to find that the results of the two tests were identical. This suggests that any crosstalk observed at the higher frequencies can be attributed either to capacitive coupling within the output analog stages and circuitry of the Nakamichi 1000 or, more likely, capacitive coupling between the twin audio output cables connected to my test equipment. In any case, separation at 1 kHz measured more than 100 dB in both tests, decreasing to around 78 dB at 16 kHz.

Deviation from perfect linearity in playback, using undithered signals from my CD-1 test disc recorded digitally onto a DAT tape and played back by the Nakamichi 1000, is shown in Fig. 7A. The results are as good as I have ever seen from a CD player. Bear in mind that, in this instance, only the D/A conversion system of the Nakamichi 1000 is being exercised, since the A/D portion of the 1000p processor was not involved. I repeated the test, this time using the analog outputs of my CD player to feed the analog inputs of the Nakamichi 1000 system (Fig. 7B). The resulting departure from perfect linearity should not be attributed solely to the Nakamichi unit under test. Remember, the D/A converters of the CD player are involved, as are the A/D converters of the Nakamichi recorder.

Figure 8 shows how minimal the deviation from perfect linearity was when low-level dithered signals were recorded, in the digital-to-digital mode, from −70 to −100 dB. Having already seen how great an influence the CD player's analog outputs were when measuring deviation from linearity for the higher level undithered signals, I saw no point in repeating the corresponding analog-to-digital test for these lower level dithered signals.

The only other spot measurement I made before turning to more pleasurable DAT recording pursuits was to check clock-frequency accuracy of the recorder/player by recording a 20-kHz test tone using digital-to-digital transfer. Even though this test was made entirely in the digital domain, it is



A

B

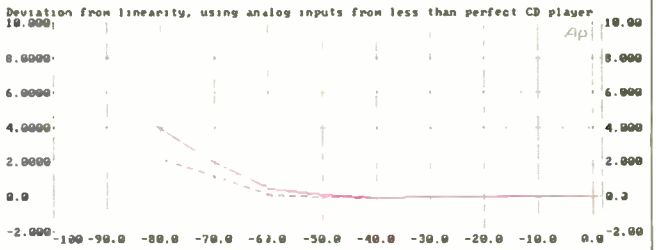


Fig. 7—Deviation from perfect linearity, using undithered signals, for record/play via the digital (A) and analog (B) inputs. The errors in 7B probably come primarily from the CD player; see text.

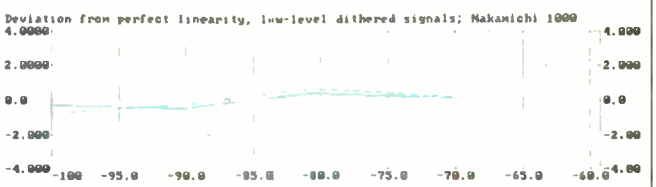


Fig. 8—Deviation from perfect linearity for record/play via digital inputs, using low-level dithered signals.

If you want the definitive DAT recorder and money is no object, the one to buy is the Nakamichi 1000.

possible that the minute error in clock accuracy observed (it was −0.0159%) might be a combination of CD player clock-frequency error and any error in the clock frequency of the DAT recorder/player. In any event, an error of this magnitude means that a 440-Hz tone (middle A in a musical scale) would be reproduced during playback at a frequency of 439.93 Hz. I know of no musician who can detect so insignificant a pitch change.

Use and Listening Tests

My biggest delight in making a few recordings with this superb system was in being able to monitor the taped results, as I do with the reference Nakamichi 700ZXL analog cassette deck that has served me so well over the years. I confess that when I first started testing DAT recorders a couple of years ago (when we thought they would be reaching these shores at any moment), one of my chief disappointments was that, as great as this new recording technology was, there was little hope we would be able to do monitoring in the same way we had with three-head analog open-reel and, later, compact analog cassette decks. The rotating-head technology of the DAT format was primarily borrowed from VCR design, and no one had ever built a VCR that permitted tape monitoring as recordings were being made. It seemed to me that, given the digital recording system's intolerance for overrecording, monitoring would be an especially useful feature for a consumer DAT recorder. I should have known that Nakamichi would figure out a way to mount four heads in the rotating drum of their DAT recorder system, and so they have.

The graphs and numbers speak for themselves. Everything I was able to record while in all-too-temporary possession of this magnificent digital recording system sounded great when played back on my reference system. My regret was that the Nakamichi recorder/player is so big and heavy that it was not practical for me to take it to a concert where I might have gotten permission to do some live instrumental recording. As it was, I was only able to transcribe a few of my favorite CDs—using the digital-to-digital interface—onto tapes I now will be able to play in my car. (Yes, my car has been equipped with a DAT player for more than a year now, and no pothole or bump in the road has ever caused me to miss a note of music!) Now that the DAT controversy has been resolved to the satisfaction of both the record companies and the hardware makers, the latter can look to the Nakamichi 1000 for inspiration as they gear up for second- and third-generation DAT recorders that more of us will be able to afford. Still, if you want the definitive DAT recorder and money is no object, the one to buy is the Nakamichi 1000. This equipment definitely merits the "1000" model designation Nakamichi has reserved for its very best efforts.

Leonard Feldman

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2

LEXICON CP-1 DIGITAL AUDIO ENVIRONMENT PROCESSOR

Manufacturer's Specifications
Frequency Response: Analog, 10 Hz to 100 kHz, +1, −3 dB; digital, 10 Hz to 16 kHz, +1, −3 dB.
THD: Less than 0.05% at maximum level, all channels.
Minimum Input Level: 300 mV rms.
Maximum Output Level: 3.5 V rms.
Input Impedance: 50 kilohms.
Output Impedance: 500 ohms.
S/N Ratio: 85 dBA, referred to maximum level at 1 kHz.
Power Requirements: 120 V a.c., 60 Hz.
Dimensions: 17 in. W × 2½ in. H × 12½ in. D (43.2 cm × 6.4 cm × 31.8 cm).
Weight: 11 lbs. (5 kg).
Price: $1,295.
Company Address: 100 Beaver St., Waltham, Mass. 02154.
For literature, circle No. 91

Lexicon is well known for its many recording-studio and professional sound-reinforcement products. The CP-1 surround processor is its first home high-fidelity product, however, and an interesting one it is. Sophisticated processors from other manufacturers have programs that are based on a series of acoustical measurements at specific performance sites. The CP-1, on the other hand, has programs that are based on fundamental characteristics of good performance halls in general. Lexicon reviewed the work of many people (Manfred Schroeder, A. H. Marshall, Michael Barron, and others) to aid in pinpointing the important factors that needed to be understood.

A rough summary of the conclusions from this analysis is that the best halls generate large differences in sound between the two ears of the concert-goer. Michael Barron found that this characteristic was created by lateral, sideways-moving reflected sound, and he defined it as "spatial impression" (SI). Only the reflections moving from side to side produce SI; those from other directions actually muddy the sound. The CP-1 is designed to increase SI from the original recording or to generate a new acoustic environment. (Some readers might like to refer to "Early Lateral Reflections in Some Modern Concert Halls," by Lothar Cremer, in the March 1989 issue of the *Journal of the Acoustical Society of America*.)

In the CP-1's "Panorama" programs, SI is extracted from the recording and processed to increase its effect; the choices are "Normal," "Wide," and "Binaural." "Binaural," a program unique to the CP-1, creates a realistic sound field from a source that was recorded for binaural headphone listening. When a listener is in the correct spot, these programs provide an almost ideal re-creation of the original recording space. Digital processing is used to cancel the crosstalk between the listener's ears from the different loudspeakers. The cancellation is high-order—much better than the first-order approach used by some processors and loudspeakers. With the CP-1's "Panorama" program, the sound is effectively spread from the two front loudspeakers in a wide arc in front of the listener. Adding speakers increases the realism of the illusion.

The Lexicon's "Ambience" and "Reverb" programs, three of each type, provide signals for driving widely spaced side and rear speakers, directly exciting sideways sound and heightening the impact over a large listening area. When there are no side speakers, these programs can be set to include a "Panorama" effect, to move the stereo image outward, past the main speakers. The "Ambience" and "Reverb" programs transform the listening room into a new acoustic space, providing six choices of environment to match the music and the listener's mood. Unlike some other hall simulators, the Lexicon provides full stereo processing.

The "Ambience" programs generate side and rear reflection patterns like those of idealized rooms and concert halls. The "Reverb" programs are similar, but they place more emphasis on rich, dense reverberant decay than on early reflections. Large, highly reverberant spaces are well simulated. Choices of "Small," "Medium," and "Large," for both "Ambience" and "Reverb," provide considerable flexibility in finding the desired hall depth, liveness, and realism to match classical, popular, jazz, or rock music.

The CP-1 incorporates the first completely digital Dolby Pro-Logic surround decoder. It is the only processor with automatic correction of azimuth and channel-balance errors, which are the most common problems in currently available films. Lexicon has also included a "Stereo" logic program for playing stereo music through a surround-sound speaker setup and "Mono" logic for expanding monaural film soundtracks.

All of the preset programs discussed above have parameters that can be modified for storage in any of 12 user program positions; the CP-1 has a front-panel LCD display for programs, parameters, and level changes. An input-level meter helps you set maximum levels which are high enough for good processing without causing distortion. The main, side, rear, center, and subwoofer outputs have level-set pots. The unit has a switch to get a phantom-center mode, in case a center speaker is not used. An unusual and valuable feature of this Lexicon processor is that it can be internally configured to match any of 12 speaker layouts in the listener's home.

Control Layout

The Lexicon CP-1 has a relatively simple front panel with easily read white designations. From the far left are three pairs of mechanically interlocked pushbuttons: "Source" ("I" and "II"), "Monitor" ("Source" and "Tape"), and "Tape" ("Pre" and "Post"). "Pre" means the tape deck gets the signal unaltered, or pre-processing; "Post" applies processing to the tape output from the CP-1, thereby including effects in what is being recorded. For such recording, the unit must be in its two-speaker configuration mode. (These

The "Binaural" program in the CP-1 creates realistic sound fields, via speakers, from recordings made for binaural headphone use.

modes will be discussed later.) Next on the right is the "Input Level" control, with a handy bar-type knob. Above is the very useful horizontal input-level meter, with 11 green LED segments and one red segment for each channel. Input meters are essential for units with digital circuitry, to ensure that the level is high enough for the best processing but not so high as to cause overload.

To the right of the meters is the two-line alphanumeric display. Each line can have up to 16 amber characters announcing programs, parameters, levels, and other useful information. When you turn on the CP-1, the software's version number and copyright date, and then the speaker configuration, are displayed for 2 S each. The last-used program is then shown until changes are made. (Details of what is displayed will be provided when the remote control is discussed.) Further to the right are three square LEDs. The first, which is green, goes on whenever a button is pushed on the remote control. The red "System Mute" LED is next, followed by the orange "Effect Mute" indicator. The "Power" on/off switch is at the lower right end of the panel.

From right to left, on the back panel, are gold-plated stereo pairs for "Inputs" ("I" and "II"), then the tape input and output jacks. Further to the left are the jacks and trim pots for the "Center," "Sub Woofer," "Main," "Side," and "Rear" outputs. The trim-pot knobs are very small, but their good knurling makes them easy to turn. Having convenient trims on all the channels makes matching levels much easier, and I'm glad Lexicon provided them. To the right of the subwoofer jack is a "Center/Out, Phantom/In" pushbutton. This switch ensures that centered information, such as dialog, is fed to the center output only if the channel is operating with a speaker.

I removed the top and side cover to get a look at the internal construction. What at first appeared to be one high-quality, chassis-size p.c. board was actually two boards. They are separated by a front-to-back stiffening rail which also provides mounting for the power transformer. This transformer was barely hot after hours of operation with the cover in place and the manual and some other papers on top. All of the parts and adjustments are identified. I could pick out elements of the circuitry which demonstrated the stereo processing capability. A Lexicon VLSI chip caught my attention, as did the Zilog Z80 CPU. The label on the socket-mounted Lexicon software chip showed that it was Version 1.04. This is a very interesting and potentially important feature: If there is an update in the programs to improve performance, a simple chip replacement is possible for all owners. As mentioned earlier, the user can check the software version of his unit just by watching the display when he turns the CP-1 on. A small touch, perhaps, but a good one.

A small board for the trim pots and associated circuitry is well supported at the back panel. I noted two fuses in clips near the transformer. The combination of the center rail and two side rails establishes good rigidity for the unit; it's even better with the cover in place. Rack adaptors are available for the CP-1. According to Lexicon, these are trays which go almost all the way back to the rear of the unit. That's an improvement on the usual mounting ears, which are only acceptable for use in systems that aren't moved around much. For use in a rack that's transported frequently (admittedly unlikely, for a home unit like this), I'd prefer to see the unit anchored at the back as well, to minimize front-panel stresses.

All program selections and parameter changes are made with the remote control unit. The Lexicon controller is smaller than those for some other surround units and is easily held and actuated. Its 26 buttons are positioned in a logical arrangement. From the emitting end are four columns of buttons, in six rows, and then a final two-button row.

The first four rows are for programs and parameters. The program buttons are in the first three columns, with "Panorama" in the first row, "Ambience" in the second, "Reverb" in the third, and "Surround" in the fourth. "Panorama" provides programs with enhanced lateral sound for either music or films. It is effective even when using just two front loudspeakers. The choices are, from the left: "Normal," "Wide," and "Binaural." "Binaural" is a program specifically designed for loudspeaker reproduction of recordings made with a dummy head. This program is unique, as far as I know, and would be very useful with such music.

The "Ambience" programs are "Small," "Medium," and "Large" and simulate concert halls of different sizes, generating reflections of appropriate directionality, delay, and spectral shape and sending them to side and rear speakers. "Ambience" has an adjustable liveness parameter, but "Reverb" is preferable when you want long reverberation times. "Reverb" has "Small," "Medium," and "Large" programs for simulating rooms of three sizes with the use of side and rear channels. The "Surround" programs are "Mono," "Stereo," and Dolby Pro-Logic, indicated by the standard double-D symbol. "Mono" logic expands the music and effects on monaural films while leaving the dialog in the front center. "Stereo" logic enhances music by bringing in the surround speakers, and it allows adjustment of parameters that are fixed in the Dolby Pro-Logic program, which provides the same decoding used in Dolby Stereo theater systems and uses up to eight speakers.

The fourth column of the remote's program section has a "Bank" button to switch between two program memory banks (for 12 factory-preset programs and 12 user-modified ones), a "Param" button to cycle through the adjustable parameters, and a pair of buttons to adjust each parameter up and down.

When "Bank" is pushed, it switches to the other set of memories without changing program number, rather than switching to whatever program was last used in that bank. Because I store my modified programs in the same memory positions as the preset programs I derived them from, I find that Lexicon's approach makes comparisons between preset and user versions easier.

Holding "Bank" in for a few seconds puts the CP-1 into configuration mode. "LCD Contrast Adj" appears in the display, and the parameter up/down buttons are used to set the contrast to personal preference. Pushing "Param" while the above words are still displayed will get the current speaker configuration.

There are 12 such configurations, and a change to any other one is a simple matter of pushing the up/down buttons. The choices are: Two main speakers; two main and one center speaker; two main and one rear speaker; two

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The CP-1's Dolby Pro-Logic surround decoder section, totally digital and with automatic correction, is the first of its kind.

main and two rear speakers; two main and two side speakers; two main, one center, and one rear speaker; two main, one center, and two side speakers; two main, one center, and two rear speakers; two main, two side, and two rear speakers; two main, one center, two side, and two rear speakers; two main, one center, two side, and one rear speaker, and two main, two side, and one rear speaker.

Whatever choice is made, the front-panel display shows what the combination is—i.e., "Configuration: 11, 2FR 1CT 2SI 1RE." The CP-1 automatically responds to whatever configuration you select by changing its internal connections and processing to get the best results with both the selected program and the actual speaker complement being used. It is very easy to make changes in the surround system, adding speakers or moving them and reconfiguring the system electronically by pushing buttons.

Modifiable parameters, primarily for the "Panorama," "Ambience," and "Reverb" programs, can be stored in the user program bank. (All of the programs also have "Set Program Name" and "Memorize Program" commands.) In the following discussion of parameters and their possible values, the factory-preset default values are shown in parentheses. In a "Panorama" program, the first push of "Param" gets "Input Balance," which has ±16 steps relative to center zero ("0"). Next are "Listener Position," with 254 steps ("127"), and then "Speaker Angle," with 12 values from 29° to 90° ("49"), which are set when calibrating the "Panorama" program. "LF Width," with unit steps from "−25" to "+25" ("0"), controls the ratio between the low-frequency information in the sum and difference channels; this varies the sense of warmth and spaciousness in the signal. "Rear Level" has unit steps from "0" to "32" ("16"). "Rear Rolloff" has 15 choices from 329 Hz to 14.1 kHz ("2.9 kHz"). "Rear Delay" has unit steps from 0 to 32 mS ("16"). Pushing "Param" until the display shows "Calibrate" puts the CP-1 into "Panorama" calibration mode. (I'll say more later about adjustments for best listening.)

The first "Ambience" parameter is "Room Shape," with "Rectangle" the default and "Fan" the other choice. "Liveness" has steps from "0" to "6" (default is "4"). "Rolloff" has 15 choices, from 329 Hz to 14.1 kHz, with 5.9, 3.6, and 2.9 kHz the defaults for "Small," "Medium," and "Large," respectively. "Panorama Eff," used for image expansion when side speakers are not used, has steps from "0" to "32" ("28"). Next are "Listener Pos," with 254 steps ("127"), and then "Speaker Angle," with 10 values from 33° to 91° ("51"). These two parameters are normally set to match the results obtained in the "Panorama" program calibration. Because of a difference in processing, the "Speaker Angle" values of "Ambience" are not exactly the same as those for "Panorama"—a minor discrepancy. The "Speech Detector" is normally on to detect monaural speech, which makes announcements with music programs sound much better; it can be switched off, if desired.

The first adjustable parameter for "Reverb" programs is "Mid RT," which stands for midrange (mid-frequency) reverberation time. Default values are 0.46, 0.92, and 2.16 S for "Small," "Medium," and "Large," respectively. Each range has 10 values, from 0.32 to 2.8, 0.64 to 5.6, and 1.28 to 11.2 S for "Small," "Medium," and "Large," respectively. "Bass RT" is the low-frequency reverberation time; its values are in terms of ratios to "Mid RT." The choices for all three room sizes are "0.7," "Equals," and "1.25." The default values are "Equals" for "Small" and "1.25" for the other two room sizes. "Treble" is the roll-off parameter, with a range of 329 Hz to 14.1 kHz; defaults are 5.9, 4.2, and 3.6 kHz for "Small," "Medium," and "Large," respectively. "Panorama Eff" has unit steps from "0" to "32"; default is "0" with side speakers and "28" without. "Listener Pos" and "Speaker Angle" are the same as for "Ambience" programs. "Predelay," with 8-mS steps from "0" to "120 mS" ("0 mS"), delays the start of reverberation, making the hall seem larger.

The only adjustable parameter for the "Surround" program's "Mono" setting is "Treble," which has a 2.3-kHz default and a range of 329 Hz to 14.1 kHz. The first two parameters for "Stereo" are "Front Effect" and "Rear Effect," which both have defaults of "8" and a range of "0" to "16." The settings determine the amount of signal steering, with higher values for more steering. "Rear Rolloff" has a default of 14.1 kHz and the standard range of 329 Hz to 14.1 kHz, plus an "Automatic" mode. In this mode, the rear channels are rolled off above 7 kHz, until the logic steers a sound effect to the rear channels, at which point the bandwidth opens up to beyond 15 kHz. "Bass Blend" takes low-bass energy from the center and shifts it to the main left and right speakers. The range is from "0" to "16" ("0").

The next "Stereo" parameter, "Auto Azimuth/Bal," is normally off, as it should be for music. When turned on for movies, it will automatically adjust the level and time offset of the two incoming channels, eliminating the need for an input-balance control for Dolby-encoded material. "Rear Delay" has a range of "0" to "32 mS" ("8 mS"), with 2-mS steps. "Rear Noise Chip" is normally off, which is best for music; it is turned on to get the special Dolby B NR used in Dolby Surround. "Calibrate" is used to check and adjust channel levels in multi-speaker systems and is *not* the same mode as "Calibrate" in the "Panorama" program. (The "Surround" program "Calibrate" will be discussed later.) The first Pro-Logic parameter is "Rear Delay," which has a range of "16" to "32 mS" ("20 mS"). Other parameters for Pro-Logic that are the same as "Stereo" are "Calibrate" and, except for defaults, "Auto Azimuth/Bal" ("On") and "Bass Blend" ("6").

Below the program and parameter sections on the remote control are the two rows of level controls. The far-left column has the "Effect" up and down buttons. Next are the "Balance" "F" (front) and "B" (back) buttons and the "R" (right) and "L" (left) buttons. The "Volume" up and down buttons are in the far-right column. A little arrow next to each level button minimizes confusion. The display of effects levels has figures from "1" to "63" for "Panorama" programs and "−64" to "−00 dB" for other programs. The horizontal bargraph-type display conveys the effective level immediately. Front/back and left/right balances are indicated with a left/right shifting bar. "Volume," which controls all channel levels simultaneously, goes from "−64" to "−00 dB." In the remote's last row are buttons to mute the entire system or the effects channels alone.

The front-panel LCD display always presents information in an easily understood form. The current program selection

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Judging spatial effects is easiest from the listening position, so the CP-1's programs are selected and varied from its remote.

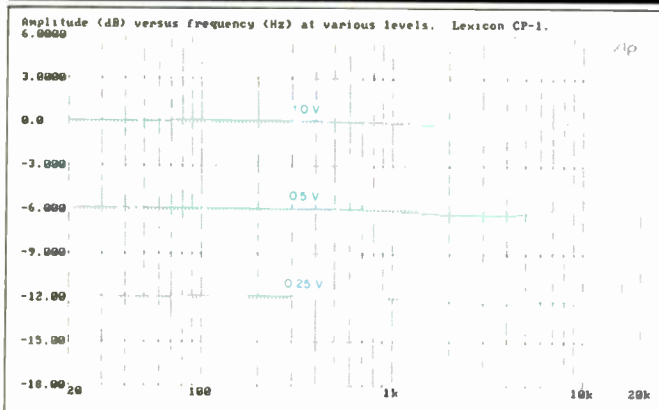

Fig. 1—Frequency response of side channel at several input levels; see text.

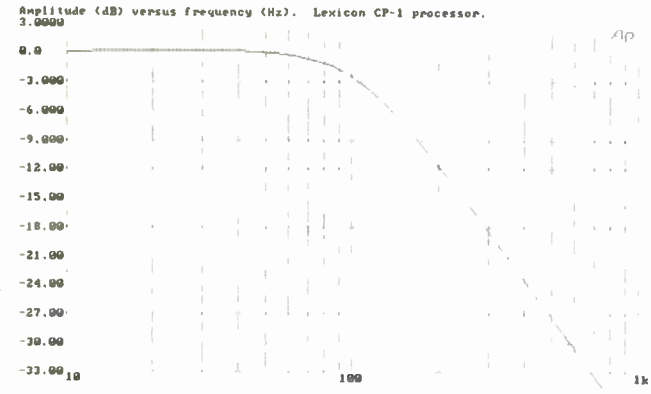

Fig. 2—Frequency response of subwoofer channel.

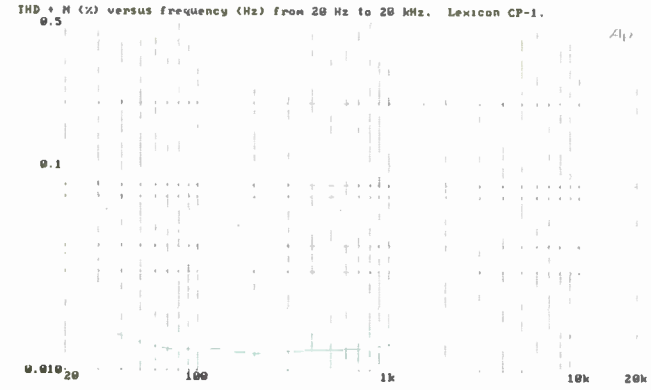

Fig. 3—THD + N at 3 V out; right main channel is shown.

is continuously shown, except when parameters and parameter values are being changed. Non-program information is normally displayed for 5 S after the last instruction.

I noted some items of good protocol while using the remote. Parameters with on/off functions are turned on with its "Param" up button and off with its down button. The last parameter checked or changed can be shifted immediately with a push of the up or down button, without pushing "Param" first. The white labels on the remote control are very easy to read against the black background.

Measurements

Let me first point out that all measurements were made after the listening and viewing. With the aid of the CP-1 service manual, I was able to defeat the normal processing so I could make instrument tests. The CP-1 was set, with the input pot, for close to maximum level (red LEDs just off) for an input of 316 mV. The main-channel response was down 0.09 dB at 20 Hz, 0.04 dB at 20 kHz, and 3 dB at 3.0 Hz and 140 kHz. The input voltage was increased to 1 V, and the pot was turned down until the red LEDs just turned off. The side-channel responses were then taken in "Surround" Pro-Logic, at input voltages of 1.0, 0.5, and 0.25 V. The reference level (0 dB) in Fig. 1 was the output voltage at 1 kHz with the 1 V input. The response at this maximum input level has a high-frequency roll-off which is less significant than it first appears. The test signal was a stepped sine wave, and the test-signal level above 2 kHz was much higher than spectral levels of music would be for the same frequencies at the same overall input level. The responses at lower, normal levels were close to 0 dB down at 20 Hz and less than 3 dB down at 16 kHz, showing agreement with specifications. The subwoofer-channel response curve is shown in Fig. 2. The roll-off above 100 Hz is at 12 dB per octave.

With the pot settings used for the listening tests, the S/N ratio was 100.5 dBA for the main channels, relative to 1 V in and out. The S/N ratios (re: 1 V in and out) for the side and rear channels, respectively, were 113.7 and 85.1 dBA for the "Panorama" program's "Wide" setting, 85.3 and 95.8 dBA for the "Ambience" program's "Medium" setting, 89.6 and 90.7 dBA for the "Reverb" program's "Medium" setting, and 82.2 and 80.6 dBA for the "Surround" program's "Stereo" setting. Overall, these figures are very good, to say the least; with the specified 3.5-V reference level, all of these figures would be 10.9 dBA higher. Figure 3 shows THD + N, across the band, for the right main channel at 3 V output. The results are typical for any of the channels, with very low distortion over most of the band.

The input sensitivity was 270 mV for maximum acceptable input level, with the input-level control at maximum, just below red-LED turn-on. The level for input clipping above the LED's turn-on varied with program selection. Waveform distortion seemed to appear with "Panorama" just about turn-on, but perhaps that was from level-sensitive processing. Input levels could be noticeably higher for other programs, but setting the control for prevention of red-LED turn-on makes sense for all programs. The maximum input level, with the control turned down, was greater than 31 V. With red-LED turn-on as the 0-dB reference, the green segments turned on at −50, −43, −37, −32, −28, −24, −19,

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The processor is easily configured for optimum results with any of twelve common speaker setups.

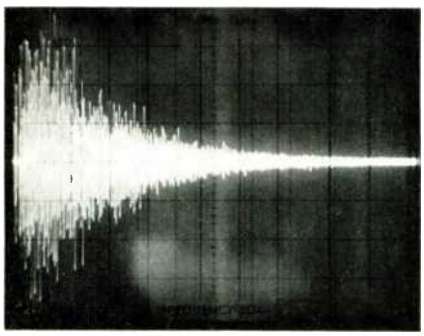

Fig. 4—Output from surround channel, in "Reverb" program's "Large" mode, for a 1-mS burst (one cycle) of a 1-kHz sine wave. Note the smooth decay; see text. (Horizontal scale: 0.2 S/div.)

−15.4, −11.2, −7.3, and −3.3 dB. The level range of the meter is certainly wide, which is good, but smaller steps at the top would be of some help. The red LED turned on with a 1-mS, 5-kHz tone burst at a continuous level 1 dB above indicator turn-on. The LED indicating −19 dB turned off 245 mS after the signal stopped—a shorter decay time than a peak-detecting meter should have. The Lexicon's meter will detect very short peaks, so the user should respond to any red flashing by reducing level. The output level for clipping was at least 4.7 V.

Figure 4 shows the output from a surround channel in the preset "Reverb" program's "Large" mode, with a single-cycle, 1-kHz burst. The smooth decay can be observed over the 2-S sweep of the oscilloscope, which is very close to the 2.16-S "Mid RT" default. The output polarity was the same as the input in the main channels. The main-channel output level was the same as the input level when the preset "Reverb" program was in "Medium," with the input level set for red-LED turn-on, the back-panel trim at maximum, and the main volume control at −11 dB. This relationship varied from program to program. The input impedance was 41 kilohms. The output impedance was 490 to 500 ohms for the various channels.

The two sections of the input-level pot tracked within 1 dB from wide open down to −47 dB. The master volume control's sections tracked within fractions of a dB for 55 dB. Each of the level steps were within ±0.03 dB of the indicated 1 dB. With a monaural input, left and right rear channels were down 25 and 27.5 dB, respectively, in the "Surround" program's "Stereo" mode and greater than 31 and 45 dB, respectively, in Pro-Logic mode. The delay adjustment range was from 0 to 32 mS. Each of the 2-mS steps was accurate within ±0.2 mS. The residue of the 33-kHz sampling frequency was down over 96 dB in the main outputs. The spectrum of the calibration noise used for channel balancing was centered at 800 Hz, with roll-offs at 400 Hz and 1.6 kHz.

Use and Listening Tests

The reference processor for the listening and viewing tests was the Yamaha DSP-1. A Yamaha AVC-50 amp was used for switching among 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. For power amplification, I used the second section of the AVC-50 for the main stereo channels, a JBL/UREI 6210 for the center channel, and a Yamaha M-35 four-channel amp for the side and rear channels.

The speakers were two JBL 4301s (main stereo), a JBL 4408 (center), a self-powered Triad Design HSW-300 (subwoofer), and four Dynaco A-25s (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 on the incoming signal. Figure 5 shows the arrangement of the system for evaluating the CP-1. The processor's subwoofer output was not used, as my subwoofer is designed to be connected across the main speakers. Two listener positions are shown because I moved back and forth, depending on the program selected and the speaker configuration used.

The owner's manual provides much useful information in a friendly page format with lucid text and well-done illustrations. Many pertinent comments throughout help the user to operate the unit and to understand what happens. The instructions on channel balancing and calibration of the "Panorama" program are well written. The sections on speaker setup and configuration and on programs and parameters are particularly good—the manuals for too many surround-sound units do not provide the detailed guidance needed. A 16-page section on theory and design is a good tutorial on certain aspects of concert halls, the design of the CP-1 programs, and how to get the most out of them. Lexicon also supplies a handy, single-sheet reference guide on stiff paper.

When setting up the CP-1, I first adjusted the contrast of its front-panel display for easiest viewing from my main listening position. Then, I moved around with the remote control to check its range. Up close, commands were received up to ±150° off axis horizontally and up to at least ±30° vertically. Control response was reliable out to ±45° at 25 feet and to greater than 30 feet on axis. I tried "Panorama" with just the center and front speakers (configuration 2) and was impressed by the spread possible in this mode. The calibration process worked well, and I found the specific parameters for my listening area quite speedily. I used the default "127" for the listener-position setting, but I preferred a speaker angle of 55° over the default "49." I did find that the best results in "Panorama" were secured with a listening position closer to the main speakers than for the other programs, particularly if the side speakers were off. The "sweet spot" did require sitting in the exact center: It was quite amazing to hear substantially nothing in the right ear with the "Calibrate Left Only" signal.

During the majority of the listening, I used two speaker configurations: Two front, two rear, and one center, and with two side speakers added. I checked all of the speaker

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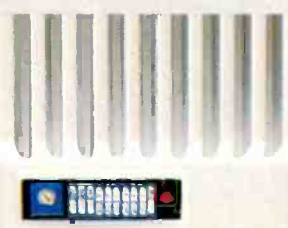
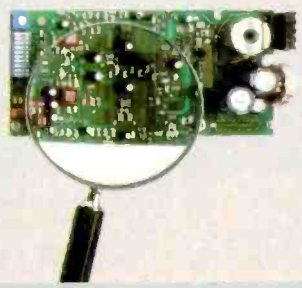
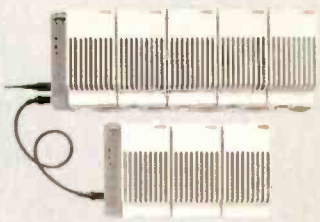


M 50 Monophonic and S 30 Stereo Power Amplifiers. The plug-in M 50 and S 30 Module Power Amps are exceptionally compact. Thanks to advanced SMD technology, they're packed with variable active electronic crossovers, fully regulated power supplies and an audiophile sound quality that belies their diminutive size.



Two Base Unit Sizes, Unlimited Configurations. The MF 3 accommodates three Module Amps, the MF 5 five Module Amps. Multiple Base Units can be daisy-chained to accommodate any number of actively-driven speakers. Bi- or tri-amplify. An unlimited variety of configurations is possible.



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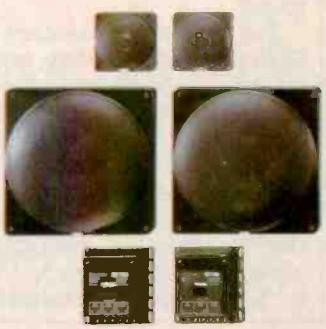

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Unlike many other units, the CP-1 can provide very satisfying sound fields with only two speakers.

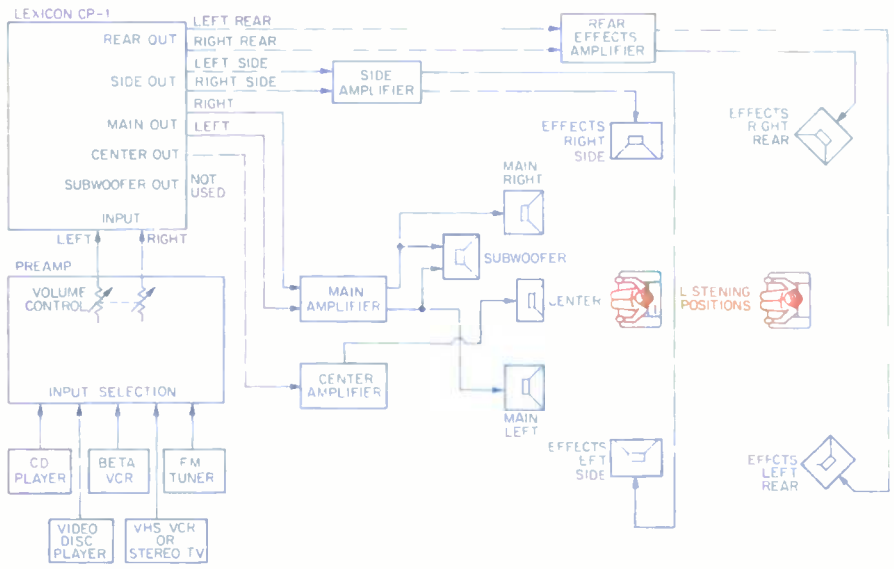

Fig. 5—Listening setup used in evaluating the Lexicon CP-1. Two listener positions were used; see text.

levels by using the calibration mode of "Surround" Pro-Logic. It was very easy to trim the levels with the back-panel trim pots as the shaped-noise signal stepped from speaker to speaker. Then I ran through all of the programs to review the effects of varying the parameters. I changed a number of values and stored all of the modified programs in the user memories.

Television

The first source I tried was television, with *Tour of Duty*, the CBS series, received in mono on the channel I used. "Surround" in "Mono" was the only acceptable program, made better with some reduction in effects level. Dialog centering was good, without any of the spread or diffusion that occurs with systems lacking center speakers. The results were similar on *Dance with a Stranger*, a movie on the Arts & Entertainment channel featuring Miranda Richardson and Rupert Everett. In both of these cases, effects were well handled, and I found some benefit in adding some voice-presence EQ.

Fine Romance (ABC), *48 Hours* (CBS), and *Different World* (NBC) all showed stereo on applause and effects but with all the dialog monaural and right in the center. I preferred "Panorama" in "Normal" and "Wide" when I was in the close listening position and "Surround" in "Stereo" and Dolby Pro-Logic when sitting in the regular position. The oscilloscope monitor showed that some television programs which turned on the stereo TV's detector had no stereo information, real or synthesized.

Videocassettes and Videodiscs

The videocassette of *Bull Durham*, the Orion film with Kevin Costner and Susan Sarandon, had a more pointed dialog sound with "Stereo," but Pro-Logic delivered a better voice quality and a superior sound quality overall. The steering of off-screen sound was very good, and the importance of the center speaker for dialog was demonstrated again and again. The videodisc of MCA Home Video's **batteries not included*, with Hume Cronyn and Jessica Tandy, was very satisfying with Dolby Pro-Logic. This program was definitely the best, with a combination of stable dialog centering and good spread of the effects, particularly when the little spaceships were zipping around. This movie had good changes in voice presence to go with the action in each scene.

Runaway Train, an MGM/UA Home Video videodisc with Jon Voight, Eric Roberts, and Rebecca DeMornay, was very good with both speaker configurations mentioned above. Many effects were very well positioned: The crowd during the boxing match, the panning of the sound of the passing train, the fast change in scene and sound localization when the runaway train hits the caboose, and the creative positioning of music. Yelling, off screen and to the left at the start of the movie, was well localized. Occasional effects actually seemed too far right or left with either speaker setup. The distraction was very minor and very much outweighed by all the evidence of good steering. Pro-Logic was the preferred program, but "Stereo" was more exciting with some scenes, including a few with the runaway locomotive. The subwoofer helped to give a solid bottom to the sound.

Star Trek IV, a Paramount Pictures videodisc with William Shatner, Leonard Nimoy, and DeForest Kelley, also benefited from the subwoofer. The whale rescue had good surround, as did a number of other scenes. "Stereo" was the better mode for this movie; Pro-Logic seemed to be more echoey. More and more, I came to the conclusion that the excessive liveness was a property of the soundtrack on the disc. Then I tried a Pioneer laser videodisc of Carole King, *One to One*. The amount of good surround information varied from track to track. The user versions of "Ambience" in "Small" and of "Surround" in "Stereo" gave the best

The CP-1 is the first unit I've reviewed that creates both good hall illusions for music and well-steered movie surround and dialog.

results overall, but for some of the tracks, I liked the preset "Panorama" in "Wide" better.

Compact Discs

The first CD I tried was Mozart's *Sinfonia Concertante, K. 364*, with Iona Brown and the Academy of St. Martin-in-the-Fields (Argo 411613-2-ZH). The user "Ambience" in "Small" or "Medium" gave me the best illusion of the hall sound I wanted. "Ambience" in "Large" was not good, but "Reverb" in "Small" and "Panorama" in "Normal" were possibilities that others might prefer. High-level trumpet notes showed some obvious modulation distortion in *The Extraordinary Roger Voisin: The Baroque Trumpet*, with the Kapp Sinfonietta (MCA Classics MCAD2-9807). The improvement over regular stereo was still very obvious with the preset "Panorama" in "Normal" and "Ambience" in "Medium." "Ambience" in "Small" was the best of my user-modified programs.

Debussy's *La Mer*, with Slatkin and the St. Louis Symphony Orchestra (Telarc CD-80071), was particularly appealing during the early, quiet parts with "Panorama" in "Normal." In later parts, I favored the illusion generated with "Ambience" in "Large" or with "Reverb" in "Medium." For Tchaikovsky's *Capriccio Italien*, performed by Kunzel and the Cincinnati Symphony Orchestra (Telarc CD-80041), it was a toss-up between "Panorama" in "Normal" and "Ambience" in "Large." "Reverb" in "Medium" provided a fairly good illusion, but "Reverb" in "Large" was unacceptable—more so in the user version. *The Music of Waldteufel*, with Kunzel and the Cincinnati Pops Orchestra (MMG MCD-10025), was much the best with "Panorama" in "Normal." A few spots with the bass drum were particularly realistic with this program. "Ambience" in "Small" was good for its tone color, and the other "Ambience" programs were also satisfactory choices.

The Fauré *Requiem*, with Shaw and the Atlanta Symphony Orchestra and Chorus (Telarc CD-80135), had a lovely, detailed sound quality with "Panorama" in "Normal," but I preferred the more large-church sound of "Ambience" in "Medium" and all the "Reverb" programs. In the "Sanctus" and "Agnus Dei" sections in particular, I felt "Reverb" in "Large" was best of all, with "Medium" my second choice. "Reverb" in "Small" was rated just below "Ambience" in "Medium." Mozart's *Opera Arias*, with Te Kanawa, Davis, and the London Symphony Orchestra (Philips 411148-2PH), sounded better with the preset programs than it did with my versions. "Ambience" in "Small" and "Panorama" in "Normal" were the best, according to my ears, and "Ambience" in "Medium" and "Panorama" in "Wide" were the only others I liked for some pieces. I found it interesting that I also preferred the same basic programs for much of Puccini's *Tosca*, with Milanov, Bjoerling, Warren, Leinsdorf, and the Rome Opera House Orchestra and Chorus (RCA 4514-2-RG). With the opera, however, the user versions created better illusions for most of the scenes, and "Ambience" in "Small" was the best overall.

Beethoven's *Piano Trio No. 11*, with the Beaux Arts Trio (Philips 420231-2PH), immediately seemed to be a good match for "Ambience" in "Medium," with the preset program the better one. This was very satisfying listening, and as I have heard the Beaux Arts Trio almost every year over a period of 30 years, I have very definite ideas on what they and the hall should sound like. For a different piano style, to say the least, I listened to *The Joint Is Jumpin'*, with Fats Waller (Bluebird 6288-2-RB). Preset "Panorama" in "Normal" and "Ambience" in "Small" were pretty good, but user "Surround" in "Stereo" was the best for this CD, which had very little stereo information on any track. I was surprised by the amount of the improvement, considering the age of the original source material.

Air Supply's *Love & Other Bruises* (Columbia CK-35047) was a good match for "Panorama" in "Wide," both the preset and user programs. Infrequently, the spread was almost too wide with these programs. "Surround" in "Stereo" and Dolby Pro-Logic weren't as good as the "Panorama" programs overall, but they had a larger good-listening area. Preset "Panorama" in "Normal" and "Wide" were both good choices for the "Italian Concerto Presto" track of Don Dorsey's *Bachbusters* (Telarc CD-80123). They weren't pleasurable earlier, however, and overall, I liked user "Ambience" in "Small" for most of the tracks. The Police's *Synchronicity* (A&M CD-3735) was very good with both preset and user "Panorama" in "Normal" and "Wide," as long as I stayed right in the center. "Ambience" in "Small" was the best choice for a larger listening area.

Conclusion

A great deal of pleasurable listening was obtained with the smooth surround sound from the Lexicon CP-1. I did not detect any limitations I would ascribe to the 33-kHz sampling rate or the related 16-kHz roll-off in the surround channels. The "Panorama" programs are different from those available from stored-measurement-type processors such as my Yamaha DSP-1 reference unit. The "Panorama" programs can provide a class of very satisfying sound fields—even with just two speakers—that are not even possible with other processors. The ease with which the internal operation of the CP-1 can be changed to match any of 12 speaker configurations is unique and could be a very important feature for some users. The CP-1 is the first unit I have reviewed that provides good performance-hall illusions with music and also delivers well-steered surround sound and properly localized dialog with movies. (I should note that I did not evaluate the Yamaha DSP-1 or DSP-3000 with the DSR-100 Pro decoder for Dolby Pro-Logic.)

The CP-1 almost always delivered a nice-sounding illusion, even if it wasn't exactly what I envisioned before selection. From one choice to another, the sound character did not usually change as noticeably as it did with the DSP-1. However, other listeners, using different parameter settings, might not agree. Whatever high-performance surround processor is evaluated by the potential buyer, the demonstration arrangement should correlate to the particular design of the unit. The Lexicon CP-1 performs best with side loudspeakers, but it can be set up for operation in a home listening space that might not accept this configuration. Its limitations are minor, and its price is quite reasonable for its features and performance quality. For music *and* movies, the Lexicon CP-1 is worthy of comparison to any other units currently on the market. *Howard A. Roberson*

3

SONY CDP-X7ESD CD PLAYER

Manufacturer's Specifications
Frequency Response: 2 Hz to 20 kHz, ±0.3 dB.
S/N: 115 dB.
Dynamic Range: 100 dB (EIAJ).
THD: 0.0015% at 1 kHz, 0 dB.
Channel Separation: 115 dB at 1 kHz.
Wow and Flutter: ±0.001% weighted peak (EIAJ).
Output Level: 2.0 V into 50 kilohms for unbalanced (fixed and variable) and balanced outputs.
Digital Output: Coaxial (SPDF), 0.5 V peak to peak; optical (EIAJ), −18 dBm, 660 nm.
Headphone Output Level: 28 mW into 32 ohms.
Number of Programmable Selections: 20.
Power Requirements: 120 V a.c., 50/60 Hz, 22 watts.
Dimensions: $18^{11}/_{16}$ in. W × $4^{15}/_{16}$ in. H × $14^{3}/_{4}$ in. D (47.5 cm × 12.5 cm × 37.5 cm).
Weight: 37.4 lbs. (17 kg).
Price: $2,000, including remote.
Company Address: Sony Dr., Park Ridge, N.J. 07656.
For literature, circle No. 92

A few months ago, Sony introduced a no-holds-barred CD player that represented the very best digital technology they had been able to come up with. The R-1 CD player was delivered as a two-piece component and carried a suggested retail price of $8,000! Needless to say, a CD player at that price was not expected to be a runaway best seller. It was designed and produced more as a reference unit against which other CD players could be compared.

Now Sony has come up with a CD player at one-quarter that cost. Amazingly, the CDP-X7ESD not only incorporates much of the advanced technology found in the R-1 but is loaded with many of the convenience features Sony has invented over the past year or two. Custom File lets you maintain your personal program bank for up to 227 CDs, so you can listen to those selections you like best on a disc, in any order you prefer. Up to 20 tracks can be selected for each disc you "file" in this data bank. You can even select points within a track—regardless of whether or not the disc has index divisions—at which to begin playback.

"Program Custom Editing" provides automatic editing of selections according to available tape length. Should you have to cut a selection at its midpoint when recording it onto tape, you can designate the time of the selection in advance, and the player will gently fade the recording level

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by Jeff Rowland

"The goal of Jeff Rowland Design Group is to design and manufacture the finest, most musical sounding audio products by incorporating innovative yet simple solid state circuit topologies.

A design should not depend upon 'textbook' technology but rather should bring original thinking to the entire range of available options. Since the late 1970s, the thrust of my research has been to determine the ability of **any** device or topology to recognize increasingly finer degrees of musical information.

Musical signals appear at the input of an amplifier as a changing voltage. Bothvacuum tubes and field effect transistors (FETs) are voltage sensing devices; therefore both have inherent advantages at the input gain stage of an amplifier. But only FETs are transconductance (voltage in/current out) devices, and thus have the ideal transfer function at the critical low-level input section of a solid state design. Bi-polar transistors are current operated devices and are thus better suited for use in the output stage of an amplifier. I feel that this synergy of different solid state technologies (FETs and bi-polars) produces the most musical results.

Critical selection of all component parts (capacitors, resistors, wire, materials and connectors) is vital to an amplifier's musical accuracy. I make every effort to minimize the use of these (imperfect) passive parts in my designs. This 'editing' of the circuit ensures that the integrity of the musical signal is maintained. A single, direct coupled gain stage, located close to the input terminal, comprises the entire gain block in each Jeff Rowland Design Group amplifier.

A plug-in module contains key circuitry and could be considered the 'heart' of Jeff Rowland Design Group products. This circuitry is encapsulated in a thermally-conductive epoxy, providing optimum temperature and mechanical stability. Long-term reliability and easy product update are thereby ensured.

Our amplifiers incorporate Differential Mode™ technology. This technology, developed by Jeff Rowland Design Group, offers several advantages over traditional balanced operation. One important benefit is high common-mode rejection over a wide bandwidth. Significant types of noise and distortion are reduced in not only the amplifier but interconnect cables as well. Differential Mode™ also allows the customer to select an optimum amplifier input impedance, which permits the use of diverse associated equipment and cables.

Jeff Rowland Design Group circuit topologies utilize no negative feedback. Rather than listing the many benefits of a low or no feedback design, I will just say that my goal was to find a topology which permitted stability and simplicity. Our products have proven reliable in many varied and demanding applications around the world and are backed with a 5 year transferable warranty.

Jeff Rowland Design Group equipment has always been recognized for its impeccable workmanship and technical innovation. More importantly, it continues to be described by reviewers and customers as being simply musical."

MODEL 1 SPECIFICATIONS:

Output power	60 watts RMS continuous, 8 ohms 120 watts RMS continuous, 4 ohms 215 watts RMS continuous, 2 ohms
Power Bandwidth	0.3 Hz to 300 kHz, -3 dB
Slew Rate	70 volts per microsecond
THD and Noise	Less than .025%, 1 kHz, 8 ohms, 20 watts Less than .035%, 1 kHz, 8 ohms, 60 watts
Damping Factor	Greater than 200, 20 Hz to 20 kHz, 8 ohms Greater than 85, 100 kHz, 8 ohms
Output Current	22 amps peak, continuous 55 amps peak, 0.1 ohm, 20 msec, 1 kHz
Input Impedance	Selectable 100k, 20k, 3k ohms
Common-Mode Rejection Ratio	Greater than 90 dB
Bridged Mono Output Power	240 watts RMS continuous, 8 ohms 360 watts RMS continuous, 4 ohms 500 watts RMS continuous, 2 ohms

To audition any Jeff Rowland Design Group amplifier or preamplifier, contact one of our authorized representatives. These dealers and distributors are among the most knowledgeable in the world.

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JEFF ROWLAND
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The D/A converters in the CDP-X7ESD are as good as, or better than, those of any stand-alone converter I have yet measured.

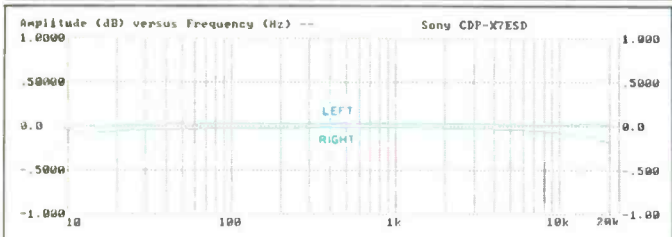

Fig. 1—Frequency response; right-channel curve has been slightly displaced for clarity.

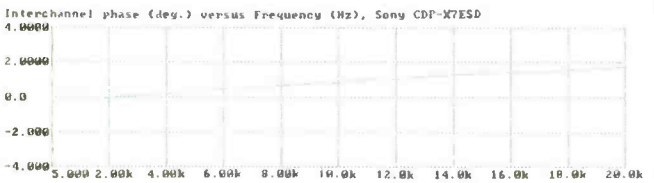

Fig. 2—Interchannel phase difference; see text.

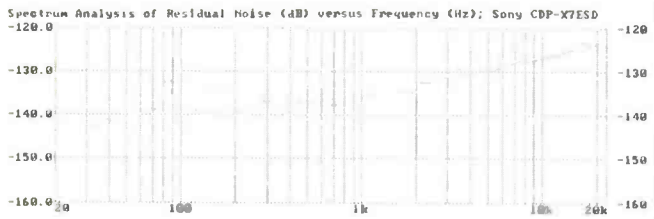

Fig. 3—Residual noise vs. frequency for "silent" track of CD-1 test disc. In this and subsequent figures, left channel is solid curve and right channel is dashed.

about 5 S before the end of the designated time and then pause automatically. "Shuffle Play," which first appeared on a Sony CD player a few years ago, is also available on this unit, as is direct track selection using the multi-function remote control supplied with the unit. There are, of course, the usual assortment of repeat modes as well.

For all the convenience features found on the CDP-X7ESD, the performance of this outstanding unit impressed me even more. Among the technological design innovations that distinguish this player from others is Sony's Digital Sync System, which helps provide highly accurate, jitterless playback. Dual, 18-bit, linear D/A converters are used, along with an eight-times oversampling, 45-bit, noise-shaping digital filter.

The Digital Sync System synchronizes the signal-processing IC just ahead of the D/A converter with the master clock that controls the converter circuit. This reduces time-based error (jitter) in the decoding of the signal, for more faithful D/A conversion and accurate phase relationships.

Thanks to eight-times oversampling, the audio signal is well separated from noise modulation components, which are now all the way out at 352.8 kHz. As a result, a very gentle analog low-pass filter can be used after the D/A converter, for improved group-delay characteristics. The 45-bit digital filter and noise-shaping system used in the CDP-X7ESD assure extremely good signal resolution, particularly at low frequencies.

Control Layout

Despite its sophisticated design, the Sony CDP-X7ESD has a relatively simple front panel. The usual power on/off switch, headphone jack, and line/headphone level control are at the left end of the panel, near the CD tray. Below the tray is a display area that can be turned on and off by means of a nearby button above the tray's "Open/Close" button. When activated, the display shows a variety of data besides the usual track, index, and time. Included are displays for repeat mode, custom index data, Custom File data, and the familiar track "calendar." Major operating controls are grouped at the right end of the panel and include buttons for stop, pause, play, audible fast forward and reverse, and track advance and reverse. A button labelled "Output Selector" (analog or digital) is augmented by LEDs that show which output is active.

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How, I wondered, could any component deliver Sony's claimed 115 dB S/N? To my surprise, it measured about 3 dB better!

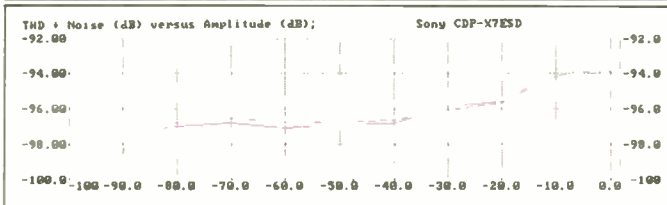

Fig. 4—THD + N vs. signal level for 1-kHz test frequency.

Fig. 5—THD + N vs. frequency for signal level of 0 dB.

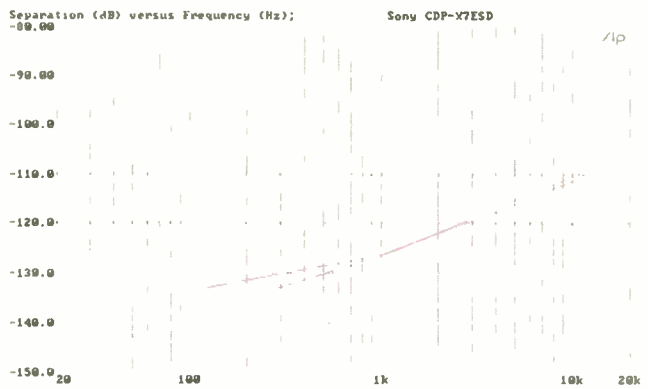

Fig. 6—Interchannel separation was virtually identical in either direction (left to right or right to left).

The rear panel of the CDP-X7ESD is equipped with fixed and variable unbalanced line output jacks as well as balanced XLR-type output connectors. Coaxial and optical digital output terminals are also included. The digital outputs can be used with separate, stand-alone D/A converters or with some of the newer preamplifiers and integrated amplifiers that have direct digital input facilities. Frankly, after measuring the performance of the CDP-X7ESD and listening to it, I can't imagine why anyone would want to use a separate D/A converter; the D/A conversion provided by this Sony Compact Disc player is as good as, if not better than, the conversion of any stand-alone converter I have measured to date.

Most of the convenience features described earlier are accessible only via the wireless remote control, which has 20 numbered keys for easier direct access of tracks or index points. If a given disc has more than 20 tracks, simply press the ">20" button, which then allows you to input dual-digit numbers.

Measurements

Figure 1 shows the frequency response of the CDP-X7ESD CD player from 10 Hz to 20 kHz. The left-channel output was flat to within better than 0.1 dB out to 20 kHz; the right channel was off by no more than −0.18 dB at that frequency. (The right-channel trace is slightly displaced for the sake of clarity this displacement does not imply any measurable channel imbalance.)

Interchannel phase difference is shown in Fig. 2. To make this plot more readable, I have adopted a new display format for this test, showing frequency on a linear, rather than logarithmic, scale and eliminating the duplicate frequency response curve which used to be superimposed on the phase curve. Although the frequency scale extends down to 5 Hz, only the portion from 2 kHz up is significant. For this Sony player, I expanded the vertical scale so that it extends only from −4° to +4° (instead of my usual ±90°). This is because the maximum phase difference between the channels of the CDP-X7ESD was an unbelievably low 1.8°, even at 20 kHz!

I used the "silent" track of my CD-1 test disc to measure the S/N ratio of this player's analog section. Frankly, I expected the player to fall short of the published S/N specification of 115 dB. How could any audio component deliver that low an S/N ratio, referred to 2.0 V output? If it met spec, that would mean a noise output of only 0.0000035 V, or 3.5 μV. Imagine my amazement when I measured an S/N ratio of 118.2 dB for the left channel and 117.6 dB for the right!

An unweighted spectrum analyzer sweep of the residual noise at the analog outputs of the player (Fig. 3) confirmed my spot S/N readings. Even in the third-octave band, in the vicinity of 20 kHz, the noise reading was more than 120 dB below the output reference level.

Figure 4 is a plot of THD + N, expressed in dB, as a function of output level. This test was conducted using a 1-kHz signal and all readings are referred to maximum recorded level (0 dB). While there is a very slight tendency for THD to increase near maximum output levels (probably due to the characteristics of the final analog output stages), even at

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It was once rare for a CD player to handle 0.7-mm data gaps on a disc; the Sony only mistracked when the gaps reached 1.5 mm!

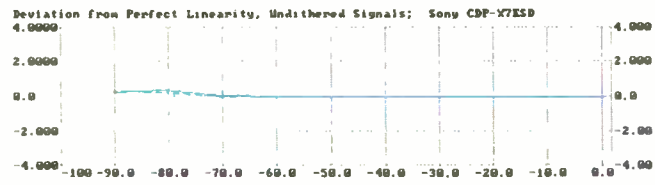

Fig. 7—Deviation from perfect linearity for an undithered, 1-kHz signal; see text.

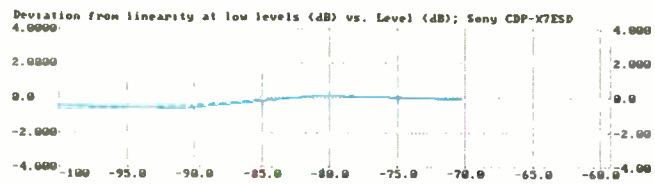

Fig. 8—Linearity deviation for a low-level, dithered 1-kHz signal.

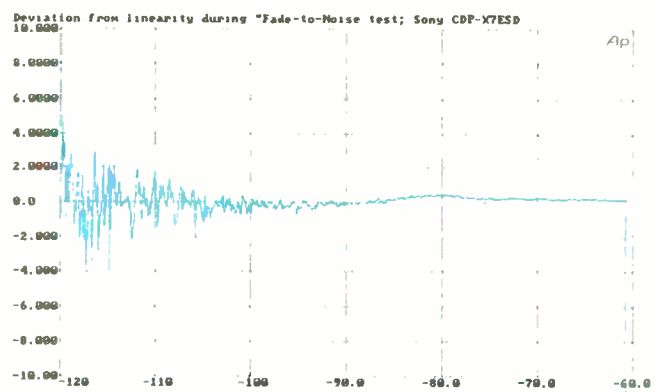

Fig. 9—Linearity deviation for fade-to-noise test of dynamic range, using a dithered signal; see text.

maximum output level, THD + N was in excess of 92 dB for the right channel and was 94 dB for the left. That 94-dB reading corresponds to a THD + N percentage of 0.002%, which almost precisely matches the 1-kHz readings for THD + N as a function of test frequency (Fig. 5): 0.0018% for the left channel and 0.0019% for the right. Even lower THD + N figures were obtained at lower test frequencies. At higher frequencies, though the curve does bulge upward at 10 kHz, my THD + N readings at that frequency and at 20 kHz were about the lowest I have ever measured for any CD player: 0.0036% and 0.0015%, respectively. I measured SMPTE-IM distortion at maximum output and obtained readings of 0.0036% for the left channel and 0.0035% for the right.

Stereo separation (Fig. 6) also exceeded published specifications by a wide margin. At 1 kHz, channel separation measured 126.5 dB in either direction (left to right or right to left). At 16 kHz, where most other players exhibit a fair amount of crosstalk, this player's separation still measured between 107 and 108 dB! Of course, no one really requires 120 dB or more in the real world of typical listening rooms. Even 30 or 40 dB would provide most listeners with a more than adequate stereo soundstage.

The next measurements I made, however, were of extreme significance and served to differentiate this player from much of the competition. As shown in Fig. 7, using undithered test signals from maximum recorded level to −90 dB, linearity was by far the best I have ever measured. At −90 dB, where even the best D/A converter systems are off by at least a couple of decibels, this remarkable unit's deviation from perfect linearity was a negligible 0.2 dB. Using dithered signals for an evaluation of ultra low-level linearity, maximum deviation from perfect linearity was no more than 0.3 to 0.4 dB at −100 dB (Fig. 8).

As I might have expected by now, the fade-to-noise test produced equally impressive results. Notice, in Fig. 9, how even at levels below −100 dB, as the noise begins to dominate the graph, the trace is still perfectly centered on the 0-dB axis. From this test, I was also able to determine that this unit's dynamic range (measured in accordance with the EIA Standard which is soon to be approved) reached the theoretical maximum of just under 115 dB! Sony's published specification for dynamic range, measured in accordance with a different standard suggested by the EIAJ specifications, is 100 dB. Using that method, I could only come up with a reading of 98.3 and 98.2 dB for the left and right channels, respectively.

To complete my study of the Sony's linearity, I used the special monotonicity test track of my CD-1 test disc. This track has recorded square waves repeated at levels from the least significant bit (LSB) to a level 10 bits higher. In a perfect player, each step will be equal in amplitude, in both polarities, and each step will increase positively (or negatively), with no regressive or partially regressive steps in the "staircase." The steps shown in the 'scope photo of Fig. 10 come as close to that definition of perfect monotonicity as any I have ever seen.

I pretty well knew in advance what to expect from 'scope photos of a 1-kHz square-wave test signal (Fig. 11) and a unit-pulse signal (Fig. 12) reproduced from test discs. How-

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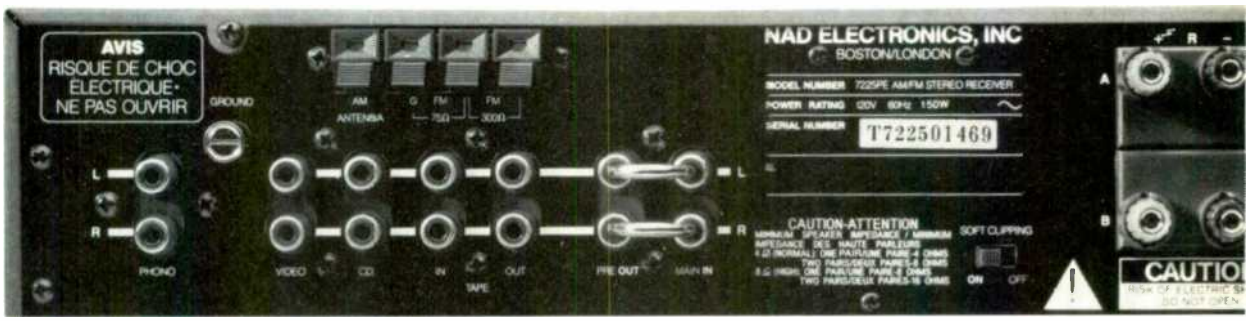

The rear panel contains additional controls and connections, including the Soft Clipping switch, speaker impedance selector, gold-plated phono-in jacks, heavy-duty binding-post speaker terminals, and preamp-out/main-in jumpers for system expansion.

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The sound quality delivered by this Sony CD player was absolutely beyond criticism, regardless of the program material I chose.

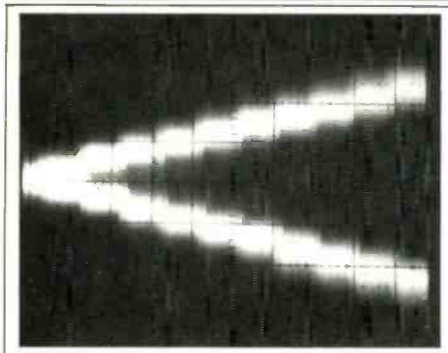

Fig. 10—Monotonicity test; see text.

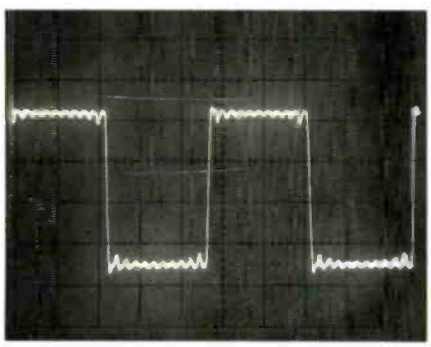

Fig. 11—Reproduction of a 1-kHz square wave.

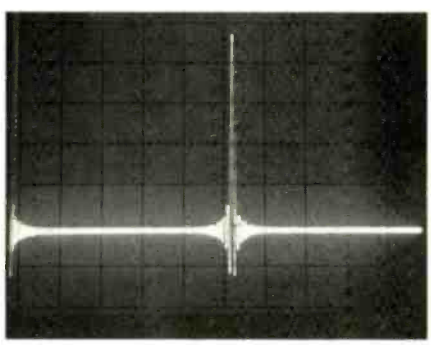

Fig. 12—Single-pulse test.

ever, just for the record, I went through these tests anyway. Both 'scope photos depict reproduction of these signals that is virtually as perfect as the CD format can deliver.

Before disconnecting the player from my lab bench, I played my newest CD "defects" disc—the one that taxes the ability of a player to track out-of-spec digital pit tracks and disc sections where missing data occur in increasing lengths. There was a time when it was rare for a CD player to handle data gaps exceeding 0.7 mm in length. This Sony player only began to mistrack—and slightly, at that—when data gaps reached 1.5 mm in length!

Use and Listening Tests

As with other Sony CD players I've tested recently, the CDP-X7ESD's access time to any track or index point is so fast it was difficult to time it accurately with a stopwatch. The sound quality this player delivers is absolutely beyond criticism, whether the program material is a solo vocalist, a jazz or chamber music ensemble, or a full symphony orchestra. For auditioning the CDP-X7ESD, I used a wide assortment of these types of program material. Among the newer Compact Discs I played were recordings of three Beethoven piano sonatas (Telarc CD-80185), jazz selections by Turk Murphy and his band (Bainbridge BCD501), and Mahler's monumental "Das Lied von der Erde" (Denon CO72592). When I listen to an important Mahler work on a CD player such as this, I can't help but think that this musical giant would have been pleased to know how magnificent his works would sound, more than half a century later, on such superb equipment. *Leonard Feldman*

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Auto search tuning

Manual up/down tuning

If any of these features compromised its sound, this is the first thing we'd remove: **YAMAHA®**

4

CLASSIC AUDIO CA260 DUAL MONO AMPLIFIER

Manufacturer's Specifications

Power Output: 50 watts continuous average per channel, both channels operating into 2, 4, or 8 ohms.

Power Bandwidth: 17 Hz to 100 kHz.

Distortion: Less than 1.0% THD at any power level to 50 watts per channel, from 20 Hz to 20 kHz, both channels operating; typically 0.1% or less, diminishing with output.

Frequency Response: 20 Hz to 20 kHz, ±0.25 dB.

S/N: 90 dB referenced to rated output; A-weighted, greater than 100 dB.

Input Impedance: 100 kilohms.

Input Sensitivity: 0.75 V.

Power Requirements: 120 V, 50/60 Hz, 4 amperes.

Power Consumption: 200 watts at zero signal output (idle); 400 watts at full rated output.

Dimensions: Front panel, 19 in. W × 7 in. H (48.3 cm × 17.8 cm); chassis, 17 in. W × 6½ in. H × 16 in. D (43.2 cm × 16.5 cm × 40.6 cm); depth, including handles, 17 9/16 in. (44.9 cm).

Weight: 56 lbs. (25.5 kg).

Price: $1,665; factory direct, $1,299.

Company Address: 238 Liberty Ave., New Rochelle, N.Y. 10805.

For literature, circle No. 93

What would you think of a tube amplifier that you could buy on approval? Classic Audio is so confident you will like their amp, they are offering it on a free 10-day home trial. If you decide you don't want the amp, you can return it. Such a deal! Classic Audio is a relatively new company run by George Kaye, the engineer who designed the products for the now-defunct New York Audio Labs.

Looking at the CA260, you find a reasonable package for two independent 50-watt tube amplifiers. Construction is of moderately heavy-gauge steel and consists of a main bottom chassis piece, a top and side cover, and a front panel. With the top and side cover screwed on, the package has good mechanical integrity and probably would be okay to rack mount.

The front panel's only control is an illuminated rocker power switch. Within the amplifier are two circuit boards and two pairs of transformers, power and output, for each channel. On the rear panel are two a.c. line fuses, a common a.c. power cord, two gold-plated RCA signal input jacks, and a four-screw terminal strip for each channel's speaker connections. Impedance taps for 2-, 4-, and 8-ohm loads are provided. There is no provision for matching a 16-ohm load in stereo operation, and this reflects current thinking among some tube amplifier designers that 16-ohm matching is not relevant or needed with today's speakers. A 16-ohm match can be accomplished in the mono mode of operation.

A handy feature of this design is that the amplifier boards are easily removable for service. This could save a lot in shipping costs, should a problem develop.

On the two p.c. boards are all the parts needed for the amplifier circuit—except, of course, the power and output transformers. The most tubelike of these parts are the tubes themselves, a dual-triode driver (12BH7 or 12AU7) and two 6550 output tubes.

The CA260 I reviewed was a "basic" unit, with two optional extras available at $100 each. The first is the inclusion of polypropylene coupling and bypass capacitors; the second option is a pair of toroidal booster transformers that, in conjunction with the existing power transformers, raise the high voltage to achieve a higher power output of some 70 watts or so.

Circuit Description

George Kaye has created an interesting hybrid here. The circuit starts out with a pair of N-channel junction FETs, connected in a common-source differential amplifier as a first stage. A third N-channel junction FET serves as a constant-current source for the input differential amp and is tied to a regulated −5 V source. A balance pot is connected between the sources of the input FETs, with its center tap going to the drain of the current-source device. Adjustment of the source resistor in this current-source circuit allows the operating point of the composite stage to be changed; this is one adjustment for distortion in the circuit. The drains of the FETs are connected to the cathodes of the driver tubes through resistors of fairly high value, on the order of 100 kilohms or more. Additionally, the FET drains are direct but cross-coupled to the driver-tube grids. From each driver-tube cathode, a parallel RC network is connected to ground. The capacitance is on the order of hundreds of microfarads, bypassed by 0.1-μF film units, and the resistance is 15 kilohms. Most of the tube plate current goes to ground through the 15-kilohm resistors. The amount of current going through the FETs is on the order of 100 μA or less. The plates of the driver stage have their load resistors fed from separate hybrid voltage regulators! (I've never seen this before.) One plate-load resistor is fixed and the other is variable, thus permitting an a.c. balance function at this point in the circuit.

The driver plates are also capacitor-coupled to the output tubes' control grids through the usual small (about 1 kilohm) grid-stopper resistors. Incidentally, the term "grid stopper" comes from the use of such resistors to stop parasitic high-frequency oscillations in output stages. This output stage is operated with fixed bias, a method whereby the output tubes' grid-leak resistors are returned to a negative supply voltage and the output tubes' cathodes are connected to ground, either directly or through small-value resistors (for measuring plate current by the voltage drop across them).

In the other common kind of output-stage biasing, called cathode or self-bias, the cathodes are returned to ground through separate resistors or share a common resistor to ground. The grid-leak resistors are also returned to ground. The nature of tubes is to be normally on, meaning that they conduct most heavily when there is no potential difference between control grid and cathode. (Junction FETs are also like this, so most tube topologies will work for junction FETs too.) If you have the control grids at ground and some appropriate resistance is placed between cathode and ground, the current flow through the cathode resistor causes a voltage drop, creating a negative grid-to-cathode voltage or a negative bias for the tube. This reduces the tube's conduction below its zero-bias value.

There is a difference between the way fixed-bias and cathode-bias output stages behave in regard to bias voltage constancy versus power output. In cathode bias, as the plate current increases from its idle value in the usual Class-AB operation, the voltage drop across the cathode resistance increases, thereby increasing the negative grid bias and tending to cut the tubes off (sliding bias, if you will). The net result is that the bias voltage for the output stage is not constant but increases for full output, and the available power is less than with fixed bias. In the CA260, each output tube grid-leak or return resistor goes to a separate bias pot,

You can feed a signal to both inputs and connect the outputs in series into one load—try *that* with most solid-state amps!

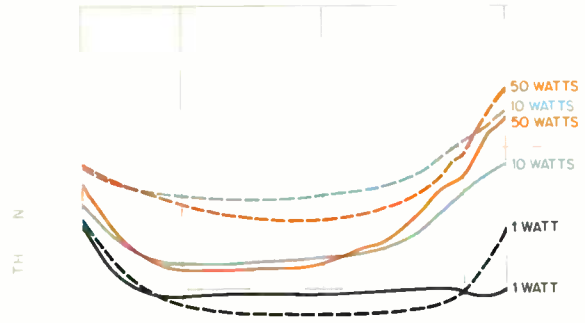

Fig. 1—THD + N vs. frequency at several power levels, for 8-ohm load on 8-ohm output taps. Solid curves are for left channel, dashed curves are for right.

thus allowing adjustment of each tube's current—a common arrangement in fixed-bias tube amps.

In his literature, George Kaye says that "the output circuit is derived from the famous McIntosh output circuit and output transformer with the tertiary feedback cathode winding." From what I can see, the output circuit and transformer of the CA260 are of a simpler type, used in some of McIntosh's integrated amplifiers. They are not as complex as the output circuit and transformer used in such McIntosh power amplifiers as the MC40 and MC275. Those McIntosh tube power amplifiers of yesteryear had output stages that operated with equal loads in their plate and cathode circuits, thereby requiring tremendous drive voltage to the output stage. This voltage was achieved by bootstrapping the plate-load resistors for the driver stage from appropriate points in the output stage. Further, the output tubes were operated as true pentodes, with a special winding to drive the screen grids in order to keep the screen-to-cathode voltage constant (a good definition of pentode operation). Since the plate, cathode, and screen circuits all had about the same amount of a.c. swing—and, consequently, the same number of turns in the output transformer—these transformers could be and were made with all these wires wound together. This gave tremendous coupling quality to the transformer, with resulting low leakage inductance and interwinding capacitance. In fact, McIntosh amps were operated virtually Class B. I remember that you could put your hands on the output tubes and not get burned. Don't try this on any other tube amp!

Anyway, on to the output circuit actually used in the CA260. The tube cathodes are tied to a grounded center-tapped winding on the output transformer. This connection provides some local output-stage feedback, said to be on the order of 10 dB. The output tubes' plates are connected to a winding which has a center tap connected to an unregulated +475 V supply. There are no screen taps on this winding; the screen grids are tied together and connected to a regulated +350 V supply.

"Aha," you say, "pentode operation of the output tubes!" Not quite. Pentode operation, by definition, requires constant screen-to-cathode voltage. In this circuit, the screen voltages don't move with respect to ground, but the cathode voltages do. In effect, the moving cathodes cause negative feedback in the control-grid circuit and the screen circuit by making the relative screen-to-cathode voltage increase or decrease in phase with the plate-to-cathode voltage. (This is what happens in normal "ultralinear" operation, where the screen grids move in phase with the plates, but by a lesser amount, and the cathodes are at ground and not moving.)

There are two more windings on the output transformer. One of these, the output to the speaker connections, is floating—i.e., not connected to ground. This would allow the user to drive both inputs of the amp in parallel and to connect the outputs in series to a single load. Try *that* with a half- or full-bridge solid-state design! The last winding on the output transformer is used for the negative feedback which encompasses the whole circuit. One end of this winding is grounded, and the other feeds a resistor that goes back to the inverting input of the input differential amp. A shunt resistor to ground at the inverting input sets the overall gain in concert with the series feedback resistor.

The CA260's power supply has some out-of-the-ordinary features right in the primary circuit of its transformer. First, the power switch works on both sides of the a.c. line. Second—and more significant—a solid-state surge limiter, in series with the primary winding, limits in-rush current at turn-on. This device's resistance is relatively high when cold and then becomes much lower, almost negligible, when warmed up—first by the draw from the tube filament and then by the plate-current draw of the amplifier. This surge limiter will undoubtedly increase the life of the CA260's power-supply components. Another solid-state device, a metal oxide varistor (MOV) placed across the primary winding, helps to limit the effect of transient line spikes entering the power supply.

The power transformer has two secondary windings, one for high voltage and the other for tube filaments. The high-voltage winding feeds a two-diode, full-wave voltage doubler terminated in two banks of photoflash capacitors connected in series. Each bank consists of four 800-μF, 330-V capacitors in parallel; the composite high-voltage filter capacitance for the two banks in series is 1,600 μF. That's a lot of energy storage in a small volume. This unregulated high voltage, +475 V, directly feeds the center tap of the output transformer. Additionally, this supply feeds a solid-state regulator that provides +350 V to the output-stage screen grids and to the inputs of two more high-voltage regulators that feed the plate resistors in the driver-tube stage.

The first regulator for the screen supply consists of two regulators in cascade or series. First, a zener-followed pre-regulator, using two Darlington-connected NPN transistors, stabilizes the d.c. voltage at something between 475 V and the final output of 350 V—I'd guess about 360 to 370 V. As

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Distortion vs. power was about the same on both the 8- and 4-ohm taps. This is not always the case with other tube amps.

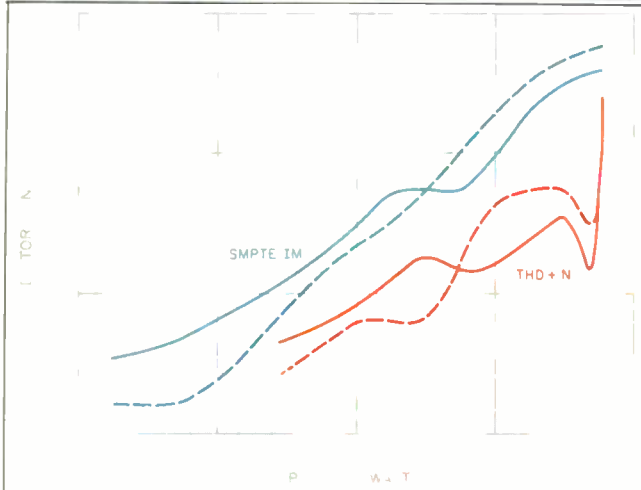

Fig. 2—SMPTE IM and THD + N vs. power output for 8-ohm loads on 8-ohm taps. THD + N is for 1-kHz test signal, with distortion products measured from 400 Hz to 80 kHz. Solid curves are for left channel, dashed curves are for right.

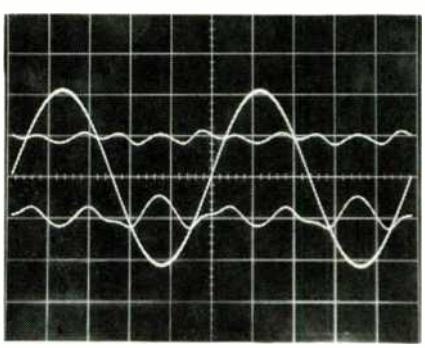

Fig. 3—Response to 10-watt, 1-kHz sine wave. Distortion products shown are for left channel (top) and right channel (bottom).

the final part of this two-stage circuit, a three-terminal regulator is floated up with a voltage divider between its output and return terminals and ground to provide the final regulated output of 350 V.

For the 335 V for the driver-tube plates, another kind of regulator circuit is used. A dual bi-FET op-amp is powered with its positive supply connected to 350 V and its negative supply connected to the bottom (ground) end of two zener diodes in series from the +350 V supply. The resistance to ground that provides the zener current is split into two separate resistors in series, to share heat dissipation. The midpoint of the upper zeners, which are probably 15-V units, is connected to the positive input of both sections of the dual op-amp and provides a reference voltage of about 335 V for the two regulators. Two N-channel junction FETs act as source followers, with their drains connected to 350 V. The output of the op-amps drives the gates. Finally, the sources are the outputs of these regulators and are also fed back to the negative inputs of the op-amps to form the negative-feedback regulating loops.

A little philosophical point here: Could the seeming advantage of using separate regulators to feed the plate resistors be a disadvantage sonically? What I mean by this is, if the regulators' "solid-state sound" signatures got into the output stage, those signatures might not be cancelled by the output circuit's push-pull action, because the signatures of two separate regulators are not identical. On the other hand, the sonic signatures of a single regulator feeding both plate-load resistors would be cancelled in the output-stage transformer.

The last little detail of the power supply concerns the tube heater supply. This is quite conventional, with about 6.3 V a.c. being applied to the tube heaters from the low voltage winding of the power transformer. One side of this winding is grounded, and a half-wave rectifier (along with a filter capacitor and a three-terminal regulator) creates the −5 V supply that is the current source for the J-FET input stage of the amp.

Measurements

The instruction manual that comes with the CA260 is pretty good and contains a rather detailed section on maintenance. To adjust the amplifier for best performance, the manual suggests adjusting the individual output-tube bias pots—along with the first-stage current-source and driver plate-load adjustment pots—for minimum distortion, using a 1-kHz test frequency. This implies that the static plate currents for each output tube may be different when such a procedure is completed. The result would be some amount of unbalanced d.c. in the primary of the output transformer. The effect of unbalanced d.c. is to push the flux in the core off center so that saturation occurs sooner in one half-cycle than in the other. This makes low-frequency distortion and SMPTE-IM distortion increase. When I received this amp for review, I connected it into my system and measured the output tubes' idling currents after a suitable warm-up time. I was surprised to find that the plate currents were quite low—around 20 tc 30 mA per tube. I also noticed that all the trim pots in the amp had their adjustments sealed, presumably at the factory. I decided to just listen and measure, with no trim pot tweaking.

In the lab, after testing the amp, the individual output-tube plate currents were measured and found to be 29.2 and 24.2 mA for the two tubes of the left channel and 22.9 and 20.9 mA for the two right-channel tubes.

Figure 1 shows THD + N as a function of frequency and

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The least expensive CD player using the same digital convertor, oversampling and filtering chips is over $4,000.

Q. What do you have to pay to get all this?

A At present, you can be saved from digital hell for $995 We are struggling to maintain the price in the future, but I cannot guarantee it

Q. Since the D2A has Theta Digital designed circuitry, IC's found only in over $4,000 CD players and it's only $995 you must have skimped on the analog portion?

A Oh ye of little faith. When it comes to Aragon quality, We don't compromise. Knowledgeable audio reviewers, from around the world, have deemed Aragon components the biggest bargain in high end audio.

Q. O.K. prove to me you didn't compromise?

A O.K. try this litany. The AC power supply is in a separate chassis to eliminate magnetic radiation and noise It mates with the main chassis via a swiss made connector with gold plated contacts Only fully rectified and filtered D.C. voltage enters the main chassis 11 separately regulated D.C. power supplies are employed, giving completely separate supplies and dual mono operation to the DAC's and the analog section The unique analog section employs no op-amp IC's It is fully discrete and class A. This analog section actually utilizes Aragon phono circuit topology The result is exceptionally musical with wide dynamic range and very low noise The sonic integrity of the analog section is then maintained by encasing the digital circuit board in a zinc chromated metal shield to prevent RFI radiation The input and output connectors are chassis mount gold plated, from Tiffany. The D2A accepts any combination of three digital bit stream sources, two coaxial inputs and one optical fiber input. In addition, it has a digital tape output and the absolute phase can be inverted from the listening position via remote switch The D2A is manufactured by a U.S medical and military contractor to one of the most stringent standards in the world We then take a component which sonically belongs in the world's finest audio systems and machine a 3/8 inch aluminum faceplate so that visually and aesthetically it also belongs in the world's finest systems.

No matter what advancements or changes occur in digital, the D2A can be easily upgraded to new technology.

The unique analog section employs no op-amp IC's. It's fully discreate and class A.

Square-wave performance was similar on all taps, which is a testament to the output transformer's coupling quality.

Table I—Hum and noise, with inputs terminated by a 1-kilohm resistance.

	Wideband	400 Hz to 20 kHz	A-Weighted	IHF S/N
Left	105 μV	46 μV	43 μV	97.5 dB
Right	158 μV	43 μV	42 μV	97.5 dB

Table II—Damping factors and output impedances. Damping factor is essentially flat from 20 Hz to 10 kHz and is slightly lower at 20 kHz.

	Output Impedance, Ohms		Damping Factor	
Tap	**Left**	**Right**	**Left**	**Right**
8 Ohms	3.4	3.8	2.4	2.1
4 Ohms	1.8	1.9	2.2	2.1
2 Ohms	0.9	1.0	2.2	2.0

Fig. 4—Frequency response at 1 watt output, for 8-ohm load on 8-ohm taps.

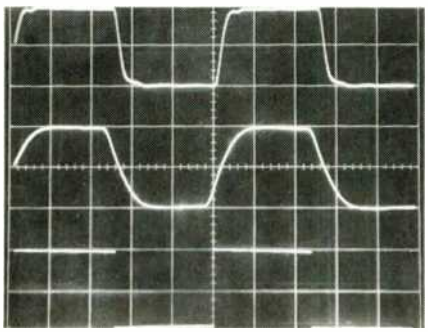

Fig. 5—Response to square wave. Top trace is 10 kHz with 8-ohm resistive load on 8-ohm taps. Middle trace is 10 kHz with 2-μF capacitance across 8-ohm load. Bottom trace is 40 Hz with 8-ohm load. Scales: Vertical, 5 V/div.; horizontal, 20 μS/div. (top and middle) and 5 mS/div. (bottom).

power output for both channels, with 8-ohm loads on the 8-ohm taps. As power levels increase, the right channel has more distortion than the left—due mostly to its lower idling current. Figure 2 shows 1-kHz THD + N, along with SMPTE-IM distortion, for 8-ohm loading on the 8-ohm taps. Studying these curves and, more informatively, looking at the harmonic and IM residues as a function of power, I concluded that the dominant nonlinearity is of the type caused by low gain at the origin, or underbiasing.

I measured distortion versus power, for 8- and 4-ohm loads, on their respective matching taps. I found the distortion to be about the same for each—not always the case in other tube power amps. Shown in Fig. 3 is the harmonic distortion residue for 10 watts output at 1 kHz for the two channels. The top distortion trace, at 0.15%, is for the left channel; the other, at 0.37%, is for the right. Neither residue waveform is very simple or low order.

To see how distortion might vary as a function of mismatching, I measured 1-kHz THD + N at 30 watts output for a 4-ohm load on the 2-, 4-, and 8-ohm taps. The results were 0.38%, 0.35%, and 0.96%, respectively, for the left channel and 0.2%, 0.55%, and 1.25% for the right. Next, I measured the maximum 1-kHz power at visual onset of clipping for the same loading conditions and found these power levels to be 40, 53, and 55 watts for each channel. With this amp, there is considerable latitude for mismatching, but best performance is likely when using the tap closest to the rated nominal impedance of your speaker.

Since the Classic Audio CA260 has such low overall feedback, its voltage gain will vary with how it is adjusted—not radically, but somewhat. I obtained readings that showed 25.8 and 25.5 dB of gain for the left and right channels, respectively. IHF sensitivities were 145 mV for the left channel and 150 mV for the right.

Next, I looked at crosstalk between channels. "What?" you ask, "How can there be crosstalk in a dual mono design?" Well, there is a tiny bit at high frequencies. With 8-ohm loading on the 8-ohm taps, the undriven input terminated in 1 kilohm, and a reference drive level of 10 V rms, crosstalk in the right-to-left direction was essentially down in the noise. In the left-to-right direction, however, crosstalk rose above the noise by about 3 dB at 5 kHz, increasing to 10 dB above the noise at 20 kHz.

Hum and noise measurements appear in Table I for various bandwidths and for the left and right channels. Inputs were terminated in 1 kilohm.

Since the CA260's output impedance was initially found to be rather high, I decided to measure it by comparing open-circuit to loaded-output voltages and then computing the output impedance from this information. For once, even though the output impedance is high, it is essentially constant over the whole audio frequency range. Output impedance is roughly half the tap impedance, thereby resulting in a damping factor of about 2. Output impedances and damping factors are shown in Table II for the 2-, 4-, and 8-ohm taps.

Frequency response, measured with 8-ohm loading on the 8-ohm taps, is plotted in Fig. 4 for both channels. Figure 5 shows square-wave performance of the CA260 at its 8-ohm taps. Results were similar on the other taps with

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I could nit-pick the CA260's sonics as being a bit on the bright side, but this amp really sounds pretty good, particularly at its price.

equivalent loading; this is a testament to the quality of the coupling between the secondary windings and the other windings in the output transformer. The top trace of Fig. 5 is for a 10-kHz square wave at 10-V peak-to-peak amplitude loaded by 8 ohms. Rise- and fall-times, with 8-ohm loading, were about 4 μS and pretty constant right up into clipping. In the middle trace, the effect of paralleling 2 μF across the 8-ohm resistor is seen. Increasing the capacitance merely rolls off the response more; there is no ringing, just increasing rise- and fall-times. This behavior is different from that of most amplifiers, whose square-wave performance usually looks textbook-perfect with resistive loading but shows ringing with capacitive loading. The CA260's nice performance with capacitive loading suggests that it would be great for driving electrostatic speakers. The bottom trace of Fig. 5 is for a 40-Hz frequency. Evident here is a good, extended low-frequency response.

Output power levels for dynamic and clipping headroom were found to be 64 and 56 watts, respectively, yielding a dynamic headroom figure of 1.07 dB and a clipping headroom of 0.5 dB.

Use and Listening Tests

Equipment used to evaluate the CA260 power amp included an Oracle turntable fitted with a Well Tempered Arm and Koetsu Black Goldline pickup, a California Audio Labs Tempest CD player, a Nakamichi 250 cassette deck, a Technics 1500 reel-to-reel recorder, a Cook-King reference tube preamp, a Sumo Athena preamp, a Goldmund Mimesis 7 preamp, a Dyna PAS-2 preamp, and YBA_3, Goldmund Mimesis 6, and Motif MS100 power amplifiers used to drive Siefert Research Magnum III speakers and Stax Sigma headphones.

Operationally, the CA260 worked flawlessly; there were no glitches or surprises.

To me, the CA260 doesn't sound like the usual older tube amp, in the sense of being mellow and nicely musical on most program material. Tonally, the sound is a bit on the bright side. Definition and detail seem quite good, although I get the feeling that this comes at the expense of some edginess and irritation. The sense of air around instruments is good but not excellent. Depth delineation is not as good as on other amplifiers I have on hand, and I get a distinct sense that room or hall reverberation dies out too quickly. Bass punch and impact are very good for an amp rated at 50 watts per channel.

Nit-picking aside, this amp really sounds pretty good and, considering the price, it probably is well worth looking into. As Classic Audio says in a brochure included with the amp, "It's got more watts, more iron, and bigger tubes than the competition." So y'all c'mon down and give it a try, ya hear?

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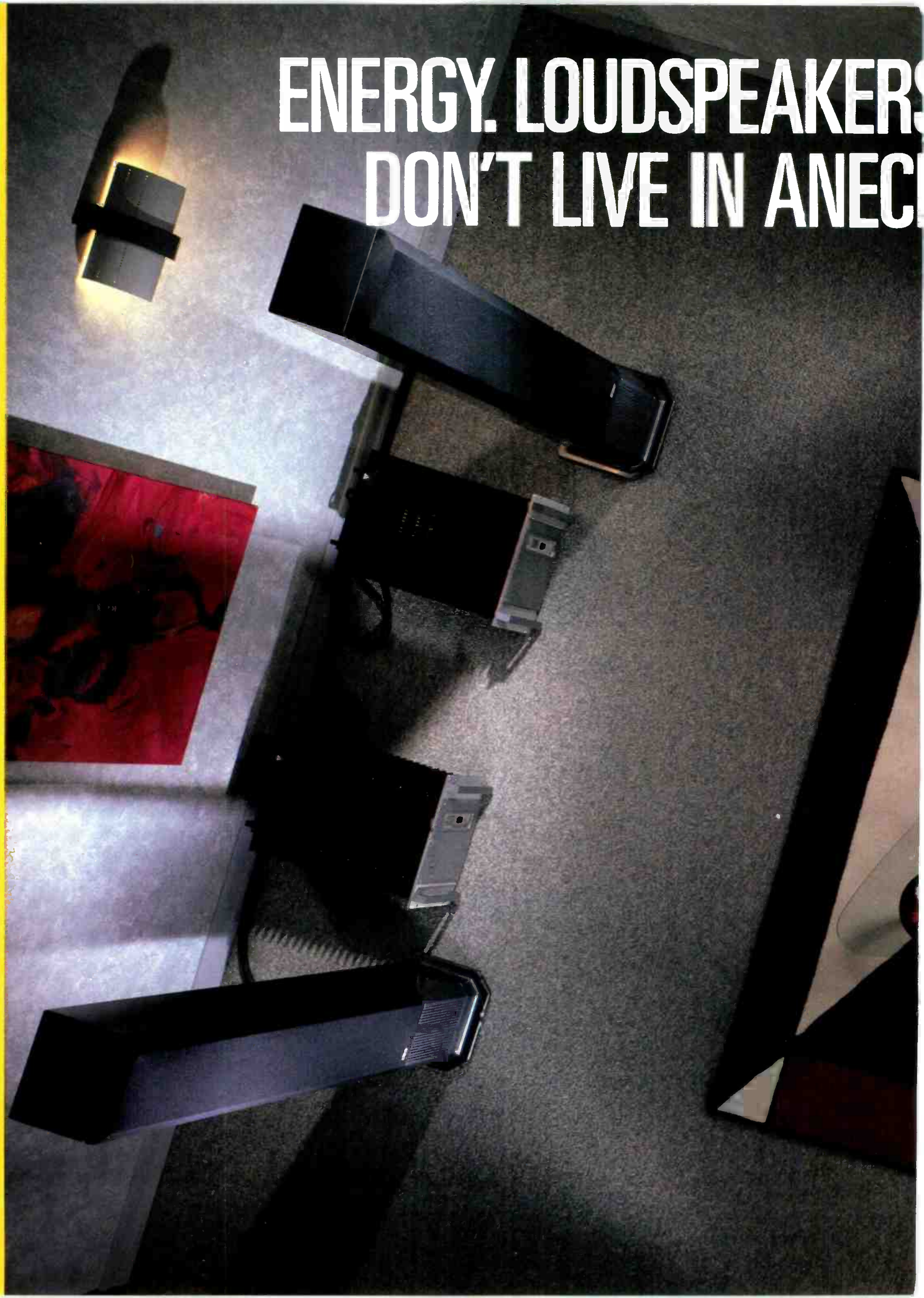
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FIFTYSOMETHING

Photograph: Dimo Safari; inset, Frank Driggs Collection

Steel Wheels: The Rolling Stones
Rolling Stones Records CK-45333, CD; DDD; 53:03.

Sound: A Performance: A

The Rolling Stones Singles Collection—The London Years
Abkco, three CDs; AAD; 66:57, 68:35, 49:45.

Sound: A Performance: A

Sputtering with macho aggression, stray egos locked in that rough but so polished groove: It only takes the first slashing chord on *Steel Wheels* to know the bad boys are back in top form.

The time off must have been good for them because this record is almost a distillation of what they've done best for a quarter-century now. That is, play a brand of basic rock which nods slightly to contemporary tastes without ever straying far from its blues/R&B roots. The dozen tunes (no bonus CD cuts) range from vintage Stones ("Sad, Sad, Sad") to more recent, glossier styles (the *Undercover*-ish "Mixed Emotions"), plus stylistic blasts from the past like "Blinded by Love," whose psychedelicized acoustic folkiness evokes Brian Jones. The Stones try their hand at heavy metal on "Hold On to Your Hat," though Keith Richards' leads feel closer to The Yardbirds than to Joe Satriani. Most curious departure: The obligatory-for-aging-rock-stars worldbeat number, "Continental Drift," which takes its inspiration from Moroccan and North African music. Though featuring a number of African musicians, it is still stamped with The Stones' personality.

Richards takes over vocals on two songs, "Slipping Away" and "Can't Be Seen," which could easily be outtakes from his solo album, *Talk Is Cheap*. They're also the only two songs on the record whose lyrics show linear thinking—i.e., they're about a discernible topic (missing your baby and dating a married woman, respectively). The others feature those classic painted-black Jagger lyrics whose ironic images convey lots of feeling but little apparent meaning, touching your emotions without really saying anything. In "Rock and a Hard Place," for instance, the aura of political relevance ("And the city gets bigger as the country comes begging to town") becomes totally obscure when you read the lyrics.

Jagger's singing, unlike some of his recent solo work, is energetic and expressive, notably on the exquisite, jazz-tinged groove of "Terrifying." Richards' guitar gets more prominence here too, and you can hear just where his reputation as a rhythm player comes from.

Sonically, the digitally recorded album sparkles. It's curious to note how The Stones have gone from the primitive musical technology and recording techniques of the early '60s to preserving their trademark grunge with digital effects that let both the distortion and the tinkly acoustic guitars come through, paradoxically, crystal clear. You'll enjoy the presence and the mix, mostly due to the co-producing work of Chris Kimsey.

What we've got here is a fine record, sure to please old fans and win over a bunch of new, younger ones to a sound that is, if not absolutely timeless, certainly a major part of the soundtrack of the 20th century.

Which brings me to topic number two—the forging of that sound. Capitalizing on the "Steel Wheels" tour, *The Rolling Stones Singles Collection—The London Years* repackages every Stones U.S. and U.K. single from 1963 to 1971, A and B sides, in a three-CD boxed set.

Talk about memory lane! Included are 58 songs and a 72-page book with lyrics, sleeve repros, notes, and photos. All the hits, plus some obscure material: The 1963 cover of Lennon/McCartney's "I Wanna Be Your Man"; the first Stones composition released as an A side ("Tell Me"), and Brian Jones playing slide guitar on "Little Red Rooster." Rarer still are three tunes never officially released in the U.S., though available on imports: "Come On" (their first single, by Chuck Berry), "I Want To Be Loved," and the quasi-instrumental "Stoned." Long-out-of-print tracks include "Jiving Sister Fanny," "Try a Little Harder," "Out of Time," "I Don't Know Why," and "Memo from Turner" (featuring Ry Cooder on slide guitar, from the film *Performance*).

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While continuing to exhibit his way around a melody, Paul McCartney offers some mature sentiments and reasonably tough tunes.

All cuts have been digitally remastered; clean and equalized, they sound as if they were meant to be heard together as an album. All original mono recordings are presented in mono. As on other collections of early material (e.g., The Beatles), there's a startling presence and clarity on many of the songs, although generally speaking, The Stones never pursued state-of-the-art recording values.

So is this set for you? It does bring together some great music, and there are a few gems, but most of these cuts are available on individual albums. The booklet has good information but also leaves out some discographical information (e.g., record numbers) and is only printed in one color (black, on multi-colored paper). And who *reads* Stones lyrics, anyway? A package of obscuranta and rarities might have been just as interesting. Still, this collection does document the definitive canon of what most people remember as The World's Greatest Rock 'n' Roll Band, so I guess it depends on how flush you're feeling. *Michael Wright*

Flowers in the Dirt: Paul McCartney
Capitol C1-91653, LP.

Sound: A– Performance: A

Hearing a new Paul McCartney record is like catching a whiff of onions frying in the pan. The fragrance is familiar, pungent, and sweet, with the promise of delicious things to come. The familiarity comes from all of those riffs and melody snatches that still bear the tang of The Beatles. The rest comes from McCartney's way with a

song—his obvious ease in the studio and mastery of several instruments and their delicate balances.

Despite more than two decades of an active career, which has included major successes with his band Wings and a solo stretch of some note, McCartney will always live with the Great Expectations thrust upon an ex-Beatle. He was the group's tunesmith, the melody maker, the Beatle who experimented with instrumentation, adding the odd wooden flute here, the unusual effect there. Without the bitter balance of John Lennon, McCartney reveals his penchant for pretty, simple tunes, and his lyrics frequently lack a sufficiently hard edge.

Still, *Flowers in the Dirt* is an album of reasonably tough tunes, with some satisfyingly mature sentiments. "My Brave Face" shows off McCartney's quest for innovation with its off-the-beaten-track chanted introduction. He continues to exhibit his way with a melody on "Motor of Love," "This One," and "Put It There," and presents a tasty variety of flavors throughout, from the bluesy "You Want Her Too" to the lugubrious, hymn-like "That Day Is Done."

If you can excise memories of the glory days of The Beatles and just sample *Flowers in the Dirt* in the present, you'll find that Paul McCartney can still cook with the best of 'em. *Paulette Weiss*

Indigo Girls
Epic EK-45044, CD; DAD; 43:53.

Sound: B+ Performance: B–

Elliptical lyrics, off-kilter harmonies, and more haunting regret than a Flannery O'Connor story: You can take all that two ways on this major-label, self-titled debut by the folkish duo of Amy Ray and Emily Saliers. After several listens, I'm still undecided as to whether these ingredients mean *Indigo Girls* is obtuse or abstruse.

I'm assuming the latter, since Ray and Saliers sing, talk, ache, and rage their lyrics so proudly and passionately that the meanings must be clear to them—if to no one else. (This from a T. S. Eliot buff who's managed to decipher as much of "The Waste Land" as the next guy.) Lines like "Feeding the cancer of my intellect the blood of love soon neglected" would be at home, I think, in any college coffeehouse.

Not to say the subject matter isn't depressingly grown-up. The raucous, rocking "Closer to Fine" is about the path to self-discovery—through gurus, aimless wanderings, analysts, and other touchstones. "Love's Recovery" is an elegy to friends lost as we grow older and apart. "Kid Fears" is an adult's wistful lament for the days of simpler, more innocent monsters. The songs are all so heartfelt I could puke.

Actually, no. I like heartfelt. I think it's because Indigo Girls are so humorless and pained. Every other song has a preoccupation with spilt blood. Aside from the previously mentioned excerpt (from "Love's Recovery"), the lyric protagonist says her "blood is running dry" ("Land of Canaan"), her heart has "bled upon my sleeve" ("Prince of Darkness"), and "in the ink of an eye" (whatever that is), she "saw you bleed" ("Secure Yourself"). Why doesn't it surprise me to find a song titled "Blood and Fire"?

This thematic sameness is partially redeemed by Ray and Saliers' often beautiful delivery of their hard-edged, unusual voices and by songwriting high-dives that don't give a damn about AM radio. Once they get past

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Maria McKee wails. There's raw passion in her voice, plus a naturalness that can be awfully appealing.

this whiny, bloody stage, Indigo Girls should have a lot to say. With any luck, they'll learn from the album's interminable closer, "History of Us," and not keep going on with their point after they've made it over and over and over and ov. . . . *Frank Lovece*

Maria McKee
Geffen 24229-2, CD; AAD; 45:06.

Sound: B Performance: B+

The big difference between Maria McKee's work on this, her solo debut, and the two albums she cut as lead singer/chief songwriter for Lone Justice is focus. The result is her best recorded work to date.

Maria *wails*. She sings as if hellhounds were on her heels and her very life depended on her vocals. There is a raw passion in her voice and a "real person" naturalness that is awfully appealing.

Producer Mitchell Froom, one of the busiest guys in the industry these days, has assembled some stellar players for Maria. Guitarists include Lone Justice alumnus Shane Fontayne, Marc Ribot from Tom Waits' band, and Richard Thompson. Bassists Tony Levin and Jerry Scheff and drummers Jim Keltner and Jerry Marotta make up some mighty rhythm sections. The occasional fiddle, recorder, or krummhorn provide welcome textural variations.

Maria goes totally solo at the piano for the one cover of the set, Richard Thompson's bleak "Has He Got a Friend for Me?" It is a scary, intense performance. This is not to detract from the excellent work she does on the fine batch of songs she has written. They are terrific songs and are rendered beautifully.

Maria McKee is an album that I care more about as her songs and singing get more familiar. Each time through, I find myself drawn to different songs, and I've found that to be a sure sign of a top-shelf album.

Incidentally, one selection, the sassy "Drinkin' in My Sunday Dress," is a bonus cut that does not appear on LP or cassette. *Michael Tearson*

Tin Machine
EMI CDP-91990-2, CD; 56:50.

Sound: B Performance: C–

Tin Machine is a band that includes David Bowie as singer and chief songwriter, Reeves Gabrels as lead guitarist, and veteran rockers Hunt and Tony Sales (Soupy's kids) as rhythm section. By the band's own dictum, this is to be taken as a band album, not a Bowie album. They declare themselves a true collective.

Tin Machine is a harsh, bruising album of as paranoid and dour a batch of songs as Bowie has ever written. The one cover included is a punching go at John Lennon's most bitter song, "Working Class Hero." The core theme of the album is the ongoing uglification and brutalization of the society we've built: Heroes are whores who will betray you. Love is no better. Hope is delusion. Yes, Tin Machine plays grim, frenzied music for an even grimmer world and uses language that is as hard as it needs to be.

Gabrels, the instrumental star here, runs apocalyptically amok on his leads while the Sales boys drive the rhythm home for Bowie's declamatory singing, his most direct and least mannered in years. The sound is in-your-face, no-stops rock, with no tenderness and little grace—qualities that don't mean much anyway in the world these songs are about. So, it fits.

This is not an album I expect to return to very often in the way I keep coming back to *Scary Monsters* or *The Man Who Sold the World*. The wit which was the hallmark of those albums is not much of a factor on this humorless new one, and its post-punk harshness leaves little room for enjoyment. In the end, *Tin Machine* is as much fun as an exercise bike.

Michael Tearson

Anderson, Bruford, Wakeman, Howe
Arista ARCD85-90126, CD; AAD; 59:25.

Sound: A Performance: A

By any other name, Yes can be called Anderson, Bruford, Wakeman, Howe, which highlights a strange situation. On one hand, Yes is still making records under the established name—even though musical similarities to the original band are tenuous and only bassist Chris Squire remains. On the other hand, we now have the rest of the original members recording as Anderson, Bruford, Wakeman, Howe, and sounding like classic Yes. Curiouser and curiouser.

Despite the naming confusion, all the elements that made up the old Yes are still here, musically speaking. Or-

chestral progressive-rock instrumentals unfold with tightly balanced interplay between Rick Wakeman's multi-keyboard cathedral washes and percussive piano and Steve Howe's impeccable, soaring electric and finger-style acoustic guitars. Songs are arranged in mini-suites ("Quartet" and

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Love and Rockets

"Order of the Universe") interspersed with singles material ("The Big Dream"). Literate vocal songs—with trademark metaphysical lyrics—feature Jon Anderson's distinctively raw piping (time shows a bit on the edges of a few phrases) and Bill Bruford's thunderous double drumming. Even the artwork is by Roger Dean. Ex-King Crimson bassist/Chapman Stick ace Tony Levin fills in the bottom end. The only musical departure from the classic sound is the contemporary Afro/Caribbean-inspired "Teakbois," which integrates easily into ABWH artiness.

As you might expect, the production is state-of-the-art ear candy—everything from sophisticated electronic effects to doubling and ping-ponging voices. The assembly of this music reflects high art. Production is by Anderson and Chris Kimsey; mixing is by Steve Thompson and Michael Barbiero. Plan to listen under optimal conditions, without disturbances.

Anderson, Bruford, Wakeman, Howe. The name has changed, but you still say "Yes" to the music.

Michael Wright

Dancing with the Lion: Andreas Vollenweider
Columbia CK-45154, CD; AAD; 39:15.

Sound: A Performance: B

It's been three years since Andreas Vollenweider's Grammy Award-winning album *Down to the Moon. Dancing with the Lion* deviates little from the concepts he refined on that recording and its predecessor, *White Winds.* Like his previous records, this CD is centered around Vollenweider's electro-acoustic harp. The ostinato rhythms and simple, lyrical melodies he plucks out are the basis of all his music—extended, elaborated, and sometimes overblown by his ensemble and an orchestra of guest musicians.

The most compelling aspect is the rich, world-music textures of Vollenweider's arrangements. His polyrhythms chirp and rustle in a jungle of woven percussion, laced by bird-like whispers and calls that come from bamboo flutes, Turkish saz, and synthesized/sampled wind instruments. Vollenweider liberally borrows from all cultures without directly referencing any, creating a lush and almost surreal environment of sound.

Much of the credit should go to producer/engineer Eric Merz. He brings this mix of over 38 instrumentalists and vocalists together in a spatial field full of depth and movement, with each detail clearly etched but adding greater textural depth to Vollenweider's compositions.

Despite the presence of so many musicians, including guests stars Mark O'Connor, David Lindley, Badal Roy, Patti Austin, and Janne Schaffer, *Dancing with the Lion* shows no new directions for Vollenweider. All the tricks are there: The dynamic crescendos, spacey interludes, corny sound effects, and loony celestial women's choirs. But despite the often cloying sweetness of his music, Vollenweider's folk-like lyricism, reinforced by his environmental arrangements, still carries you through his optimistic, exuberant music.

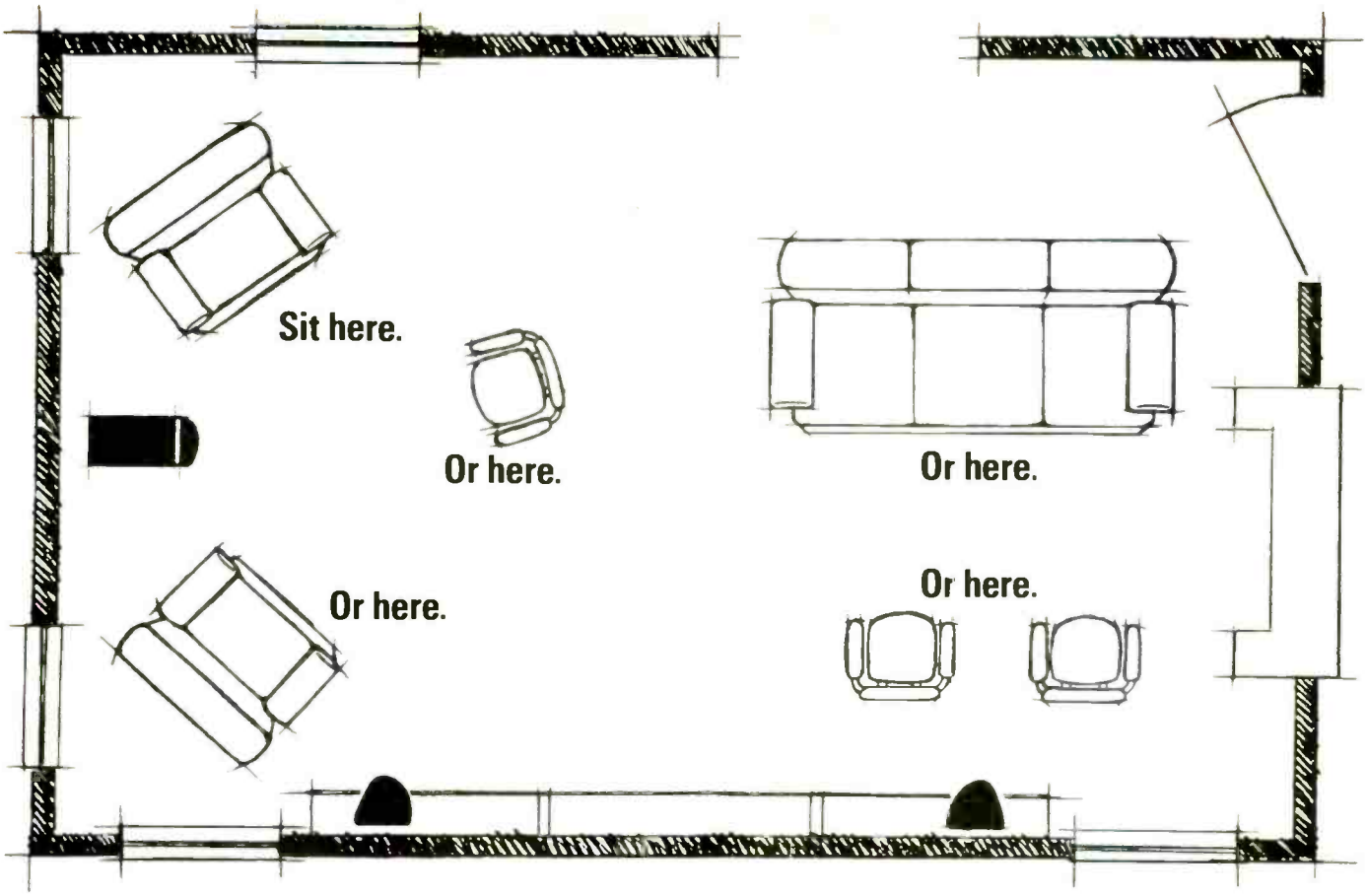
John Diliberto

Love and Rockets
RCA 9715-2-R, CD; AAD; 41:53.

Sound: B Performance: B–

From Bauhaus (the band from which this group evolved) to your house comes Love and Rockets. With this, their self-titled fourth album, the group takes on an almost architectural style—simple structural lines (a trio with vocals, guitar, bass, and drums) and a machine-age sensibility (e.g., the industrial percussion on "No Big Deal") that is actually a more experimental posture than their three previous recordings. Take, for example, "The Purest Blue," which mixes the faintest organ-like guitar way back, while minimalist lyrics and percussion punctuate the near silence. Or "****(Jungle Law)," with its bathtub sound and bleeped-out words. Elsewhere, the sounds of distorted, psychedelic guitars bounce spacily from channel to channel and build crescendos of feedback. If you're interested in music that will stretch your thinking *and* your ears, check out *Love and Rockets.*

Michael Wright



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BOWLED OVER BEETHOVEN

Illustration: Rick Tulka

Beethoven: Piano Trio in D Major ("Ghost"), Opus 70, No. 1; Piano Trio in E Flat, Opus 70, No. 2. The Castle Trio (Lambert Orkis, fortepiano; Marilyn McDonald, violin; Kenneth Slowik, violoncello).
Smithsonian Collection of Recordings ND-036, CD; DDD; 59:16.

These two trios, the first popularly known as the "Ghost," are standard fare for chamber music and have been ever since 1808. At least for a century, they have been played on what pass, today, for "modern" instruments, and this sound, like that of most other Beethoven, is that which is familiar and taken entirely for granted by most musicians and audiences.

The enterprising Smithsonian—which has the august Library of Congress next door all beat and far behind—gives us here a fascinating "new" sound. The piano dates from Beethoven's later years and is contemporary with one of the same make produced for Beethoven himself—that instrument had four strings per note, in an attempt to make up for the composer's deafness. A Graf, from Vienna, where Beethoven lived and worked. As restored here, this one is a splendid, strong instrument, clearly able to "take" the unprecedented force of Beethoven's big middle-period works (even if strings might break and sometimes did). But does it sound like a Steinway? A Bösendorfer? Far from it—the thing is startlingly unlike those suave and monochrome later instruments. With this piano, a violin and cello, both much older, also play.

These are the unrevised versions, as all the Stradivarius instruments and such originally sounded. This is a Guarneri, no less, which is a big name. It has the now-familiar, typical, earlier violin sound, thin and wiry, a silvery effect, almost wistful at times, never loud or guttural, as the rebuilt violins.

What we hear, then, is very much the sound that those in Beethoven's day heard, and is it potent! One of the astonishing things that recording can do, you understand, is to re-create the loudness and nearness of such instruments that was taken for granted then, long before our enormous concert halls. In recorded form, thus, the music can be as "big" as it ought to be and was, which is wholly impossible in a modern concert hall, unless with electronic amplification. (Even then, it doesn't work for most close-up music.)

The familiar sound of the harpsichord, for instance, is virtually inaudible in Carnegie Hall. And in most smaller halls (today's size), it is wispy and faint, a travesty of the strong harpsichord sound we know.

In this splendid Beethoven, the piano is far and away the leader. It thunders, roars, bangs, speaks in muffled tones or whispers, then glitters like a very loud xylophone—a range of sonority and volume you can scarcely believe. The player is the same Lambert Orkis who manned the huge 10-foot Chickering of 1865 in another Smithsonian recording recently reviewed here. He is fantastic! In the flesh, a mild-looking man with a simple grin (and no long hair); on the keyboard, he is a genial maniac, right from the very opening blast of the "Ghost," which will knock you out of your seat if you are unprepared. Wow! What Beethoven. Throughout, it is the piano we hear—the two strings, violin and violoncello, add only a modest, if definite, surround and exchange of ideas.

Is this an artifact of the recording? Is it, rather, in the performance itself? Or is it Beethoven? I have faith in the recorded sound. The string players, on the unreconstructed type of instrument, are unobtrusive—as I am sure they were in the live sound. The writing, moreover, definitely subordinates them, in the written notes. Beethoven, remember, was a big pianist and solo performer before deafness stopped him. So our Mr. Orkis is a Beethoven-the-pianist re-creation, and a decidedly splendid one.

If you want to hear what "period instruments," along with recording, can do for the loudest and most strenuous early Romantic music, here's the chance. It's an epoch-making Beethoven recording, far more powerful in sonic impact than any "modern" performance, whoever the artists.

Edward Tatnall Canby

Beethoven: The Complete Quartets, Vols. 1 & 2. The Orford String Quartet (Andrew Dawes and Kenneth Perkins, violin; Terence Helmer, viola; Denis Brott, cello.)
Delos D/CD-3031 and D/CD-3032, two CDs; DDD; 71:10 and 62:36.

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ing, with minimal interference from extraneous pleasures such as banging drums and clashing cymbals or, if you wish, clashing tone colors. This does not recommend the string quartet to most owners of high-end equipment.

But they are wrong. Music speaks in its own way, and by no means entirely in highs, lows, and transients. The more basic problem for us has always been the way the music is *played* and the way it is *recorded*. Try this series, and you'll understand what I mean. It's a model for good listening.

The earliest quartet recordings inherited a 19th-century musical attitude that made things tough for audio engineers and for listeners. I can trace three phases from then to now. The very first recordings are dim in the memory and strangely styled—some acoustical attempts and a few early electrics; the Léner Quartet was one. Thin, distant in sound, the music played in a curious style (Beethoven's own? who knows?), full of odd slides and wavers yet truly reflecting the playing of the early years of the century, when this was the norm. Doubly difficult on the old "phonograph"; even more difficult for us today. Then came the "Grand Period" of the recorded quartet, out of a new, tough breed of players who took the 19th-century reverence for the quartet literally and did their best to make it sound symphonic in scope. There were many, but only one matters—the Budapest. Great playing. Harsh, strident playing, forcing the instruments beyond their very nature. It was hard to record and tough on the ears as well. The mikes did not like those heavy string swipes, nor the frequent out-of-tune eloquence that was a part of the tremendous power of the Budapest. Distortion in the loud passages merely made things worse—yet we listened, fascinated! This was super-Beethoven, especially the formerly "unintelligible" late quartets, at last brought in hand and as big as life.

Then, postwar, came a typical change: Quartet playing went in the other direction, into a no-nonsense, tough, polished professionalism, like a faceless corporation. Strong, yes, but as impersonal as a subway station. It was here that I dropped out of quartet listening. I didn't enjoy the corporate approach, hi-fi or no.

And now, what a change! We are back to Romanticism, to emotional playing, delicacy, gentleness, all sorts of things that were taboo in the terrible '50s and '60s. Often wrong-mindedly. Some neo-Romantics merely drool, in all the wrong places. Inevitable. But some hit it right, a whole new way of playing old music for current-day effectiveness. And for recording, too.

The Orford String Quartet is all that is best: Gentle, but strong where strength is needed and always very much aware of the musical shape and sense. Their phrasing and shaping of the lines are impeccable, and best of all, *they play in tune*, rigorously, even in the most stridently demanding chords. I blessed them as I listened.

This group, too, reflects a whole new attitude toward early Beethoven, which used to be considered as merely 18th-century leftover frilliness. The Opus 18 quartets here are a revelation for me, after those earlier stylings. They are *Beethoven*, for real. It has to be right. As for the late-late quartets, they lack the incredible force of the Budapest-type playing, but only because they are played as quartets, not as would-be towering symphonies. As for distortion, the string quartet bugbear in the past—if it's there, it's your system.

Edward Tatnall Canby

Tchaikovsky: "Manfred" Symphony. Concertgebouw Orchestra, Riccardo Chailly.
London 421441-2-LH, CD; DDD.

Of the thousands of classical CDs that have been issued, comparatively few are so outstanding in terms of musical performance and sonic verisimilitude that they have achieved the status of a landmark recording. Without question, this new recording of Tchaikovsky's "Manfred" Symphony, with Riccardo Chailly conducting the Concertgebouw Orchestra, deserves this kind of recognition.

Most people are familiar with Tchaikovsky's six symphonies, but the infrequently performed "Manfred" Symphony remains relatively obscure. More is the pity, for despite its brooding overtones, the work is extremely exciting and dynamic, with much colorful orchestration and Tchaikovsky's unique melodic effusions.

I made the first stereo recording of "Manfred" with Sir Eugene Goosens and the London Symphony Orchestra, using three-channel 35-mm magnetic film—state of the art, in those days. The recording was widely praised for its fine sound, but I'll be the first to admit that, good as it was, it was merely a faint harbinger of the awesome sonic grandeur here.

Engineer John Dunkerley, who has given us all those splendid recordings of the Montreal Symphony Orchestra made in the flattering acoustics of St. Eustache Church, also engineered this "Manfred" Symphony. I think it is safe to say that, in this recording, Dunkerley has captured the essence of what a great orchestra sounds like in a large, acoustically superior hall. The soundstage is huge, with layered front-to-back depth. The Concertgebouw is arrayed in just the right position to provide stunning detail.

Every orchestral element is fully resolved with a most natural perspective. High strings are sweet and smooth; contrabassi thrum with resonant authority; woodwinds float magically in the soundstage, and the bass drum has massive impact. Throughout the work are flamboyant fanfares for trumpets, trombones, and French horns, and their fortissimo projection is simply enormous.

Fortunately, it appears that the Concertgebouw Orchestra and their new conductor, Riccardo Chailly, are enjoying a happy marriage. Chailly's performance is fully up to the magnificent sound. It is a broad, expansive reading—very expressive, with a strong emphasis on dynamics. The playing he elicits from his musicians is as splendid for its precision as it is for its tonal beauty.

Be warned that if you set the volume controls on your audio system so that the pianissimo passages are just barely audible, you had better have a lot of power handling to accommodate the other end of the dynamic scale!

Bert Whyte

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This is too much Corelli for one sitting, but it is so beautifully recorded that it warrants listening, bit by bit.

Corelli: The 12 Trio Sonatas of Opus 3 (1689). The Smithsonian Chamber Players.
Smithsonian Collection of Recordings ND-035, CD; 74:51.

Here is another of the splendid Smithsonian re-creations on period instruments, beautifully recorded for CD and beautifully, impeccably played. This one is not for continuous listening, unless you want a mere background—look at the length! And the works are all, relatively speaking, of a similarity, so that the mind is soon overstuffed. Corelli himself couldn't take *all* of these at one sitting. So play them in segments, using the excellent and quick indexing provided.

Corelli, we realize ever more clearly, was the Italian founder of the baroque music that is so popular today—on through J. S. Bach, Telemann, Vivaldi, and so on. These works were published when Bach was four years old. They serve as a bridge, along with the larger Corelli Concerti Grossi and such, between the earlier, pristine baroque of Schütz and then Purcell and the familiar type noted above. On modern instruments, with a bit of extra orchestral heft added (as is still the usual), Corelli just sounds like solid baroque—a bit bouncy and variable, the movements fairly short, but otherwise entirely in a familiar and nonexotic harmonic idiom. He invented it.

Curiously, as played on the original types of instrument in this recording, Corelli suddenly sounds much "earlier." This is purely because of the very different tonal effects in these "authentic" (within rather loose bounds) playings. The violins are of the old configuration, silvery, metallic, sweet; the continuo on the organ sounds breathy, as it should, and the cello is like the violins, though not as noticeably, since its tones are lower in pitch. But the most unusual sound here is the theorbo, an "arch" lute (like an archbishop), a big instrument that plucks on a great many strings and plays wide-spaced chords with bass.

Two of the players here are the same two who play Beethoven Trios on another CD along with Lambert Orkis, the fantastic pianist. He's not present here—there was no piano in Corelli's day—but the violin family was just entering its great age, to shape music right up to the present.

Edward Tatnall Canby

Weill: "Threepenny Opera Suite"; Varèse: "Octandre"; Bowles: "Music for a Farce"; Martinů: "La Revue de Cuisine." Chicago Pro Musica.
Reference Recordings RR-29, CD; DDD; 55:08.

This is a welcome addition to the small, worthwhile number of Chicago Pro Musica recordings. Many will first be attracted to it, and ultimately buy it, for the Weill *Kleine Dreigroschenmu-*

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Although the Weill suite will attract most listeners, three other composers offer their gems, all soul children from the 1920s.

sik, and not without good reason, but there are three other composers on this release, and three further gems.

The works are soul children of the 1920s. Not our Roaring Twenties, the time of Duesenbergs, coded-knock speak-easies, and wondering if income tax would live up to its promise to stay around. "Threepenny" (1928), "Octandre" (1923), and "Kuchyňská Revue" (1927) are from Berlin, New York via Paris, and Prague. Paul Bowles' "Music for a Farce" (1938) is American but very much the product of the composer's expatriate wanderings during the two interbellum decades. There were dark and ominous currents afoot when these expanded chamber pieces were assembled into suites: Anti-semitism, fascism, life after the '29 crash, the final rout of the 19th-century idiom in music and its replacement by something more cutting.

The Chicago Pro Musica, an ensemble of Chicago Symphony soloists, has often tackled early 20th-century works for virtuoso chamber forces. They've had the good taste to do so in front of the fine microphones of Keith Johnson, in the Medinah Temple auditorium of their city. The sound is open, big, unencumbered. Hearing what these guys (and one gal) do cleanly and with such impact, one wonders why some of the much larger companies simply fail to aim for this sort of audio. Yes, it's fairly costly to do initially, but the results are so eminently listenable and such a marvelous setting for the music. There's not a hint of studio dryness, nor is there the sense of any control over the balance other than the performers' own.

The little Martinů "Kitchen Revue" is humorous, as are Paul Bowles' eight untitled numbers (each 0:48 to 2:30 long), and they rattle along in a way that draws heavily on both early jazz and, to my ear, pre-Great War Stravinsky. The textures are unambiguously clear and non-symphonic. The sweet and sentimental elements always end up getting sandwiched between lemon-tart sections with biting sarcasm. Most enjoyable stuff! "Octandre" was a milestone at the time of its writing and still commands respect, especially as played here.

The eight movements of the Weill suite may never have been played so smoothly and tunefully, and therein lies my one regret about the album. Do you know the recording of the same suite (coupled with Milhaud's "Création du Monde," 1923) by Arthur Weisberg's Contemporary Chamber Ensemble, admirably taped by Marc Aubort for a 1973 Nonesuch LP? It has more bite, more bounce, and a rollicking pungence that the Chicago Pro Musica just misses. But this Reference Recordings performance is still too good to miss, as these folks *do* have their own very personal view of this music and the other delightful works.

Christopher Greenleaf

—**Lecnard 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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KILLING HIMSELF SOFTLY

Photograph: Frank Driggs Collection

The Complete Pacific Jazz Live Recordings of the Chet Baker Quartet with Russ Freeman
Mosaic MR4-113, four LPs; MD3-113, three CDs.

Sound: A– Performance: A–

Probably more than any other musician, Chet Baker epitomized the cool, soft, laid-back sound that became known as "West Coast Cool" jazz in the 1950s.

According to Joe Goldberg's exceptionally well-written liner notes, Baker developed his own trumpet sound—very, very soft and well modulated—before he ever heard Miles Davis play. That soft sound and bop-oriented style enabled him to work, for a time, with Charlie Parker in California and Canada. Basically, Baker remained an introspective player, using the middle register of his horn with minimum execution.

He reached his peak with Gerry Mulligan's quartet in 1953 and 1954, winning both the *downbeat* critics' and readers' polls ahead of Miles Davis. Most of the quartet's recordings were not released in the U.S. but in Europe, where Baker later developed a following as a singer. This release comprises three 1954 dates; only the Ann Arbor set was ever released in its entirety by Pacific.

These dates capture the full range of Baker's work. Although the point is made over and over again that he had precious little knowledge of chords and really couldn't read music very well, it's evident that Baker was a highly intuitive player who could grasp what was needed from a song or composition almost as he played it.

"My Funny Valentine," long associated with Mabel Mercer, is one of Baker's most compelling statements. "Stella by Starlight" was done by Baker long before it became associated with Miles; dig it and compare. "Everything Happens to Me," a superior song, suits Baker's introspective muse well. There are a number of Latin-tinged tunes, including "Frenesi," which will remind everyone of Artie Shaw; Baker and pianist/arranger Russ Freeman and company handle it with complete ease, as they do everything else in their repertoire. On Jerome Kern's classic "All the Things You Are" (which Freeman calls one of the greatest songs ever written), Baker's lack of formal training leads him way out on a limb, but with his superior skill, he manages to resolve his solo as a complete entity.

Freeman, who today is a prominent conductor and studio arranger in California, is very well recorded, and this set represents some of his best work. He, bassist Carson Smith, and drummer Bob Neel get a wonderful groove established on "Stella by Starlight."

This Mosaic release ought to be most welcome, as Baker's passing in 1988 marked the end of an era. Luckily, we have his recordings—and there aren't many—to remind us of his talent.

Frank Driggs

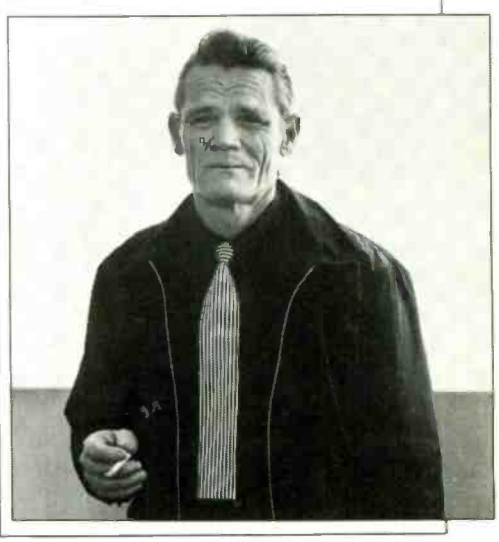
Chet Baker Sings and Plays from the Film "Let's Get Lost"
RCA/Novus 3054-2-N, CD.

Sound: A– Performance: B–

I must be the only one out there who has trouble with Chet Baker's vocal quality and delivery, not to mention his (lack of) range. It's not that I'm cynical; at heart, I'm a romantic, but this nostalgia thing is out of hand. By all accounts, Bruce Weber's recent film documentary on the now-late Baker deserves the heaps of praise it's receiving. Still, I can't help but think that this album pinpoints our society's uncanny ability to play the capitalistic role of predator. Why not promote a guy when he's alive?

There is little debate that the purveyors of jazz's 1950s "West Coast Cool School" left their mark on the idiom. Overall, the importance of Baker's fine work with Gerry Mulligan, the Southern California Limehouse bunch, and others has been underestimated or, worse, overlooked.

Still, I don't enjoy being manipulated. While *Let's Get Lost* (the soundtrack) has many fine moments, it is not a great piece of work. Baker's voice



Otis Rush

cracks; at times ("Imagination" and "Blame it on My Youth"), he either sounds like he's jammed his mouth full of marbles or he slurs, which merely serves as an aural reminder of his excesses. While Baker's presentation of Elvis Costello's "Almost Blue" has been called a stroke of genius and a demonstration of Baker's scope and breadth, I can't help but think of it as a marketing ploy.

There is a plus side here, though. "Moon and Sand," for instance, is delivered cagily and smoothly. The phrasing in "Every Time We Say Goodbye" is excellent. Throughout, Baker's trumpet seems strong, lyrical as always, sensitive, and accurate—all trademarks.

Each accompanist works well, too: Pianist Frank Strazzeri (particularly on "I Don't Stand a Ghost of a Chance with You"), bassist John Leftwich, and guitarist/flutist Nicola Stilo. Baker had worked with drummer/percussionist Ralph Penland many times previously; their intuitive communication is readily apparent.

But in the end, *Let's Get Lost* comes across as a series of slow, slower, and slowest compositions. Perhaps it's an accurate portrayal of Baker on his last legs. I hope not, because if so, it makes me all the sadder.

Jon W. Poses

Cadillac Daddy—Memphis 1952: Howlin' Wolf
Rounder SS-28, LP.

Sound: B– Performance: A–

With a voice that always sounded as if he'd swallowed the microphone, Howlin' Wolf projected a singular and uncompromising blues. His was a rough-and-tumble music that became one of the mainstays of the Chess catalog. Before his great fame with Chicago musicians and the Chess label, the Wolf made some rather obscure recordings which surfaced only recently due to the resurgence of interest in the blues.

This particular LP not only demonstrates some of the crudest blues Wolf ever made but also shows the development of his voice. There are several moments where he reveals a different voice than the growl we are most familiar with; he ventures into a higher range and practically falls out of character. For a second, it sounds as if two people are singing, and then you realize that Wolf actually had another voice besides his trademark, low-down and nasty self. "Color and Kind" and "I Got a Woman" give you a glimpse at that other Howlin' Wolf, somewhere between the man and the legend, and it's a revelation.

Some of the playing on the record is not up to the songs and the singer, as this was recorded before Wolf teamed up with Hubert Sumlin, whose distinctive guitar lines and cranky tone added much to Wolf's recorded persona. In fact, the faint-hearted might find themselves put off by Willie Johnson's guitar, which often drifts into off-key territory on side one. But no matter. The singer is never thrown by the litter of bum notes or by a missed snare hit.

Finally, a good word should be put in on behalf of producer Sam Phillips for making these tapes in the first place. And kudos go to Colin Escott, Frank Green, and Dr. Toby Mountain for restoring them to a completely listenable state. These recordings stand with the best of the Chess works and belong in any serious blues collection.

Jon & Sally Tiven

Howlin' Wolf

Tops: Otis Rush
Blind Pig BP-3188, LP.

Sound: B Performance: A–

Blues fans may argue forever over who's the best living blues guitarist, but inevitably Otis Rush is acknowledged as a master. The cover photo of *Tops* reveals a spectacled, middle-aged man, but the music is that of the youngster who took Chicago by storm with a flurry of hits in the late '50s. Unfortunately, he's been recorded less than any other bluesman of his stature.

If you've never heard Otis Rush, "Gambler's Blues" is worth the price of the album. It's indicative of Rush's talent that this B. B. King number is now more closely identified with Rush than King. Rush remains a concise, economical guitarist who draws on deep reservoirs of technique and emotion—at once sophisticated and raw. As with his few peers, Rush's music can be identified by a single solo, and sometimes even by a brief phrase.

When *Tops* is viewed against the background of Rush's few recordings, however, the album is a bit of a disappointment. Cut live at the 1985 San Francisco Blues Festival, all the tracks save one have been previously recorded, and two appeared on his last live set, the wonderful *So Many Roads* on Delmark. The title track on *Tops*, a new instrumental, rates as a work in progress. This album is also a victim of Rush's decision to employ local groups when he's touring rather than maintain his own band. The backing Bobby Murray Band may be sympa-

Photograph: Frank Driggs Collection

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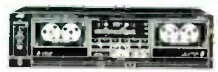

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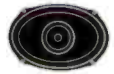

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Steps Ahead is miles ahead of what passes for fusion these days, but on this album they're only walkin'.

thetic, but their arrangements are tentative. Rush's own musicians, however, drove him to new heights with aggressive arrangements. I imagine that it's well-nigh impossible for the members of Murray's band, who grew up cutting their teeth on Rush's 45s, to challenge their temporary leader. The band particularly falls down on "Keep on Lovin' Me Baby," one of Rush's first hits.

Rush has so rarely recorded that *Tops* qualifies as a blues event. Yet his fans can only wonder why his first album in a decade is a live set that's over three years old upon its release.

Roy Greenberg

N.Y.C.: Steps Ahead
Intuition/Capitol C1-91354, LP.

Sound: B+ Performance: C+

Even with the departure of drummer Peter Erskine and saxophonist Michael Brecker, Steps Ahead still plays smart, high-tech fusion, bristling with insistent rhythms and catchy melodies. Mike Mainieri, the only remaining original member, assumes a more dominant role on *N.Y.C.*, especially with his expanded palette of MIDI vibes triggering a Synclavier. Mainieri sets up cycles of percussive vibes echoed by electronic sounds and samples, and it is this melodic-percussion approach which drives pieces such as "Well, in That Case . . ., "Senegal Calling," and "Get It."

With Steve Smith on drums and Tony Levin on bass and Chapman Stick, there's no lack in the rhythm section. And the production maintains their high-tech sheen with clever arrangements interweaving acoustic and electronic colors.

It's in the front that Steps Ahead falls behind. Guitarist Steve Kahn and saxophonist Bendik don't have the distinctive voices of their predecessors. In particular, although Bendik has a more raw, textured sound than most fusion clones, he is a predictable soloist, usually climaxing with some guttural mid-register growls. The writing, which falls to Mainieri and Bendik, is like a sketchbook of interesting but largely underdeveloped ideas—the lovely Bendik ballad, "Red Neon, Go or Give," notwithstanding.

Steps Ahead is miles ahead of what passes for fusion these days, but they're still just walkin'. *John Diliberto*

Superblue
Blue Note B1-91731, LP.

Sound: A– Performance: A

Here's an octet of powerful players, many of whom are just hitting their stride. Trumpeter Don Sickler arranged seven of the pieces, and alto saxophonist Bobby Watson arranged the other, his own "Conservation."

This is a group of musicians whose careers have often intersected in the last decade, and the tightness and interplay here underscore that fact. Tenor saxophonist Bill Pierce and Watson

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Stylistically, you could not find a more compatible jazz band than Superblue, an octet of brash upstarts and wily veterans.

are early-1980s graduates of The Jazz Messengers; pianist Mulgrew Miller, now a leader in his own right and a mainstay in Tony Williams' elegant quintet, also did time with Art Blakey. The band's other brass players, trumpeter/fluegelhornist Roy Hargrove and trombonist Frank Lacy (a 1989 Messenger), perform regularly with Watson as part of the altoist's cohesive group, Horizon. And bassist Bob Hurst, a Blue Note prodigy who was part of the label's original OTB (Out of the Blue) enclave, has a wealth of mutual credits with the others, not to mention a sustained stint with Wynton Marsalis.

Stylistically, you couldn't ask for a more compatible group. Choice of material, such as Tina Brooks' hard-driving affair, "Open Sesame," pays tribute to and is reminiscent of two of Blue Note's legends, Kenny Dorham and Horace Silver. Curtis Fuller's "Time Off" demonstrates Watson's ever-increasing prowess and depth; he's ready to take, and hold, center stage at any given moment. As for Watson's "Conservation," it presents us with a big band feel while showcasing not only the solo work of Watson, Miller, and Pierce, but also drummer Kenny Washington, who gets better and better with every record. The only ballad is Benny Golson's much-travelled but never tiresome "I Remember Clifford," which spotlights the phenomenal talent of trumpeter Hargrove. (The standard ballad, "Summertime," also makes an appearance, but its atypical, offbeat arrangement is a bit too quick-paced for my liking).

Superblue is a superb effort by a group of already-developed young upstarts and keen mid-career veterans.

Jon W. Poses

Live in the Whispering Gallery: The Persuasions
Hammer 'N Nails HNCD-1988, CD; DDD; 34:41 (Available from Hammer 'N Nails Records, c/o North American Digital, 215 Englewood Ave., Englewood, N.J. 07631.)

Sound: B Performance: A–

That sublime a cappella group, The Persuasions, returns in vintage form from a long recording absence with this live performance from April 1988, recorded direct to DAT. Sadly, it is their final recording with charter member Herbert "Toubo" Rhoad, who has since passed on. As always, their repertoire is soulful standards and some gospel—songs like "Get a Job," "Place in the Sun," "Sea of Love," and Otis Redding's "Amen." After more than 25 years together, the camaraderie is a joyous thing to hear. The Persuasions have always made uplifting music with nothing more than voices and hand claps.

The sound here is warm and feels like the live performance that it is. The presence is not outstanding, but it still feels good. *Michael Tearson*

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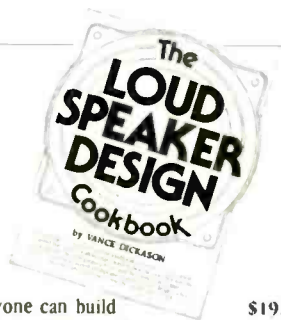

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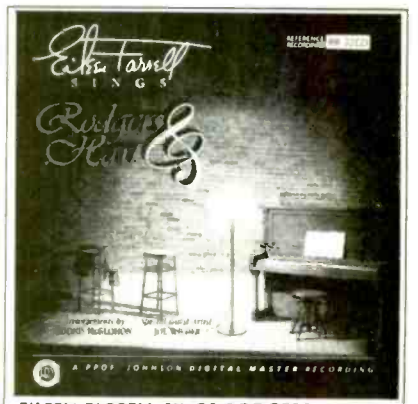

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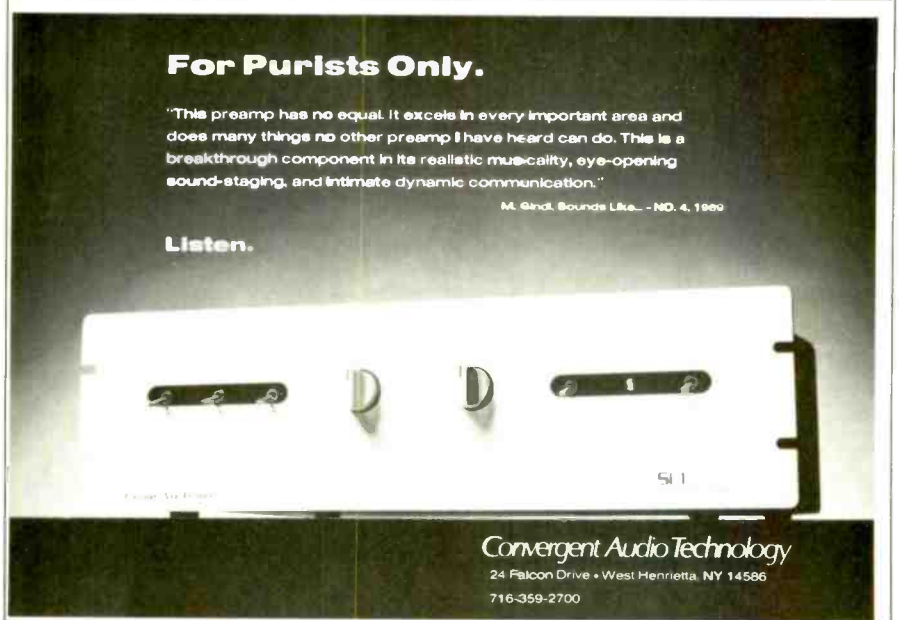

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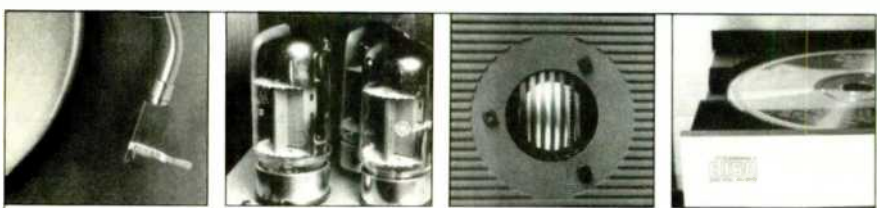

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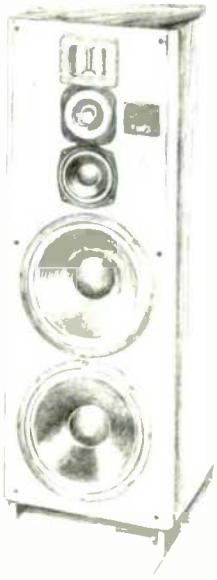

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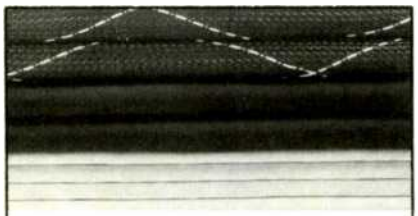

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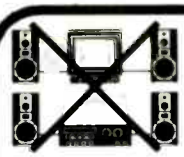

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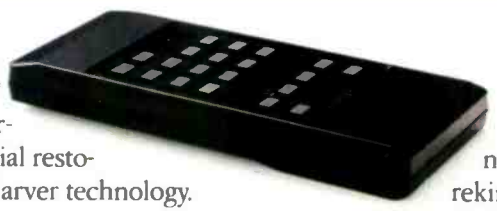

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