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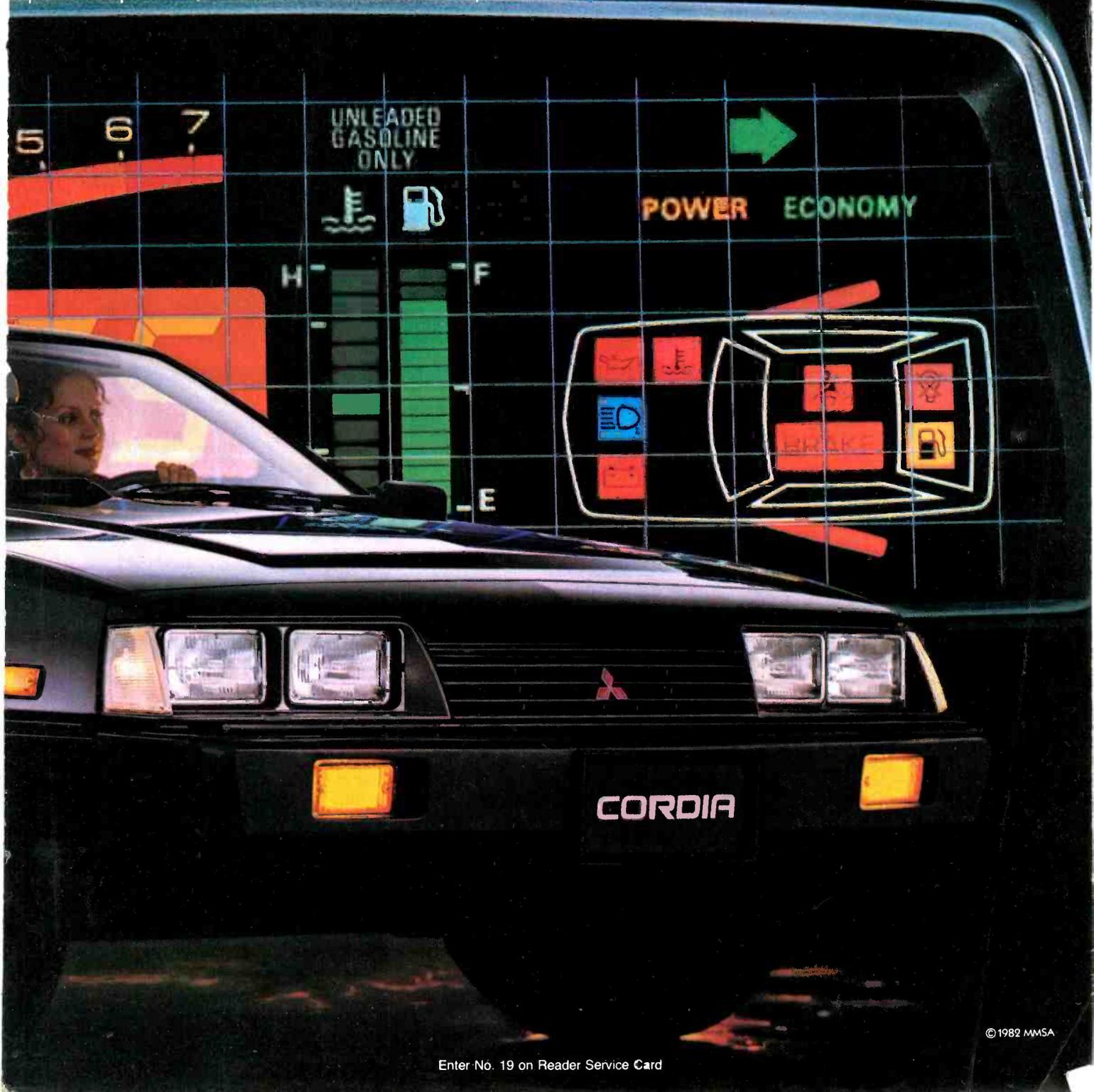
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DECEMBER 1982

VOL. 66, NO. 12

*James
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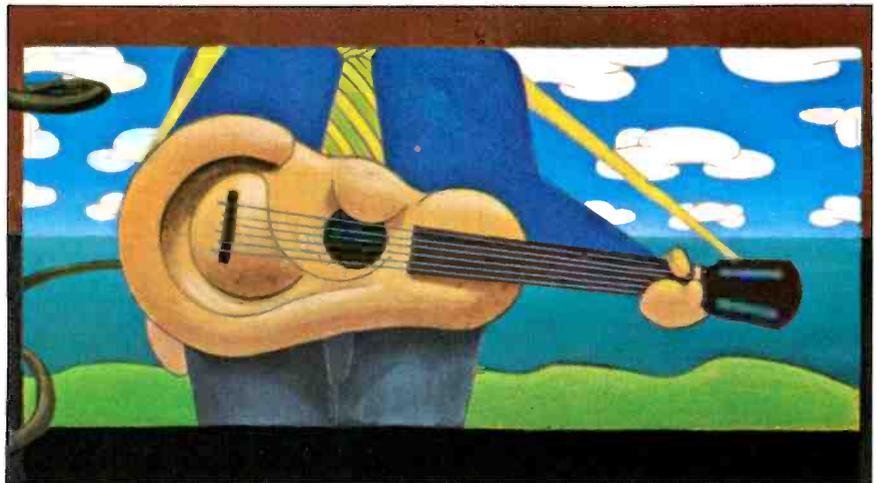
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CARVER



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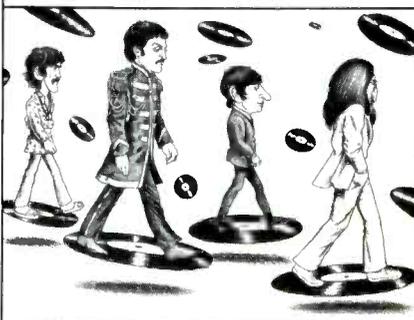
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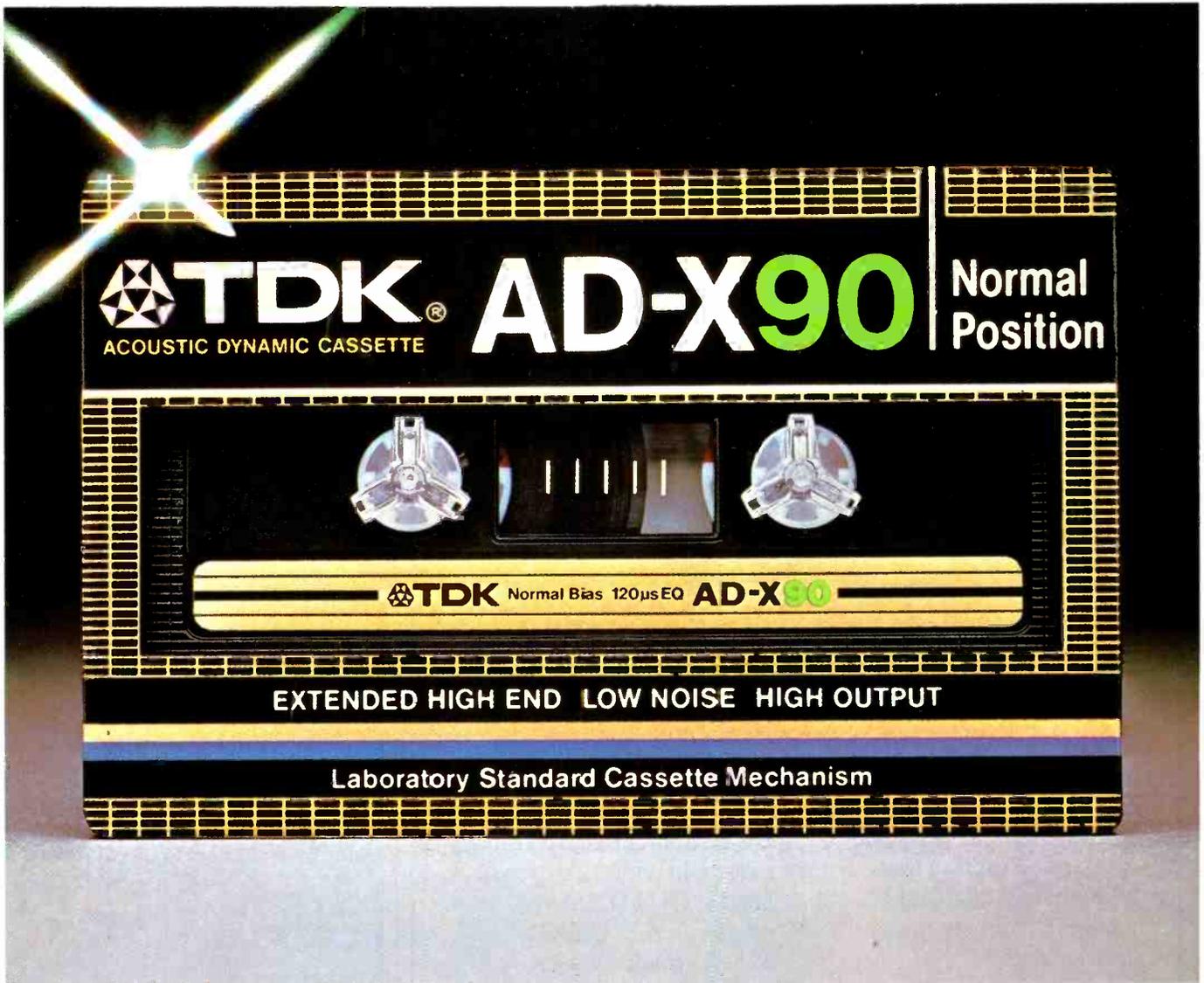
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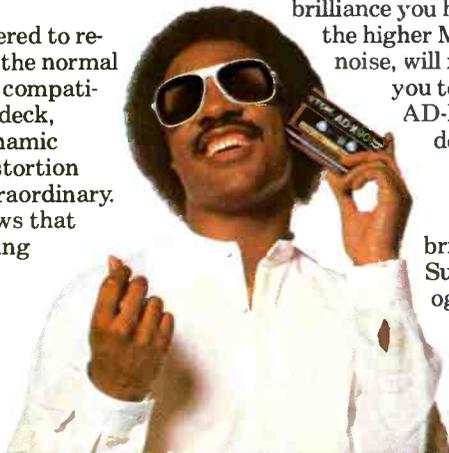
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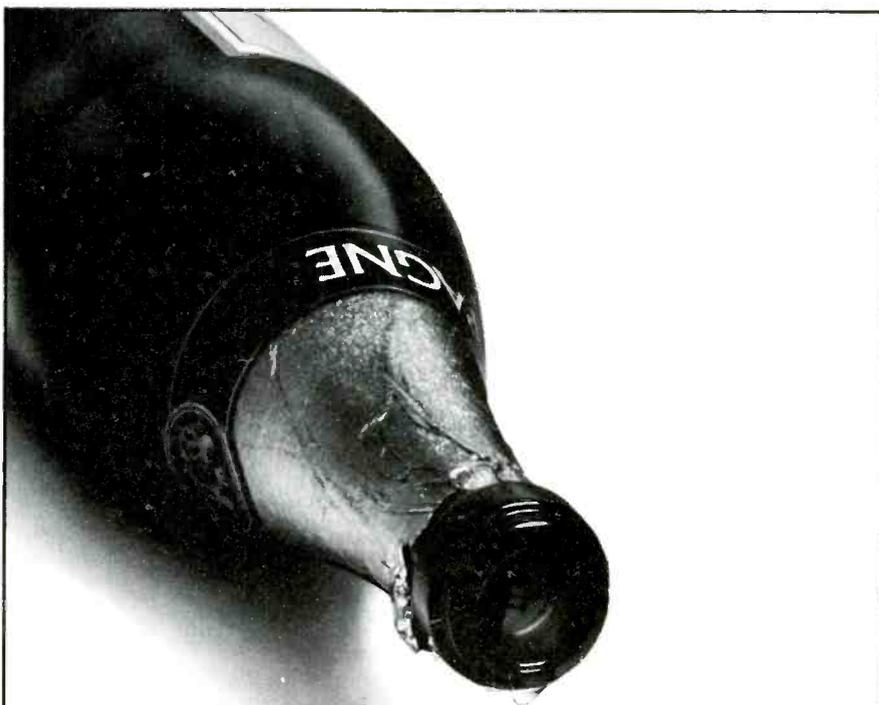
ticle—based on the same formulation that's made TDK the leader in audio and video tape technology.

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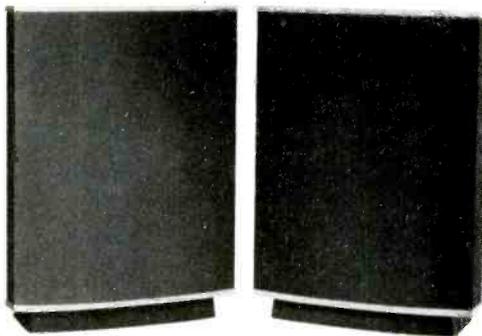
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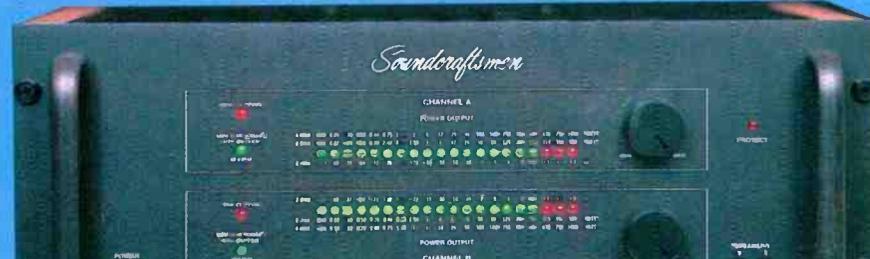
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TAPE GUIDE

HERMAN BURSTEIN

Ch-Ch-Ch

Q. I was trying to make a disc-to-cassette copy of "La Vie En Rose," and upon playback the beginning portion, where there is a lot of high end, was not crisp but instead had a "ch-ch-ch" quality. I tried various recording levels and bias settings, as well as recording with Dolby NR both on and off. I cleaned and demagnetized the heads and other components. All of this produced slightly better results, but not perfect ones. Am I expecting too much? Am I overlooking something?—Mark Kelinski, Brooklyn, N.Y.

A. One possibility is that you didn't reduce record level enough. If there is a lot of high-end material at high amplitude, this could be far above the average level of the program material. Hence, a strong reduction in record level would be needed to avoid tape distortion. Keep in mind that substantial treble boost is employed by the record electronics of a cassette deck. This increases the likelihood of tape

saturation, and distortion, at high frequencies. It is possible that the record electronics were overloaded, that the cassette you were using is defective, or that something is wrong with the early part of the cassette. Perhaps you will have to reduce recording level on those portions of this particular disc which give you the problem.

Effects of Skew

Q. Does cassette skew affect flatness of response on subsequent playback? If so, by how much?—Luke Lanford, Indianapolis, Ind.

A. Skew refers to wandering of the tape as it crosses the heads so that the long dimension of the tape is not perfectly perpendicular to the head gaps. In effect, skew refers to changes in azimuth as the tape is in motion. Departure from correct azimuth (perfect perpendicularity) in recording can be compensated by equal departure in playback. Therefore, we are concerned with the net difference in azi-

imuth between recording and playback. Well under 1° of skew can produce substantial loss of treble. The amount of loss for a given amount of skew increases with frequency, increases as tape speed is reduced, and decreases as track width is decreased. To give an idea of how severe a loss can be produced by skew, a departure of 30 minutes (one-half degree) from correct azimuth will produce a loss of about 20 dB at 10 kHz in the case of a cassette running at 1½ ips. Skew is rarely significant when the same deck is used for playback and recording, unless it has separate recording and playback heads. Skew is quite significant, though, when tapes made on one deck are played back on another. A

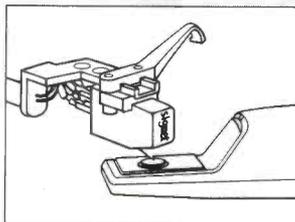
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COOL, CLEAN, AND COLLECTED

Months ago, I rashly promised to put together the whole ensemble of the Technics Studio Collection, entirely apart from all my other gear, to find out what it would do on its own as a Whole. Impossible! At least in terms of any useful comment that might ensue.

There is only one way to evaluate a complete system and that, paradoxically, is to go after its component parts. In audio, the Whole is never the sum of its Parts; the audio chain does not work that way. One small weakness can bottleneck a hundred virtues, which thereby are prevented from adding up. Simple-minded thinking? Maybe, but not enough of us, makers and consumers alike, engage in that kind of thought process.

So I've been trying first one and then another of that great and flourishing Collection, but never all at once. My thanks go out to the patient distributors who supplied so many simultaneous goodies for my perusal! They've had to wait. The concept of the one-brand collection is what interested them, and it surely interests me too. But this is the more reason for taking due time, in deference to such a concept.

I've long since enthused over the Technics Collection linear-tracking turntable, which continues to operate astonishingly well and is by far the easiest automatic (don't-ever-touch-the-arm) I've ever used. I spoke, too, of the complexities for the radio listener in the Technics memory tuning for AM-FM, minus dial and knob. I like the Technics tuner but I remain unenthusiastic about helter-skelter memories and accidental erasures of same. Give me the old dial and knob for easiest finger tuning! (These comments apply virtually to all tuners now on the market; I intend no special criticism of Technics.)

Speakers? There again, a pair of speakers integrated into a complete system can't be properly judged by what they emit. I got an idea of the sound of Technics' new flat honeycomb midrange and tweeter display and called it "shiny." Good word, I think, because it was not a value judgment, either pro or con. But until I had worked with the Technics SB-6 pair hooked into other known equipment, with all else except the speakers un-



changed, I could not be definite. As a matter of fact, I suspected that some of what seemed to be the speaker sound was actually a product of the Technics-supplied phono cartridge. So—once again, analysis. Yes, now I know. I have tried these speakers directly against those I formerly used. I've changed the phono cartridge for another make. The speakers do reflect this last change—but they remain shiny in the sound.

In other words, the Technics speaker is potent in the high end, if smooth, to the point where I turned down both tweeter and midrange controls to within a few steps of the off position before, in my own listening situation, I could please my own ear. In contrast, my older speakers play with the same type of dual controls, tweeter and midrange, in the open or normal position. Therefore, in a hard room, with metal and glass (I have a lot of glass in French windows), Technics tends to overdo the brilliant side. On the other hand, in many well-padded environments, more common than my type, they should be useful in maintaining musical presence.

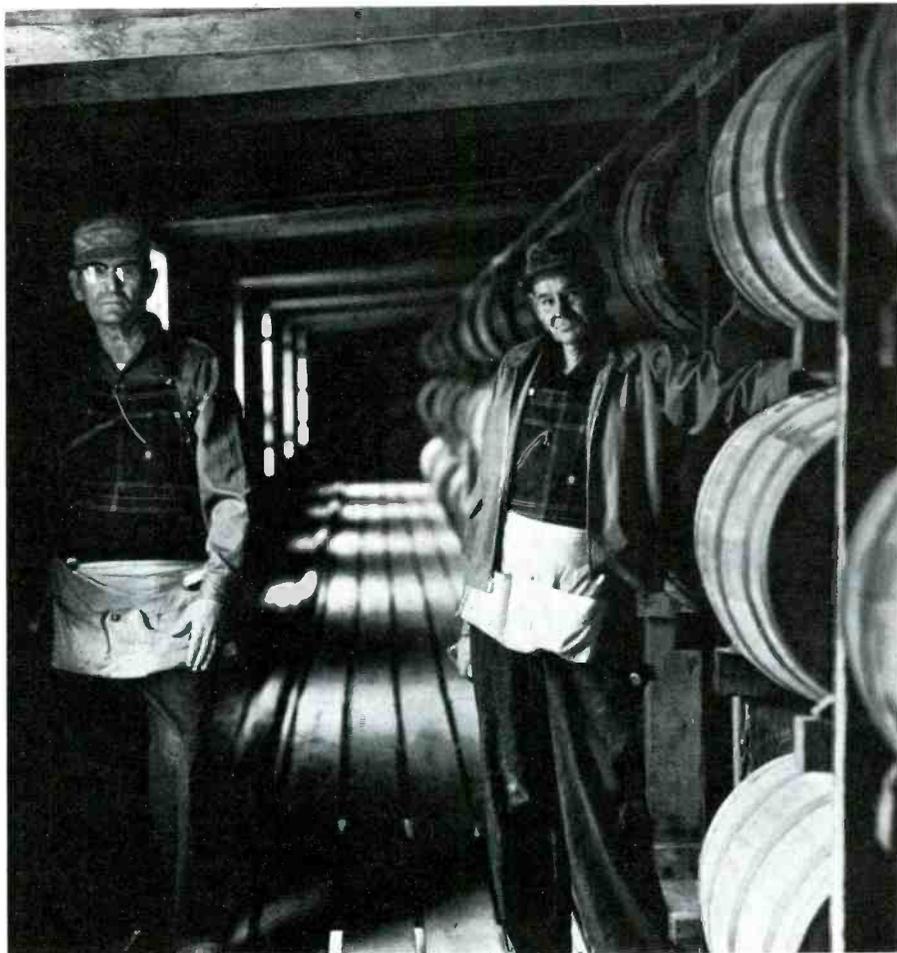
I had an instructive experience in cassette-player technology when, recently, I found myself needing two

cassette players at once. I pulled out my earlier two-channel portable and put it together with the Studio Collection (a.c. line) M280 cassette player, which I forgot to list in my earlier column. Hadn't yet tried it. This made an interesting combination because, where the portable is one of the latest representatives of the all-mechanical cassette drive—even the pilot light is optional to save battery life—the newer indoor-type Technics is the opposite; virtually every function is, shall I say, relayed and lit up in colors. (Well, there's power to spare, after all.) The running controls are of the new light-touch type, including mute and that all-important touch button, "Record." If you ask me, this last, like other Technics controls, is too easy to touch by accident. These new operations are not for people with shaking palsy. But the automatic release from the "Record" position when other controls are touched does do the basic protection job very well. The M280 is taller than the other ultra-pancake units in the Collection but otherwise matches them in width and decor. The unit has three drive motors and is quartz-locked. Controls or no, I found it pleasant to use, and very quick to respond to function changes.

The Studio Collection, like so many lines of new equipment, is really plastered with what to me are unnecessarily fussy readouts and the above-mentioned relays, so that the mere printed type that goes with the little lights is virtually illegible from further away than a few inches; even then, what with assorted overhangs, you must squat down or stretch your neck up to achieve a level before you can see anything. I find this annoying. It is style alone and just plain unnecessary. But I will say, given the premise, the cassette unit is laid out with good clarity. The more intermittent adjustments, bias and the like, are hidden behind a drop-down panel and out of the way, once set. The more esoteric memory functions are off to one side and out of the fingers' range as, so to speak, you shift gears. The operating indicators light up behind a plastic block, with the now inevitable peak-read meters. So, in spite of many concessions to style, this is a very workable unit for a home system. And a Collection.

But so is my all-mechanical portable recorder, and in this starkly utilitarian unit I found a couple of significant advantages not present in the Technics model. Sometimes the fancy functions nudge out the practical. Both recorders, of course, have microphone inputs, two channels, and both have outputs for headphones (larger plug size). The portable has a volume control on its headphone output—essential for any serious work. Technics doesn't. One set of phones I used on Technics practically blew me out of the room, and nothing could I do. Also, the portable's mike inputs have an optional attenuation, for mikes with high output that may overload the first stage. Again, important for any serious microphone work and I have often used this attenuation myself. But there is none on the Technics input. Perhaps Technics can take a higher mike level? Frankly, I'd rather be sure. Thus do we pay for all those extra relays, readouts and what-not.

I could not use the Technics SU-A8 d.c. control amplifier at all and for a complex of reasons. First, for all its extra features, including the option of "straight direct coupled" (i.e., down to d.c.), the unit has only one each of the essential (to me, at least) connecting



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circuits, tape monitor and so on. I need more! So do you, in all probability, what with all the add-on equipment around today. My elderly and still indispensable Crown IC-150 sagely offers two of everything, even two main outputs and two phono inputs (to one preamp), and that was years ago. I

have been blessing Crown for its perspicacity ever since.

More crucial, the Technics control amp (see Len Feldman's "Equipment Profile" of this and the companion SE-A7 power amp, May 1982) carries current gadgetizing to an absurd point. Tone controls, of course, must now be

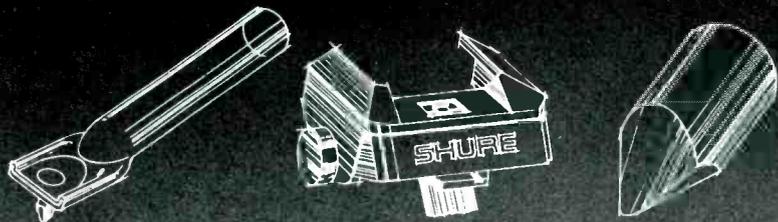
sliders, not the stylistically forbidden knobs. Okay, and I wouldn't mind if these were coverable by a simple drop-down panel, like that in the cassette machine. I might even go for a handy retractable drawer, movable by the fingers. But to put those controls inside a *power operated* drawer with its own separate motor appears preposterous. You push a button; it goes Zzzzzzz and slides out, too slowly. Push again and it goes Zzzzzzz back in again. Or is supposed to. In this, Technics is just asking for the well-known Murphy. And gets him. At first, the drawer stuck for me. Motor tried, and failed. No controls available. When this was freed (chassis misalignment), I found that somehow, in its shipping travels, one slider control inside the drawer had broken loose and slid only itself; another control had snapped off and was inoperable. A Murphy field day! There was no way to tell where these controls were set—so no control at all. The entire unit was useless.

Next, an interesting example of what I used to call "plural trouble"—it's still around—cropped up in my experience with the companion SE-A7, the main power amp for the Studio Collection. This amp, by the way, was an interesting replacement for a Pioneer M-22 amp, operating Class A, which boasts a heavyweight array of huge capacitors and transformers, and a vast heat output of the egg-frying sort, typical of Class A inefficiency. Worth it in performance but, it must be admitted, the Technics amp was refreshingly smaller, a thin pancake size, and its heat was practically cool. Yet this amp is described as having "new Class A synchro-bias." Class A virtues without the encumbrances.

Such a pity, then, to find that, apparently, one channel was going bad and I would have to bypass this Technics item without a decent trial. While I was away, people in my house (including an electronics engineer), reported one channel intermittent, plus distortion and ominous cracklings. I heard them for myself on my return, but I wasn't going to give up without double checks. My fingers were crossed—they always are.

Fortunately, I can play all of my channels (six) in pairs or individually,

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“There’s only one way to evaluate a system, and that, paradoxically, is to go after each of its component parts individually.”

and reverse any pair at various points, to determine what is happening and where. It did not take me long, for instance, to discover that the speakers—my first alternative thought for the trouble—were okay. The distortion or total silence switched nicely from side to side, quite impartially. (I had suspected an overload reset button, and indeed it did occasionally stick.)

But then I found that any suddenly loud signal, even an on-off switch surge, would bring the missing channel back into action. Bad! And when I saw an accompanying tell-tale blue flash inside the amp, I groaned. It seemed to say, unequivocally, *here is your problem*. Most owners at this point would have shipped the thing straight back to the factory, I am sure. But my fingers weren’t uncrossed. *No reason* for this amp to fail! It has plenty of protection, it had not been violently misused, it surely is a mature and well-built design, near the top of the Technics line. More routine checks, getting even simpler. Speaker cables. ALWAYS check these first.

And there it was, right at the amp itself and strictly due to my inability to cope with Technics’ new design. Instead of the more conventional binding post connectors, this amp uses the new and convenient quarter-turn instant fasteners. Push the bare wire into the center hole and twist tight. Alas, however easy they are to use, you cannot SEE whether your connection is workable or not. One of mine wasn’t. The valiant Technics amp coped beautifully and was undamaged. In a few seconds I re-did the loudspeaker connection, all distortion disappeared, and both channels have worked perfectly ever since. (Though I keep nervously looking over my shoulder for Murphy.)

Need I toss one more item in? Yes—important. Len Feldman, again, has pointed out a somewhat unsatisfactory manufacturer-supplied phono cartridge in one of his one-brand system reviews. By no coincidence and quite independently, I began to suspect the same for the Technics cartridge that comes with the Studio Collection. Have to be careful—it might be trouble somewhere else. The Technics is replaceable by various other makes designed to fit the same mounting. But

keep in mind that this Studio Collection is more enlightened assemblage, without overall model designation and providing a good deal of alternative variety, including provision for other-brand units. Compatibility is still 100%. So I asked at Shure and found they had a model, I think adapted from the V15

Type IV. There are numerous other brands, to your choice. So I installed a Shure—and instant gratification! Sorry Technics, but it was much superior, all other units remaining unchanged. No longer a one-brand system, but a better system as a whole. Isn’t that as it should be? 

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BERT WHYTE

A VIDSTAR IS BORN

This is a report on the new JVC Vidstar HR-7650U VHS stereo videocassette recorder. In going over the features of this most sophisticated of VCR decks, I was struck by the technical advances that have been made in the manufacture of VCRs in the relatively short time since their introduction.

The earliest home videocassette decks had but one recording speed, permitting only up to one hour of recording. Operating control was via mechanical fingers. The VHF and UHF tuners were mechanical rotary types, with detents for each channel. There were no facilities for still pictures or slow motion and no "fast scan." In some cases, timers were an accessory item, and there certainly was no multi-programming capability.

This JVC HR-7650U is a sleekly styled, very clean and functional looking VCR. JVC video decks have always been a bit more compact than units from their competitors, and so is this one: It measures 18 $\frac{1}{8}$ in. W \times 6 $\frac{1}{8}$ in. H \times 14 $\frac{3}{8}$ in. D and weighs in at 26 $\frac{1}{2}$ pounds.

The HR-7650U is one of the new breed of front-loading videocassette decks. In use, the cassette is inserted about halfway into the loading slot, and then a motor-driven device pulls in the cassette and lowers it into the tape transport mechanism. The deck employs no fewer than five motors. One is a new brushless, quartz-locked direct-drive recording drum motor; other motors are for capstan, reels, tape wrapping the tape around the heads, and the aforementioned cassette loading.

The HR-7650U is loaded with features, many of which were mere fantasy just a few years ago. It uses the helical-scan recording system. The recording drum has one pair of video heads exclusively for standard-play mode, and another pair of video heads for extended play. Recording time is two hours in the SP mode and six hours in EP, on T-120 videocassettes. (The new T-160 videocassettes will provide 8 hours of recording in the EP mode.) The deck automatically switches playback speed to match two-hour SP, four-hour LP, and six-hour EP recordings.

The HR-7650U boasts two audio channels which can be for bilingual



The HR-7650U is loaded with features, many of which were mere fantasy a few years ago.

use or stereophonic sound. Dolby B noise-reduction circuitry is furnished. All control functions are activated by touch buttons with a microprocessor-based electronic logic-control system. Other electronic functions include a 14-day, 8-program timer. The tuner has 16 channel presets and 105-channel cable-ready capacity. There is a fluorescent display for tape counter, clock time, and programmed timer recording data. The shuttle search function operates at about seven times SP mode and 21 times EP mode, in forward or reverse direction. This works quite well, with good picture quality but with some noise bars visible. The still-picture function and slow motion are the best I have seen, with no noise bars whatever. A slow-motion tracking control can also vary the speed of the image. As with many new VCRs, shots can be edited together without picture break-up at the transitions. And those who make home movies will appreciate the direct camera input on the front panel of the VCR.

An infrared remote control is also furnished with the HR-7650U. It can turn the unit on and off, select channels on the VCR tuner, select slow-motion playback, activate pause or still-picture modes, activate audio dubbing, advance the picture frame-by-frame, and, of course, control record, play, stop and fast-forward and rewind shuttle search. This is very convenient: Load a cassette into the VCR, sit down with the remote control at

your side, and you're ready to record whatever suits your fancy, without going back to the machine. The remote transmitter is powered by two AA-size batteries; an LED on the transmitter flashes when commands are sent to the VCR.

As with most current timer/programmers, the one on this VCR is quite complex. It can be set, for example, to record the same program or channel at the same time on successive days of the week, and numerous other combinations of 8 programs in a 14-day period.

There are many other features on the HR-7650U, such as a blinking LED to show you the tape is running when you're too far away to watch the tape or the counter. A "Tape End" LED lights when there is about 10 minutes of tape left to record and starts to blink when there is only five minutes of recording time remaining. Unlike most VCRs, the HR-7650U has a stereo headphone jack as well as two microphone and two line inputs for stereo recording; these will come in handy when stereo TV arrives on the scene. On the rear panel are corresponding channel-1 and channel-2 audio output jacks for stereo playback, the usual video in and out jacks, and antenna connections. I have used the stereo record function with Dolby B noise reduction, and although this helps, the signal-to-noise ratio is still only 46 dB.

With respect to Dolby movie cassettes, Jim Fosgate of Fosgate Re-

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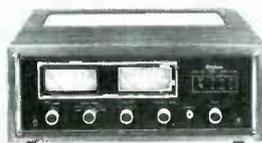
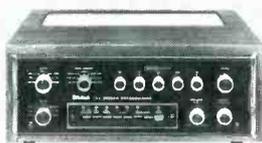
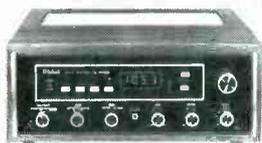
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"Fixed-pitch instruments, such as piano, suffer dreadful wow, which is a problem that affects all videocassette recorders."

search just sent me a new version of his SQ decoder and surround-sound synthesizer. He tells me that if I feed the HR-7650U's stereo outputs through his unit and set up the appropriate side and rear speakers and amplifiers, I'll get a good approximation of the Dolby surround sound as heard in movie houses.

The HR-7650U is certainly the most versatile, sophisticated and best-performing VHS VCR I have yet encountered. Picture quality in the SP mode is really excellent. Using Maxell HGX videocassettes, there was a minimum of grain, with good contrast and brightness ratios; colors were pure, clean and highly saturated. Recording in the EP mode, while not as good as in SP, was eminently viewable.

Unfortunately, however much the sound was helped by the Dolby noise reduction, fixed-pitch instruments such as bells and piano suffered from dreadful wow and pitch variations. This tape-motion problem, affecting all VCRs, is the next big area for improvement, and it will be necessary with the advent of stereo TV and Dolby stereo movie cassettes. Ideas for this sorely needed improvement range from a balanced, dynamic tape-tension system (probably expensive) to some form of digitally controlled tape-motion system.

Speaking of digital, as you know, both Beta and VHS videocassette decks are used to record the signals from digital processors. I have been using the HR-7650U with great success in conjunction with a Sony PCM-F1 processor. The accuracy and stability of the VCR's tape travel is particularly important in digital sound recording. The HR-7650U rarely required tracking-control adjustments, even when playing tapes recorded on other machines. (Head cleaning appears to be especially important when recording or reproducing digital signals, too. A new, disposable wet head cleaner from Koss seems to be excellent, but I'll report on it more fully at a later time.)

In spite of the HR-7650U's formidable list of features and functions, I found it a very easy machine to use. It performed flawlessly and, thus far, reliably, and certainly must qualify as the best VCR I have used to date. **A**

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BERT WHYTE

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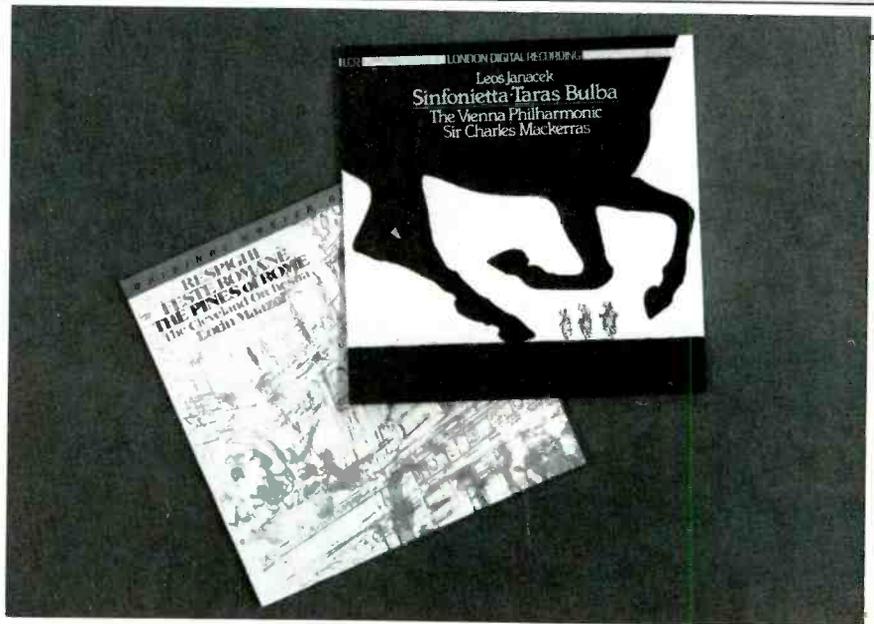
I see by the calendar that this is the Christmas issue. There are those who say that the holiday has become too commercial, and one must concede there is much truth in this assertion. However, the season is, after all, a time for the giving and receiving of gifts. So herewith some baubles to consider which may gladden the heart of an audiophile come Christmas morning. Or consider these items as bright new audio toys to enhance your own listening pleasure.

Some of the items I have selected are inexpensive, while others are quite costly. The products were chosen for the sonic improvements they can contribute, with their cost not a determining factor.

Lest we forget, all of our striving for ever higher levels of sonic fidelity is—or should be—for the reproduction of music that most closely simulates the concert-hall listening experience. Needless to say, the key factor here is the program source itself, be it from a disc or cassette or open-reel tape. The best audio system is of little use if the recordings played on it are of poor quality.

There are many fine recordings that are considered to be of demonstration quality. Some are from the standard repertoire, otherwise known as potboilers; others may be relatively obscure works which are sonically exciting. A given piece of music is far more enjoyable and exciting if it happens to be a thrilling performance as well as a sonic blockbuster. What I propose to do in my choice of recordings is to single out extraordinary productions whose performances are imbued with the grandeur, sweep, vitality and intensity that the composer intended—along with the closest possible sonic facsimile of the orchestra in the concert hall. In other words, recordings of music with heart-stopping emotional impact. Obviously, there is the matter of musical taste. It is not my intent to force-feed anyone's musical appetites, but an audition of these recordings should be more than sufficient to make my point.

There are many recordings of Respighi's colorful tone poems, "Feste Romane" (Roman Festivals) and "The Pines of Rome." Few are as compelling and exciting as that of Lorin Maa-



The spectacular recordings of "Feste Romane" and "Taras Bulba" are good choices for a Christmas list.

zel conducting the Cleveland Orchestra on Mobile Fidelity Sound Lab (MFSL 1-507). This recording is licensed from Decca, whose original version was brilliantly engineered under the master hand of Jim Lock. This Mobile Fidelity version has been remastered with the half-speed cutting process using the Ortofon cutting system, operated by master cutting engineer Stan Ricker. With an immaculate pressing from JVC, here is a recording that blazes with sonic and musical excitement. The original scorings, which include organ, are used.

"Feste Romane" is a riot of orchestral color, with many great fortissimo passages for brass, percussion and full orchestra. The orgiastic tarantella finale is taken at such a frenetic tempo it will leave you limp! The "Pines of Rome" is a more contrasting work and explores the dynamic resources of the orchestra. It is unusual in the symphonic literature in that a tape recording (phonograph record in earlier times) of nightingales is used in the "Pines of the Janiculum" section. The final section, "Pines of the Appian Way," is meant to suggest the ominous tread of the Roman legions. These passages show off the great dynamic range of this recording, beginning with pianissimo murmurings from strings,

woodwinds, brass and bass drum. This increases in intensity in a long crescendo, culminating in a stunning outpouring of sound from the full orchestra with pounding tympani, bass drum and the stentorian roar of full organ. Truly, this is one of the most stirring and thrilling finales in all of music. The recording is superlatively clean, with all inner orchestral balances and the spacious acoustic perspectives realistically delineated by Jim Lock, and is one of the most outstanding orchestral recordings currently available. If you have an audio system capable of doing it justice, you are in for a rare musical treat.

Another spectacular recording with a programmatic score is "Taras Bulba" composed by Leos Janacek, on London (LDR 71021). The record also contains his brilliant "Sinfonietta." Taras Bulba is a Ukrainian Cossack folk hero from olden times, and Janacek has written a very colorful score with a quasi-Oriental flavor to depict his hero's adventures.

The recording is wonderfully atmospheric, another Jim Lock masterpiece. Ravishing playing here by the Vienna Philharmonic conducted by Sir Charles Mackerras. Sir Charles uses the original scoring, and the triple-fortissimo finale of "Taras Bulba," with the

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sonority of full orchestra, pealing bells and thunderous organ, will thrill even the most jaded of musical palates.

Unfortunately, space will not permit detailed analysis of the following recordings, but rest assured they are outstanding in their sonic and musical verities:

"Symphony No. 7" and "The Age of Gold Ballet Suite" by Shostakovich. Bernard Haitink conducting the London Philharmonic (London LDR 10015).

"Petrouchka" by Stravinsky. Antal Dorati conducting the Detroit Symphony (London LDR 71023).

"Symphony No. 9" by Mahler. Herbert von Karajan conducting the Berliner Philharmoniker (Deutsche Grammophon 2707125). Multi-mike, but well done.

The following two direct-to-disc recordings are musts for transient evaluation and hi-fi fun and games:

"The Sheffield Drum Record" (Sheffield Lab 14).

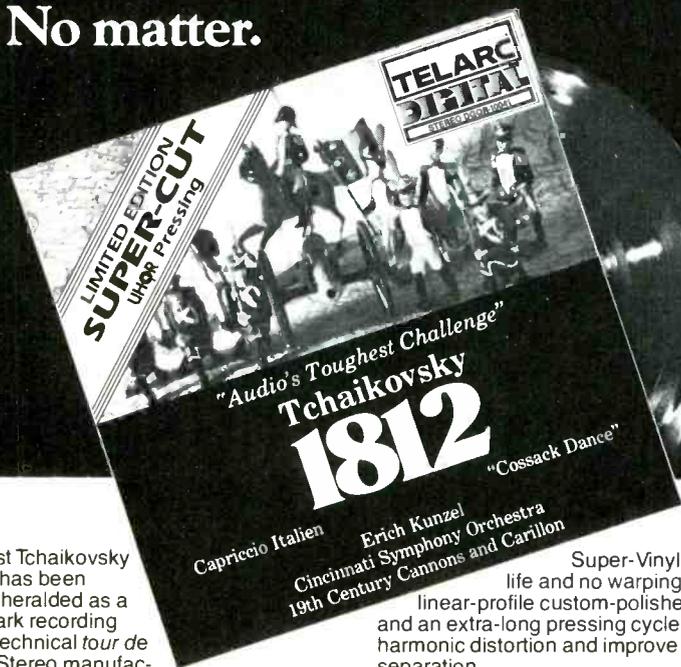
"Hot Stix" (M & K Realtime RT 106).

To ensure optimum tracking geometry and accurate playback of the high-quality discs listed above, a Dennesen Soundtractor alignment gauge would make a great stocking-stuffer gift. Even the most conscientious attention to detail in most manufacturers' instructions for setting up phonograph arms gives you about two chances of its being right—slim and none. The sad truth is that the vast majority of tonearms are incorrectly adjusted. A Soundtractor can get you on track (pun intended), and you will be impressed by how much better your cartridge and recordings sound.

How many times have you sat in front of your loudspeakers, listening to a Dolby B-encoded prerecorded tape, when along comes a pianissimo passage and you become aware of that old demon—tape hiss? The Dolby B circuits are doing their job, but there just isn't enough noise reduction to cope with residual tape hiss, especially if you have a tendency to prefer higher than average playback levels. That is why Ray Dolby came up with the 20 dB of noise reduction in his Dolby C system, but Dolby C is an encode/decode system. What you need is a "single-ended" noise-reduction system that can operate on noise existing in recorded material. That is the function of the DNR-450, a Dynamic Noise Reduction outboard unit manufactured by Advanced Audio Systems International of San Jose, Cal. This \$249.00 unit uses the National Semiconductor LM1894 Dynamic Noise Reduction chip (described in the November 1981 issue of *Audio*). The 450 is a compact 1 1/2 in. W x 2 3/4 in. H x 8 1/2 in. D It has a power switch, a bypass switch, a 10-segment LED audio-bandwidth indicator from 800 Hz to 30 kHz, and a threshold sensitivity control. The rear panel has four RCA phono jacks for connection

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Someday, perhaps, all records will be this good. At Telarc we can't wait. Your boxed, serial-numbered record is ready...whenever you are. **TEL-10041UHQR \$49.95.**

NOTE: You may find the unique new Telarc Demo/Test two-record set helpful in getting the most from your equipment. One side checks tone arm geometry, and a variety of test signals and music helps you judge system quality without test equipment. **TEL-10073 \$29.95**



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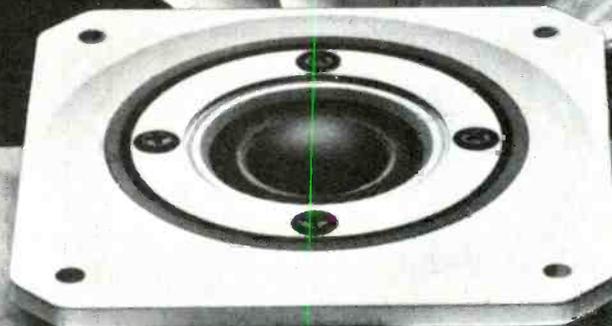
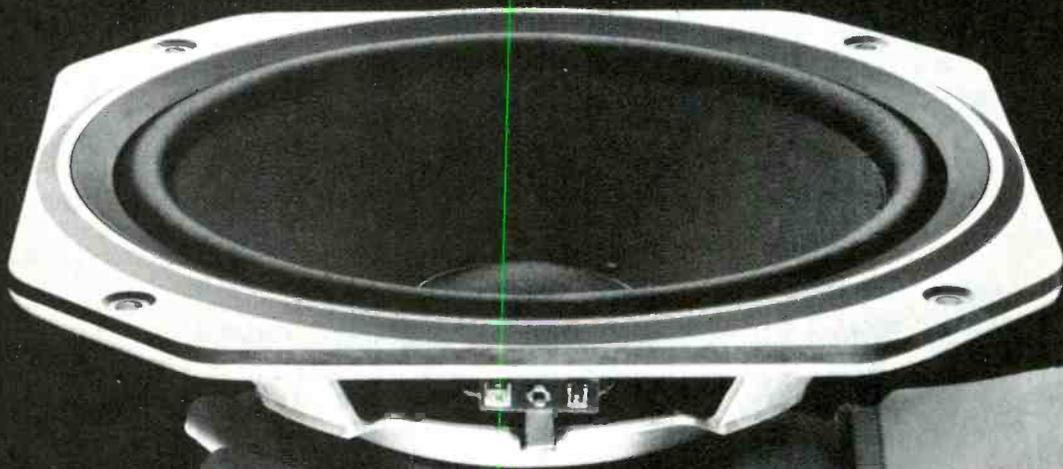
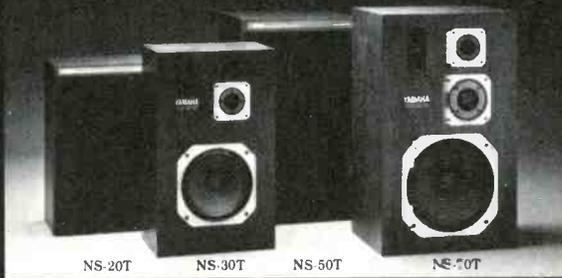
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"How many times have you become aware of hiss in a Dolby B tape? What you need is a single-ended noise reducer."

into a tape loop on preamp or receiver. However, if the unit is to be used with a cassette or open-reel tape deck, the lines from the decks can plug directly into the 450, and the output of the unit can then plug into a high-level input on the preamp. The 450 offers 5 to 14 dB of noise reduction according to the

setting of the threshold control and the audio bandwidth you find acceptable. Used too liberally, it is easy to determine that high frequencies are being attenuated. One quickly learns how to get optimum settings to afford useful noise reduction without sonic degradation. The 450 is especially useful in

cassette playback to get rid of the aforementioned residual hiss. Steady-state surface noise on discs can be reduced somewhat, but there is no improvement in impulse noise. Used properly, the 450 did not exhibit noise modulation effects of any consequence. Distortion levels were very low and the signal clean.

For the "big" Christmas present you give yourself, you couldn't fare much better than the new Technics ST-S8 FM/AM stereo tuner, which is priced at \$500.00. I confess that I haven't used an FM tuner for years, even though I worked with Major Armstrong, FM's inventor, and with Murray Crosby, and supplied these great FM pioneers with stereo tape recordings for their multiplex stereo experiments. One of the reasons I haven't used a tuner is that I have thousands of records and tapes. The other reasons are dissatisfaction with the poor transmission quality of many FM stations, and the almost total demise of "live" classical music broadcasts. I can't truthfully say the situation (at least in New York City) is any better today, but I want to be able to record certain classical works which are unlikely to be made into commercial recordings. Thus, on checking out the Technics ST-S8, I was introduced to the modern FM world of quartz synthesizer, PLL tuners. I must say the sensitivity, selectivity, very low distortion and, above all, the stereo separation of the ST-S8 just amazed me. Such ease of pushbutton tuning with not only digital readout of station frequencies, but at the touch of another button, a digital readout of signal strength expressed in decibels. The latter was a valuable feature with the little Technics SH-F101 FM wing antenna I used. This unit was reviewed in the August 1981 issue of *Audio*, and its effectiveness was startling, even though I live in a suburb quite far from the station transmitters. With the kind of reception quality possible with the ST-S8, it is just a crime we can't have the same ultra-high quality, live symphonic broadcasts exemplified by the BBC in London.

This by no means exhausts the list of recordings, components, and accessories suitable for audiophile Christmas gifts. But if I don't stop now, I won't have time to complete my own shopping! Happy holidays to all. *A*

ANALYZE

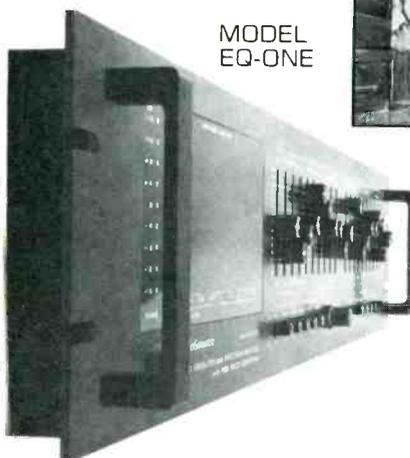
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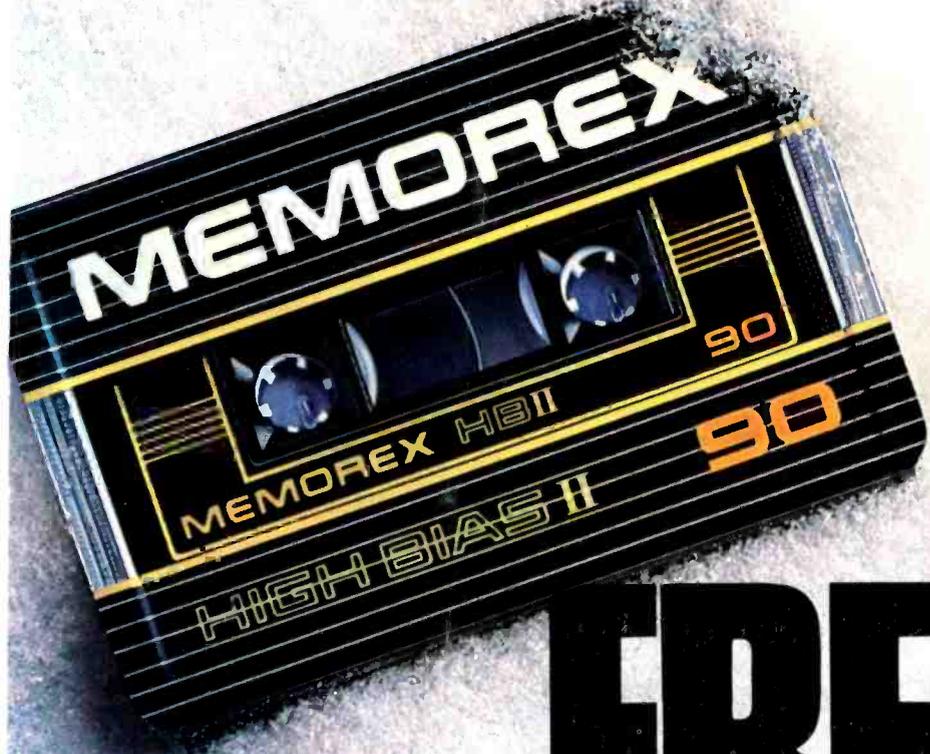
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MICHAEL TEARSON
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BADLANDS OF NEBRASKA

Nebraska: Bruce Springsteen
Columbia TC 38358.

Sound: B- Performance: A-

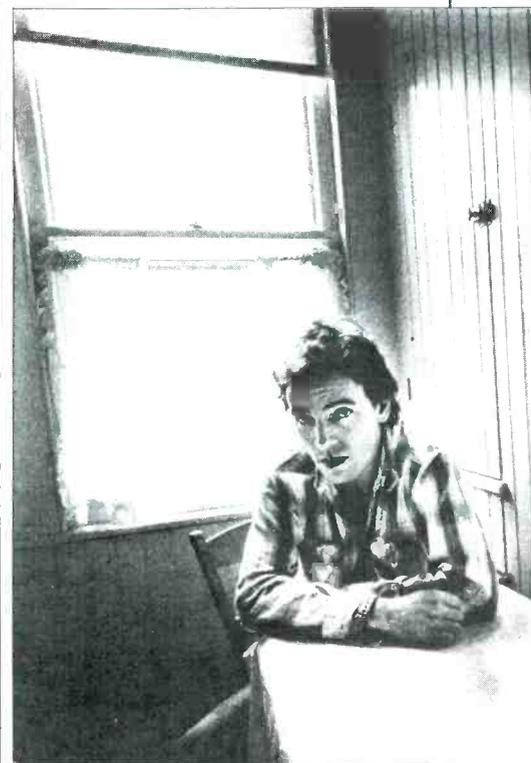
It seems that the hope of the '70s has turned into the pessimism of the '80s: Bruce Springsteen's new album is just loaded with desperation, scenes of death row, and imagery copped from Terry Malick's classic film *Badlands*. One could get a clue that this was coming from Springsteen's appropriation of that film's title for a song on *Prove It All Night* or from the fact that the title song from his last album, *The River*, was much in this gloomy style. What we have here in a nutshell is a pared-down Springsteen primarily playing acoustic guitar and harmonica without the "horn and keyboard wall of Asbury Park" to hide his voice. There's an occasional piano, glockenspiel, electric guitar, or screaming background vocal thrown in for a little color on the canvas, but this is basically a black-and-white scenario.

If that minimalism isn't enough, *Nebraska* was recorded at home on a four-track cassette deck, so you get a little distortion on the voice from time to time. It also sounds like it was mixed down in a conventional studio since there are some outboard effects (reverb and delay to the max) in evidence.

It certainly has to be Springsteen's

most compelling album, if nothing else—for once you get a straight-on view of the guy—but his twisted lyrical stance might cloud the issue of the album's musical/production merits. For the first time on any Springsteen album, you can hear the lyrics, but just so you don't miss the point, they're also printed on the inner sleeve. Most of the songs are written from the point of view of a guy who wants to return to his childhood or a criminal who was a victim of circumstance/society. You'd have to say that this was a pretty strange type of empathy, especially if you consider John Lennon's murder the single most influential event of the '80s. Springsteen's fascination with "The Wild and The Innocent" appears to have become tangled up with the fates of the guilty as well, and he's having some trouble dealing with it—as though he is trying to exorcise some confusion through his art.

As for Springsteen's choice of musical idiom, it's a natural evolution and suits him better in many ways than the overproduced Phil Spector haze he's had to sing through in the past. One would imagine that he'd have done an album of this type sooner had he not been branded as "The Next Bob Dylan" so early in his career. There are bound to be comparisons to Mr. Zimmerman made, even now that Bruce Springsteen has established himself as a force.



Overall, *Nebraska* is a good 40 minutes of music and will probably be compared to Neil Young's *Tonight's the Night*, John Lennon's *Plastic Ono Band*, and *Another Side of Bob Dylan*. This record has more in common with a cinematic vision than a musical one, so it might be that some or all of it will

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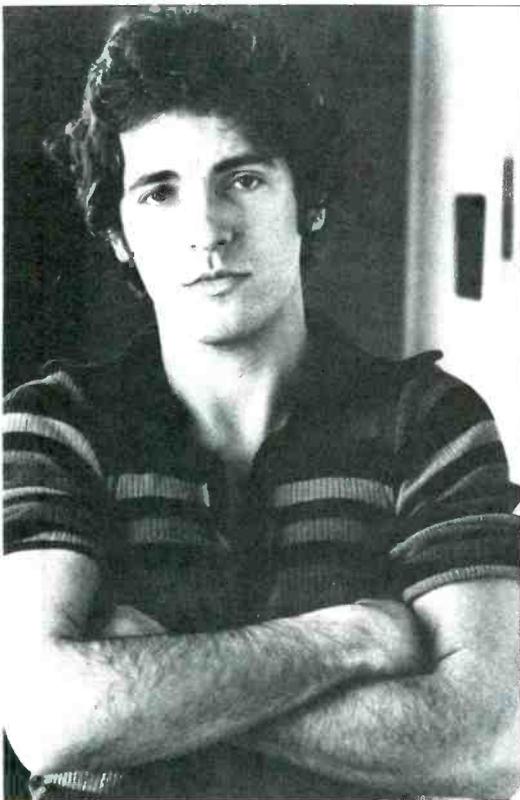


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"Bruce's fans, who fill arenas for the E Street Band, are not going to like the album . . . it's too bleak and downbeat."

wonderful E Street Band and kept his record company and his fans happy. Instead, he made a home movie of an album. *Nebraska* is a solo piece, virtually entirely acoustic, and recorded in a living room on a four-track cassette machine. Not even a reel-to-reel but a blinking cassette! The extra two tracks beyond guitar and voice are used for a second vocal and one extra instrument in most cases. Of necessity and intent, the result is raw and primitive sound; this starkness very much suits the songs.

The cuts on side one are all about desperate, often violent people who have been pushed to the edge. "Nebraska" retells the saga of Charlie Starkweather, a Midwestern lad who picked up his girl and went off with her for a murder spree one day in the '50s. "Atlantic City" begins with word of the Chickenman and his house getting blown up "in Philly last night." That's a real incident. The late Chickenman was a local Mafia chieftain and victim in a long and bloody war that erupted in the wake of Atlantic City being opened up for legal gambling. Side two is more upbeat, but not much.

Springsteen's performances are stunning. He assumes various accents to play out the songs: A nasal Midwest twang for "Nebraska," his own New Jersey drawl for "Atlantic City," an immense weariness for "State Trooper,"

an upstate New York roundness for "My Father's House." However, despite the obviously brilliant songwriting and the great feel of the lyrics (as if he ripped them right out of people's mouths as they spoke them), I must dock points for lyrical laziness as two separate key lines are repeated in two songs. In one case, Bruce differs from the lyric sheet to make the duplication.

Far more serious is the callow disrespect Columbia has given a premier artist of Springsteen's caliber in the technical area. The mike noise and popped Ps are part and parcel of home recording, but the wretched pressing (and mastering?) of the American edition is not. That is the company's doing. Have they sensed the lesser commercial appeal of the project and tried to gum it up? That I cannot say. However, I have acquired a Dutch pressing with only a fraction of the surface noise and vocal distortion of the U.S. version. The difference is remarkable; it lets you hear unintelligible mumbles turned into lyrics. It's still raw, but it is so much more listenable that I must recommend the import to anyone who wants to take this album as seriously as Springsteen intended.

Many of the legion of "Brooce" fans, the ones who fill arenas for the E Street Band, are not going to like this album. It is too bleak and downbeat for them. It doesn't hold out hope to them. That's

be incorporated into a film. One could also wonder why side two clocks in at nine minutes shorter than side one (was a song omitted at the last minute?). But the most obvious thing to do is to just enjoy the record—sort of.

Jon & Sally Tiven

Nebraska: Bruce Springsteen
Columbia TC 38358.

Sound: D Performance: A -

Bruce Springsteen didn't have to do the *Nebraska* album. He could have just made another rock album with his

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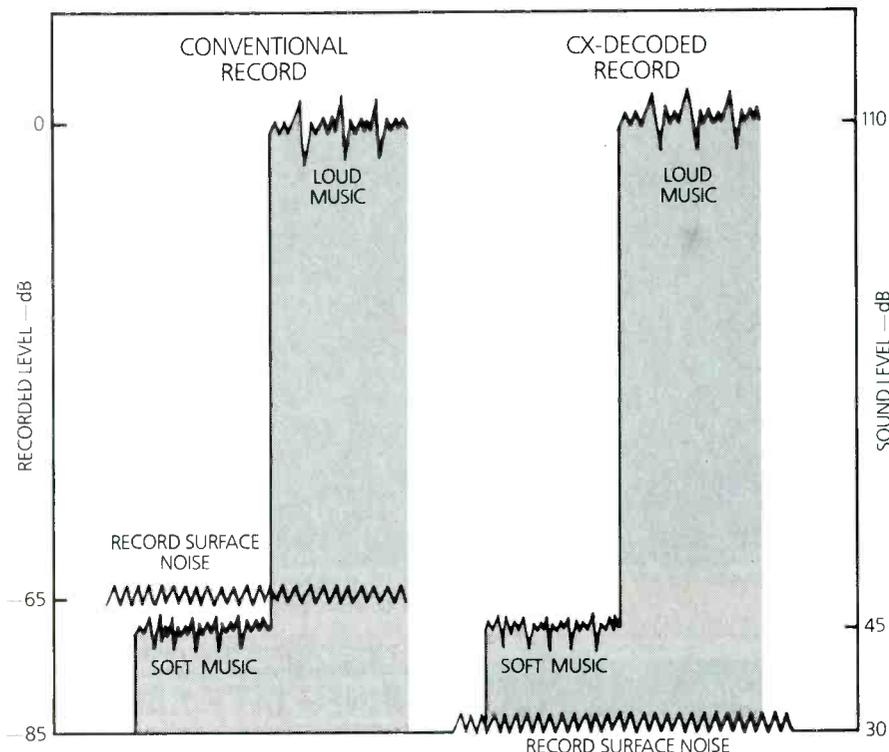
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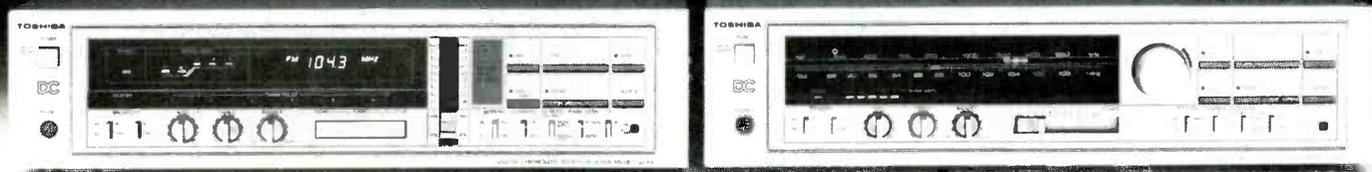
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"The records of Hank Williams, Jr. can't be beat for good spirits laced with conviction and honesty."

their loss. *Nebraska* is a very serious and very courageous album for Springsteen to release. I'm sure it's an album that means a lot to him, and it is full of brilliant work.

In the end, *Nebraska* is an album to separate serious fans from the lemmings. *Michael Tearson*

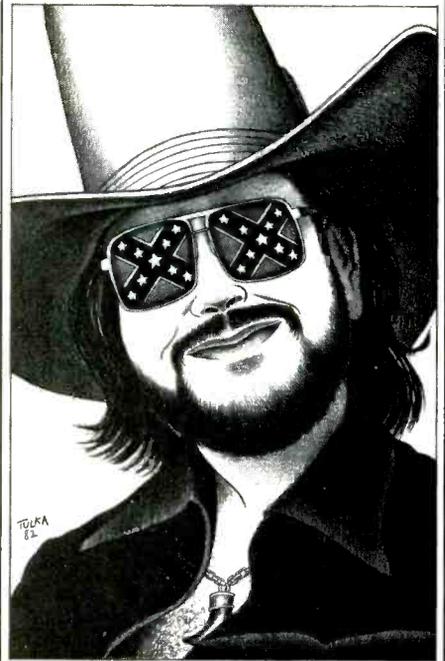


Illustration: Rick Tulka

High Notes: Hank Williams, Jr. Elektra EI-60100, \$8.98.

Sound: A Performance: A

Beginning with 1977's *New South*, Hank Williams, Jr. has churned out eight albums of remarkably consistent quality. The newest, *High Notes*, somehow sounds extra fine, good as any and better than most.

There's the usual amount of rousing good ol' boy spirits with "If Heaven Ain't a Lot Like Dixie (I Don't Want to Go)," "Whiskey on Ice (Women on Fire)," and "The South's Gonna Rattle Again," but as usual there are some surprising wrinkles. Hank's authoritative voice wrangles new and unexpected nuances from "Norwegian Wood" as he takes it somber and straight. And speaking of chestnuts, his version of his Daddy's "Honky Tonkin'" is just plain terrific.

The whole album is played straight and true. There may be the occasional fiddle, but no track is stricken with the

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| 3. Jeff Lorber | <i>Soft Space</i> |
| 4. Dan Siegel | <i>The Hot Shot</i> |
| 5. Sadao Watanabe | <i>California Shower</i> |
| 6. Judy Roberts | <i>The Other World</i> |
| 7. Jean-Luc Ponty/
Stephane Grappelli | <i>Bowing-Bowing</i> |
| 8. Tim Eyeman | <i>Aloha</i> |
| 9. Hiroshi Fukumura | <i>Hunt Up Wind</i> |
| 10. Dan Siegel | <i>Nite Ride</i> |
| 11. Jeff Lorber | <i>Fusion</i> |

MAINSTREAM Side 2

- | | |
|----------------------------------|------------------------------|
| 12. Eddie Jefferson | <i>The Main Man</i> |
| 13. Great Jazz Trio | <i>Love For Sale</i> |
| 14. Cybil Shepherd/
Stan Getz | <i>Mad About The Boy</i> |
| 15. Gerry Mulligan | <i>Paris Sessions</i> |
| 16. Lew Tabackin | <i>Rites of Pan</i> |
| 17. Django Reinhardt | <i>Hot Club of Paris</i> |
| 18. Joe Sample | <i>Round Midnight</i> |
| 19. Roy Eldridge | <i>I Remember Harlem</i> |
| 20. Helen Humes | <i>They Raided The Joint</i> |
| 21. Laurindo Almeida | <i>How Insensitive</i> |
| 22. Buck Clayton | <i>These Foolish Things</i> |
| 23. Abbey Lincoln | <i>People In Me</i> |
| 24. Dizzy Gillespie | <i>Say "Eh"</i> |

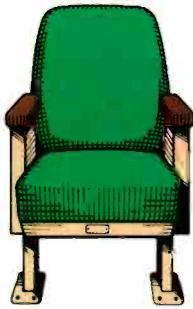
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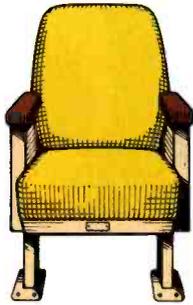
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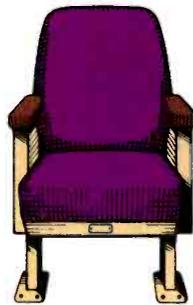
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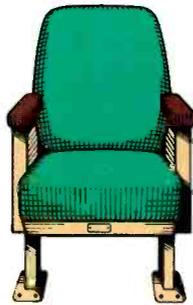
Grand Ole Opry House, Nashville



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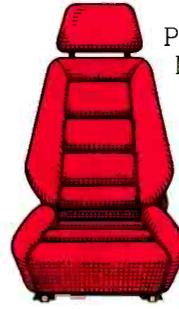


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"Crosby, Stills and Nash are still a class act, but *Daylight Again* is just too cold-blooded to help stalled careers."



Stephen Stills, Graham Nash, and David Crosby

Illustration: Rick Tulka

dreaded string section bog that never sits too well with Hank's gruff presence. The recording is warm and close with super detailing.

The music of Hank Williams, Jr. has been one of my secret pleasures for ages. You can't beat his records for good spirits laced with conviction and honesty.

Michael Tearson

Daylight Again: Crosby, Stills and Nash

Atlantic SD 19360, \$8.98.

Sound: C

Performance: C+

Precious little fanfare accompanied the release of *Daylight Again*, the third CSN album and the first since 1977. So passes time. In '77 CSN's release was still a major media event, but in '82 this new album is nothing more than another piece of plastic.

Daylight Again feels listless, and I suspect a good part of that derives from the album's very motivations. The word is that it was originally intended to be a Stills/Nash duo until thoughts of commercial reality hit them in the face. Neither is exactly 1982's golden boy, and so Crosby was recruited to try to recapture the palpable and special magic the three have only in ensemble. This would explain Crosby's relative invisibility in the harmonies and his getting but two lead vocals to Nash's four and Stills' five. Score another skirmish for Commerce over Art.

Maybe time's passage also accounts for the lack of punch delivered by the songs. To be sure, there are

some glimpses of excellence, but it is significant that the two brightest flashes are both older songs, the '74 vintage "Southern Cross," a previously unrecorded Stephen Stills song, and the title track which interpolates "Find the Cost of Freedom," the flip side of the 1970 single of "Ohio."

The album sounds clean and clear but antiseptic, mastered entirely too cold. Perhaps time's passage has left the production style of 1969's landmark *Crosby, Stills and Nash* behind, as the airy acoustic sound has become updated to a more fashionable and lush '80s mode.

At their best, CSN undeniably remains a class act when they play off each other. *Daylight Again* is just too cold-blooded an album to allow that or to breathe fire into stalled careers.

Michael Tearson

Sippie: Sippie Wallace

Atlantic SD 19350, \$8.98

Sound: B

Performance: A-

Sippie Wallace, now 83, first came to prominence in New Orleans around 1916. She sang sassy, jazzy blues in a mighty voice with unique phrasing. Her first records date from 1923. Eventually, following personal setbacks, she retired from the blues and for years devoted her singing to the Church. In 1965 she was coaxed back to jazz and blues only to fall ill in 1970.

Fate stepped in, as blues aficionado deluxe, Bonnie Raitt, then starting her illustrious recording career, covered

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Sippie Wallace

three Sippie Wallace classics on her first two albums—"Women Be Wise," "Mighty Tight Woman," and "You Got to Know How." All three turned into staples for Bonnie, both as concert items and recordings.

Sippie Wallace's new album was recorded live in the studio one night in February 1982. The band was Jimmy Dapogny's Chicago Jazz Band. They were joined by none other than Bonnie Raitt completing the circle with three duets with Sippie, including a go at "Women Be Wise."

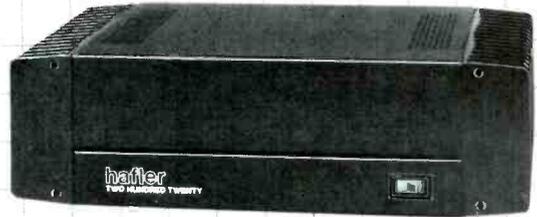
It sounds like everyone had a ball that night, for the album positively sparkles with verve and glee. Sippie is remarkably spunky for 83. Time may have taken some of her timbre, but her voice is still mighty sassy, and she hasn't forgotten a thing about how to use it to bend a note. The Dapogny band is wonderfully sympathetic to the ins and outs of Sippie's blues. They have great chops, too. And the Wallace/Raitt duets are among the year's true recording events. Bonnie's singing is the most relaxed she has done in the studio in years, with a flow and an eloquence all too missing on her recent records.

The album includes new versions not only of "Women Be Wise," but of "Mighty Tight Woman" and "You Got to Know How," too. And classics like "You Been a Good Old Wagon (Daddy But You Done Broke Down)," "Everybody Loves My Baby," and Irving Berlin's "Say It Isn't So." Plus some new Sippie Wallace compositions that can stand toe-to-toe with her classics, especially the ribald "Won't You Come Over to My House (Ain't Nobody Home But Me)," "Up the Country Blues," and "Suitcase Blues."

Sippie is just a purely wonderful album.
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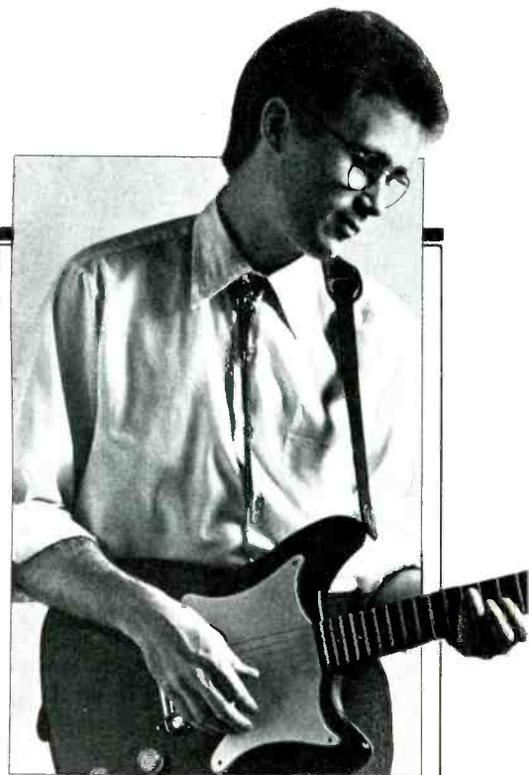
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Marshall Crenshaw
Warner Bros. BSK 3673, \$8.98.

Sound: C — Performance: A —

Entering the ring, with the double-edged blessing/curse of being a critics' darling, is the bespectacled Marshall Crenshaw. Fortunately, Crenshaw has a classic pop song sense that validates the Buddy Holly comparison his appearance invariably provokes.

He makes up songs with finger-popping melodies and smart, understated lyrics. His voice has a combination of cool and yearning, devoid of the petulance or whining of, say, Elvis Costello, and this makes it downright difficult to dislike the guy.

Crenshaw's band is a basic guitar-bass-drums unit with his brother Robert Crenshaw and Chris Donato in the rhythm roles. The arrangements are spare and stated gracefully in the tradition of Holly's Crickets.

Richard Gottherer's production is surprisingly laid-back and under-aggressive for the '80s. A punchier bass guitar and drum sound might have made for a more fashionable album, but its innocence might have been trampled. You give something to get something.

As he is now, Marshall Crenshaw is a polished yet unspoiled natural gem of a writer and a fine singer who can only get better and better with experience. As a debut album, *Marshall Crenshaw* is mighty impressive.

Michael Tearson

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The Beatles: The Collection
Mobile Fidelity Special Edition, 14 discs, \$350.00.

Sound: A+ Performance: A+

The Beatles were a recording industry phenomenon in every sense of the term, and practically every phase of their activity was guided with this in mind. From the first, their records were mastered with a highly subjective ear, and the Mobile Fidelity renderings allow us to hear what we perhaps weren't intended to hear originally: The Beatles' music reproduced accurately, with all the material intact and not quite as much accent on the vocals. A lot is revealed through this process.

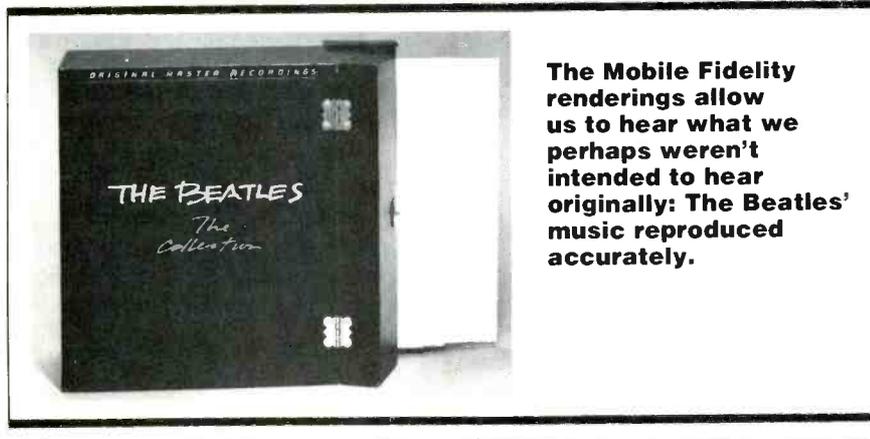
The earliest records by The Beatles represented a tremendous task for producer George Martin: He had two excellent writers and singers, but a band with more instrumental exuberance than chops. There were two ways to remedy this problem, and both were used—de-emphasizing the instrumental portion of the material and, when George and Ringo simply couldn't handle the material, bringing in session players. (Drummer Bernard Purdie and various session guitarists, Cornell Dupree for one, it is reported, were brought in from America.) With the rather amazing separation of tracks afforded on these editions, the differences in sound between the John and Paul with Bernard sessions and those with the rest of the group are readily apparent. One can imagine that the decision to let George and Ringo sing, which greatly helped to establish The Beatles as personalities, was a concession by John and Paul to make up



for their exclusion as players. The characteristic background vocal sound that pervades all Beatles records is even easier to hear on these discs, and on songs like "Boys" there's a real party atmosphere. Also, while producer George Martin's original approach put the emphasis on clarity (as compared to contemporary Andrew Loog Oldham, The Rolling Stones' producer, who buried everything in a swirl of reverb), with these even more accurate reproductions one can hear new things. On "Please Please Me," for example, the echo chambers are brought up at the very end of the song and there's a heavy dose of wetness on the harmonica.

By the time of *Beatles for Sale* (known in America as *Beatles '65*), the group was finally playing their own instruments on most of the tracks, and Ringo's drumming was being disguised with tambourines, acoustic guitars, and anything else available. What was happening was that rock was being invented—the style of playing, recording, songwriting, the works—and though the two main Beatles and George Martin had a fair bead on what they wanted, George and Ringo were pretty much following the leads of their taskmasters. George plays some pretty rank phrases and sour notes—his technique didn't really cover much beyond Chuck Berry and Carl Perkins at this time—and this present disc doesn't mask them the way they were in the past. However, by the time *Rubber Soul* came around, George seemed to have gotten his fingers moving a little more fluidly, and he delivers some genuinely incredible solos ("Nowhere Man"). Incidentally, McCartney was also playing guitar on certain Beatles songs around this time, and it is unclear exactly which parts are whose.

Revolver and *Sgt. Pepper* are often looked upon, respectively, as the bottom and the top of The Beatles' recording career, an unfair characterization which has more to do with sales



The Mobile Fidelity renderings allow us to hear what we perhaps weren't intended to hear originally: The Beatles' music reproduced accurately.

"Not only a joy to listen to, *The Beatles: The Collection* is a fantastic insight into the career of a group that is still a mystery."

than musical content. *Revolver* was ignored because Lennon made some careless remarks regarding the Savior, while *Pepper* was acknowledged a masterpiece because the great public was starting to catch up to The Beatles' psychedeleation. In truth, *Revolver* was a very much better album

with highly developed recording techniques ("Tomorrow Never Knows," "I'm Only Sleeping"), incredible guitar work ("And Your Bird Can Sing"), and the most consistent songwriting and playing on any record by the group. But because of the nature of its experimentation and the fact that the Ameri-

can version of the album left off several crucial tracks, *Revolver* was dismissed and *Pepper* was embraced. Not to denigrate the latter, but *Revolver* was truly the apex as far as a group statement; *Sgt. Pepper* was McCartney's trip (he wrote almost all the songs, played most of the instruments, and dominated the sound).

The White Album was a tasty pastiche of solo albums disguised as a group effort. *Yellow Submarine* and *Magical Mystery Tour* were basic soundtrack albums where each member did his own track for the film, and *Abbey Road* featured a side of The Beatles as a rock band and a side of McCartney playing most of the instruments. Only on *Let It Be* did the group decide that The Beatles was about four people playing together. For all its rough edges it does make a statement about rock 'n' roll, as well as having some fine songs by a group which had pretty much ceased to be a group at least four albums earlier.

The Beatles: The Collection draws the lines more clearly than they've ever been seen before. The ability to distinguish exactly who is doing what is heightened incredibly in this set. There are still times when McCartney's voice sounds like Lennon's and vice versa, but that's because they were aping each other, not the result of the mix-down. This is the whole unadulterated truth, and you can draw your own conclusions.

Mobile Fidelity has, however, made a few decisions that seem a bit imprudent in terms of choice of material. There are several tracks which are excluded due to the disparity between American and British releases. There were no British equivalents of *Something New*, *Yesterday and Today*, and *The Beatles' Second Album*. Thus, songs like "She Loves You," "Day Tripper" and "We Can Work It Out" are not on this 14-disc set. Perhaps Mobile Fidelity could put together these leftovers with "You Know My Name" and other B sides, call it *The Best of the Rest of The Beatles*, and put it out as a two-LP set for next Christmas. For now, *The Beatles: The Collection* is not only a joy to listen to but a fantastic insight into the career of a group that is still a mystery despite all the information in print.

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IVAN BERGER

Delco-GM/Bose WIZARDRY ON WHEELS

**Table I—
Factory specifications for the
Delco-GM/Bose receiver/
tape player.**

<i>Receiver</i>	
20-dB Quieting	1.3 μ V
Stereo Separation	37 dB
Frequency Response	20 Hz to 20 kHz, ± 2.5 dB
Distortion, 1 kHz	0.35%
<i>Cassette Player</i>	
Signal/Noise Ratio, w/NR	63 dB
Frequency Response	31.5 Hz to 14 kHz, ± 2.7 dB
Distortion	Less than 0.24%, 100 Hz to 14 kHz
Wow & Flutter, unwt'd.	0.21%

The gentleman below, named Morgan, is a dummy but an excellent listener. He's the lowest paid employee of the Bose Corporation, but he may be one of the most valuable—certainly one of the most expensive.

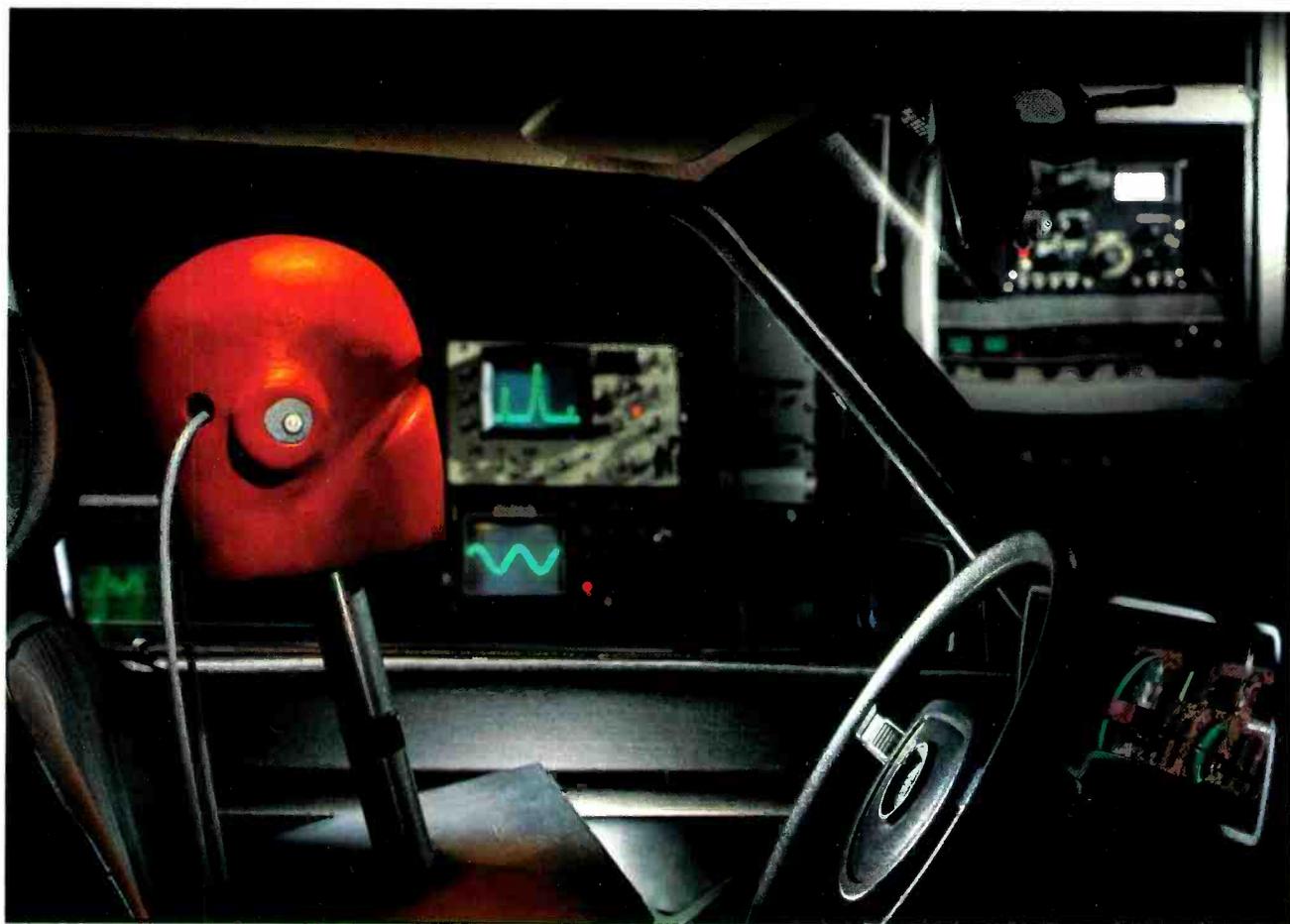
Morgan is the front man for Interval (Interpretive Visual Analysis Language), an extensive, computerized research program used by Bose (with Delco and other divisions of General Motors) to develop a revolutionary new car-stereo system.

What's revolutionary about it is its total systems approach, integrating the acoustical design of the car and the system in a way that can't be done in the home. "It's an engineer's dream," says Dr. Amar Bose, "being able to control all the listening parameters, including source position, listening position and environment. It's the

first time the system and environment were designed together."

To me, the biggest advantage of the new system is its ability to achieve good stereo balance on both sides of the car at once. That's no problem in home systems, where listeners tend to be roughly equidistant from the speakers. But in the car, with listeners far closer to one speaker than the other, conventional balance controls can only give one listener good balance by totally sacrificing it for the listener on the other side of the car. The Delco-GM/Bose system, however, does it with no balance control whatever.

The system's speakers are set far forward of the listeners, and angled so that each is aimed at the passenger on the other side of the car—a setup which owes a great deal to Interval and Morgan. As a result, the sound of the speaker nearest each listener is



attenuated by his off-axis position, compensating for the attenuation of the opposite speaker by distance. Each listener gets a definite stereo feeling, with a lush sense of ambience. Stereo imaging is imprecise, as you'd expect with this arrangement, but the overall effect is far better than one gets in any but the most elaborate custom systems.

The advance Bose lays most stress on, however, is flatter frequency response, achieved through custom-engineered speaker enclosures and custom equalization matched to each model car. This work was mostly by Bose, but it could not have been done without heavy cooperation from GM and a considerable investment in car-stereo research by both companies.

The four speaker enclosures used in each car (Fig. 1) are vented types, each with a volume of about three liters. Each holds a single full-range driver similar to that used in the Bose 1401 after-market car-stereo system—that is, basically a 2-ohm version of the one used in the Bose 901, beefed up to handle such mobile environmental problems as temperature, humidity and vibration.

Each of the enclosures also holds a highly efficient "digital-mode" or "two-state" switching amplifier incorporating special equalization. Efficiency is particularly important in this application, since the amplifiers get little cooling air and cannot use the car structure as a heat-sink.

Car-stereo frequency response depends not only on stereo system but on the car's interior shape and upholstery and on the speaker placement. According to Dr. Bose, "Even a 2-inch change in position is significant."

There are obvious constraints on car design and speaker placement in the car (though GM's Fisher Body Division cooperated with Bose as far as possible), so most of the responsibility for flat response rests with the sound system. The speaker enclosures play a major role here. Car speaker designers rarely have more than a vague notion of the enclosure volume their speakers will work with, or of how much those enclosures will leak through window slots, open-back rear seats and so on. Matched speakers and enclosures for car use have, until

now, been externally mounted mini-speakers, which limits their possible locations. By working with GM's Fisher Body Division, Bose was able to engineer three-liter, tuned bass-reflex enclosures which could be mounted within the car's body panels, and be sure that space would be left within those panels to receive them.

Figure 2 shows the response of an unspecified speaker, both with and without enclosure, mounted in the door of an unnamed compact car. The improvement appears dramatic, with 15 dB claimed and about 17 shown; however, the system is not yet available on compacts (unless you count Corvettes). On larger cars which do offer the system, like the Cadillac Seville, Bose claims a difference of +5 dB at 50 Hz for the enclosure, enough to turn a bass droop into a hump.

Though the enclosure extends the bass, its port does not—at least, not directly. The port is not used in the conventional way, to extend bass frequency response, but only to increase low-frequency dynamic range. In any bass reflex, the port allows more output for a given cone excursion at the frequency to which the port is tuned. "In conventional bass-reflex systems, with larger boxes," says Bose's John Wawzonek, "the resonance of the speaker and box alone would be low enough to give you decent bass response even without a port. Adding a port tuned just a bit below the speaker's resonance in the box extends the response a bit lower.

"But it also increases the bass roll-off below resonance, from the 12 dB per octave of a sealed box to 18 dB per octave. In a larger box, that's a reasonable trade-off. But with a 4½-inch driver in a three-liter enclosure, the resonance is about 90 Hz." Tuning a port to that frequency would give you no low bass at all. Instead, the bass is extended by active equalization circuits in the amplifiers. By 50 Hz or so, however, the speaker is reaching its maximum excursion. That's where the port, tuned an octave below the speaker's resonance, comes in, allowing greater air movement and sound output from the available cone excursion. The result, says Bose, is improved reliability and lower distortion, as well as more bass output.

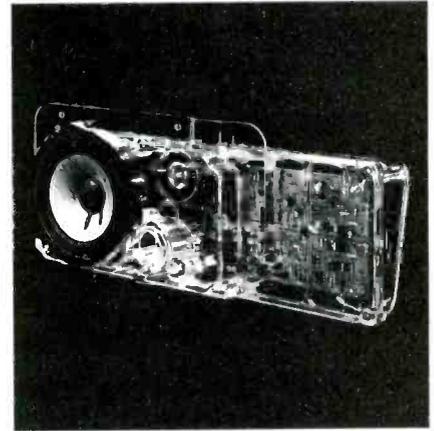


Fig. 1—The tuned, vented, 3-liter enclosures also house 25-watt/channel digital switching amplifiers.

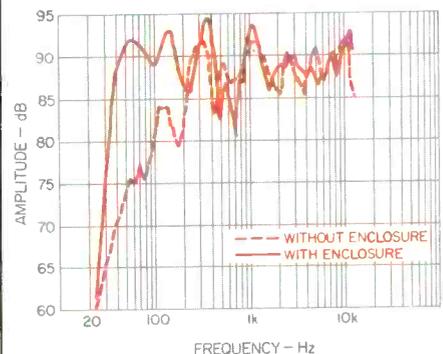


Fig. 2—In a compact car, a tuned enclosure adds about 15 dB of bass at 50 Hz. In larger cars (not shown), there's still a 5-dB improvement.

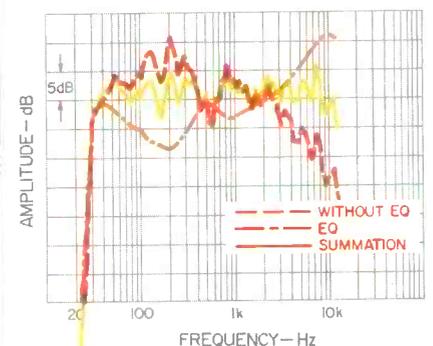


Fig. 3—A typical car's acoustical response (dashed line) can be smoothed by equalization (short-and-long dashed line) into a more even summation curve (solid line).

"The main achievement is good stereo balance on both sides of the car at once—with no balance control."



The amplifier has another advantage, according to its designers: At high volume levels, it compresses more than it clips. (As the Riviera we used for auditioning was well insulated, and I don't normally listen at high levels, I forgot to check this.)

As a result of all these frequency-controlling techniques, the frequency balance was quite reasonable, without the whopping mid-frequency humps so common in car systems. There was less high-end sparkle than on good systems with separate tweeters. Bass was fine for rock and pop, but extreme low notes, such as organ pedal tones, were lacking—as they are for most car-stereo systems without subwoofers.

No user-controlled, multiband equalizer is included. This is "absolutely by design," says Dr. Bose, not only because the system's pre-equalization solves many of the problems people add equalizers to cure, but also because, "In a car, by the time you'd finished fiddling to get the sound just right, you could be on top of a telephone pole." No such equalizer seemed necessary to me either. There are bass and treble controls, nominally flat at their full-on positions. I never felt the need for any treble boost or, indeed, any treble-control adjustment. However, I found it desirable to cut the bass a bit to relieve a slight bass heaviness. [So did I.—E.P.]. According to John Wawzonek, there actually is a bit of boost at the top of the bass control range to allow for the systems which might come off the assembly line needing it (and, I suspect, for listeners who like their bass juiced up a little).

That brings us to where the controls are, and to Delco's part of the system—the in-dash receiver (Fig. 4). According to Dr. Bose, "We realized early on that a project like this would take three companies, one each with expertise in acoustics, in car receivers, and in building the car itself. With Delco and GM, we got the last two together."

But, says Dr. Bose, his engineers resisted his suggestion that they test a GM Delco car-stereo receiver for use in the proposed system. (I can believe that, as Delco never publicly releases specifications, receipt of which audio-

The enclosures also protect the speakers against water drips in doors, damage from objects loaded into trunks, and damage during installation. The drivers in these enclosures have edge-wound, 2-ohm voice-coils for greater efficiency; the amplifiers, naturally, are designed for the low, 2-ohm load.

The amplifiers are "two-state" switching types, and switching amplifiers are extremely efficient. When their transistors are on, they pass maximum current with a minimum of resistance or voltage drop, in which case little power is dissipated as heat. When their transistors are off, they pass virtually no current, and again little power is dissipated.

A switching amplifier's output is basically a square wave from which the

signal is recovered by low-pass filtering. In this instance, the square wave has a frequency of approximately 200 kHz and a duty cycle proportional to that of the input signal. Unlike other switching-amplifier designs, according to Bose, this one includes a negative-feedback loop to control frequency response and distortion.

The equalization built into each amplifier does more than just extend the speaker's bass response. It also corrects for the car's acoustical problems (which can be quite severe—see Fig. 3). Surprisingly, the Interval research program showed that this equalization would have to be different for each car model offering the system (even the Riviera and Eldorado, which share the same basic body shell) and for the front and rear speakers in each car.

"The system took three companies' expertise: In acoustics, in car receivers and in building the car."

philes take as proof of hi-fi intent). He adds, however, that the test results showed the Delco to be the best mobile receiver around. I'm not so sure about this—but I can say the Delco is at least among the better car receivers, based both on my impressions over a weekend's informal testing of a Delco-GM/Bose system in a Buick Riviera and on Delco's in-house laboratory specifications (Table I).

The receivers used with the Delco-GM/Bose system (Fig. 4) share all the features (and presumably some circuits) of Delco's E-2000 and E-2700 receivers with cassette. Those features include bass and treble controls, digital tuning with clock, scan and seek plus manual tuning, memories for eight stations (four AM, four FM), auto-reverse cassette with locking fast-forward and rewind, automatic pinch-roller release when the ignition's off, and DNR single-ended noise reduction.

The only two features obviously added for the new system are in its cassette section—a tape equalization switch and full-time Dolby B noise reduction. Having the Dolby circuits on constantly, without a defeat switch, makes sense; when was the last time you played a non-Dolby tape (unless it was a dbx one)?

The DNR system worked well on FM, AM and tape. Switching it in reduced noise without appreciably softening high-frequency response; I left it in most of the time, even when listening to Dolby tapes.

The system receivers have no balance controls, as we've already seen. The front-rear fader control is also unconventional. Instead of fading out all frequencies, it fades only the upper ones. This shifts stereo localization and apparent loudness towards the front or rear, but without affecting overall power level and bass output.

With the sound faded fully forward, rear-seat passengers get a slightly better stereo image than front-seat listeners, with no annoyance from the speakers behind their heads. The sound field from the rear speakers seems more solid and balanced in some GM models than in others.

Sound and sensitivity struck me as good on both FM (which is fairly common) and AM (which is not). Delco's system for setting station memories

(tune in, pull out the button, press it in again) is more convenient than the separate memory-button system found on many import radios. As with many after-market radios, there is no stereo/mono switch; automatic circuits gradually fade the stereo separation and decrease high-frequency response as the station fades into the distance. Signal overload was not a problem in the midtown New York areas where I normally test for that. I heard no wow and flutter, even when traversing bumpy roads. No ignition noise was heard, on AM or FM [except during our acid test for sensitivity—a trip through the Lincoln Tunnel between Manhattan and Union City, N.J. The receiver's ability to pull in stations going into and out of the tunnel has been equalled by only one other receiver, a portable, which had substantially worse noise performance.—E.P.].

Behind all these developments lies an extensive, computerized research program, using Morgan and Interval. The signals picked up by Morgan's microphone ears are analyzed by the Interval computer program, using fast-Fourier analysis for frequency response, and "interaural cross-correlation" to measure the similarities and differences in time and amplitude between the sounds reaching each ear. The human ears and brain, say Bose researchers, carry out similar cross-correlations.

All measurements taken by Interval are stored in digital form, allowing for future analyses not foreseen at the time of the original tests. The system allows for remote sensing, too, so that what Morgan "heard" at Delco and Chevrolet test facilities in Michigan was simultaneously recorded and analyzed by computers at Bose in Massachusetts.

Ordering the Delco-GM/Bose systems in place of the standard radio system will add \$895 to the base cost of the car (just over \$15,000 for a Toronado). But the total cost of the system is higher (\$1,125 in the Toronado's case), counting the saving you eschew by not ordering the normally radio-equipped car with no sound system at all. The systems will be available only in the U.S. and Canada, and in a few of the cars GM exports to other countries. Versions for smaller



Fig. 4—The matching Delco receivers have both DNR and Dolby. Note the absence of a balance control.

GM cars are likely, but not this model year.

There's no possibility that Bose will develop similar systems for other car makers, at least as long as they're working with GM. "We have to work so far in advance," says Dr. Bose, and "we know too much about GM's cars to work with other manufacturers." Other companies could, however, work up similar approaches.

Installing similar systems in existing cars might be possible, but only on an expensive, custom basis. Even assuming an installer had the computer equipment and expertise to perform similar analyses on individual cars, optimum speaker enclosure and placement might not be possible in many cases. In my own Saab, for example, the space where the front speakers would go in the Delco-GM/Bose system is occupied by the window crank and its associated mechanism. Even the cars for which the system is available will offer it only as a factory-installed option, since it requires a specially designed, specially routed wiring harness, according to GM, to avoid interference problems.

This much is sure: Morgan was the only one associated with this project that you could call a dummy. *A*

the only component you
can't replace:

EARS

SIMEON COSTA

Unless ears translate a sound wave, it remains nothing more than a mass of vibrating air, no matter whether the wave is bass or treble, loud or soft, instrumental or vocal. And if that sound is distorted or lost in the mysterious chambers of your ears, there isn't much point in investing time and money to achieve "perfect" sound. All of this is good reason, even while you are engrossed in the superb performance of the latest turntables, receivers, equalizers and speakers, to pay some attention to your personal hearing components.

The two ears you started out with are the only ones you will ever have. Should anything happen to this original equipment, your friendly stereo dealer won't be able to supply replacements. What's more, even though modern microsurgery sometimes can do such amazing things as reattach arms and legs, there is no way to repair one of the most common types of ear damage that causes hearing loss.

This limiting of ears to two per customer might not be anything to be concerned about if we didn't have an oversupply of ear troubles. More than 16-million Americans already have defective hearing. And the longer we live, the more likely we are to develop substandard hearing. According to U.S. government figures, the incidence of impaired hearing grows from about 36 per 1,000 at ages 45-54, to 64 per 1,000 at ages 55-64, to 125 per 1,000 at ages 65-74, to 262 per 1,000 at ages above 70.

Of particular interest to audiophiles is that when hearing goes haywire in

middle age, the capability most often affected is the ability to hear high-pitched tones. There are no statistics on the number of people 30 and older who no longer are able to hear higher frequencies properly and make the critical tone distinctions required to appreciate high-fidelity music. From every indication, however, it seems that a big slice of the U.S. population suffers from this peculiarly annoying kind of hearing loss. Stereo owners hate to admit they have a problem that no amount of equipment upgrading can correct, but one slightly gray-at-the-temples audio buff was heard to say, "By the time I could afford the very best in sound equipment, my hearing was too far gone for me to enjoy it!"

That's the bad news.

The good news is that you can protect your precious ears and greatly increase the odds that your hearing will be okay even after you are collecting Social Security. Also, improvements in hearing aids are helping some people hear the sounds of stereo better.

The basic problem with the human ear is that it is a very old model. There have been no changes in the fundamental design for millions of years. Your auricles (external earflaps) may be less hairy than those of your prehistoric ancestors, but otherwise your ears duplicate ones worn during the Stone Age.

At the time the original Mark I human ear was designed and approved for production, environmental conditions and lifestyles differed considerably from those of today. For example, there wasn't too much noise in the pri-

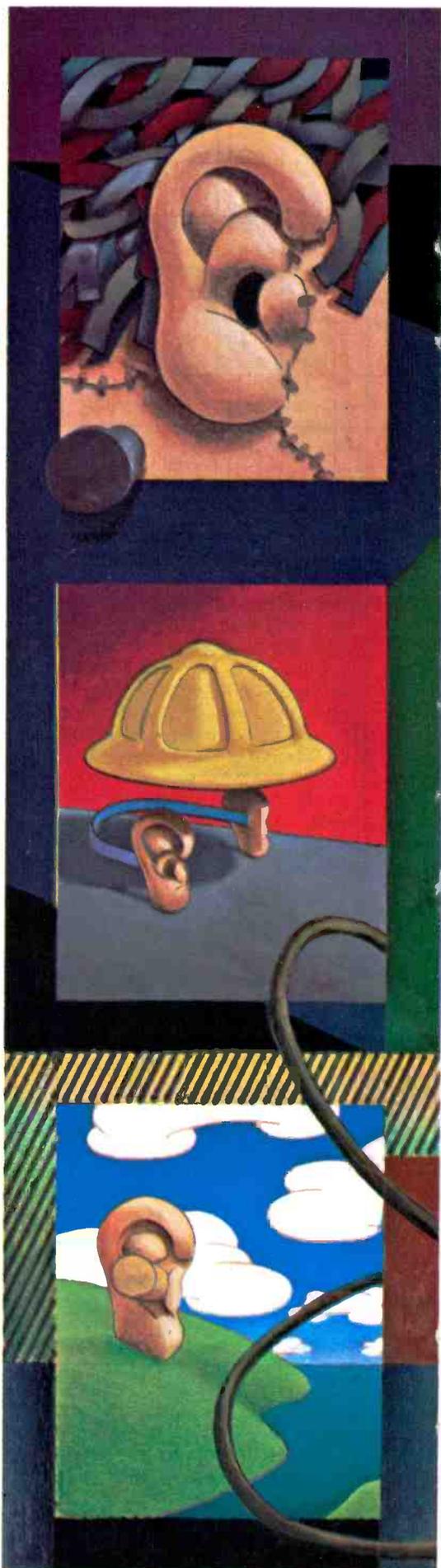
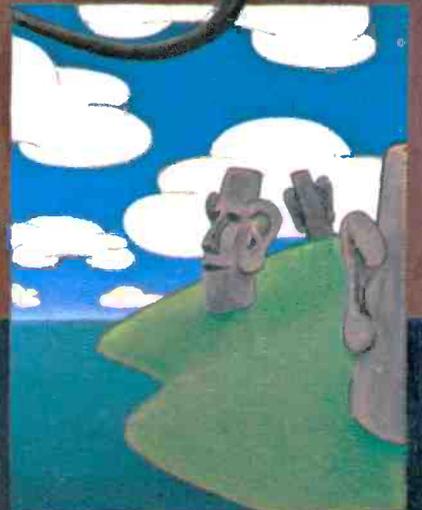
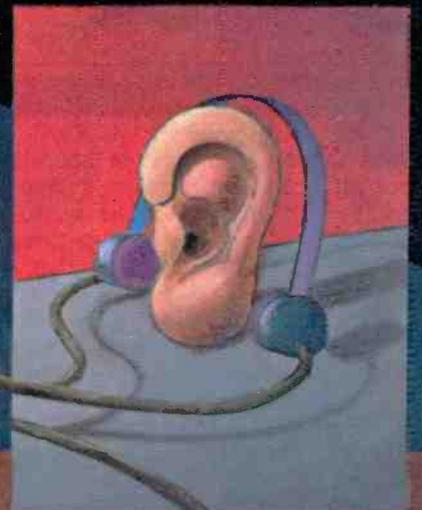
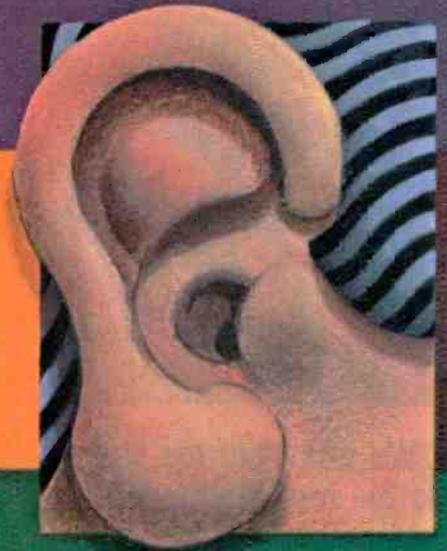


Illustration: Bart Stabler





“We often get too close to the high-frequency noises created by turbo-jet engines, high-speed tools, and other devices that assault the ears.”

meval forests. The loudest sounds were an occasional clap of thunder and the screams of animals or humans. Nobody was cutting up trees with a chain saw or racing around in a snowmobile.

Loud and *continuing* noise can damage hearing beyond repair by destroying some of the 30,000 “hair cells” or nerve endings in the inner ear. These actually convert sound vibrations into neuroelectrical energy for transmission to the hearing center of the brain. Once damaged, these cells are gone for good. They never grow back!

The Mark I ear—the kind you are currently wearing—is equipped with some built-in, although limited, protection against thunderous noises. Any loud, sudden bang causes a reflex action in two tiny muscles located in the middle ear. The *tensor tympani* contracts and stiffens the eardrum so it can’t vibrate as freely as it normally does. And the *stapedius* muscle pulls on the little *stapes* (stirrup-shaped) bone which more or less immobilizes the movement of the little chain of bones that transmits sound from the eardrum to the inner ear. The overall effect is to reduce the transmission of sound and shield the delicate nerves of the inner ear.

This muscle-reflex action, while a kind of Rube Goldberg engineering, probably gave adequate protection in quiet, prehistoric times. Thunderclaps are relatively infrequent and come at

longish intervals, so the little ear muscles received an opportunity to rest between bangs. Today, however, things like engines and rivet guns bang, bang, bang hundreds of times a minute and for long periods. The tiny *tensor tympani* and *stapedius* muscles become tuckered out in a few moments and leave the ear wide open to a flood of destructive decibels.

Another shortcoming of the Mark I protection system is that it does little to shut out high-frequency sounds. This was of no great importance to early man who probably was careful to keep his distance from such high-pitched noises as the scream of a saber-tooth tiger. Besides, anybody who found himself inches from the mouth of a screaming carnivore probably never got to the tribal otologist to be checked for possible impairment of his hearing. Today we are not involved with saber-fanged felines, but we often get too close to the high-frequency noises created by turbo-jet engines, high-speed tools, food blenders, air-circulators and other modern devices that assault the ears.

You can work or play in a noisy environment—if it isn’t too bad—for a limited time and suffer only a temporary loss of hearing acuteness. But sustained noise levels of 85 dB (some authorities put the danger line at 75 dB) or more are hazardous to human hearing. Noisy city streets with blaring automobile horns can develop upwards of 80 dB, and subway stations have been metered at levels over 110 dB when trains were pulling in and out.

Finally, your obsolete Mark I ears have no built-in protection against the extreme “impact” noises of civilization—such as gunfire, firecrackers, blasting, huge gongs and church bells (when close up), super-foghorns and a whole catalog of industrial bangs and shrieks. In addition to destroying nerve cells, the implosion of literally ear-splitting sounds actually can split eardrums and dislocate or fracture the internal ear bones.

When and if genetic engineers get around to redesigning the human ear, some important changes would be highly desirable. Certainly the Mark II ear should offer far better noise protection than the current model.

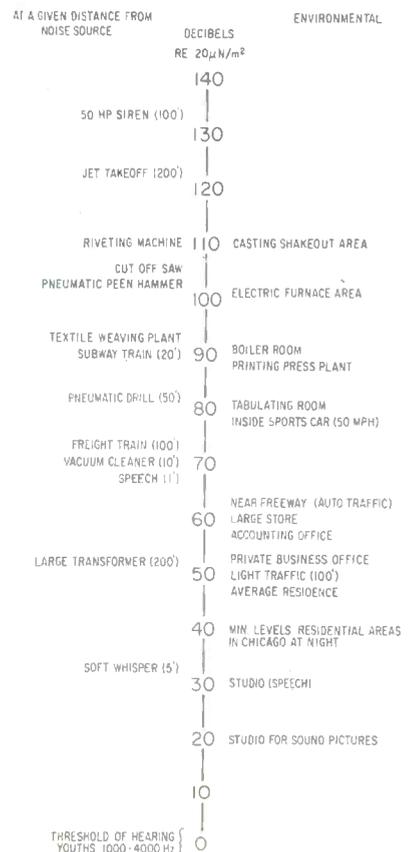
One way would be to develop extended and movable auricles. These would resemble the hanging earflaps found on some breeds of dogs, but would incorporate voluntary muscles under the control of the individual. Upon entering a noisy area, the flaps could be fully or partially closed, de-

pending on the volume of sound encountered. This volume control would be particularly valuable at rock concerts and disco palaces, where it is desirable to admit some sound, but not the full impact of high-decibel music which has proved hazardous to hearing.

Promising as biological earflaps might be, their possible future development offers nothing to us today since we must make do with standard Mark I ears for the rest of our lives. Fortunately, there are two immediately available methods for protecting hearing from excessive noise.

One is through government action to eliminate or reduce noise pollution through regulatory control in certain places—industrial plants, city streets, public buildings, etc. The U.S. Environmental Protection Agency was empowered by the Noise Control Act of 1972 to develop criteria with respect to

TYPICAL A-WEIGHTED SOUND LEVELS



Typical modern sound levels, in dB relative to threshold of human hearing. Sustained noise levels above 75 to 85 dB are dangerous to the ear. (From the Handbook of Noise Measurement by Arnold P. G. Peterson and Ervin E. Gross, Jr., published by General Radio.)

noise. These criteria form the basis for regulations which already have been put into effect in many places, and a great deal of ear-destroying din has been hushed. Where the nature of a process is such that it cannot be quieted—certain types of metal stamping, for example—companies are required to furnish ear protection to be worn by employees when working in the noise areas.

There are, however, limits to what government can do. It is impossible for any government agency to police every snowmobile, outboard motor, home workshop tool, vacuum cleaner, kitchen appliance, and other possible noisemaker after it leaves the factory. A moped, for example, might be equipped with an engine muffler that reduced noise to an acceptable level, but there is no certainty that the owner will replace this muffler should it become ineffectual. In fact, speed enthusiasts have been known to gut mufflers of automobile and motorcycle engines to obtain more varoom.

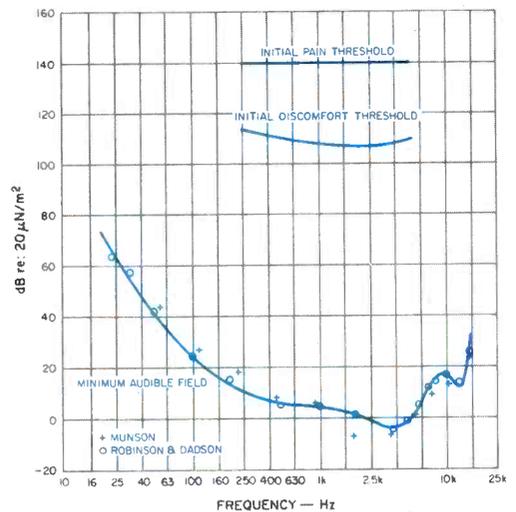
Since government cannot control every source of noise, a great deal of ear protection must be left up to the individual. Common sense tells you to avoid noisy places as much as possible—or, at least, keep your distance from the heart of the noise. The nerves in your ears can be damaged by excessive decibels, irrespective of whether said decibels are produced by a fascinating rock group or by an iron worker demolishing an old boiler with a sledgehammer.

For protection from noise that can't be avoided, it is a good idea to get a set of earplugs and/or headphone-type mufflers. Noise plugs look something like rubber swimming plugs, but are specifically designed to block sound waves rather than keep out water. Some are ready-made and others are custom-fitted. Earplugs are quite inexpensive and usually available at drug stores, hearing aid dealers, sporting goods stores and gun shops. (Hearing protection is a must for target shooters!)

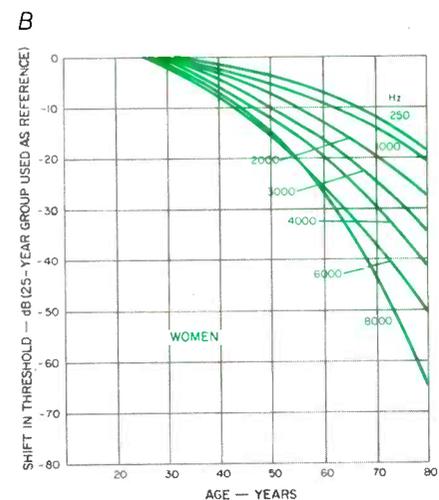
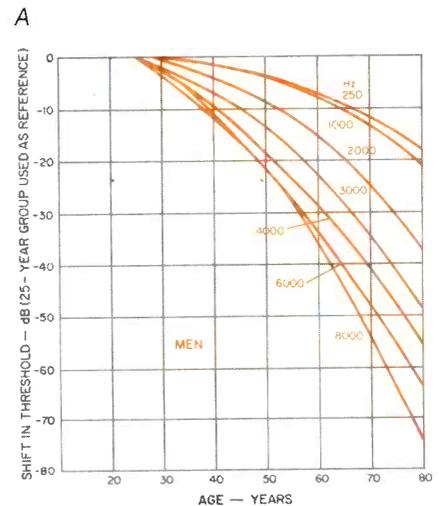
Earmuffs, which look like stereo headsets, give the best protection but aren't quite as handy to carry around. The latest models are held in place by a flexible steel band that goes around the back of the head instead of over the top, so they don't interfere with wearing a hat or cap.

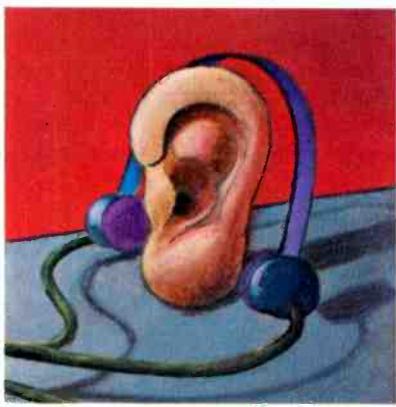
Protecting your hearing actually is no more difficult than protecting your eyes with sunglasses or safety goggles—and is just as important. After a while, you make it a habit to insert your

Hearing threshold and tolerance vs. frequency: ISO standard curve, compared with measurements by Munson (1933) and Robinson and Dadson (1956) on subjects under 25 years of age. Note that the ear is most sensitive at mid-frequencies. (After the Handbook of Noise Measurement.)



How hearing sensitivity declines with age for men (A) and women (B) at specific frequencies. (After the Handbook of Noise Measurement.)





“Nerves in the ears can be damaged by excessive decibels, whether produced by a rock group or a worker with a sledgehammer.”

earplugs or put on your earmuffs before tuning an engine, operating a power tool, shooting a firearm or exposing your ears to any other type of hazardous noise. While you are guarding your own precious ears, don't forget ear protection for your kids—particularly when they mow the lawn with a noisy gasoline mower.

The current human model ear is water-resistant but not truly watertight. When you go swimming, there is nothing to stop water from getting into the outer ear canal. Normally this does no harm, since the water can't get past the eardrum. However, it can get into the middle ear via the nose and Eustachian tube that leads from the throat to the middle ear. This doesn't happen very often, and even when it does a few drops of *clean* water are not likely to create any problems. It usually just drains out.

Only after mankind managed to pollute the rivers, lakes, ponds and even the oceans he swims in, did the lack of waterproofing in the Mark I ear prove a serious design defect. Various unpleasant fungi and bacteria now get into ears, sometimes with dire results. The invention of the surfboard, high-diving board, and scuba equipment has also subjected human ears to buffeting and pressures not anticipated in the original design.

The ears of whales and dolphins are protected because they have no external openings. Birds, too, many of which are aquatic, have completely

enclosed ear structures. However, the breeding of an "earless" human race would be a formidable task, even for the most ingenious geneticists, so the practical solution to the swimming problem lies elsewhere. If there is the slightest suspicion that a body of water is polluted, it is best not to swim in it. Since practically all water on this planet is marginally suspect these days, it is always a good idea to use swimming plugs. Should water still get into an ear, lie on your side for a few minutes and let it drain out. With these simple precautions, a case of "swimmer's ear" is less likely.

Ears, like other parts of the human structure, are complicated arrangements of flesh and muscle tissue, bones, nerves, blood vessels and fluids. Most of the time, ears work fine—but they can get out of kilter. When an ear is in trouble, it sends out distress signals. These signals may be an ache or stinging sensation, ringing (*tinnitus*), a stuffed or dull feeling, dizziness or loss of hearing.

Should you or anyone in your family experience any of these symptoms, immediately arrange to see a doctor. The trouble may amount to practically nothing—like an accumulation of ear wax. (Don't ever try to remove wax yourself!) Or it could be an infection, tumor or special ear problem. These are always serious because they can lead to a loss of hearing. Fortunately, thanks to antibiotics and surgery, many ear sicknesses can be cured if treated in time. Never give a minor ear problem a chance to become a major hearing defect. Only an ear specialist can tell if a person's hearing has gone bad, in what ways, and how much of the lost hearing can be restored. Every ear problem must be evaluated and treated on an individual basis.

Some types of hearing loss can be corrected surgically. For example, occasionally the little stapes bone in the middle ear becomes rigidly fused in place. By replacing it with a metal or plastic "bone," the surgeon can put the ear back into service.

On the other hand, one of the most prevalent kinds of hearing loss is not curable by surgery. That is the loss caused by damage to the hair cells or nerve endings in the inner ear—often the result of exposure to noise. Fortunately, this type of hearing deficiency often can be offset with a hearing aid.

Although hearing aids have been around for many years, most people seem to know very little about them. Unless somebody in your family uses one, you are likely to think of a hearing

aid in terms of a black box hanging around the neck and attached to an earpiece by a tube or wire. This kind of hearing device has about the same relation to a modern aid that a hand-wound gramophone has to a modern stereo system.

Today's hearing aids utilize space-age electronics. Their tiny receivers, amplifiers, speakers and batteries can be packaged in cases that may fit entirely within the outer ear, may be located "over-the-ear," or concealed in the temple of an eyeglass frame. The chest-worn black box is used only for nearly deaf people who require extremely powerful amplification.

The primary purpose of a hearing aid still is to enable those with a hearing loss to hear and understand speech. Early aids accomplished this with simple amplification, but in recent years a measure of what might be called "tone control" has been built into hearing aids to meet the special needs of individuals. Those who have lost some of their ability to hear high- or low-frequency sounds can be provided with an aid that emphasizes the upper or lower range of pitch. There are practical limitations to how much selectivity can be employed, but even a relatively small adjustment in pitch amplification can be of tremendous help to the music lover.

Perhaps the best news to audiophiles is that for some years now hearing-aid designers have been improving the sound fidelity of their products. Dr. Mead C. Killion, senior engineer for a prominent product development organization in the hearing-aid field, writes, "Some of today's *production* wideband hearing aids have a fidelity that would have been considered near miraculous 10 or 15 years ago."

Whether or not a hearing aid will restore an ability to hear and appreciate music is not something that can be promised. Ears and ear conditions vary greatly with individuals. The only way somebody with deteriorated tone perception and hearing can determine how much a hearing aid will help in the music area is to try it. This means consulting with an audiologist who dispenses hearing aids, telling him about your concern with sound *quality*, and arranging to try one or more aids on an experimental basis. It could turn out to be a waste of time—and a few dollars. On the other hand, you might open the door to full enjoyment of your high-fidelity sound equipment now and for many years to come. There could be a lot of good listening left in those old Mark I ears!

▲

Christmas Buying Guide

A handful of holiday hints for the household hi-fi
hobbyist description overleaf.



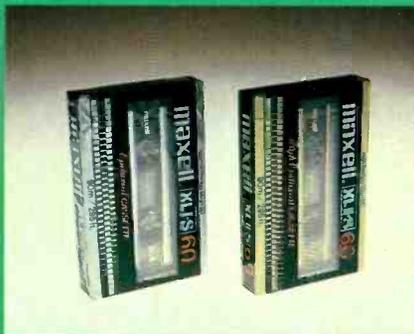
Photograph: Robert Lewis

Christmas Buying Guide



Kenwood KH-7S phones are an Audio-tested lightweight delight with personal portables. The foam crushes slightly to secure the driver within the ear, and it can be worn all day without discomfort. Available at retail for about \$25.00.

Additional cassettes are always a gift welcomed by the audiophile who's into recording particularly where the cassettes are top-rated like these XL I-S and XL II-S tapes from Maxell. List price varies with length there is generally a discount at retail.



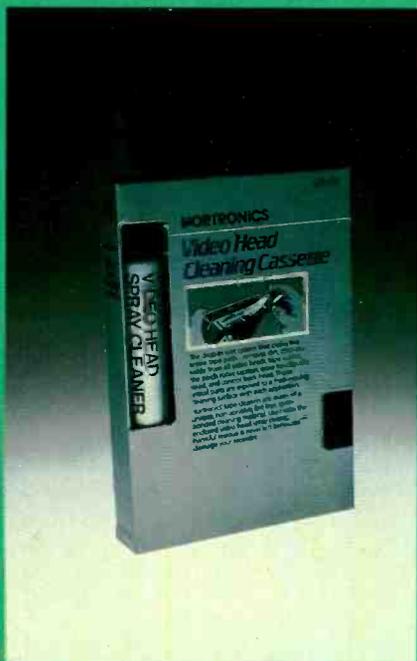
Nortronics VCR-130 is a drop-in type of cleaner for video recorders using a nonabrasive, wet technique to clean the entire tape path. All parts are exposed to a fresh, moving cleaning surface with each application. List price is \$30.00.



The DiscHandler, from Discwasher, provides a sure means to move discs from album jacket to platter without any possibility of scratches or fingerprint contamination. Available at retail for about \$10.00.



Records, good ones, are a joy to every audiophile, and here are four we find excellent: *Mozart Piano Trios*, Centaur CRC-1C05; Peter Serkin, *Chopin Program*, RCA Red Seal ARC1-4356; *Brahms First Symphony*, Szell with Cleveland, CBS MY 37775; *The Organs of Oberlin*, Gasparo GS-217.



Niles Audio's CPM-31 component patching matrix adds up to five additional tape decks, equalizers, signal processors, etc. to any hi-fi system. Just flick a few switches for any patching arrangement. Available for \$179.95 direct (P.O. Box 160818, Miami, Fla. 33116) or through dealers.

AKG's RCB-1 record-cleaning brush is said to contain one million carbon fibers, each just 0.0003 inch in diameter. Whether there really are a million or not, we can attest that the brush does a good job of clearing loose debris from the groove. Available at retail for about \$15.00.

Originally used to conserve space in delivery vehicles and warehouses, these wooden boxes fold to just 1½ inches thick, yet are sturdy enough for records or stereo gear. One-bushel size shown is \$21.46; two lines of type cost \$3.50. Hubbard Folding Box Co., Box 09, Downing, Wisc. 54734.



The A40s from Boston Acoustics are excellent small speakers to our ears, bearing comparison with anything its size, whatever the price. Their list is \$75.00 each. Boston Acoustics, 130 Condor St., East Boston, Mass. 02128.

Stanton's SC4 stylus-cleaning system includes a specially formulated fluid, which is safe yet effective for its purpose; a cleaning brush, which is dense enough to control penetration of the stylus, and a 5X magnifier for easy examination. Available at retail for about \$7.95.



Allsop 3 Ultraline cassette head-cleaning unit provides a unique scrubbing motion, making use of a gear system driven by the deck itself to move tiny felt pads across the heads. Available at retail for about \$9.95.



Mi-Fi MPS-6300s are micro speakers with a 3½-watt IC amp built in, and they make Walkman-type portables into desk-toppers. The speakers are \$109.00 per pair, including a.c. adaptor, from microFIDELITY, Dept. A, 205 Liberty Square, Norwalk, Conn. 06855.

1

CARVER TX-11 STEREO FM TUNER

Manufacturer's Specifications

Usable Sensitivity: Mono, 11.3 dBf; stereo (with/without special circuitry), 16.3 dBf/34 dBf.

Fifty-dB Quieting Sensitivity: Mono, 16.1 dBf; stereo (with/without special circuitry), 21 dBf/37 dBf.

S/N: Mono, 82 dB (@ 85 dBf); stereo (with/without special circuitry), 74 dB/74 dB (@ 85 dBf).

Stereo Separation (Wideband I.f.): (With/without special circuitry) 45 dB/45 dB @ 1 kHz, 30 dB/36 dB @ 100 Hz, and 15 dB/36 dB @ 10 kHz.

Alternate Channel Selectivity: Narrow, 90 dB; wide, 35 dB.

Capture Ratio: 1.0 dB.

AM Suppression: 50 dB, 65 dB with special circuitry activated.

Image Rejection: 110 dB.

I.f. Rejection: 110 dB.

Spurious Rejection: 110 dB.

Power Requirements: 120 V a.c., 60 Hz, 15 watts.

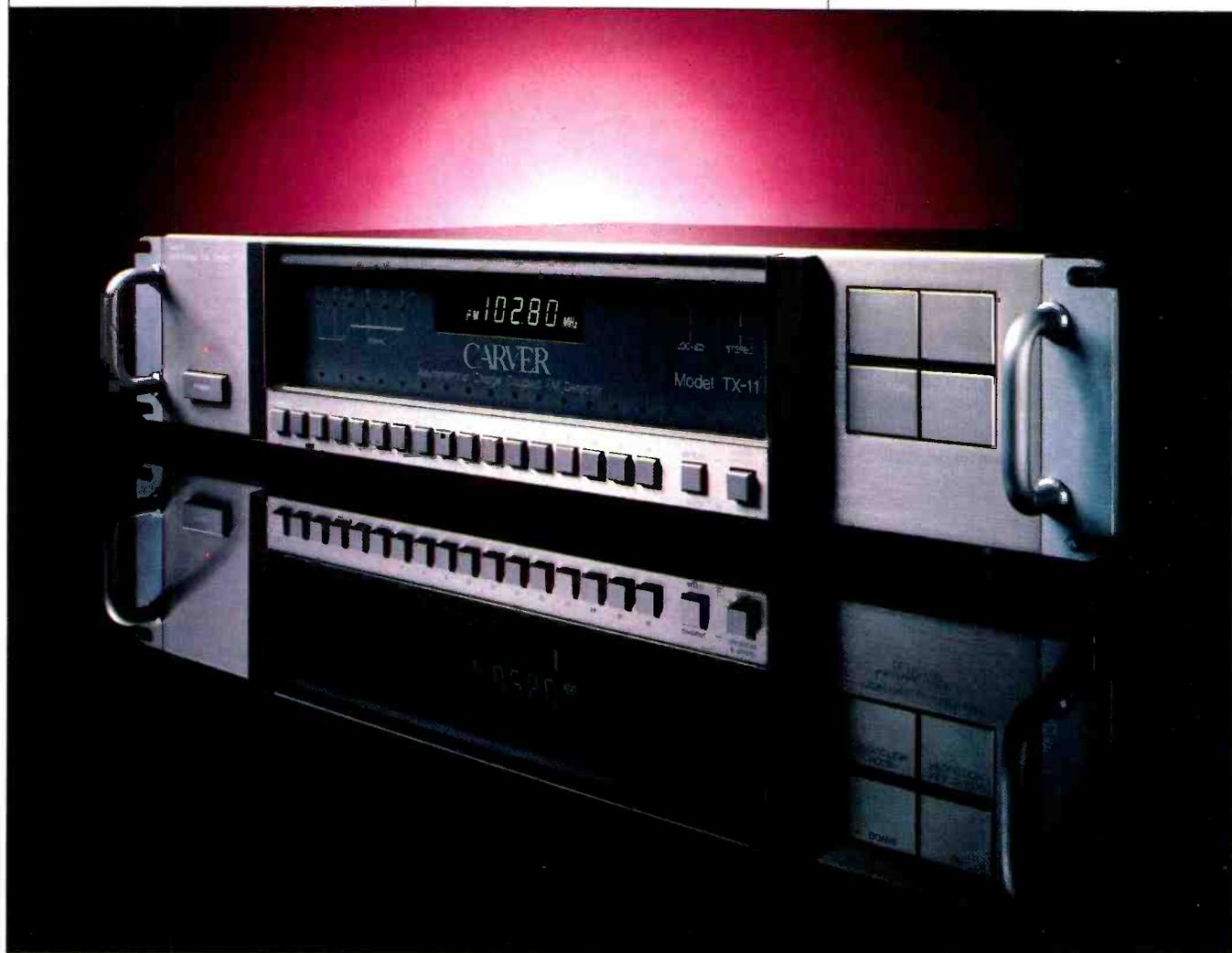
Dimensions: 17½ in. (44.5 cm) W x 3½ in. (8.9 cm) H x 12½ in. (31.8 cm) D, less rack-mount hardware.

Weight: 11¼ lbs. (5.1 kg).

Price: \$549.00.

Company Address: P.O. Box 664, Woodinville, Wash. 98072.

For literature, circle No. 90



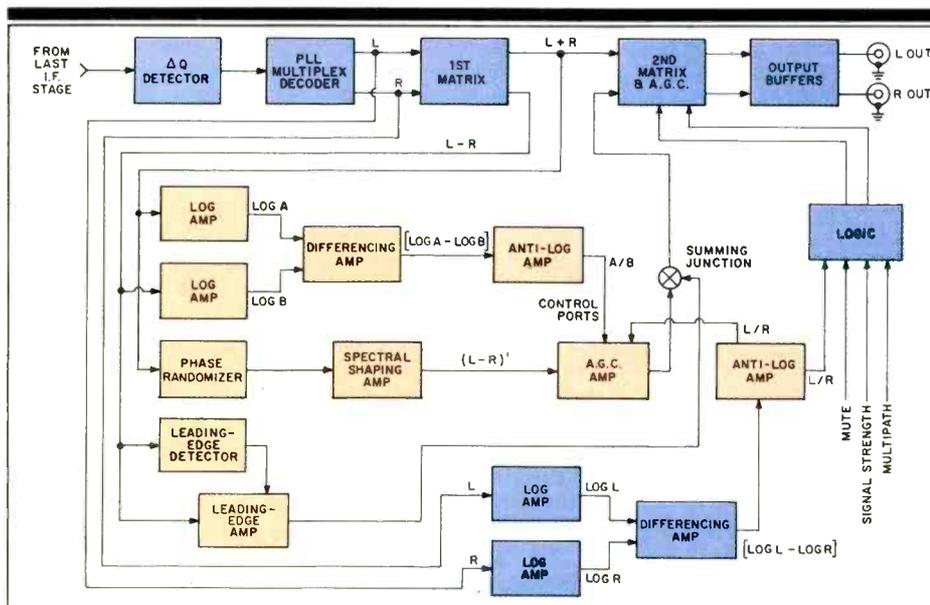


Fig. 1—Block diagram of Carver TX-11 tuner's special noise-reduction and multipath-reduction circuitry.

Bob Carver seems to have done it again! This time he has turned his inventive genius to FM stereo and come up with a tuner which long-suffering fringe-area residents and those plagued by multipath distortion and interference have probably been praying for since the FCC approved an FM stereo transmission system that degrades stereo signal-to-noise by up to 23 dB! As is often the case with inventor types, Carver's TX-11 tuner was a bit late in reaching dealer's shelves, and even later than promised in reaching my lab. What Carver finally delivered to me was well worth waiting for. Furthermore, as is also fairly typical of inventor types, the version he brought me is really generation two, in that it incorporates modifications which are direct results of conversations that Carver and I had last June, at the Consumer Electronics Show, when Carver first described and demonstrated his tuner to me.

As originally designed, the TX-11 tuner offered a very significant reduction in background noise and multipath interference when tuning in to weak-signal FM stereo stations. Through a combination of four different circuit innovations, Bob Carver had managed to clear up these reception problems without losing audible or apparent stereo separation. He had, in fact, provided stereo reception with the noise and distortion levels of mono, no small feat. Upon further questioning, however, I learned that he had sacrificed steady-state, tone-measured separation significantly. Product reviewers (such as yours truly), when subjecting the tuner to simple lab-bench measurement, would be shocked to find separation figures dropping as low as 10 or 12 dB at some frequencies. As Carver pointed out (and as many psychoacousticians have confirmed over and over again), 10 to 12 dB of separation is all that is really needed to maintain a good stereo effect. But I countered that less knowledgeable audio enthusiasts would never accept a tuner with such low measured separation, no matter how good the stereo effect *seemed* to be. Apparently, Carver agreed, for he went back to the proverbial drawing board and has now come up with a version of the TX-11 that not

only sounds great and improves weak-signal stereo reception by several orders of magnitude, but even offers respectable single-tone separation measurements on the lab bench. I'll get to the circuitry presently, but first let's take a look at the tuner's physical layout.

Designed to accommodate rack-mount adaptors, the Carver TX-11 gunmetal-finished front panel has a power on/off switch and power indicator light at its left end. The center section of the panel is equipped with a smoked-gray transparent plastic "dial glass," behind which are a digital frequency display area, a six-LED signal-strength indicator, a stereo indicator light, and another indicator which illuminates when the frequency-synthesized tuner correctly locks in an incoming signal. Below the dial area are 16 FM station preset buttons, a "Memory" button for assigning favorite stations to specific presets, a manual/automatic scan selector, and a narrow/wide i.f. bandwidth selector button. The rightmost section of the panel contains "Up" and "Down" tuning buttons plus two buttons which activate the circuits that make this tuner so outstanding. Both are identified as "Asymmetrical Detector" buttons, with one of these further designated "Noise Reduction" and the other as "Multipath Reduction."

In his owner's manual, Bob Carver calls his circuit an "asymmetrical charge-coupled FM detector." I haven't got the slightest idea what that name has to do with the way the circuits work, now that they've been thoroughly explained to me. But if it makes Carver happy to devise esoteric sounding names for his circuits, that's okay with me—so long as the circuits work as well as these do.

The rear panel of the TX-11 is equipped with 75- and 300-ohm antenna terminals and a pair of output jacks. There are no external fuses, and output level is fixed.

Noise- and Multipath-Reduction Circuitry

As Carver explains it, there are four separate circuit innovations which contribute to the noise reduction in weak-signal stereo reception when the noise-reduction and multi-

"A unique combination of four circuit techniques clears up background noise and multipath interference."

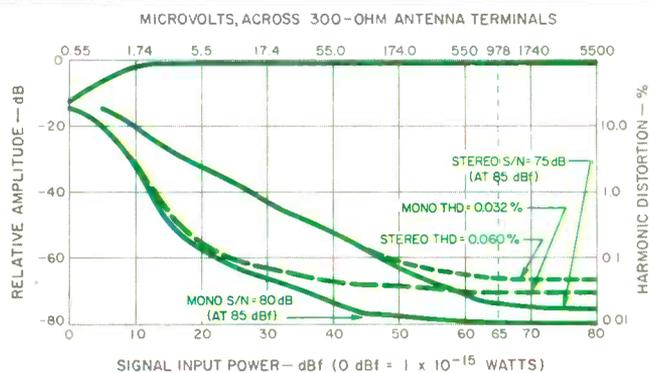


Fig. 2—Mono and stereo FM quieting and distortion, wide-band mode, without use of special Carver circuits.

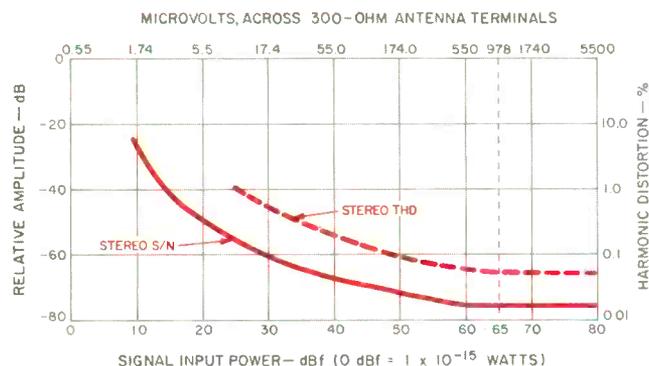


Fig. 3—Stereo quieting and distortion, wide-band mode, with noise- and multipath-reduction circuits activated.

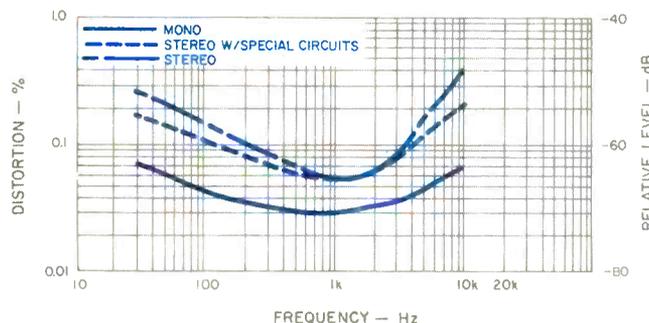


Fig. 4—Distortion vs. frequency, mono and stereo, with and without special circuits (wide-band mode).

path-reduction buttons are depressed. The block diagram of Fig. 1 shows all the circuit elements involved in the TX-11. With the exception of the block at the upper left of Fig. 1 (the Delta-Q Detector), all of the new circuitry occurs after detection of the composite audio signal via this detector and the following standard PLL multiplex detector. The Delta-Q is a variable-bandwidth FM detector. Simply stated, under weak-signal conditions, this detector's bandwidth is automatically narrowed to the minimum needed to pass FM sidebands for reasonable results. Under weak-signal conditions, an improvement of between 2.5 and 3.0 dB in signal-to-noise ratio takes place, at the expense of some increase in high-frequency harmonic distortion and some loss of high-frequency separation. This element of the system is perhaps the least important of the four and is also the simplest to understand: Reduce overall bandwidth and you reduce noise.

The remaining three elements of Carver's system are a result of his deep and penetrating investigations into both psychoacoustics and the standard sum-and-difference matrix techniques used in the transmission and recovery of the left and right stereo FM signals. Having recovered the L and R signals from a conventional PLL multiplex decoder, these signals are first recombined into L + R and L - R signals. The L + R constitutes a mono signal, while the L - R signal conveys the "stereo" or "difference" information. In Carver's approach, the L - R signal can be thought of as containing two types of signals: L - R information having random phase and L - R information having specific localizing phase information. The localizing information provides the left and right stereo image location in a sound field. The nonlocalizing information provides the stereo ambience contained in a stereo sound field. Carver maintains this nonlocalizing information is completely redundant with information that is already available in the L + R signal. But the L + R signal (mono) is, as we all know only too well, a lot quieter (about 23 dB worth) than the L - R information. It is also less vulnerable to multipath effects.

What Carver does, therefore, is to create a sort of synthesized L - R signal, using the quieter L + R signal, to provide the randomized or ambience information that does not help in stereo localization. If you follow the line leading from the L + R output of the first matrix block, you will see that it leads to phase-randomizer and spectral-shaping blocks, the output of which has been designated as (L - R)'. However, since stereo localization must also be derived from the real L - R signal, this signal is also directed to a series of four blocks (a pair of log amps, A and B, a differencing amp, and an anti-log amp) to establish the instantaneous ratio between true L + R and true L - R. The true L - R signal is also fed to a series of blocks called a leading-edge detector and a leading-edge amp. These blocks take advantage of a psychoacoustic phenomenon known as the precedence effect. When fast, short-term L - R information critical to the localization process occurs, these blocks allow that information to become part of the "mix" that occurs at the summing junction.

So, thus far we have the contributions of the artificially created (L - R)' and the leading-edge detector at this summing junction, the output of which feeds the second matrix

“If Carver had stopped with his original design, the tuner would have sounded fine, but possibly disturbed critics.”

detector, along with the unmodified L + R signal. If Carver had stopped here (as he had, before our conversation last June in Chicago), the tuner would have sounded just fine. However, critics and reviewers might have been disturbed when they fed in single-tone test signals to an FM generator and discovered that under those conditions, separation was reduced to 12 dB or even less at some frequencies.

To get around that, Carver added a few more blocks, shown at the lower right of the diagram, taking advantage of the fact that totally discrete L and R signals are available from the regular PLL multiplex decoder in the system. When L-only or R-only signals modulate the r.f. signal, that information is conveyed back to the summing junction via another pair of log amps, a differencing amp, an anti-log amp, and finally the a.g.c. amp. In this way, high orders of separation are maintained during single-tone tests.

I realize that I have skimmed over a complex combination of circuits, but space simply does not permit a more detailed explanation of the Carver TX-11 circuitry. What's important is that the system does what is claimed for it, both in terms of improved reception of weak signals and retention of good stereo imaging and separation. That it does both became apparent as I went through my usual sequence of tuner performance measurements and listening tests.

Measurements

I discovered very early on that the special circuits of the Carver TX-11 offer improvements primarily in the stereo mode. Improvement in mono is negligible (about 1 dB of signal-to-noise improvement), but of course, it's stereo that suffers most from noise and multipath. Accordingly, comparisons of performance with and without the special circuits are confined to stereo.

Figure 2 shows the usual plots of noise and distortion (at 1 kHz) versus input signal strength for mono and stereo operation, without the special circuits engaged, and using the wideband i.f. mode. Usable sensitivity in mono was 11.5 dBf, while in stereo it was 18 dBf. Fifty-dB quieting under these conditions was at 15 dBf in mono and 38 dBf in stereo. Ultimate signal-to-noise for mono was just short of 80 dB, while in stereo I measured 75 dB. Distortion at 1 kHz was an extremely low 0.032% in mono and an almost as low 0.06% in stereo.

Figure 3 is a plot of stereo noise and distortion versus signal input when the special circuit buttons are both depressed. I didn't bother to replot mono in this figure, since results are, as I said, essentially the same as they were for Fig. 2. But notice what happens at weak signal levels in stereo. For a 20-dBf stereo signal, for example (that's about 5.5 μ V), the signal-to-noise reading obtained without the special circuits was 32 dB, making it a barely listenable signal. When the special circuit buttons were depressed, the same input signal strength resulted in a signal-to-noise reading of 48 dB—an improvement of 16 dB! And at 22 dBf, the 50-dB quieting point had been reached. Furthermore, as shown in Fig. 4, mid-frequency harmonic distortion remained virtually constant, while distortion at the frequency extremes actually improved slightly when the special circuits were switched in.

That brings us to the question of stereo separation. In Fig.

Fig. 5— Frequency response and separation, wide-band mode, with and without special circuits activated.

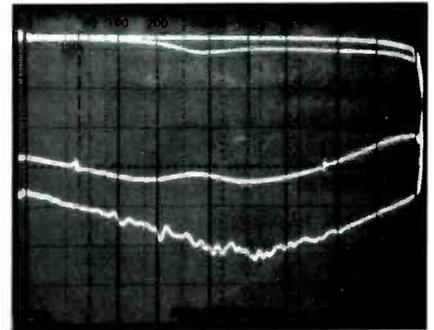


Fig. 6— Same as Fig. 5, but in narrow-band mode.

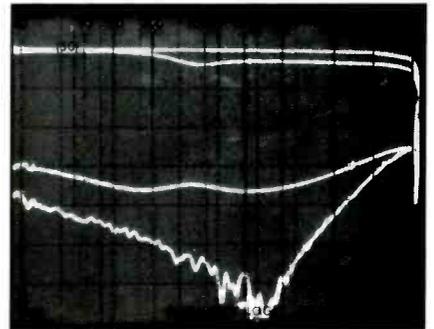
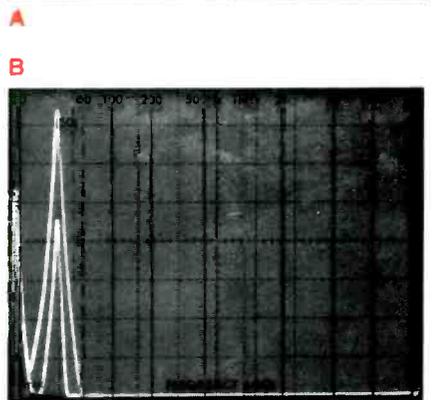


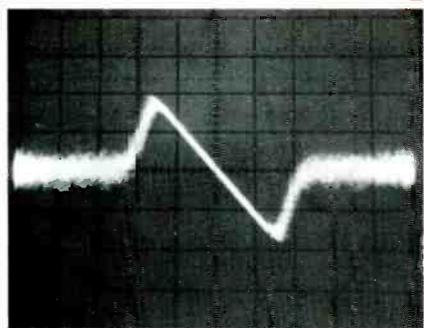
Fig. 7— With special circuits off (A), crosstalk of 5-kHz modulating signal into unmodulated channel is typical of most tuners. With special circuits on (B), separation diminishes, but crosstalk distortion components are no longer visible.



"The Carver TX-11 is one of the few important circuit developments in FM radio to come along in the past several years."

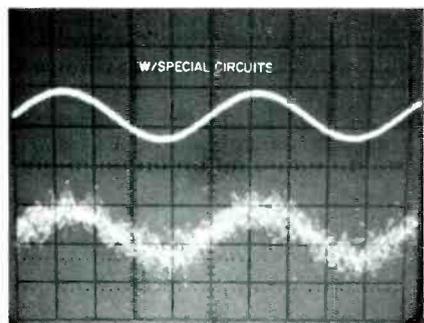


A

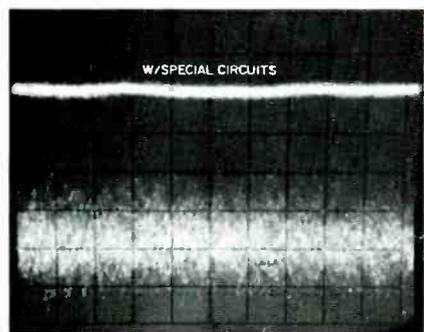


B

Fig. 8— Automatic variable-bandwidth FM detector "opens wide" for strong signals (A), but closes down to just over ± 75 kHz linear range for weakest signals (B).



A



B

Fig. 9— At weak signal levels, activating the noise- and multipath-reduction buttons significantly reduces background noise, whether incoming signal is modulated (A) or not (B).

5, I have plotted frequency response and separation versus frequency for both operating conditions (with and without the special circuits). The uppermost plot in the 'scope photo shows uniform response from 20 Hz to beyond 15 kHz; the lowest curve shows output in the unmodulated channel for that mode of operation (without the special circuits). The slightly displaced frequency response curve just below the flat one shows a minor dip at around 500 Hz caused by some phase-cancellation or "comb-filter" effects of the special circuitry, amounting to no more than 2 dB maximum. Of more importance is the fact that single-tone separation for a left-only or right-only signal remains more than adequate from one end of the audio spectrum to the other. Specifically, at 1 kHz I measured 52 dB of separation without the special circuits and 41 dB with the circuits activated. At 100 Hz, separation went from 42 dB to 34 dB and at the most difficult 10-kHz test frequency, turning on the circuits reduced separation from 42 dB to a still satisfactory 26 dB.

All of these plots were repeated for the narrow-band i.f. operating mode and, surprisingly, mid-band separation actually seemed to be higher than before without the special circuits, but homed in at almost exactly the same separation values when the circuits were turned on (see Fig. 6).

In conducting the usual 5-kHz crosstalk analysis measurements for this tuner (in which I modulate one channel with a 5-kHz signal and observe crosstalk and other distortion products in the unmodulated channel's output), I discovered another surprising benefit of the Carver circuits. Figure 7A shows results obtained without benefit of the special circuits. The tall spike at left is the output (5 kHz) of the modulated channel. Sweep is linear this time, from 0 Hz to 50 kHz. The shorter spike contained within the taller one is the fundamental 5-kHz crosstalk output from the unmodulated channel output. Going further up in frequency, we see harmonic distortion components of 5 kHz as well as subcarrier product outputs at 19 and 38 kHz. In Fig. 7B the tests were repeated with the special Carver circuits turned on. While 5-kHz separation is significantly less, notice that there are no longer any visible amounts of harmonic distortion or subcarrier products in the unmodulated channel output!

Those measurements relating to the conventional portions of the FM tuner turned out to be pretty much as specified by Carver. Selectivity in the "narrow" bandwidth position measured around 88 dB, while in the "wide" mode it decreased to around 37 dB. Capture ratio was 1.0 dB, as claimed, while AM, i.f. and spurious rejection were all in excess of 100 dB (the limits of my test equipment).

The oscilloscope photos of Figs. 8, 9 and 10 are all intended to show demonstrable operating characteristics of, and performance improvements provided by, the novel circuitry devised by Bob Carver for this tuner. Figure 8A shows the relative bandwidth of the FM detector when it is being fed a strong input signal, while in Fig. 8B signal strength has been reduced and the linear portion of the detector bandwidth has decreased accordingly.

Figure 9 tells the story of noise reduction about as well as it can be told in print. To believe it, you have to hear the difference for yourself when a weak signal is "cleaned up" by pressing those two front-panel buttons. The lower trace

"In my area, 10 or 12 stations are too noisy for stereo. Pressing the buttons made *every one* listenable and acceptable!"

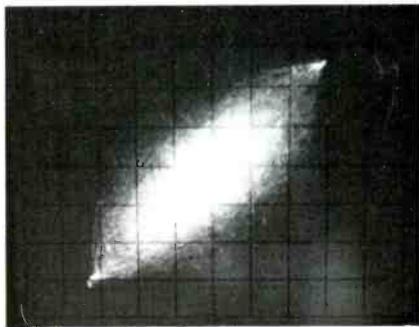
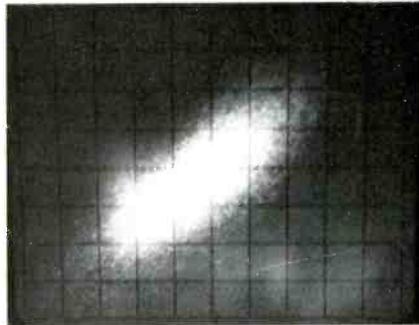


Fig. 10—
Multipath distortion, indicated by compressed tips of this stereo 'scope display (A), is virtually eliminated (B) by TX-11's special circuitry.

A

B



in Fig. 9A represents a noisily received test signal. The upper trace represents the same signal as it appears at the output of the tuner after the two special-circuit buttons are depressed. In Fig. 9B, the same sort of comparison is made, but this time there is no test tone modulating the r.f. carrier except the 19-kHz pilot signal needed to make it a stereo and therefore "noisy," weak signal.

The two 'scope photos of Fig. 10 are intended to show how the special Carver circuits help to reduce the effects of multipath reflections in received stereo signals. Notice the "pinched" ends of the stereo program display in Fig. 10A; they indicate the presence of rather severe multipath distortion. For the photo shown in Fig. 10B, the same received signal is displayed, but the Carver special circuits have

once more been activated, effectively cleaning up the multipath distortion.

Use and Listening Tests

As much as the 'scope photos, spectrum analysis charts, and graphs show about this novel Carver tuner, the significance of its design can only be fully appreciated by setting up the unit and tuning to the weakest, most unacceptable stereo signals you can find, then pushing in those two magic buttons. In my listening area, of the 50 or so stereo signals that I can pick up (using a good outdoor antenna, of course), at least 10 or 12 are so noisy in stereo that I normally have to switch to mono to merely be able to understand the content of the program. For *every one* of those 10 to 12 stations, depressing the noise-reduction and multipath-reduction buttons on the Carver TX-11 tuner made the reception quality acceptable and listenable! Separation was still there; only the background noise had been diminished, and with it, much of the sibilance and hissy edginess so characteristic of multipath interference.

To be sure, in my situation there are plenty of good, strong signals that really can't be significantly improved by the introduction of the special Carver circuits. Remember, it works best for weak signals but does little for strong signals that are noise-free to begin with. Still, I can easily see where many FM radio enthusiasts who live in less ideal areas will welcome this tuner as their first and only solution thus far to good, noise-free FM stereo.

Could I find anything to criticize about the Carver TX-11? Yes, one minor point. When you decide that an incoming signal is too noisy and want to press those buttons on the front panel, there's a time delay of about two seconds before the special circuits latch on and do their things. Hearing memory being notoriously short, I am concerned not that users won't have the patience to wait for the improvement to be heard, but that with that interruption in sound, they may not fully appreciate the amazing degree of improvement that takes place when the sound finally comes back on. That would be a pity, since to my way of thinking, the Carver TX-11 is one of the few important circuit developments to come along in the FM radio field in several years, and I would hate for anyone to be less than fully aware of its significance!

Leonard Feldman





Some Differences Aren't Apparent

Looks are deceiving. The ZX-7 is *the* standard of professionals, *the* recorder experts use to evaluate cassette tape, *the* most versatile deck yet developed. The ZX-9 is its alter ego—a Super-Tuned Edition of the ZX-7—an improvement of what already is one of the most extraordinary cassette recorders in the world.

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2

AUDIO
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Audio Design Ltd. is a small firm based in Ancaster, Ontario, Canada. Their products, to date, have been confined to high-current audio amplifiers, an impedance-matching pre-amplifier, and this preamplifier/control unit, the Model One, which I tested in the lab and in the listening room. Adhering more to the audio purist approach than to the "bells and whistles" approach to preamplifier design, the Audio Design preamp nevertheless boasts several apparent and a few not-so-apparent features which are worth detailing.

Perhaps the most outstanding of these is the precise phono cartridge matching feature which allows the user total flexibility in precisely matching the cartridge impedance to that of the electronics. Rear-panel sockets hold tiny

matching capacitors; a bag of these, in values from 47 to 470 pF (two of each, of course), is supplied, clipped to the rather clearly written owner's manual. Design of the phono preamp/equalizer stage has also been given a great deal of careful consideration. The critical phono preamp stage has high output current to be able to drive the reactive RIAA network. A switchable infrasonic filter is also incorporated, and the phono stage has been designed to eliminate r.f. detection.

As for the high-level section, it does *not* incorporate any tone control circuitry, but does feature two tape in and out circuits. Only one of these, however, is a full tape in/out loop, the second one being simply a setting on the main program-source selector switch. Another unusual feature of

"The phono stage was within ± 0.2 dB of the RIAA spec. It's hard to measure with any greater accuracy than that."

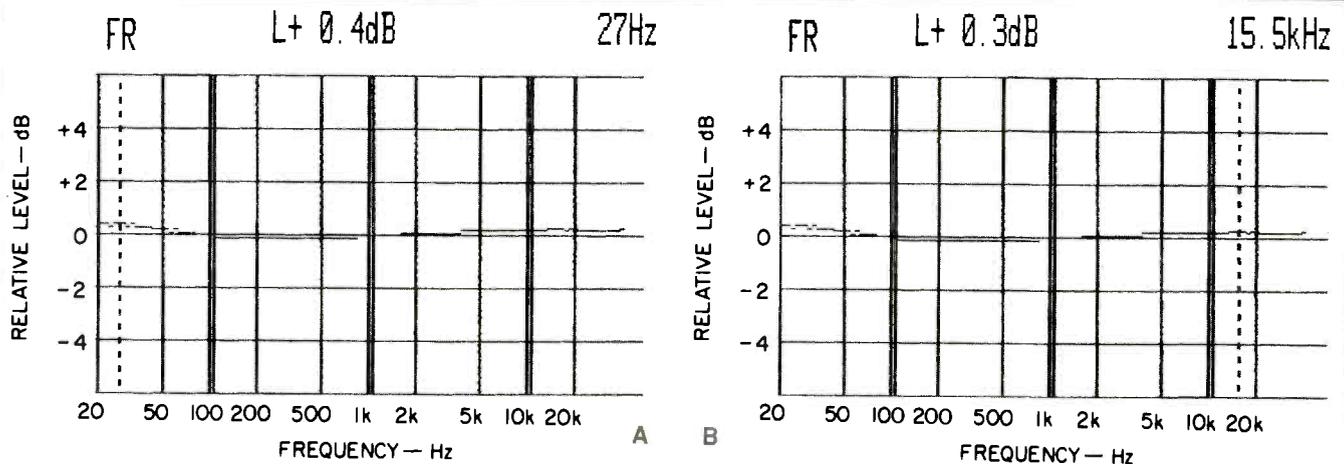


Fig. 1—Maximum deviation from RIAA playback equalization at low (A) and high frequencies (B). Note that vertical scale has been expanded to 2 dB per division.

the Model One is the presence of two headphone outputs, each of which is able to drive dynamic headphones of just about any impedance to respectable output levels.

Circuit Highlights

Serious audio enthusiasts who dread having to ship their equipment off to some never-never land for servicing (should the need arise) will be pleased to learn that full servicing information (complete trouble-shooting guide, parts list and, of course, a schematic as well as a main circuit-board layout diagram) is included in the owner's manual. From the schematic I learned that an IC is used for the phono preamp stage. This same type of IC (also used, incidentally, as the headphone amplifier elsewhere in the circuit) can drive up to 40 mA of current into a load, such as the highly reactive RIAA-feedback network imposes. A pair of oppositely polarized small-signal diodes prevents voltages in excess of 0.6 volt from damaging the phono input stage. A small capacitor across the inputs of the phono IC prevents r.f. detection, but its effects on impedance or frequency response are negligible thanks to the "bootstrap" action of this stage's wideband feedback.

Another IC, connected as a "bi-FET" op-amp, is used for the infrasonic filter stage. In addition to providing an 18 dB per octave filter below 15 Hz, this stage also contributes 6 dB of gain for the high-level section, reducing the gain and noise requirements of the line amplifier which follows the volume control.

Still another IC serves as the high-level or line amplifier stage of this preamp/control unit. The high output-current capability of this amplifier allows it to perform double duty as the headphone amplifier as well as the main output voltage amplifier. Its output is d.c. coupled to the two headphone sockets, which are wired in parallel.

The Audio Design Model One is always "on" when its power cord is plugged into an a.c. receptacle. The front-panel power switch is merely there to control two of the four

rear-panel a.c. receptacles. Since the entire Model One consumes all of 3 watts, leaving it on at all times is probably better for its components than the surge of turning it on and off each time it is used—not to mention the avoidance of clicks and pops or the need for expensive time-delay relays. While I don't completely agree with the statement made in the owner's manual that "You will never notice it in your electric bill," I will agree that the cost is negligible. (It's around 21¢ per month in my area of high utility rates.)

Control Layout

The two headphone jacks are located at the left end of the front panel, next to the program selector switch. Four pushbuttons near panel-center handle mono/stereo selection, output muting, the tape-1 monitor loop, and activation of the subsonic filter. Rotary controls to the right are for channel balance and volume adjustment. The power on/off button, already described, is at the extreme right end of the panel. Appropriate input and output jacks are located on the rear panel, along with the four a.c. outlets (two switched, two unswitched) and the previously described sockets, adjacent to the phono inputs, which accept whatever loading capacitors the cartridge requires.

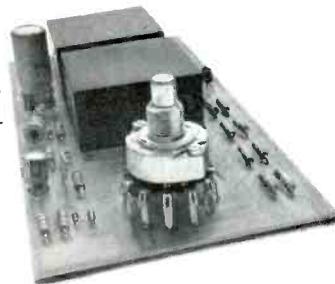
Measurements

Figures 1A and 1B depict the compensated RIAA frequency response of the phono preamp section, measured at the main outputs of the Model One. Notice that I have expanded the vertical scale of these graphs to 2 dB per division (rather than my usual 10 dB per division) to show minute deviations from exact RIAA playback response. And minute they were! In Fig. 1A, I have moved the dotted line cursor to the maximum low-frequency deviation point (27 Hz), where the error was a mere +0.4 dB. In Fig. 1B the plot is identical, but the cursor has been moved to show the maximum deviation from true RIAA response at the high end of the spectrum. This turned out to be even a bit lower,



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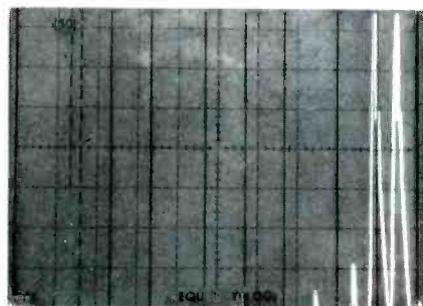


Fig. 2—Twin-tone IHF IM, using worst-case 19 and 20 kHz, shows only minute amounts of spurious IM products. (Scales: Horizontal, linear, 0 Hz to 20 kHz, 2 kHz per div.; vertical, 10 dB per div.)

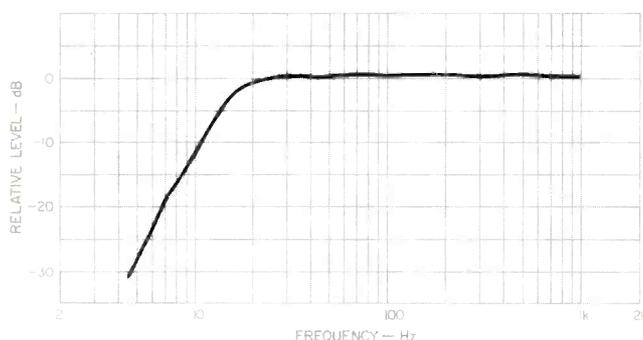


Fig. 3—Subsonic filter response.

+0.3 dB. Since there were virtually no negative deviations, it would be fair to say that RIAA accuracy was within ± 0.2 dB overall. It's pretty hard to measure accuracies greater than that, let alone maintain them in a consumer product.

Unfortunately, Audio Design seems not to have gotten the word about the new Amplifier Measurement Standards which are now accepted by the EIA. Accordingly, some of their specifications won't lend themselves to easy comparison with my measured results, but I'll try to reconcile these as I go along.

Input sensitivity of the phono inputs measured 0.95 mV (for 0.5 V output). Phono overload, at 1 kHz, measured 185 mV, a bit short of the 200 mV claimed but certainly more than adequate for any recording I know of, even when played with high-output magnetic cartridges. Hum and noise, in phono, measured a very high 82.5 dB using the standard 5-mV reference level and A weighting. That's not easy to compare to the manufacturer's own rating, since Audio Design gives itself both the 6 dB advantage of a 10-mV reference level and the roughly equal disadvantage of unweighted measurement. In any case, 82.5 dB of S/N, measured the new standard way, is superb!

High-level signal-to-noise ratio (referred to 0.5 V input, with the volume control set back for 0.5 V output) measured an excellent 87.5 dB, while hum and noise, with the volume control set to minimum, was 95 dB. Harmonic distortion for the unit measured 0.004% at 1 kHz, 0.003% at the low-frequency extremes, and 0.0035% at 15 kHz. The SMPTE-IM distortion was 0.009%, CCIF twin-tone distortion read 0.004%, and IHF-IM twin-tone distortion (worst case) measured a very low 0.03%. I suspect that Audio Design may not

have included that last one when they stated that "all" forms of distortion were less than 0.005%, but no matter. Figure 2 shows the spectrum analysis obtained in arriving at the IHF-IM figure. The two spikes at the left are the desired 19- and 20-kHz test tones, while the small spike to the left of the 19-kHz signal is the major contributor to the IHF-IM total.

Figure 3 is a plot of the response of the subsonic filter which does, indeed, have its -3 dB point set at very nearly the specified 15 Hz and does provide a slope of 18 dB per octave for effective elimination of subsonic tonearm and turntable rumble components. I checked out master volume-control tracking and found that it was accurate to within 1.0 dB down to -60 dB below maximum, and to within 1.5 dB down to -70 dB below full volume. At that setting, the volume control is barely cracked open; I couldn't expect much better tracking from any master volume control, regardless of the price of the preamp.

Use and Listening Tests

I've thought for some time that many of the differences we think we hear when comparing the sonic qualities of one preamp against another are largely a function of correct matching between the phono cartridge and the preamp input and, to a lesser degree, between the preamp's output and the associated power amplifier's input circuitry. (Mind you, I'm not going to say that that's true when comparing power amplifiers; there are many, many more factors to consider here, not the least of which is how a given amp reacts to a given speaker load.) My premise was easily demonstrated with the Audio Design Model One, where, with unusual ease, I was able to substitute one value of loading capacitance after another across the outputs of my currently favored cartridge. It was when I settled on a value within 25 pF of my cartridge maker's recommended value that I heard the kind of well-balanced, uncolored sound I would have expected from such an elegantly designed, yet simple preamp/control chassis as this one.

I was interested in Audio Design's claims regarding immunity to r.f. detection and, unfortunately, I have an easy check that I make from time to time to verify such claims. I call up my next door neighbor, an amateur radio operator, and ask him to go on the air. In previous experiments of this kind, with some older but much-esteemed preamps, I was usually able to hear his voice loud and not-so-clear, mixing nicely with my favorite audiophile disc. In the case of the Audio Design Model One, I won't say that *all* r.f. interference was absent, but it was so slight as to be quite tolerable under the circumstances. (His 1 kW of output is literally no more than 10 feet from the lab entrance!)

In all, I liked this preamp and the concepts behind its design. I know that there are those who insist that a high-quality phono preamp must use discrete transistors (no ICs, please!), but I think those folks haven't really kept up with what's now possible in the way of low-noise, wide-bandwidth ICs. Here's aural proof that if you know what you're doing, an IC-based preamp circuit can sound just fine. This one does just that, and I'm sure its completely reasonable price arises, in part, from the fact that integrated circuits were used. No sense spending more than you have to for this kind of preamp performance, I say! *Leonard Feldman*

INTRODUCING A TURNTABLE THAT KNOWS A GOOD SONG WHEN IT SEES ONE.

In the history of recorded music, there have probably been one... maybe two people who liked every song on a record.



If you're not one of them, chances are you'll take an immediate liking to the new Pioneer PL-88F turntable. It's programmable.

Which, simply put, means that your index finger can now spare your ears from a less-than-favorite tune. Just push a button or two, and the turntable will play only the cuts you select. And skip right over the ones you don't.

Of course, before you know what order to play them in, you'll want to know what order they're recorded in. And for that, there's Index Scan, which plays the first ten seconds of each cut.

What makes this turntable so smart? A brain. A tiny microprocessor that works in



SENSOR Optical double eye sensor searches for the shiny inter-selection bands and insures that the stylus sets down in the exact center. Even on off-centered records.

conjunction with an optical double eye sensor. The sensor actually "reads" the record grooves to carry out the commands you've programmed into the turntable.

That same microprocessor even makes the PL-88F smart enough to improve your recordings. A special deck-synchro system sees to it that the tape deck is placed in the pause mode whenever the turntable tone arm lifts off the record.



At the touch of a button the PL-88F's platter glides out. Drop a record on, push the button again and the platter retracts and starts to play automatically.

(Providing that you're smart enough to use a Pioneer Auto Reverse Tape Deck.)

Of course, the most impressive part of the new PL-88F turntable comes when you put on your favorite record, sit down in your favorite spot, relax and do something you've probably been too busy to do with your ordinary turntable.

Listen to music.

PIONEER®
Because the music matters.



3

THORENS TD115 TURNTABLE/ ORTOFON TPO-70 PHONO CARTRIDGE WAND

Manufacturer's Specifications

TD115 Turntable

Drive System: Belt.

Motor Type: D.c. with 72-pole tachogenerator.

Speeds: 33 $\frac{1}{3}$ and 45 rpm, with electronic selection.

Pitch Control: $\pm 6\%$ illuminated stroboscope.

Wow and Flutter: Less than or equal to 0.05%, DIN 45-507.

Rumble: Unweighted, -48 dB, DIN 45-539; weighted, -68 dB, DIN 45-539.

Dimensions: 17 $\frac{1}{2}$ in. (445 mm) W \times 14 in. (335 mm) D \times 5 $\frac{1}{8}$ in. (130 mm) H, dust cover closed; with dust cover open, \times 15 $\frac{3}{4}$ in. (400 mm) H.

Weight: 15 $\frac{1}{2}$ lbs. (7 kg).

TPO-70 Cartridge Wand

Length: 8 $\frac{3}{4}$ in.

Effective Mass: 7.5 grams.

Offset Angle: 23°.

Skating Compensation: Magnetic force without friction.

Stylus Pressure Appliance: Setting scale on counterweight.

Cartridge Section

Type: Moving magnet.

Output Voltage: 3 mV at 1 kHz, 5 cm per second.

Frequency Response: 20 Hz to 20 kHz, ± 2 dB.

Channel Separation: Greater than 25 dB at 1 kHz.

Tracking Ability: Greater than 70 μ m, 300 Hz lateral.

Tracking Force Range: 0.75 to 1.25 grams.

Recommended Tracking Force: 1 gram.

Replacement Stylus: D200E.

Price: \$435.00.

Company Address: c/o Epicure Products, 25 Hale St., Newburyport, Mass. 01950.

For literature, circle No. 92

Editor's Note: The new TD-115 II, shown, has 78-rpm speed, a lower wow and flutter spec (0.04% DIN), a heavier mat, and comes in gray.—E.P.



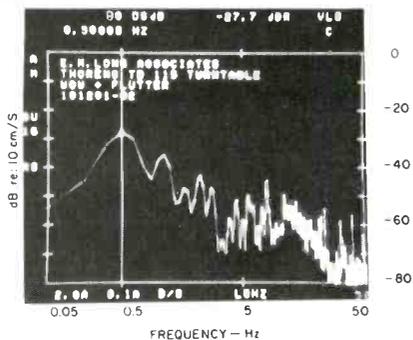


Fig. 1—Spectrum of wow and flutter components. The cursor indicates the output at 0.5 Hz is -27.7 dB relative to a 0-dB reference of 10 cm/S; 0.5 Hz is the rotational speed of the turntable at 33 1/3 rpm.

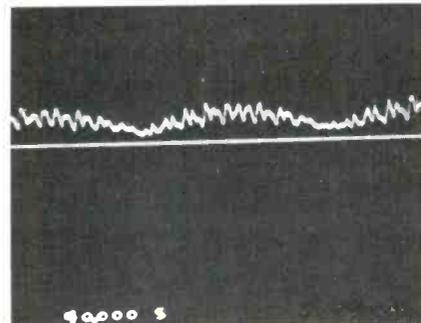


Fig. 2—Long-term change in wow and flutter. Part of the 40-second recording is cut off in this photo. The cyclical rate is about 16 seconds (see text).

Thorens has been making turntables for many years and has achieved an enviable reputation for high quality and reliability, always putting the music first. But their roots are deeper: They started with precision music boxes in 1883 (still made, by an independent offshoot), and cylinder phonographs by 1898. I remember their music boxes from a New York High Fidelity Show in the late '50s, together with the now-classic TD-124 turntable, which established Thorens as "King of the Hill" for knowledgeable audiophiles.

The Thorens TD115 turntable combines proven belt drive with electronic speed control. Thorens has teamed with Ortofon to produce a special low-mass tonearm/cartridge combination, the TPO-70. Ortofon was one of the first to produce moving-coil cartridges back in the late '50s and, at present, makes both moving-coil and moving-magnet cartridges. The TPO-70 combines a moving-magnet cartridge and the forward part of the tonearm to create a "cartridge wand." It plugs into the Thorens tonearm near the arm pillar so that the mass of the coupling ring is closer to the arm pivot, rather than out near the cartridge as in most other tonearms which use conventional headshells. Because most of the mass is near the tonearm pivot, the dynamic mass of the arm-cartridge combination is extremely low. Thorens was the first company to use this concept. The Ortofon cartridge built into the TPO-70 is like Ortofon's "Concorde" series and uses a Concorde stylus.

Many of the features and specifications are shown in tabular form to compare the manufacturer's data with my measurements, but some items are worthy of separate comment. While the report concerns itself with the TPO-70, I also used the TP-70 cartridge wand which accepts individual cartridges such as the AKG P8ES. Thorens supplies a plastic guide which made mounting the cartridge into the wand a cinch. The wand was then plugged into the arm, and a mirror, also supplied, was used to align the stylus vertically, as viewed from the front of the tonearm. Two counterweights are supplied, one weighing 65.6 grams to

be used with cartridges such as the AKG P8ES, and one of 33.9 grams for the TPO-70.

The tonearm has spring-suspended jewel bearings, with dual tracking-force calibrations expressed in milliNewtons (mN) and Ponds (p; 1 Pond = 1 gram). Sidethrust calibrations for both elliptical and spherical stylus tips are provided, and sidethrust can be adjusted while listening to a record. At the end of a record, a velocity-type sensing device shuts off the motor and raises the tonearm.

Selector controls for speed, manual versus auto mode, and vertical arm motion are in the form of slide bars mounted on the front of the turntable, which is also the location of the variable pitch control. The turntable and tonearm chassis is suspended separately from the main base by a highly damped system Thorens calls "Ortho-inertial." An aluminum

MEASURED DATA

Model: Thorens TD115
Serial No.: 39965

Specification	Speed	Measured	Comment
Speed Accuracy	33 1/3	33 1/3	Adjustable
	45	45.5	Adj., 1% fast
Speed Stability	33 1/3	±0.27%	Good
	45	±0.035%	Good
Wow ... DIN Unwtd.	33 1/3	0.18%	Good
Flutter ... DIN Unwtd.	33 1/3	0.04%	Excellent
W&F ... DIN Unwtd.	33 1/3	0.18%	Very Good
	DIN Wtd.	33 1/3	0.07%
Rumble ... Unwtd.	33 1/3	-50.3 dB	Very Good
	"B" Wtd.	33 1/3	-78.2 dB
Suspension Resonance			Too low to measure
Platter Resonance		150, 475,	Moderate
		925 Hz	damping

"The reproduction of extreme low bass was found to be excellent by the listening panel."

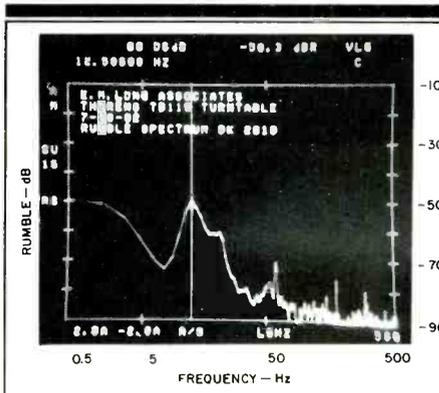


Fig. 3— Spectrum of rumble components, principally at the 0.5-Hz rotational speed and at arm/cartridge resonance. Part of the rotation wow is record eccentricity.

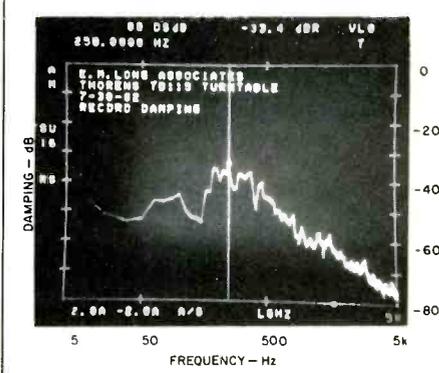


Fig. 4— Spectral components of the output, mainly at 250 Hz, due to a mechanical impulse applied to the edge of a record with the stylus resting in a groove.

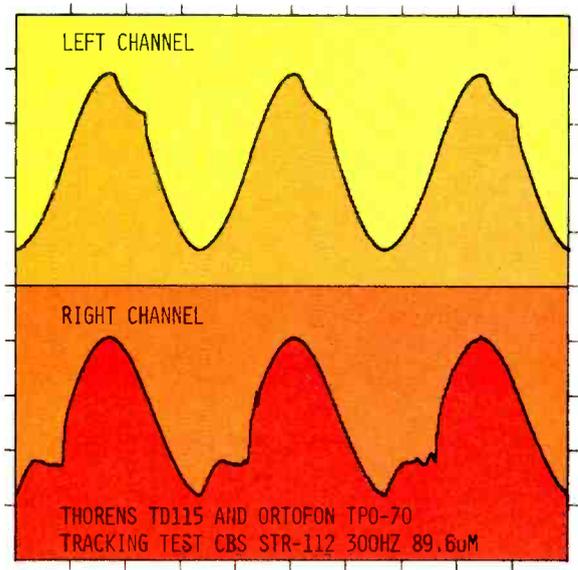


Fig. 5—Tracking of the highest level band on CBS STR-112, 300 Hz, with tracking force at 1.2 g and sidethrust at "4."

disc fits over the spindle and, when reversed, acts as a 45-rpm adaptor. The rubber mat has raised ribs near the center and at the standard 7- and 12-inch record diameters to hold the record off the surface of the mat. Strobe markings for 33 $\frac{1}{3}$ and 45 rpm surround the rim of the platter. The TD115 is very light, weighing only 15 $\frac{1}{2}$ pounds, and requires only 5.6 watts of power.

Technical measurements were made concurrently with the setup adjustment. For instance, the tracking force and sidethrust were adjusted while observing the output of both channels on the display of the Nicolet Explorer III digital oscilloscope. For signals, I used the high-level test bands on the B & K and CBS test records, and I recorded the data simultaneously on floppy discs. This approach assures that the turntable/tonearm/cartridge combination has been adjusted as precisely as possible so listening evaluation can be made without worrying about possible setup error. It also means I was able to record much more data than is usually published here. The absolute polarity of the cartridge was checked, and it is negative for modulation toward the center of the record.

After the TD115/TPO-70 combination was adjusted and tested in the laboratory, a listening panel was assembled for the subjective tests. In this report, I did not try to separate the two forms of testing but, rather, have tried to correlate them by presenting the technical data along with comments from the panel regarding various aspects of performance.

Figure 1 shows the spectral components of wow and flutter. The vertical cursor at the main component is due to the rotational speed of the record at 33 $\frac{1}{3}$ rpm, which occurs at 0.5 Hz. The wow and flutter figure of -27.7 dB is very low and is partly due to the concentricity of the test record. The flutter components above 50 Hz are not shown, but they were below 60 dB which is also very good. Figure 2 shows the cyclical variation of wow and flutter over time and indicates that it tends to increase and decrease over a 16-second period. This effect has been seen on a number of belt-drive turntables which I have measured and is different from the steady, but faster "cogging" effect measured on direct-drive models. I have not yet been able to correlate these "signature" differences between turntable types with any specific perceived aural effects during the listening sessions, probably because other aberrations are masking them.

Figure 3 reveals the spectral components of rumble. The cursor shows the main component at 12.5 Hz, the frequency of the tonearm/cartridge resonance. The rumble is very low, and no comments were made by the any panel members even though the listening system is capable of uniform acoustical output down to 24 Hz.

When the turntable was reproducing solo guitar, comments were made about a slight tubby quality, and a similar effect was noted on drums and double bass. This perceived effect seems to correlate with the spectrum in Fig. 4, which shows a considerable amount of energy centered around 250 Hz as a result of an impulse test applied mechanically to the edge of a record while the stylus was resting in the groove. Perhaps the addition of one of the new highly damped mats would help reduce this effect. The

The Kyocera R-851 AM/FM Tuner/Amplifier... Beneath the sleek styling lurks the devastating power of an MOS/FET output

Unsurpassed technology. Uncompromising quality. From beginning to end.

"Never design solely for the sake of design, never change solely for the sake of change." This is the philosophy that has kept Kyocera at the forefront of technology in sophisticated audio components. A philosophy that led to the Kyocera R-851.

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both channels driven into 8 ohms
from 20-20,000 Hz with no more than
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"The TD115 has very low rumble, good speed stability and is very simple to operate."

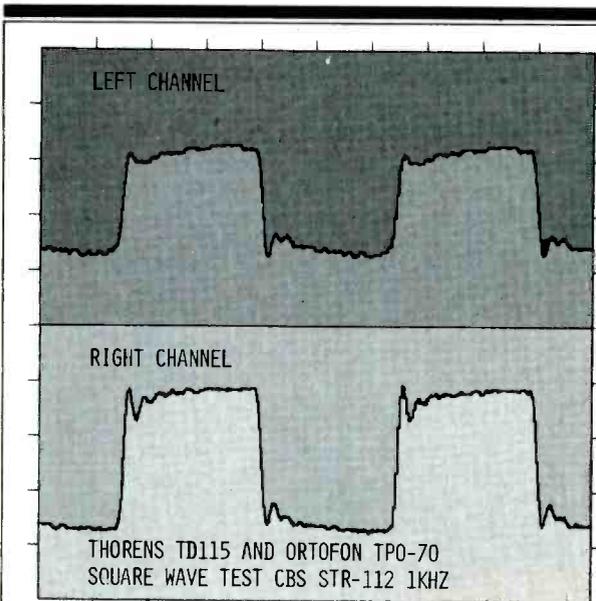


Fig. 6—Square-wave response to band 1 of CBS STR-112, 1 kHz, at 3.54 cm/S modulation in each channel.

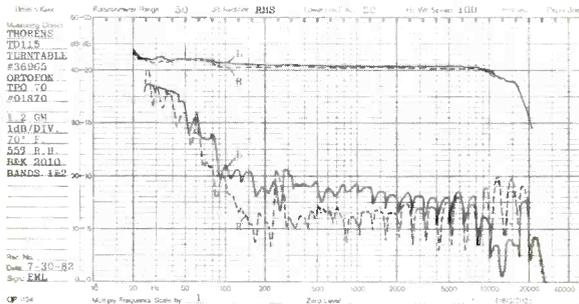


Fig. 7—Frequency response and interchannel crosstalk, B & K 2010.

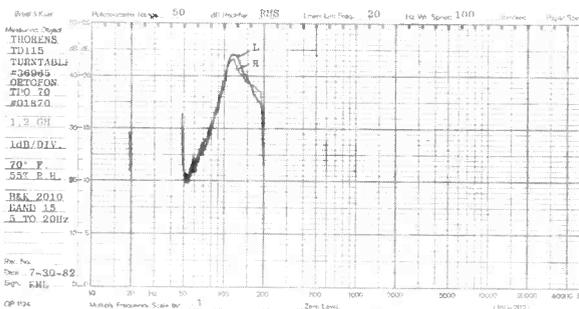


Fig. 8—Low-frequency tonearm/cartridge resonance is at 12.5 Hz with a "Q" of 4.0, B & K 2010.

use of a heavy mat or center weight is not recommended, however, because of the light suspension.

Figure 5 shows the output of each channel while attempting to reproduce the highest level band of the CBS STR-112 test record (a 300-Hz tone at +18 dB relative to a level of 11.2 microns). Although this is a fairly high level, even higher levels can be found on some records and a few members of the listening panel commented on the effects of mistracking. Tests for tracking were also made using the B & K 2010 record, and similar results were recorded for the highest level band.

Members of the listening panel commented on the stereo image and its stability. There seemed to be a shifting in the image, accompanied by a sense of compression, when high-level, complex orchestral passages were played. The extreme high frequencies seemed a bit dull and not as easily localized as the middle and upper-middle frequencies, which were very clear and more precisely positioned. This certainly seems to correlate very well with the information presented in Figs. 6 and 7. Figure 6 shows the output of the left and right channels to the 1-kHz square wave of band 1 of the CBS STR-112 test record. There is a definite difference between the upper and lower traces and, although not shown, the left- versus right-channel response showed considerable phase difference when trying to reproduce this complex signal. The curves of Fig. 7, while indicating remarkably good interchannel balance, show a definite difference in the crosstalk between the channels which changes as the sweep tone goes from low to high frequencies. The decrease in output at higher frequencies can also be seen. Another measurement, not shown in this report, was a rise-time of 32 μ S, which corresponds to the rolled-off high-frequency response shown in Fig. 7.

The reproduction of extreme low bass was found to be excellent by the listening panel, and Fig. 7 shows that there is actually a rise in output at the low frequencies. Figure 8, the tonearm/cartridge low-frequency resonance, also indicates a strong low-frequency output. The "Q" of this resonance is quite high, but the response is down considerably at the major warp-induced frequencies, and warped records could be played without groove jumping, mainly due to the low dynamic mass of the combination.

The effect of acoustical feedback from loudspeaker to turntable was checked; it was great enough to recommend that some sort of isolation be considered when setting up. During listening, the unit was mounted on a wall shelf.

The relatively negative comments in this report about the TD115/TPO-70 must be taken in context and balanced with the very positive statements about very low rumble, good speed stability, and simplicity of operation. It should be noted that the listening panel was making comparisons between the Thorens/Ortofon combination and a reference system costing several times as much and considered by some to be the very best available. However, the relative costs of the systems were not considered by the panel, and indeed they were instructed only to make notes concerning the perceived differences in reproducing accuracy. Bearing this in mind, the TD115/TPO-70 combination should be considered as a very good pairing, one capable of very fine performance, and a very good value. *Edward M. Long*

4

AUDIO INTERFACE CST-80 STEP-UP TRANS- FORMERS

With the multitude of low-output moving-coil phono cartridges currently available to the audiophile, there is need for an exceptionally good, yet moderately priced step-up device with which to raise the low output from these phono cartridges to a level suitable for the magnetic phono-input stage of a typical preamplifier. Though many preamplifiers have input stages for moving-coil cartridges, I have found that most of these built-in active devices (pre-preamplifiers) leave much to be desired, because of their higher gain and noise, etc. It is rare indeed to find a high-quality step-up device that does justice to a moving-coil phono cartridge and that is also available at a reasonable price. About two years ago I became aware of such a device that was reasonably priced. This unit is the Audio Interface CST-80, developed jointly by Dean Jensen and Anthony Sukanuma, President of Audio Interface, exclusively for this firm. The CST-80 is available in either a 3-ohm or 40-ohm version, completely wired and tested, or as a kit at a lower price. The manufacturer's specifications are excellent, and my laboratory measurements verified the more important parameters. I did not assemble or test the kit versions.

Manufacturer's Specifications	CST-80L	CST-80H
Primary Source Impedance	3 ohms	40 ohms
Secondary Load Impedance	47 kilohms	47 kilohms
Turns Ratio	1:36.5	1:10
Impedance Ratio	3/4,000	40/4,000
Input Impedance, @ 1 kHz	31 ohms	420 ohms
Secondary Source Impedance, @ 1 kHz	5,200 ohms	5,450 ohms
Voltage Gain	31 dB	19.7 dB
Frequency Response, @ 20 Hz	-0.35 dB	-0.3 dB
Frequency Response, @ 20 kHz	-0.02 dB	-0.02 dB
Bandwidth, @ -3 dB	148 kHz	170 kHz
Phase Response, @ 20 Hz	+6°	+2°
Phase Response, @ 20 kHz	-11°	-10°
Rise-Time (10% to 90%)	2.0 μS	2.3 μS
Overshoot	1%	1%
Max. THD (Below Saturation)	0.12% @ 20 Hz 0.06% @ 30 Hz 0.027% @ 50 Hz 0.025% @ 1 kHz	0.12% @ 20 Hz 0.065% @ 30 Hz 0.03% @ 50 Hz 0.006% @ 1 kHz
Maximum Input Level, @ 1% Saturation (dBV re: 775 mV)	-24 dBV @ 20 Hz -19 dBV @ 30 Hz -13 dBV @ 50 Hz	-12 dBV @ 20 Hz -7 dBV @ 30 Hz 0 dBV @ 1 kHz
Transformer Noise Figure*	1.4 dB re: 2.7 ohms**	1.7 dB re: 36.1 ohms**

*Referred to impedance of 4,720 ohms (CST-80L) or 4,935 ohms (CST-80H); parallel value of secondary impedance and load.

**Parallel value of source impedance and input impedance.

Prices: Wired, CST-80L (3-ohm version) or CST-80H (40-ohm version), \$300.00; kit, CST-40L (3-ohm version) or CST-40H (4-ohm version), \$220.00.

Company Address: P.O. Box 7369, Van Nuys, Cal. 91409.

For literature, circle No. 93

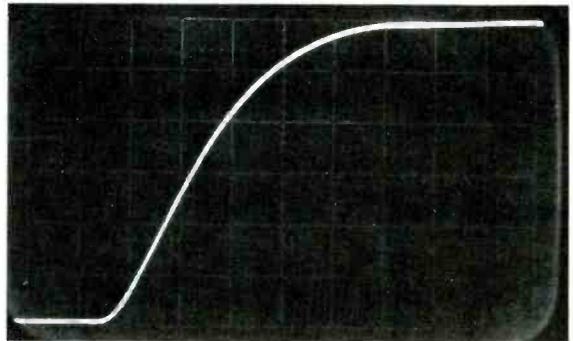


“Because the moving-coil cartridge generates power rather than voltage, the step-up device becomes an important link between cartridge and preamp.”

The CST-80 step-up transformer is of the non-toroidal type. It utilizes a precision split winding on a specially selected core material for a low-level signal. Although the construction itself is not unusual, Audio Interface uses a computer to aid in the design and production of the transformer. In design, all the parameters are determined by a combination of computer and extensive listening tests. In production, the essential parameters of every transformer, such as distortion, frequency response, phase response and gain, are checked and measured by a computer. Using these measurements, the individual transformers are then paired, thus assuring that both primary windings are identical and, similarly, both secondary windings are the same.

The transformer is built into a 5.1 × 2.0 × 3.0 inch (12.9 × 5.1 × 7.6 cm) rugged case of black anodized aluminum extrusion, and all the electronics are epoxy-encapsulated (potted) for extra durability. Because of this rugged construction, Audio Interface offers a five-year limited warranty to the original purchaser. The CST-80 is built with premium components throughout, including gold-plated phono connectors for minimum contact resistance. Besides the input and output jacks, there is a ground terminal to which the turntable ground is attached. There are two versions of the transformer output available: The “E” model has phono output jacks, while the “D” model has a permanently attached, 1-meter output cable consisting of two shielded phono cables and a separate chassis ground wire. The output cable is a high-quality, low-capacitance type which minimizes frequency response degradation of low-level signals. The cable’s high shield density guards against induced r.f. and electrostatic noise. The CST-80 transformer is immune to both induced noise or noise from the transformer itself. It is enclosed in a double mu-metal magnetic shield and a Faraday electrostatic shield plus an all-metal case which provides additional electrostatic shielding. This combination of shielding minimizes hum, noise, and r.f. interference. However, it is always wise to keep all transformers as far away as possible from any source of strong

Fig. 1—Square-wave rise-time, CST-80L (3-ohm version).



electromagnetic fields, including power-supply transformers and motors.

The output jacks or the output cables are connected directly to the standard magnetic phono inputs of the preamplifier. If the turntable is located too far from the rest of the system, it is recommended that the cables from the turntable to the transformer be extended, rather than the output cable from the transformer to the preamp. However, the length of cable between the turntable and the transformer should not exceed 4 feet (1.3 meters).

The Audio Interface CST-80 transformer is available in two impedance ranges; the CST-80L is a 3-ohm version for low impedance cartridges (3 to 5 ohms), and the CST-80H is a 40-ohm version for medium-high impedance cartridges (10 to 50 ohms). The 3-ohm version provides 30 dB of gain and matches the moving-coil cartridge output to the usual 47-kilohm phono input of the typical preamplifier. The 40-ohm version differs only in that it provides 20 dB of gain.

Like all transformers, the CST-80 requires neither an a.c. power source nor batteries inasmuch as it is a passive device. Because the moving-coil cartridge generates power rather than voltage, any such step-up device becomes a very important link between the moving-coil cartridge and the preamp. The CST-80 is ideal for this specific purpose, as it provides maximum energy transfer without degrading the sound of the moving-coil cartridge.

Measurements

In the laboratory, I measured the gain of the 3-ohm transformer as 30.5 dB and that of the 40-ohm version as 20 dB. This is sufficient gain for just

about any moving-coil phono cartridge. I have not found a moving-coil phono cartridge that could overload this transformer at any audible frequency. The 1-kHz square wave is relatively flat on both the top and the bottom for both transformers. The 1-kHz square-wave rise-time (10% to 90%) is among the best I have ever measured, 3.3 μS left and 3.8 μS right channel for the 3-ohm version, while the 40-ohm version measured 2.7 μS left and 2.85 μS right channel. A typical square-wave rise-time oscilloscope picture is shown in Fig. 1. Frequency response for the 3-ohm version measured -1 dB at 20 Hz, 0 dB from 70 Hz to 25 kHz, -1 dB at 50 kHz, -3 dB at 90 kHz, -5 dB at 150 kHz, and -6.5 dB at 200 kHz. Frequency response for the 40-ohm version measured -1.5 dB at 20 Hz, 0 dB from 70 Hz to 40 kHz, -1 dB at 60 kHz, -3 dB at 100 kHz, -6 dB at 150 kHz, and -8 dB at 200 kHz. I was unable to induce hum in the transformers and concluded that the shielding was very effective. All in all, these are excellent data and certainly indicate both CST-80 transformers are of excellent quality.

Use and Listening Tests

I auditioned both Audio Interface CST-80 3-ohm and 40-ohm step-up transformers during the past 18 months with a variety of moving-coil phono cartridges. At no time was I able to discern any aural signal degradation due to either transformer. Neither transformer introduced any coloration or sound of its own, performing in all aspects as claimed by the manufacturer. I have found both transformers to be among the best step-up devices currently available for moving-coil phono cartridges. *B. V. Pisha*

The purpose of a turntable is to remain quiet. It should contribute no noise or vibration to the sounds picked up by the cartridge.

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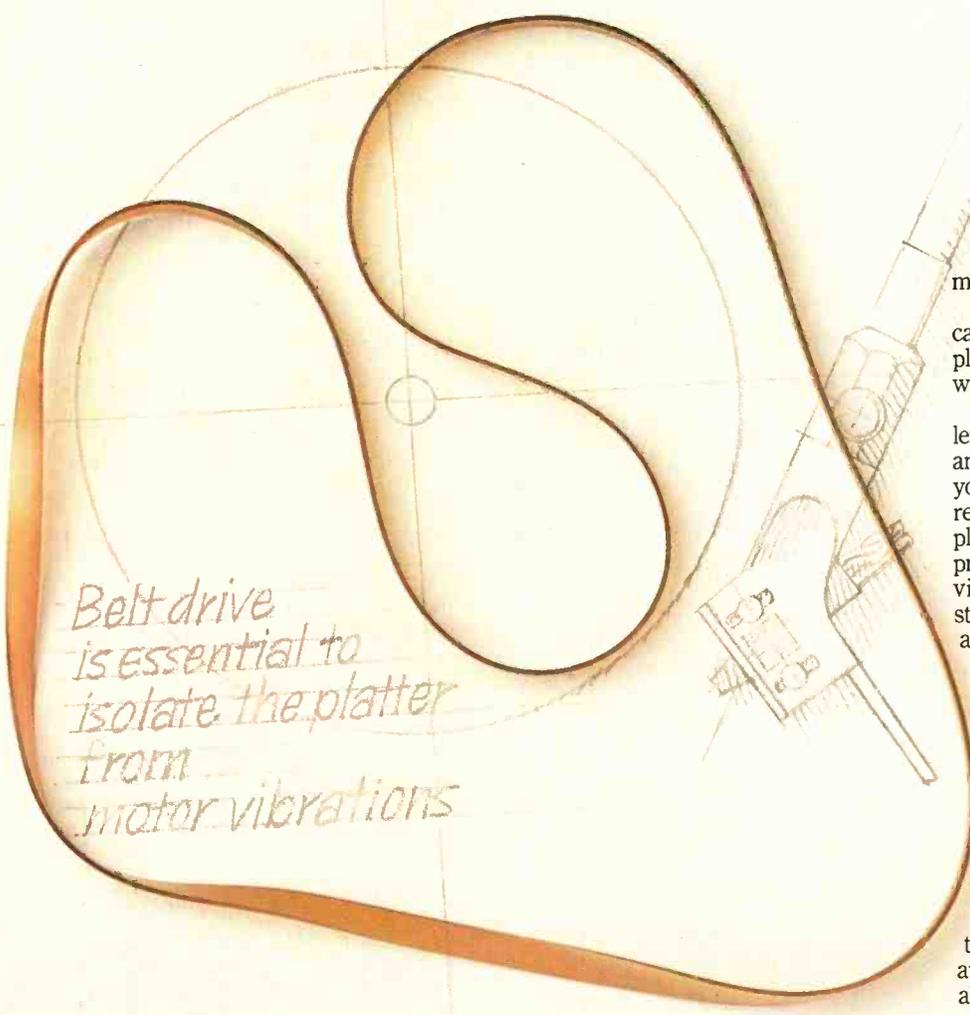
A belt design, of course, requires more careful engineering to achieve a constant platter speed. But we considered it well worth the effort.

In fact, we went to great lengths to make the T-Series among the finest turntables you can buy. Doing so required using massive platters; wooden bases that provide isolation from room vibrations; as well as disc stabilizers and vibration-absorbent platter mats.*

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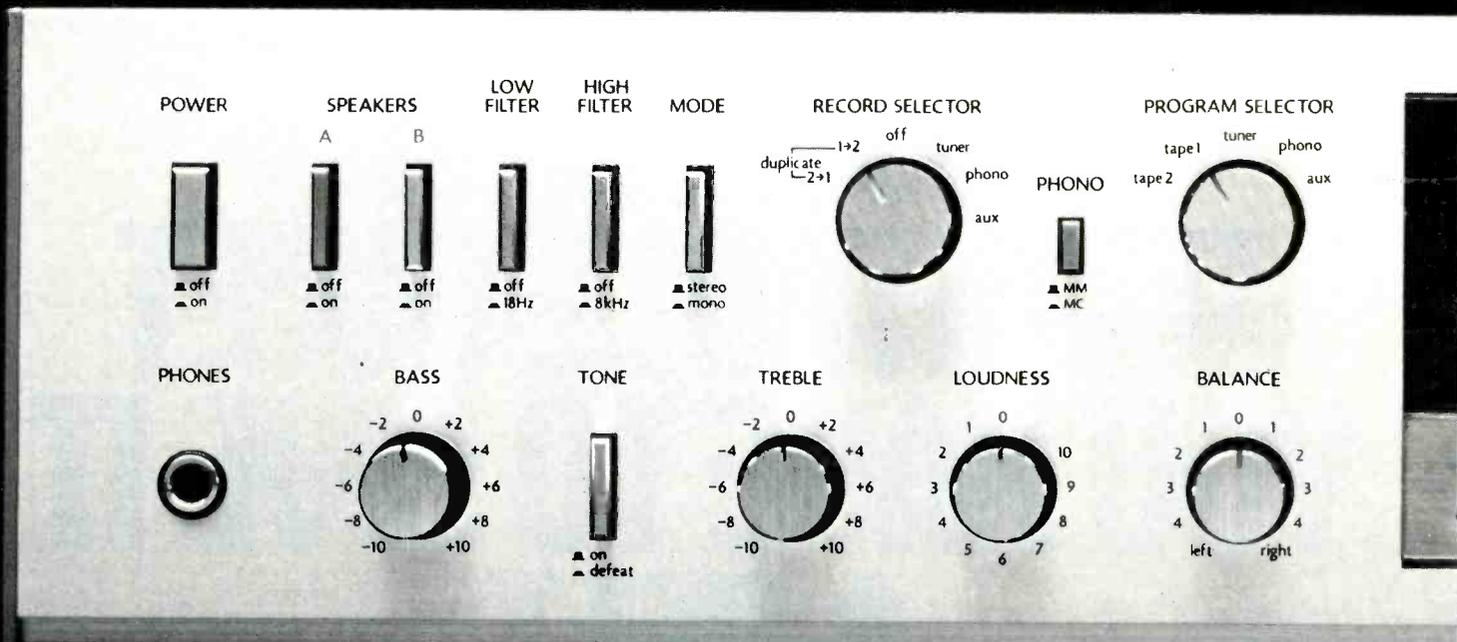
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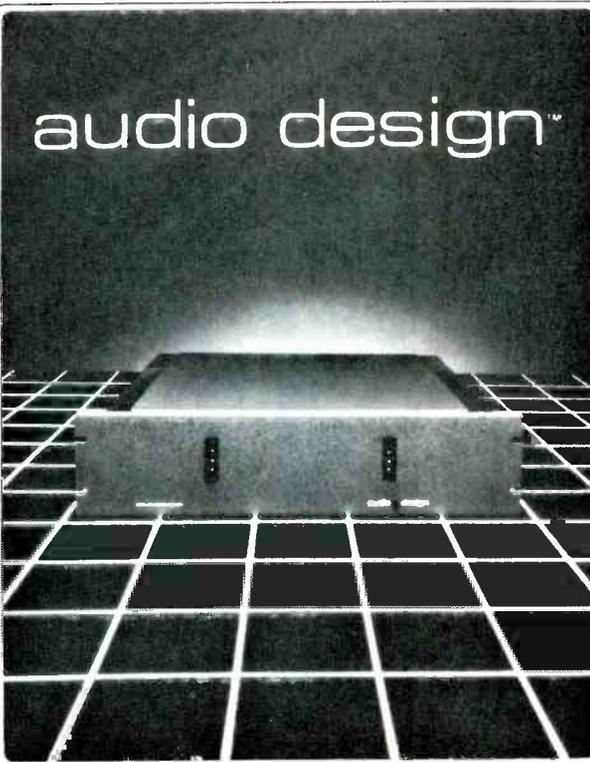
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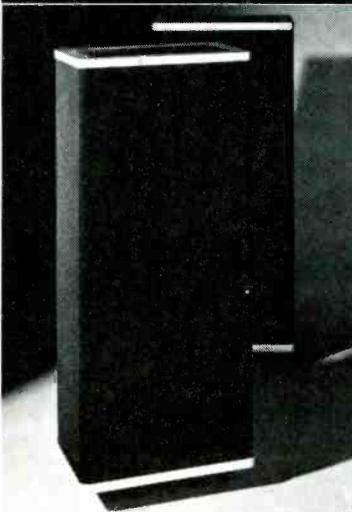
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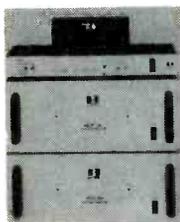
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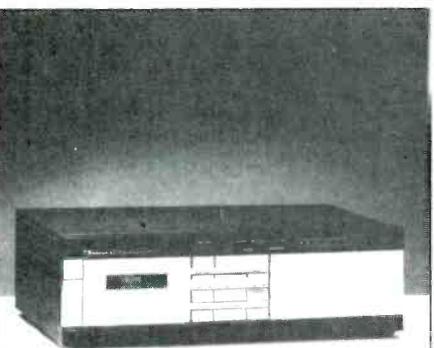
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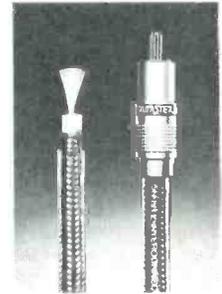
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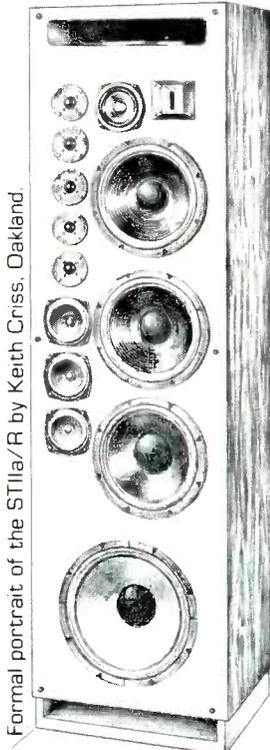
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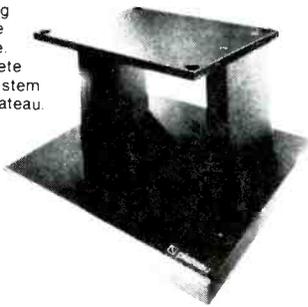
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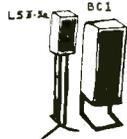
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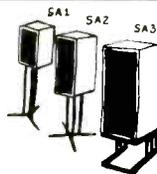
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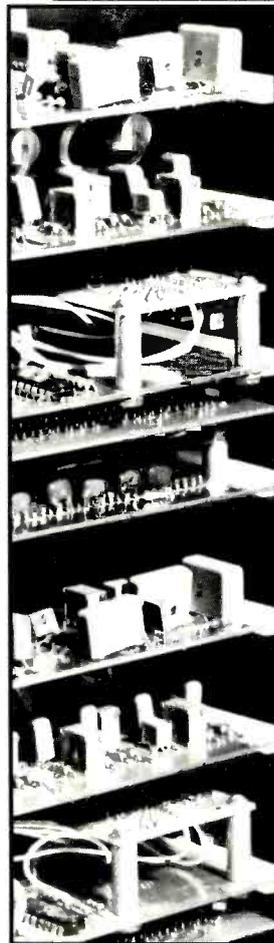
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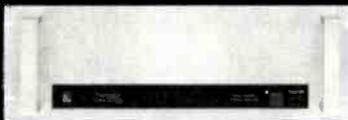
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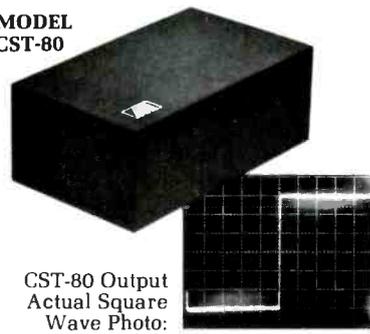
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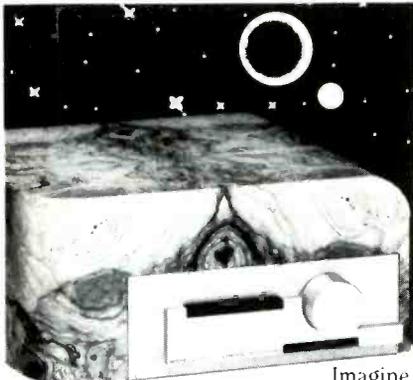
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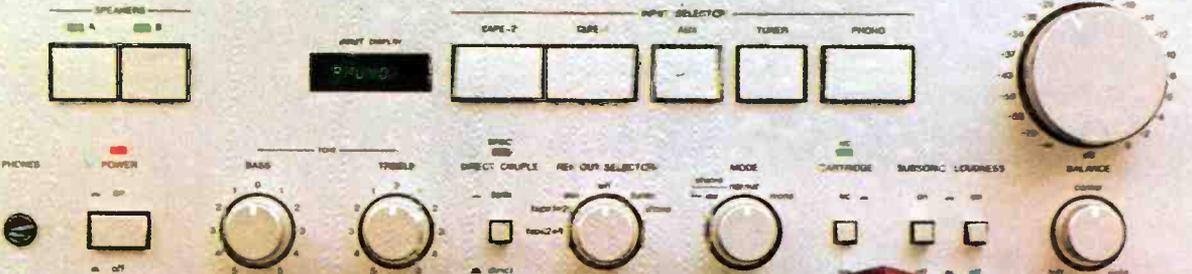
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Non-switching A circuitry can also be heard in the DRA-400 AM/FM Receiver, in addition to its built-in Moving Coil Head Amp and Digitally Synthesized FM tuning. With the DRA-400, Denon has made a new standard of listening quality available to those demanding economy and operating convenience in a compact package.

Denon products share more than a name alone.

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Only technology this advanced can achieve music reproduction this pure. The Technics Digital Cassette Recorder.

No tape hiss. No wow and flutter. Not even head contact distortion. With the digital technology in the Technics SV-P100 Cassette Recorder, they no longer exist.

Utilizing the Pulse Code Modulation (PCM) digital process, the SV-P100 instantaneously translates musical notes into an exact numerical code, stores them on any standard VHS cassette, then "translates" them back into music on playback. Duplicate tapes are exactly the same as the original. Thus, every recording and every copy is a "master."

The revolutionary size of the Technics SV-P100 Cassette Recorder (17" x 11" x 10") is the result of state-of-the-art semiconductor technology. The built-in videotape transport mechanism brings the convenience normally associated with conventional front-loading cassette decks to a digital application. Tape loading is

completely automatic. And, frequently used controls are conveniently grouped on a slanted panel with LED's to confirm operating status.

Despite its compact size, the SV-P100 Recorder offers performance beyond even professional open-reel decks. Since the digital signal is recorded on the video track the space usually available for audio can therefore be used for editing "jump" and "search" marks. The unit employs the EIAJ standard for PCM recording. And, in addition, editing and purely digital dubbing are easily accomplished with any videotape deck employing the NTSC format.

The Technics SV-P100 Digital Cassette Recorder is currently available at selected audio dealers. To say that it must be heard to be appreciated is an incredible understatement.

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