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TESTS STEREO/BALANCE

CLASSE DR-3 AMP

QUALITY DESIGN,
IMPRESSIVE DYNAMICS

INTERVIEW: PHIL RAMONE
YEARS IN THE LIMELIGHT

REVIEWS

MARANTZ PMD430
CASSETTE DECK

PROTON D940 RECEIVER

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DR-3

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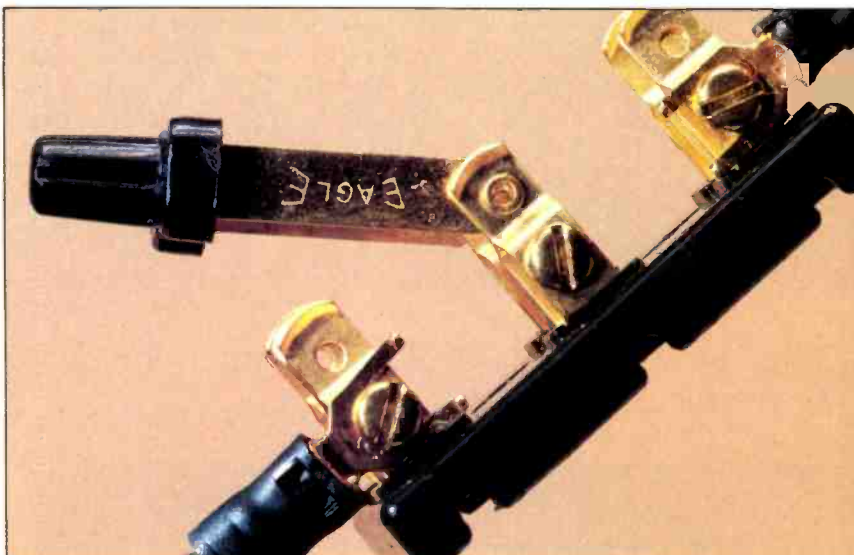
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Yamaha
is introducing
an audio/video
control amp,
a rear-channel
stereo power amp,
a video enhancer,
a multi-mode
surround sound
amp,
and an interactive
audio/video system
remote controller.

This is it.

It's called the AVC-50. You can use it to control just about everything in your audio/video system. It has a total of four video and six audio inputs. And the included remote can be used to control other Yamaha interactive audio components. So you can turn on your entire system, select audio and video source, control volume and playback or tuner, turntable, cassette deck, even a CD player.

The AVC-50 is also a full-featured integrated amplifier with 45 watts of power per channel. That's enough power to use it as the primary source of amplification in your A/V system. Or as a supplement to your present source of amplification, you can use it to drive a pair of rear channel speakers. Either way, the AVC-50 can decode the Dolby[®] Surround signals. And when used with a rear speaker setup, you'll enjoy the full surround sound effect of movies that are encoded with this special sound-track feature.

But many stereo movies can't have surround sound. Which is why the AVC-50 has a special feature called the Yamaha Natural Surround mode. This unique circuit creates the same thrilling effect by feeding the appropriate background and ambient sounds through the rear speakers.

The AVC-50 can even simulate stereo and surround sound from a mono source. And since most network and cable TV programs as well as many movies on cassette are mono, you should get a lot of use out of this feature.

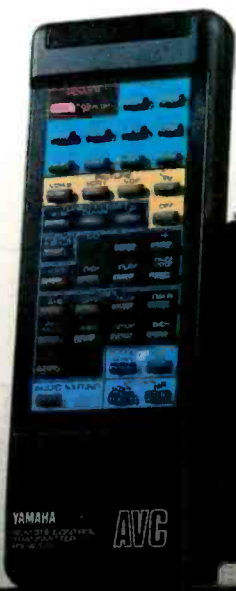
You should also appreciate the video enhancement features built into the AVC-50. Three front panel controls give you continuously variable control over picture detail, sharpness and video level. Meaning you can not only improve the quality of the video signal during the recording process, but you can also improve the picture quality during playback.

There is one thing the AVC-50 can't do, however, and that is usher you to your seat. But once you are seated, with one of these at your command, you may never have to get up again. Or want to.



- *45 watts RMS per channel, both channels driven into 8 ohms, from 20-20,000 Hz, at no more than 0.05% Total Harmonic Distortion.
- **Dolby is a trademark of Dolby Labs, Inc.

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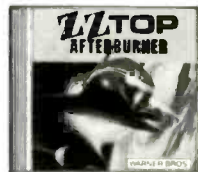
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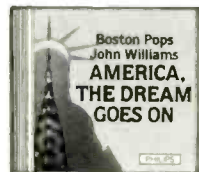
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Ella Fitzgerald: The Johnny Mercer Songbook • Too Marvelous For Words, Skylark, Dream, etc. Verve 163610

Brahms, 21 Hungarian Dances Claudio Abbado conducts the Vienna Philharmonic Orchestra. DG DIGITAL 115408

Alabama: Greatest Hits • She And I, Why Lady Why, Feels So Right, Tennessee River, others. RCA 120247

Carmen (Highlights) • Film soundtrack. Migenes-Johnson, Domingo, Maazel conducts. Erato DIGITAL 154105

Phil Collins: No Jacket Required • One More Night, Sus-sudio, Don't Lose My Number, etc. Atlantic 120771

Stars And Stripes Forever • The Philip Jones Ensemble plays 15 Sousa greats. London DIGITAL 115051

Mozart, Symphonies Nos. 40 & 41 (Jupiter) • James Levine with the Chicago Symphony. RCA DIGITAL 104810

Tears For Fears: Songs From The Big Chair • Everybody Wants To Rule The World, Shout, etc. Mercury 143666

Bach, Organ Works • Daniel Chorzempa plays the Toccata & Fugue in D Minor, others. Philips DIGITAL 115193

Daryl Hall & John Oates: Live At The Apollo • Apollo Medley, Everyday You Go Away, others. RCA 140625

Wagner, Orchestral Highlights From The Ring • Vienna Philharmonic Orchestra/Solti. London DIGITAL 115426

Kenny Rogers: The Heart Of The Matter • Morning Desire, Tomb Of The Unknown Love, title cut, etc. RCA 153995

The Cars: Greatest Hits Tonight She Comes, Drive, You Might Think, Shake It Up, others. Elektra 153702

The Canadian Brass: High, Bright, Light & Clear • Baroque gems for brass ensemble. RCA DIGITAL 144529

Mozart, Requiem • Schreier leads the Leipzig Radio Choir & Dresden State Orch. Philips DIGITAL 115039

Pavarotti: Mamma • 16 great Italian songs, arranged & conducted by Henry Mancini. London DIGITAL 115310

Sunday In The Park With George • Bernadette Peters, Mandy Patinkin & original cast. RCA DIGITAL 154014

Bach, Brandenburg Concertos Nos. 4-6 • The English Concert led by Trevor Pinnock, Archiv DIGITAL 125417

Rimsky-Korsakov, Scheherazade • André Previn conducts the Vienna Philharmonic. Philips DIGITAL 115415

Prince: Around The World In A Day • Pop Life, Raspberry Beret, America, Temptation, etc. Warner/Paisley Park 124370

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VGS52 AT



WHAT'S NEW



Luxman Amplifier

The small window on the front panel of this Luxman Brid amp displays the cheery glow of tubes: The LV-105 is a hybrid design, combining FETs in the first

amplification stages, twin triode tubes in the driver stage, and high-current MOS-FETs. These devices are all voltage amplifiers, and the design is said to reduce nonlinearities

caused by the use of devices which amplify both current and voltage. The LV-105 delivers 80 watts per channel, and uses dual power supplies and Duo-Beta circuitry. The amplifier has three audio/video inputs and an amplified video switcher. Audio facilities include MC and MM phono inputs, and two-way tape dubbing. Price: \$700.

For literature, circle No. 101



CWD Cabinet

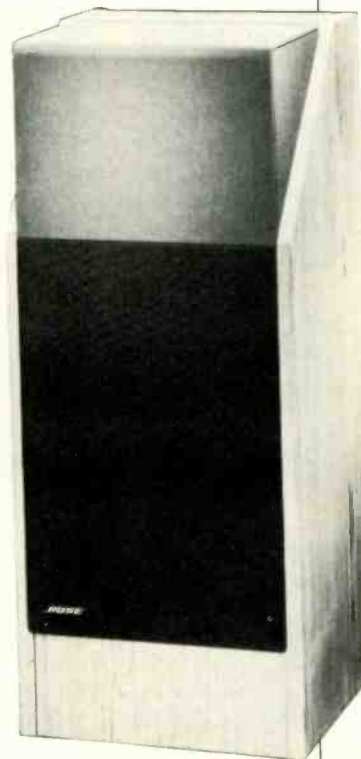
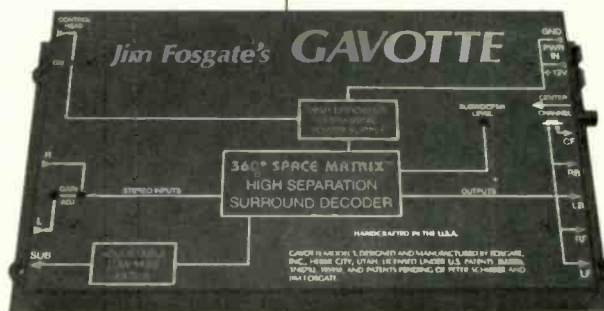
At the touch of a button, the Magic Lowboy cabinet from Custom Woodwork & Design becomes a highboy, as its contents rise up for easy access. The cabinet is large enough to hold a 26-inch video monitor and a selection of audio and video components. Dimensions are 47 1/4 inches wide by 19 inches deep by 34 inches high when closed, 55 inches high when open. Price: \$2,000 with oak finish, \$2,300 with walnut finish.

For literature, circle No. 100

Fosgate Mobile Surround Processor

Designed to be mounted in a car's trunk and controlled from within the passenger compartment, Fosgate's Gavotte brings to the car the 360 Space Matrix introduced for home use last year. The unit recovers ambience from a stereo signal and provides outputs for left and right channels, front and rear; there are also outputs for optional subwoofer and center-front speakers. Even without subwoofers, the system sums bass to provide equal low-frequency output on all main channels below 100 Hz, keeping bass constant regardless of the front/rear balance selected. Price: \$299.95.

For literature, circle No. 102



Bose Loudspeaker

The Series III version of the Bose 601 uses two 8-inch woofers in a new enclosure design, and four 3-inch cone tweeters. Each of the long-throw woofers is housed in a separate compartment that vents into the main cabinet; the cabinet's port is a long slot, designed for lower port turbulence. The tweeters are placed in a multi-directional array, which radiates high frequencies three-dimensionally to promote ambience while maintaining a strong central image. Price: \$1,026 per pair.

For literature, circle No. 103

REDEFINITION.

THE CARVER RECEIVER

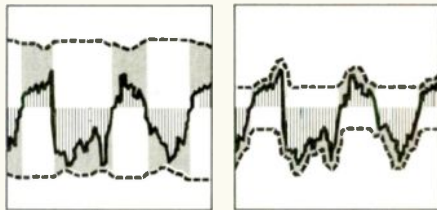
Redefines your expectations of receiver performance with the power you need for Digital Audio Discs plus virtually noise-free stereo FM reception. A receiver with astonishing performance incorporating two highly significant technological breakthroughs: Bob Carver's Magnetic Field Power Amplifier and his Asymmetrical Charge Coupled FM Detector.

ESSENTIAL POWER: Your system needs an abundance of power to reproduce, without distortion, the dynamic range of music on Digital Audio Discs and fine analog recordings.

The Magnetic Field Amplifier in the CARVER Receiver gives you 130 watts per channel* of pure, clean power with superbly defined, high fidelity reproduction.

The Magnetic Field Amplifier produces large amounts of power (absolutely necessary for the accurate reproduction of music at realistic listening levels) without the need for heavy heat sinks, massive transformers, and enormous power capacitors required by conventional amplifier design.

Unlike conventional amplifiers which produce a constant, high voltage level at all times, irrespective of the demands of the ever-changing audio signal (Even when there is no audio signal in the circuit at all!), the Magnetic Field Amplifier's power supply is signal responsive. Highly efficient, it produces exactly and only the power needed to carry the signal with complete accuracy and fidelity.



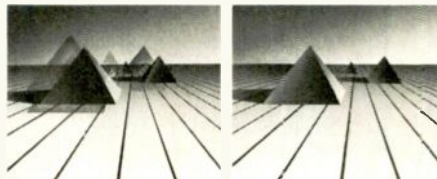
Solid line: audio output signal. Broken line: power supply voltage. Shaded area: wasted power. Vertical lines: power to speakers.

The 130 watts-per-channel* CARVER Receiver is about the same size and weight of conventional receivers having merely 30 watts per channel!

NOISE-FREE RECEPTION: The AM-FM CARVER Receiver gives you FM stereo performance unmatched by that of any other receiver.

As it is transmitted from the station, the stereo FM signal is extremely vulnerable to distortion, noise, hiss and multipath interference.

However, when you engage CARVER's Asymmetrical Charge Coupled FM Detector circuit, the stereo signal arrives at your ears virtually noise-free. You hear fully separated stereo with space, depth and ambience!



Reflected multi-path signals cause audible distortion.

Asymmetrical Charge Coupled FM Detector gives your ears a true sonic image.

The Asymmetrical Charge Coupled FM Detector was first introduced in CARVER's TX-11 Stereo Tuner, receiving unparalleled critical acclaim:

"A major advance... its noise reduction for stereo reception ranged from appreciable to tremendous. It makes the majority of stereo signals sound virtually as quiet as mono signals, yet it does not dilute the stereo effect."

Julian D. Hirsch, STEREO REVIEW (December, 1982)

"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."

Leonard Feldman, AUDIO (December, 1982)

"What distinguishes the TX-11 is its ability to pull clean, noise-free sound out of weak or multipath ridden signals that would have you lunging for the mono switch on any other tuner we know of."

HIGH FIDELITY (January, 1983)

"The Carver Receiver is, without question, one of the finest products of its kind I have ever tested and used."

Leonard Feldman, AUDIO (June, 1984)

The CARVER Receiver has been designed for fidelity, accuracy and musicality. You will want to visit your CARVER dealer for a personal audition of this remarkable instrument.

*130 watts per channel RMS into 8 ohms, 20 Hz to 20 kHz with no more than 0.05% total harmonic distortion.



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Or, add the PM840 to your present system for an immediate and incredible improvement to your system's sound!



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PM840—\$499 (Shown in system above installed in a PCX-1 Rack Mount Kit, optional \$49.00)

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"audiophile" musical performance. Its 8-ohm power is **410 watts**, 205 Watts per channel, 20Hz to 20kHz, less than 0.05% THD. And you can add this tremendous high current amplifier to your present stereo receiver system, by using our famous **\$39.00 PC-1 Power Coupler**. Just hook up the PC-1 to your receiver's speaker terminals, then plug its 2 cables into the PM840 for an immediate transformation of your present system into a new high powered world of incredibly improved sound!

FOR A DEMONSTRATION, VISIT NEAREST DEALER LISTED BELOW

However, many additional Dealers—too numerous to list here—are located throughout the U.S. with many models on display. If no dealer is shown near you, or you encounter any difficulty, please phone us at 714-556-6191, ask for our "Dealer Locator Operator"

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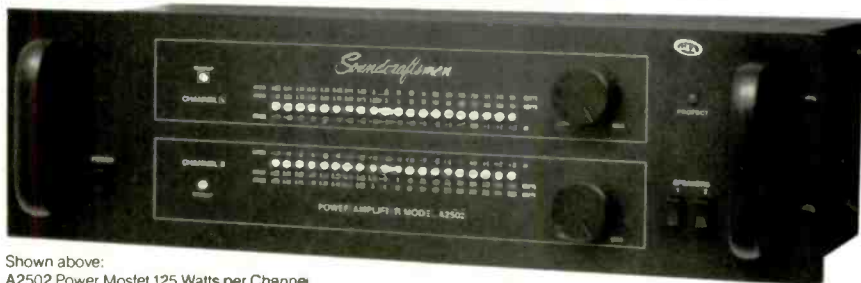
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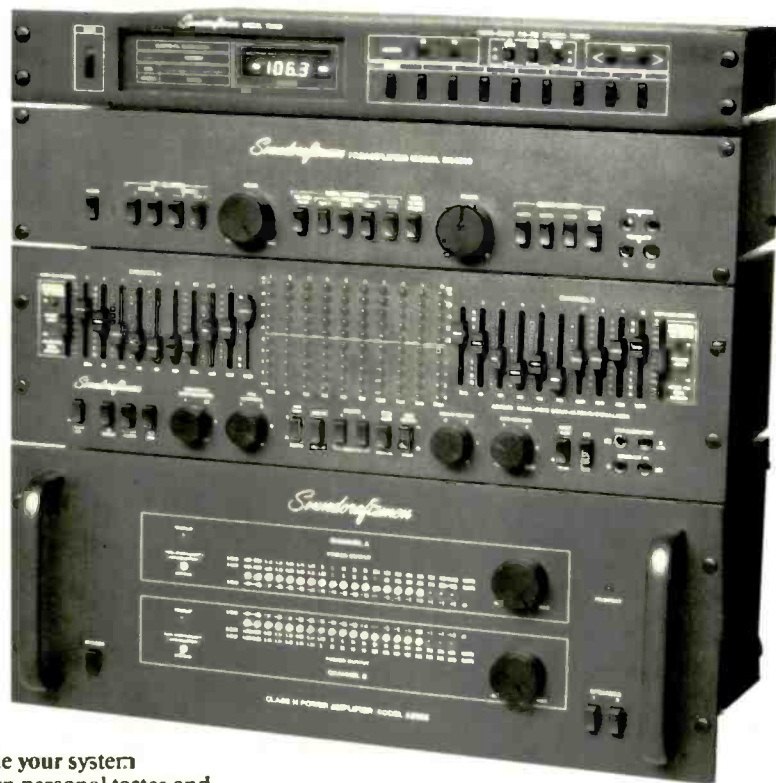
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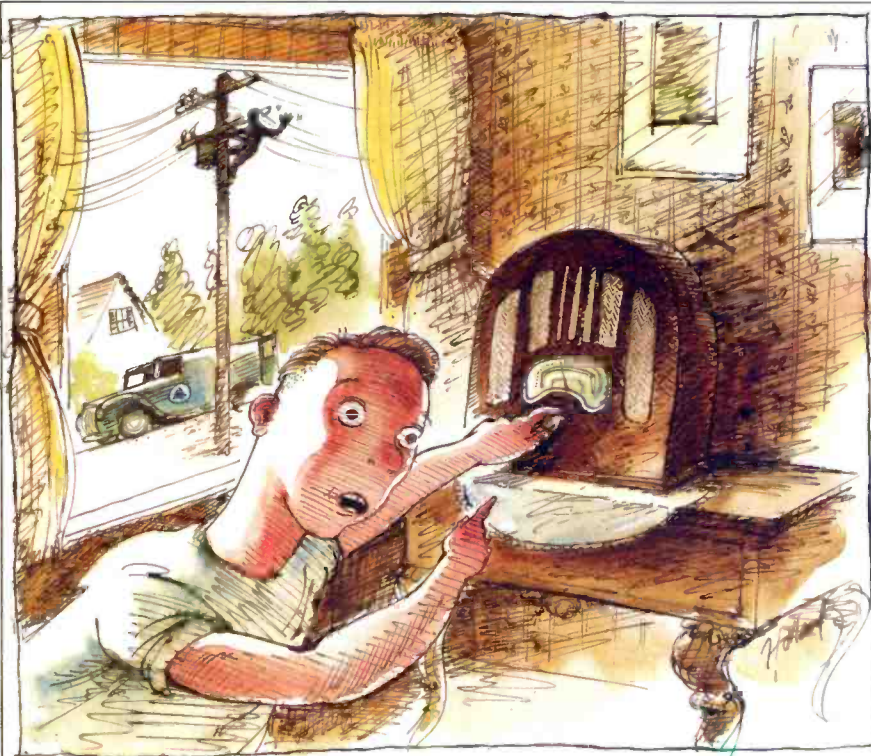
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EARLY HEARD GETS THE WORD



For all my references to past audio, I had almost forgotten that high fidelity is more or less approaching its 50th anniversary. But when? I stick to my own dating: The hi-fi era began when FM went on the air with regular service, and was receivable on consumer equipment available to everyone. Then, at last, we could hear a sound worthy of the name, in our living rooms if not our cars. Does that make it 1939-40? If that's so, then we have a few more years to wait.

The Editor has suggested that the following letter from John K. Mitchell of Westwood, Mass., an old-time "Ma Bell" professional, would complement my own recent recollections, and I agree. Much of it dovetails neatly with what I remember.

Mr. Mitchell describes Dr. J. O. Perrine's travelling demo show for A.T.&T., around 1937. He used equipment remarkably like the 1936 Carnegie phonograph with which I was working concurrently—but A.T.&T. had an advanced pro pickup and a batch of those superb 16-inch "electrical transcriptions," vertical cut, which I later discovered in our FM studio. Dr. P.'s "trunk" speaker enclosure was of a

size and weight comparable to that of the Carnegie—both had very large cone woofers plus tweeters for real highs (which I never heard on my machine, as I've said before). Dr. P.'s speaker box was an infinite baffle (not counting leaks); Carnegie's was more elegant but less liftable and had, I think, bass reflex ports. And two tweeters, same type.

Mr. Mitchell and I emphatically agree on the obstinate Major Armstrong, who demanded "impossible" standards of audio quality—and got them. A 15-kHz equalized broadcast line from his New York quarters to the transmitter in Alpine, N.J.! It was a matter of only a few miles, but read what a job this turned out to be using existing lines. Mr. Mitchell helped do it. You'll understand why I really think hi-fi began with Armstrong FM. Here's Mr. Mitchell's letter.

Ed Canby, in his April "Audio ETC," says that high fidelity has been with us for a very long time, and I agree. But I can remember when "wireless" buffs in the late '20s boasted about how their homemade speakers, using Baldwin phone drivers,

made the music from WJZ sound almost lifelike. This shows that even in those early days of radio, the public was less than completely satisfied with its tonal qualities.

The Baldwin phone driver—a tightly stretched airplane-cloth diaphragm about 3 feet square, on a wooden frame—did a pretty good job, but, possibly because it had no baffling, it was shy in the low end. With the introduction of the electromagnetic cone speaker, a start was made on better reproduction of the lows. The man who mounted his cone speaker in a wall solved the problem of the back wave, and many explanations were advanced by hobbyists until its destructiveness was understood.

Tours through the RCA studios whetted the public's appetite for greater fidelity, but it wasn't until A.T.&T. introduced the "broad-band" radio line to broadcasters that high fidelity was born. However, broadcasters knew that the limitations of amplitude modulation would forever prevent the true reproduction of music, and felt that the situation was hopeless. But Mother Bell had a few tricks up her sleeve to create demand among the public for better broadcast quality.

I first heard high fidelity not by radio but at a demonstration. At that time all radio broadcasting of music was by amplitude-modulation radio transmission, which was—and still is—limited by law to a maximum frequency of 5,000 Hz. Everyone knows that is not high fidelity. And it wasn't until Maj. Edwin Armstrong commenced the development of frequency modulation at his experimental station—W2XMN, above the New Jersey Palisades at Alpine—that any serious thought was given to the broadcasting of high-fidelity sound.

To create demand for broad-band radio lines, Dr. J. O. Perrine of A.T.&T. lectured to the public, throughout a wide area of the country, about the quality of electrically reproduced sound. He would use school auditoriums and such for his presentations, and he had equipment that would rival some of Lirpa Labs'. In his talk, "Words, Waves and Wires," he was actually introducing high fidelity to the public. That was in 1937 or 1938. I helped him in some of the New Jersey

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Serious thought was first given to broadcasting high-fidelity sound when Maj. Armstrong developed frequency modulation at his radio station.

locations, because I was one of a small group of "jacks of all trades" who worked for the New Jersey Bell Telephone Co. They called us Inductive Interference Engineers.

Dr. Perrine's equipment consisted of 19-inch stand-alone racks which included patch boards, vacuum-tube audio amplifiers, and power supplies to drive two loudspeaker systems consisting of 15-inch electromagnetic cone speakers and multi-cellular horn tweeters. The cone speaker was mounted in a steamer trunk which formed an infinite baffle; the tweeter sat on top of it when the lid was removed and the trunk was set up vertically. Each trunk weighed almost 100 pounds. The racks of equipment were somewhat heavier; it took two of us to lug them into the school and onto the stage of the auditorium.

Dr. Perrine had a preamplifier that would permit him to demonstrate the differences between bands of frequencies 300 to 2,100 Hz, for telephone quality; 100 to 5,000 Hz, for broadcast quality, and 50 to 8,000 Hz, the band of fundamental frequencies produced by musical instruments. He used a Western Electric studio-type pickup and turntable which played "hill and dale" recordings on 16-inch platters. These discs were played from the inside to the outside, and their quality was exceptional. At that time, no consumer records could produce such quality. After conducting a search, I found that only Brunswick produced the low frequencies comparable to what we heard there, but they lacked the highs. (Brunswick produced and franchised the boomy jukeboxes that were then prevalent.)

Dr. Perrine had a very impressive demonstration, and its effect on me was long lasting. In fact, it induced me to emulate his quality. The most notable part of his demonstration was the playing of an orchestral recording of Wagner's "Ride of the Valkyrie." It was mostly the reproduction of the tympani and the cymbals that was so memorable to me.

Shortly after, all of the big broadcasters ordered 8-kHz radio lines to their transmitters, and there appeared to be improvement. I was involved in the equalization of the telephone lines for WJZ and WOR and for most of the

North Jersey stations whose antennas were in "Radio Swamp," the swampy area that had to be filled with exceptional quantities of sand to allow the New Jersey Turnpike to exist.

When Ed Armstrong wanted radio lines from his studio in New York City, he insisted that they be 15-kHz lines. I was part of the team that equalized them. The cable from Closter to Alpine was one of the oldest in New Jersey, and I spent a week making noise measurements of all the spares to find noise-free pairs to use for the lines. (The best signal-to-noise ratio we could get was 45 dB, which wasn't quite good enough for the Major, and we were continually beset with complaints from him.) I think we were the first to equalize a 15-kHz studio-to-transmitter radio line; a few years later we were doing it for others.

Our test equipment consisted of a 19-inch, stand-alone, rack-mounted vacuum-tube line amplifier that we had determined, by testing, to be flat to about 20 kHz. It stood about 3 feet high and weighed about 75 pounds. Our audio generator was by General Radio, and our meter was a thermocouple milliammeter. We used an "order wire" with headset and operator-type transmitter to talk to the engineer at the end of the section being equalized. Bell Labs supplied us with prototype equalizers for Armstrong's lines, and their adjustment consisted of strapping terminal posts mounted on top of their cans. We never did know what was inside the can. I'll never forget my nemesis: The Western Electric 2A noise meter. It weighed close to 50 pounds, and measurements had to be made between midnight and 4 or 5 a.m. to avoid the influence of crosstalk. Apparently I was low man on the totem pole for that job.

Please forgive an old man for reminiscing, but Ed Canby's column triggered this over-long letter. He described high fidelity's gestation, and I wanted to tell of its birth pangs. I think the key for setting the date would be to get A.T.&T. to tell when they sold their first 8-kHz equalized radio line or when W2XMN went on the air with 15-kHz quality. Perhaps Ed would write about his experiences in an article commemorating high fidelity's 50th anniversary.

John K. Mitchell

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BERT WHYTE

THE CASE OF THE IMPROVING MEDIUM



I have been reviewing Compact Discs since their introduction, and by now I have listened to thousands of them. The most memorable and remarkable aspect of this listening experience has been the well-nigh incredible playback reliability of the medium.

Of the thousands of CDs I have listened to, I have encountered fewer than a dozen truly defective recordings. These defects were in the form of odd repetitive noises, intermittent mistracking which caused "skips" and loss of signal, and sections where the tracking system would become "stuck" and endlessly repeat several notes of music. I also found a number of CDs which mistracked in minor ways; quite often these anomalies could be corrected simply by cleaning the disc. One might possibly attribute the remarkably low percentage of defective CDs to sheer luck, but I know quite a few people with substantial CD collections who also attest to their basic reliability.

Reliability is not a matter of luck, but is an inherent characteristic of the medium, stemming from CDs' clever and efficient error-correction system. The error-correction system is really inter-

dependent with the laser-tracking and focus servo systems. When these servos function properly, they can compensate for disc eccentricity, surface irregularities and undulations, variations in disc reflectivity, and even changes in the intensity of the laser beam. When the laser encounters dust, dirt, fingerprints, scratches, or any kind of oily film on the surface of the disc that can diffract the beam and de-focus it from the information pits, the CD's error-correction code comes to the rescue. This is really a combination of CIRC (Cross Interleave Reed-Solomon Code) and CRCC (Cyclic Redundancy Check Code), and one can certainly say that without it the Compact Disc would never have become a viable music-playback system.

This code corrects many of the errors that disturb or interrupt the data stream. If each error can't be corrected outright, the circuitry will analyze accurate signals surrounding the unreadable error signal, predict what data would be needed to mask the error, and then actually supply data to conceal it! Of course, when the errors in the disc are too massive, even the large redundancy built into the CRCC

is overwhelmed and the result is an audible glitch or a complete loss of signal.

All of the foregoing will be rather basic information to many people, while others may find it enlightening. My purpose in discussing it, however, is to preface the point that while all CD players use the basic code as originally specified by Philips and Sony, some manufacturers incorporate engineering changes in the error-correction circuitry to enhance its efficiency. Thus, error-correction and concealment performance can—and does—vary among different brands of CD players.

Not all the errors that these systems are called on to correct are due to these infrequently encountered major anomalies in the discs. Some are due to external influences, and not enough attention is paid to the isolation of CD players from external vibrations and mechanical and acoustic feedback. Error-correction systems treat vibratory phenomena as errors and use up so much of their correction capacity in dealing with them that even the best are at times overwhelmed and cause various distortions and dropouts.

However, while major disc anomalies are rare, they do exist. During a recent listening session I encountered a CD that could only be described as a sonic disaster area. It grossly distorted, skipped, intermittently lost signal, and emitted all manner of rude repetitive noises. Now, I was listening to this disc on one of the most highly regarded and expensive CD players, and I have access to many machines, including most of those that are considered state-of-the-art. Some of them use the Sony 16-bit linear decoding system; some use double oversampling, and others are prime examples of the Philips quadruple-oversampling technique. Well, friends, I played that offending CD on all these machines, and although some players' error-correction systems valiantly tried to restore order, all failed—save one. On that particular CD player, the manufacturer had gone to considerable lengths to improve the efficiency of the error-correction system. The company calls it "variable error correction," and while they do not offer detailed technical information on this proprietary system, they are in no way bashful about extol-

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Note: All applications are subject to review. The CBS Compact Disc Club reserves the right to reject any application.

I have a CD that is a sonic disaster area, and none of the high-quality units I played it on could fix its errors—save one.

ling its virtues. And well they might, for on their player, this most flawed of CDs was perfectly reconstructed and provided lovely music with not so much as a polite hiccup!

Surely one would think the CD player that accomplished this feat must be the latest and greatest chromium-plat-

ed, turbo-charged example of the digital art. Would you believe it was the quiet, unassuming, but well-dressed ADS CD3? This middle-priced CD player is a nicely integrated design, a well-made, user-friendly unit that combines functionality with an uncluttered control panel. The machine provides

superior performance in all the important CD parameters, and deserved the quite favorable review in the June 1985 issue of *Audio*. I have not tried my nasty CD on every CD player, and there may well be some other machines which can cope with its anomalies, but the CD3 is an exemplar for the outstanding qualities of its special "variable error-correction" system.

I am not saying that the performance of error-correction systems is the single and absolute criterion for judging the quality of a CD player. Certainly there are many other important considerations. However, there is little doubt that good error correction plays a major role in successful CD playback.

To continue the saga of my errant CD: The manufacturer of the expensive, high-quality player I was using earlier when I discovered that CD asked if they could borrow the disc. They were quite chagrined, and I expect a bit chastened, to find that their really quite splendid CD player did indeed have problems playing through my super-defective disc. At their plant, the CD was examined under a high-power microscope, which revealed that in the passage with the most anomalies, the information pits were oddly shaped and a number of tracks were skewed beyond the tolerances normally allowed in the mastering.

This by-now notorious CD is at present on its way to Philips in Holland, where it will be examined under a scanning electron microscope. Under the tremendous magnification possible with the SEM, the nature of its problems will quite likely be clarified.

Incidentally, I have a duplicate CD of the one which had caused so much trouble, and it plays back flawlessly on all the CD machines on which I have tried it, no matter what their pedigrees. Could this CD have been processed, somehow, from a different master of the same program?

I found my involvement with the anomalies of CDs—and the complexities of error correction—quite interesting and stimulating. It certainly impressed me anew with what a technological tour de force the Compact Disc system is, and made me marvel that such a sophisticated product is so widely available and so reasonably priced.

A

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AURAL ARGUMENTS



Contrary to the sensational accounts presented on a certain television show, life here in Miami is generally pretty quiet. This is particularly true at the University of Miami, where the quest for scholarship enhances the air of tranquility. As Professor of Music Engineering, my biggest worry is keeping dry during tropical downpours.

Thus I was surprised when a fight recently broke out between two of my top students. It was a heated exchange, with the kind of intensity saved for very serious questions indeed. But instead of shouts of "tastes great!" and "less filling!" I heard cries of "one-beam!" and "three-beam!" Compact Disc player pickup design had provoked yet another altercation.

No matter where you go, a Compact Disc is a Compact Disc. Whether manufactured in Langenhagen, Terre Haute, or Tokyo, all are 120 mm wide, with a spiral pit track that is 0.6 μm wide and 1.6 μm away from the adjacent track. That's the CD Standard. But when it comes to hardware to read those pits, it's every man(ufacturer) for himself. Differences of opinion on the best way to play CDs have created considerable engineering diversity.

That diversity starts right at the pickup, where a disc's pit/land transitions are optically read by a laser beam, later to be converted into an r.f. (radio frequency) signal and then demodulated to extract audio and control data. The pickup must maintain focusing and tracking even under adverse playing conditions, such as when dirt, shock, or vibration are present.

We have four methods for tracking the pit spiral: One-beam push-pull, one-beam differential phase detection (DPD), one-beam h.f. (high-frequency) wobble, and three-beam. Three techniques are available for generating a focusing signal: Cylindrical lens using astigmatic focusing, Foucault focusing, and critical-angle focusing.

Of course, any pickup must simultaneously perform both tracking and focusing, so a complete design must incorporate techniques for both. Fortunately, we are spared the task of analyzing all the possible combinations, because when the focusing and tracking mechanisms are linked, two pickup designs stand out from the rest: One-beam push-pull tracking with Foucault focusing, and three-beam tracking with astigmatic focusing.

Both of these designs have been

used in commercial players, with the Europeans generally favoring the former and the Japanese the latter. Thus, the battle lines for one-beam versus three-beam designs have been drawn. Only in portable players have these rivals generally agreed on pickup design—one-beam, in this case, primarily because it saves space.

The optical components of a one-beam design are shown in Fig. 1, along with the photodiode array used to generate tracking and focusing signals as well as the data signal. A solid-state diode generates the laser beam which strikes the semi-transparent mirror; a collimator and objective lens focus the beam on the disc's reflective pit-track surface. As the track flies by, the pits and land areas of the data stream reflect the laser beam with varying intensity; the land is highly reflective, whereas the pit (perceived as a bump from underneath) cancels and disperses the light and is therefore less reflective.

On its return path, some of the reflected laser light passes through the semi-transparent mirror and strikes an optical wedge. This splits the light into two beams which are adjusted to strike an array of four horizontally arranged photodiodes, D1, D2, D3, and D4. The outputs of all the photodiodes are summed to provide the data signal, which is demodulated to yield audio and control data.

The diodes also generate error signals for tracking and focusing. As the pickup wanders from the pit track, it creates an intensity difference between the two split beams. Either photodiode pair D1/D2 or D3/D4 generates a stronger signal from the increased laser light; the difference between the pairs produces an error signal which is used to move the pickup back on track.

When focus varies, the focal point of the system is shifted, and the split beams draw closer together or farther apart, thanks to an effect first observed by J. B. L. Foucault in the 1850s. The difference between diode pairs D1/D4 and D2/D3 forms a focus-error signal which is used to move the objective lens back into focus. Of course, in practice, the four photodiodes simultaneously perform all three tasks of data reading, tracking, and focusing.

A three-beam pickup design is shown in Fig. 2. Two side beams are added; these are used exclusively for tracking, while the center beam takes care of focusing and data retrieval. In addition, the actual focusing technique uses astigmatic instead of Foucault focusing. The primary laser beam is split into three beams by a diffraction grating; two of these beams are directed to either side of the pit track. As the pickup wanders off the track, the side beam encounters more land and thus receives more reflected light, while the beam striking the pit track receives less. The intensity difference in the beams striking photodiodes E and F creates a tracking-error signal, which moves the pickup back on track.

Meanwhile, the center beam passes through a cylindrical lens and is directed to photodiodes A, B, C, and D. (The secondary tracking beams to E and F do not pass through this lens.) As the distance between the objective lens and the pit track varies, the focal point of the system changes, and the image projected by the cylindrical lens changes shape because of the astigmatic properties of cylindrical lenses. The shape of the image on the photodiode array generates the focus-error signal.

In the final analysis, both designs perform the same functions. But the engineering advantages seem to favor the one-beam design. The optics in a three-beam system are inherently more complicated; there are at least five components (objective lens, collimator, grating, cylindrical lens, and beam splitter) compared to the four components in a one-beam design (objective lens, collimator, wedge, and semi-transparent mirror). In addition, the three-beam design requires several factory adjustments, including secondary-beam and diffraction-grating alignment, whereas the one-beam design needs only a single adjustment, of the photodiode assembly's horizontal position.

A three-beam design is also more complex from a mechanical viewpoint. A one-beam system can be mounted on a single pivoted arm, which describes an arc across the disc surface; since there is only one moving part, wear is minimal and reliability is high. A three-beam pickup requires linear

movement because the three beams must stay in a fixed position relative to the pit track. The three-beam pickup is thus mounted in a sled which moves radially across the disc. (A one-beam pickup could also be mounted in a sled.) The sled is often driven by a lead screw; the pitch of the screw's thread is a compromise between the fine thread required for normal tracking (at 35 mm per hour) and the coarse thread needed for fast forward and reverse (at, perhaps, 35 mm per second). Often, a coarse thread is used to achieve fast disc access, and a movable mirror is inserted in the laser's path to deflect the beam quickly to handle small differences such as track eccentricity.

On balance, it appears that the one-beam is the better design, because it is simpler. (When one prominent manufacturer switched from a one-beam to a three-beam pickup in its CD players, I asked the chief design engineer why. He replied that his engineering division

firmly preferred a one-beam design, but the marketing division felt that consumers perceived three beams as being better than one. Engineering was forced to go along, strictly for marketing reasons.) In terms of traditional specifications such as frequency response, channel separation, etc., there should be no sonic difference between one- and three-beam designs. However, it is possible that one design has the edge in tracking and focusing, which would be manifested in reduced need for error correction and concealment. In the long run, that adds up to fewer audible errors. Ultimately, though, performance must be evaluated on a player-by-player basis, bearing in mind that a one-beam design might have a built-in advantage. When you're shopping for a player, it's certainly one more thing to think about.

Uh-oh—looks like another fight has broken out! I can hear shouts of "analog filtering!" and "digital filtering!" from the stairwell.

Fig. 1—Layout, tracking, and focusing of a single-beam CD player pickup.

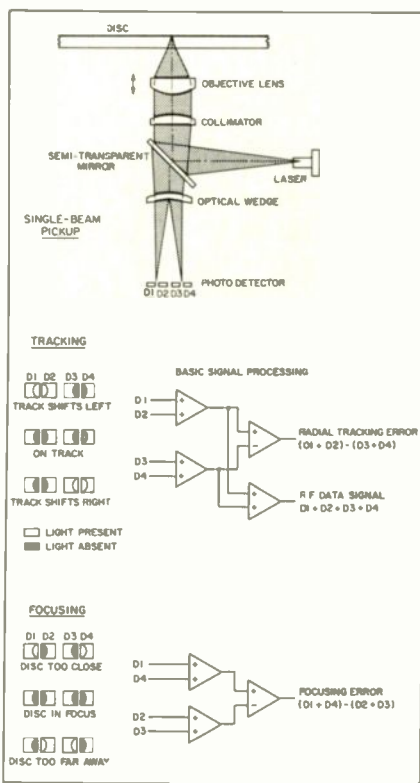
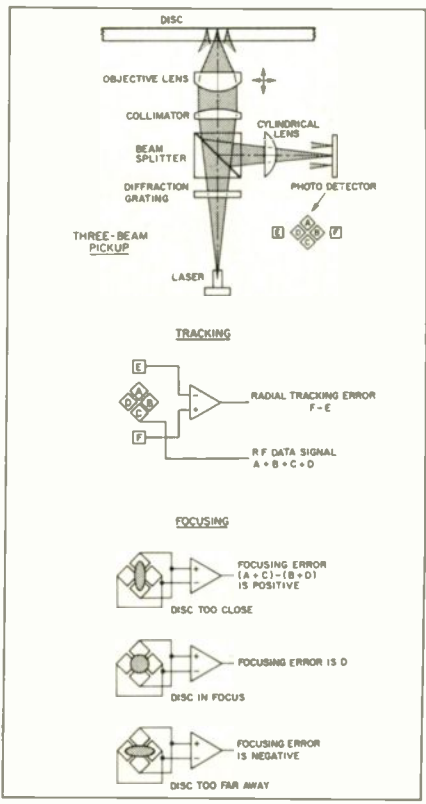


Fig. 2—Layout, tracking, and focusing of a three-beam CD player pickup.



Treble Loss

Q. When I record from any source, with or without Dolby NR, it seems that my cassette deck adds a lot of bass. Is this normal? I play the cassettes in my car system, and there is hardly any treble.—Chris Valencia, Tylot, Mich.

A. You did not indicate in your letter whether this problem is heard when you play these tapes back on the deck that made them, or whether you only hear it in your car.

If you hear this problem in both places, then we must next ask whether your home deck has separate record and playback heads. If so, it may be that the two heads are not in azimuth alignment with each other—that is, the gaps of each head may not form the same angle with respect to the tape. (This angle should always be 90°, for compatibility between tape decks.) If only your own recordings sounded "off," the problem might be caused by misalignment of either head, or of both; if tapes made on other decks also sounded incorrect, then the problem would probably be with your playback head's alignment. However, since you hear the same problem when playing these tapes in your car, the recording head is more likely at fault. If your deck uses the same head for recording and playback, an azimuth error would show up only when tapes made on this deck were played on other decks.

Excessive bias or improper equalization in recording could also cause treble loss. These causes could apply to either three- or two-head decks.

In playback, inadequate treble could also be traced to such factors as a widened head gap, dirt (including tape oxide) on the head, or improper equalization. It is more likely, however, that the treble loss occurred in recording on the one deck than that it is due to coincidental playback problems on both tape machines.

If you hear this problem only in your car, and hear it only from tapes recorded on your home deck, then azimuth problems in your recorder are the most likely cause of your treble loss. To check this, tapes which sound good in your car should be played on your home recorder. If you hear a similar treble loss when playing these tapes at home, then you have probably pinpointed azimuth error as your problem,

especially if your home deck does not have separate record and playback heads. Head alignment is a finicky job which you may want to farm out.

Tape Squeak

Q. I have four prerecorded cassettes, three from the same label, that have started to squeak during playback. The squeaking gets worse with each use. Can I eliminate the squeaking by breaking the cassette shell, removing the tape, and putting it into a new shell?—Victor H. Orellana, Culver City, Cal.

A. I rather doubt that putting the tapes into new shells will remedy the problem. (But it just might, particularly if the pressure pad is the cause.) More likely the tape is responsible. Sometimes it helps, if only temporarily, to put the cassette in a box with well-moistened blotting paper for about three days.

Incidentally, do the tapes squeak when played on decks other than yours? If they don't, it could be that something is amiss in your deck—perhaps tape tension. Or it could simply be that the particular tapes and your deck are a mismatch, something that happens from time to time even with components that are individually very good.

Long-Playing Cassettes

Q. I have heard that there are long-playing cassettes on the market. If so, how good are they, and how long is their playing time? Who makes them? Do they require special players? Who makes these players?—Tommy Langerak, Fort Collins, Colo.

A. The longest playing cassettes are C-120s, which play for 120 minutes on any standard player when operated in both directions. They are generally not recommended for high-quality reproduction because of such problems as greater distortion, greater print-through, and a tendency toward jamming, tangling, and other physical malfunctions. Hence some tape manufacturers don't make C-120s, while others offer only a very limited selection.

On the other hand, when high-quality reproduction is not necessary, they may be very satisfactory. Several readers have informed me that they have had good success with C-120s for

such purposes as recording lectures and conferences.

To find out what brands and tape types are available in the C-120 length, consult the Annual Equipment Directory in the October 1985 issue of *Audio*.

Head Misalignment

Q. I recently had my cassette deck in a repair shop to have the heads replaced. At first it sounded great, but after a while the left channel seemed to record at a lower level than the right one. Then the deck wouldn't erase the tape. I noticed that the erase head was hitting the cassette shell and not touching the tape. I turned the erase-head adjustment screw so that the head would touch and erase the tape. But now the right channel records at a lower level than the left. Can you please tell me what the problem is?—Andy Warren, Miami, Fla.

A. Apparently the repair shop was careless about aligning the heads or securing their adjustment once correctly aligned. A record-playback head (or separate heads) requires very careful alignment in three respects: Height, so that the two gaps cover the correct portion of the tape; azimuth, so that the gaps are at a perfect (or nearly so) right angle to the long dimension of the tape, and tilt, so that the left and right gaps make equally good contact with the tape. To make these alignments correctly, one needs appropriate test tapes. The erase head requires similar alignment. I think that you should return your deck to the shop and insist on correct alignment and securing of the alignment.

Wrong Key

Q. My cassette deck provides only for automatic switching of bias and equalization according to type of tape, using the key wells of the cassette shells. There is no manual switching. Recently I got some Type II cassettes which were mistakenly put into Type I shells. If I use a 10-band graphic equalizer, could I adjust the signal going to the tape deck for recording so

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



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Recording a tape with the "wrong" EQ does no harm, as long as you use the same EQ in playback, but recording with the wrong bias can cause problems.

as to give fairly linear response in playback? Also, please clarify the differences between Type I and Type II tapes with respect to equalization and bias.—Bruce D. MacGregor, Victorville, Cal.

A. Type II tape requires appreciably more bias—roughly 50% more—than

does Type I. Inadequate bias produces increased distortion and exaggerated treble response. You could compensate for the exaggerated treble by judicious use of your graphic equalizer, but you would still be left with the distortion problem.

In playback, Type I tape requires

120- μ S equalization, signifying bass boost beginning at 1,326 Hz (up 3 dB) and levelling out (3 dB below maximum) at 50 Hz. Type II (as well as Types III and IV) take 70- μ S playback equalization, namely bass boost beginning at 2,274 Hz and levelling out at 50 Hz. Thus, if you used Type I playback equalization with a tape that had been recorded with Type II equalization, you would exaggerate the treble—about 4.5 dB by the time you got out to 10 kHz and beyond. On your deck, however, this problem would not occur, because the deck would automatically select the same "wrong" equalization in playback that it used in recording. No equalization mismatch would take place.

Still, considering the uncorrectable problem of insufficient bias, I think the wisest course by far is to exchange your mis-shelled tapes for correctly shelled ones.

"White-Box" Tape

In response to questions about "white-box" tapes (those not identified as to manufacturer), this magazine has taken a negative position if high fidelity is desired. Our feeling has been that while such tape may be satisfactory, one faces a buyer-beware situation. The tape may not have been originally intended for audio purposes, and therefore may not have the appropriate magnetic characteristics. It may be inaccurately slit down from wider tape; it may not have adequate lubrication, and so forth.

However, at least one reader has had a very favorable experience with white-box tape. Robert E. Blay, of Rutland, Vt., writes:

"Several months ago I purchased 40 1,800-foot reels of white-box tape. The cost was about \$1.35 each. I used 36 of them for a project and didn't have a clinker in the bunch. In fact, their quality exceeded that of many so-called premium tapes I have used in the past. I have been taping on open-reel for about 18 years and up to now would never have considered using white-box tape. But henceforth I'll be using it for all but the most exacting requirements. Incidentally, the supplier was not only extremely courteous and helpful but prompt. I received my order in a week."

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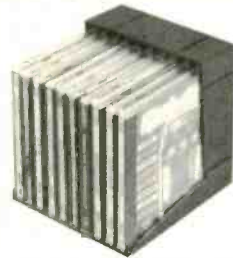
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Bypassed Filter Capacitors

Q. I notice that many power supplies use a 0.1- μ F capacitor in parallel with a 10,000- μ F filter capacitor. Why?—Tom Unger, Gardena, Cal.

A. The 0.1- μ F capacitor is there to suppress switching transients, so that they won't find their way into the audio circuits. Its use also tends to keep r.f. out of the power supply. Yes, the large filter is there, and you wonder: "How can this small capacitor work if the big one won't?" The answer is that the large capacitor is not a perfect capacitor at high frequencies. It possesses inductance, which is effectively in series with the r.f. being bypassed, reducing the amount of effective bypassing which will be accomplished by the filter capacitor at high frequencies.

Transient "Click" on Turnoff

Q. When I turn my receiver off, a "snap" or "pop" is heard, and the protection indicator flashes for an instant. I wonder if this means that the amplifier is producing so much power that there is a chance of damaging my loudspeakers. I've heard all sorts of opinions about this annoyance, ranging from "they do all do it" to "don't worry about it." What are your thoughts about this?—Name withheld

A. I receive many letters of this kind. From what I read and from my own experience, they *don't* "all do it."

I have never heard of an instance where the "click" was so pronounced as to drive the power amplifier to a point where its protection circuit was activated. I have to believe that your protection circuit flashes not because of an overload, but because the operating voltages have fallen, leading to erroneous reading of that circuit.

Why would some gear act as you have described and other equipment be free from such noise? I have yet to figure it out. One manufacturer told me that much depends on the way the circuit grounds are laid out. I have noticed that many units which exhibit this set of symptoms are also subject to interference from external power-line transients, such as those produced by the turnoff of a refrigerator or the operation of a furnace.

I suggest that you check with the maker of your equipment or his representative to see if he has a solution. If

you wish to experiment, and if you do not mind violating your amplifier's warranty, you can try wiring a resistor and capacitor, in series, across your amplifier's power-switch contacts. The capacitor should have a value of about 0.02 to 0.05 μ F and be rated at 600 V d.c. The series resistor's value should be 50 to 200 ohms, and it should be rated at 1 watt. I have successfully silenced such problems, in some cases, with just this simple circuit.

Heads or Tails

Q. I was asked to send a cassette to someone "heads out and ready to roll." Can you tell me what the term "heads out" means?—Steve Kranick, Loudonville, N.Y.

A. A cassette's beginning is said to be the "head" and its end to be the "tail." If we play a cassette to the end and do not rewind, we say that it is wound "tails out." If the tape has been rewound and is ready to play again, we say that it is wound "heads out."

These terms are carry-overs from professional recording-studio practice. Open-reel master tapes are always stored tails out, because the tape is wound more neatly on its reel or hub than it would be if it were rewound prior to storage. Wound tails out, there are no protruding turns of tape, whereas if the tape is rewound, there is a tendency for it to be more loosely packed, with some edges standing out from the pack. When the tape is placed in its container, these raised tape edges will be squeezed or folded down. This, in turn, causes permanent wrinkling of the tape and leads to less-than-perfect contact between the playback head and the tape.

People who request cassettes to be wound "heads out" need to be able to play them immediately, without waiting to rewind them.

Incompatible Equalization With Different Speakers

Q. I own a pair of speakers employing 5-inch woofers. I didn't like the way the tweeters sounded, so I disconnected them. To restore the lost treble, I used an equalizer, and found treble boost settings which enabled me to restore the sound to "normal." In fact, I even prefer the sound from these woofers to some three-way speakers I own

which cost hundreds of dollars more than the little systems. However, when I try these same equalizer settings with some of the other speakers, the music sounds awful. Why?—Anthony Mauldin, Lewisville, Tex.

A. There are a few factors operating here. First, your small systems use woofers which themselves are reasonably small. Thus, with some treble boost, these woofers are capable of producing reasonably smooth highs.

Your letter doesn't mention whether your other systems are still equipped with their tweeters. If so, before the equalizer is switched in, the treble is already more or less flat. If you then add the boost, the highs will be exaggerated. So the sound is likely to be "awful."

Perhaps, in fact, you did remove the tweeters from your larger systems before introducing the equalization. In that event, your midrange driver may be of such a design that it is simply incapable of producing the full range of highs, even with treble added. Even if the driver can reproduce the frequencies, there may be a number of serious peaks and dips in the treble region that make the sound "awful." Or perhaps there is a low-pass filter associated with the crossover network which you should have disconnected.

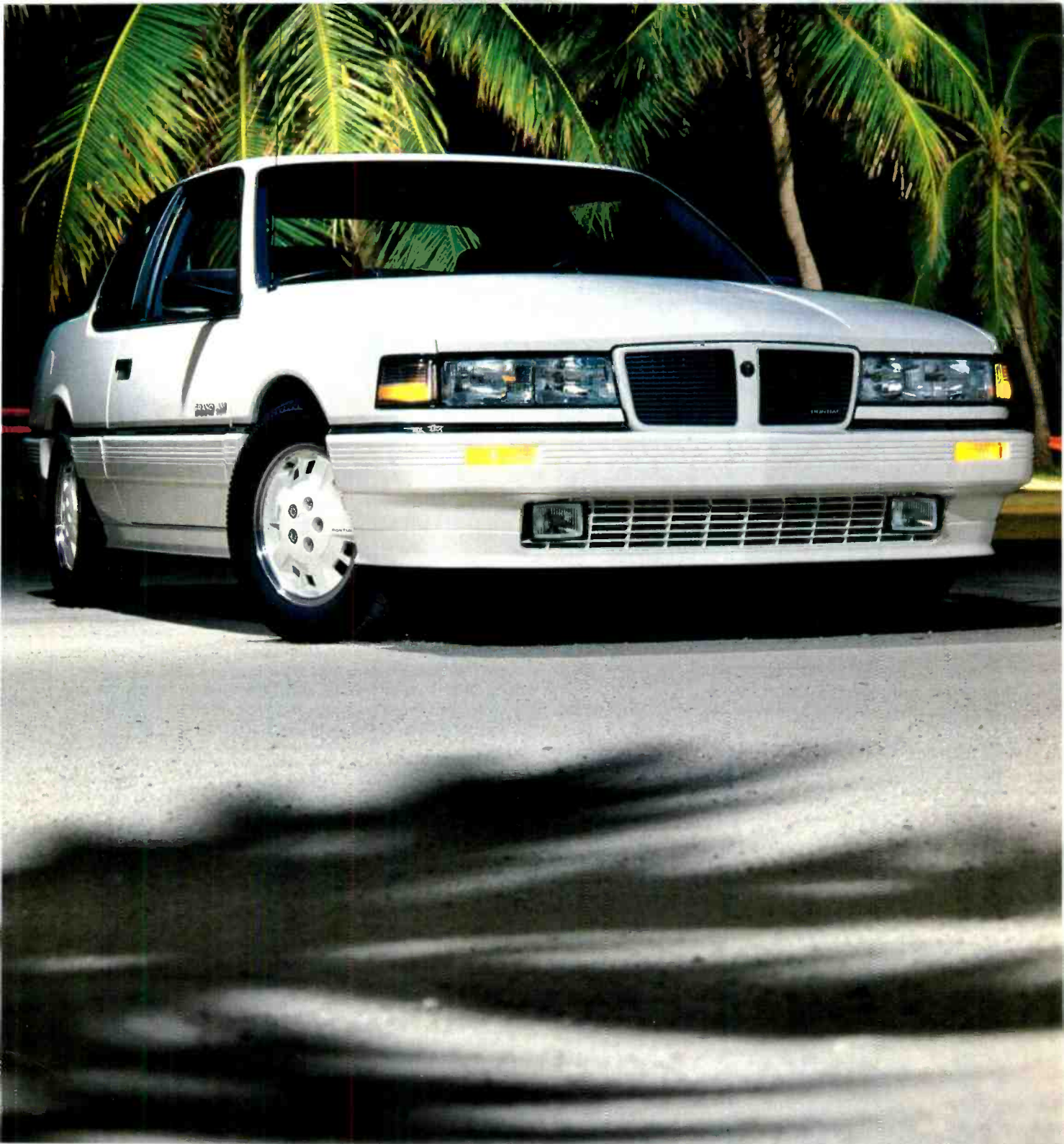
With all of this, it is likely that, with your three-way speakers, you need a different EQ curve to bring about the smooth highs you obtained from your small speaker systems.

Matching a Preamp to a Power Amp

Q. My old tube preamplifier is specified to have an output impedance of 1 kilohm, and is designed to work best into a load of 100 kilohms or more. My transistorized power amplifier has an input impedance of 20 kilohms. The owner's manual for the preamplifier states that, in such a case, a modification can be made to the preamplifier to achieve optimum results, but gives no indication as to what this modification might be. Can you help?

Is there an ideal ratio for imped-

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Intermittent failure of an amp may be due to the protection circuit being triggered, but the list of possible causes is long.

ances of interconnected audio components?—Tom Unger, Gardena, Cal.

A. To make your preamplifier drive your power amplifier without loss of bass response, change its output coupling capacitor to a value five times higher than that which it now has. If you like, ten times its original value will also be fine.

The problem of bass loss can occur in a situation like yours because of voltage division between the preamp's output coupling capacitor and the input impedance of the power amplifier. By making the value of the capacitor greater, the amount of such low-frequency loss is minimized.

The obvious question is, why didn't the maker use a large coupling capacitor in the first place? The answer is that he tried to prevent low-frequency pulses from finding their way into the power amplifier, where they would add distortion and perhaps damage the amplifier's output stage and/or the speakers. It is likely that, when the

preamp was built, most power amplifiers had high input impedances.

As for ideal ratios between output impedance of the driver and input impedance of the load, if we are not discussing cartridges and loudspeakers, I usually suggest that the impedance of the device being fed should be ten times that of the driver. This is done so that a maximum voltage is transferred between the two devices (rather than a maximum of power, which would be transferred if the impedance between the devices were matched).

Intermittent Power Amplifier Operation

Q. Not long ago my integrated amplifier just stopped working. I took it to an authorized service shop, where I was told that it was working properly. Reinstalled, the amp worked properly for a few days, then cut off again. I checked the power and other circuit breakers with an ohmmeter, and there was continuity across each of them.

What could be wrong?—Elpidio Arocho, Newark, N.J.

A. I would venture that you may be operating the equipment somewhere near its maximum power output. Perhaps the cutoff is the result of the protection circuit turning off the amplifier.

The next time this occurs, turn off the amplifier. Wait a minute and then turn it on again. If I am correct, all will be well. Of course, to keep this problem from recurring, operate the equipment at a somewhat reduced volume.

What I have mentioned is certainly the simplest situation to deal with. But many other factors can bring about an intermittent failure of your equipment. There may be poorly soldered connections, cracked circuit foils (which open when hot), dirty contacts on switches and controls, internal components which can cause problems if permitted to heat up, etc. The list is almost endless, and intermittent conditions are usually the most difficult for a service technician to deal with. A

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Matthew Polk's ultimate dream loudspeaker, the SDA-SRS, won the prestigious Audio Video Grand Prix Speaker of the Year award last year. Stereo Review said "Spectacular... it is quite an experience" and also stated that the SRS was probably the most impressive new speaker at the 1985 Consumer Electronics Show. Thousands of man hours and hundreds of thousands of dollars were spent to produce this ultimate loudspeaker for discerning listeners who seek the absolute state-of-the-art in musical and sonic reproduction.

Matthew Polk has, during the last year, continued to push his creative genius to the limit in order to develop a smaller, more moderately priced Signature Edition SDA incorporating virtually all of the innovations and design features of the SRS without significantly compromising its awesome sonic performance. The extraordinary new SRS 2 is the successful result. Music lovers who are privileged to own a pair of either model will share Matthew Polk's pride every time they sit down and enjoy the unparalleled experience of listening to their favorite music through these extraordinary loudspeakers, or when they demonstrate them to their admiring friends.

"Exceptional performance no matter how you look at it"

Stereo Review

Listening to any Polk True Stereo SDA* is a remarkable experience. Listening to either of the Signature Edition SDAs is an awesome revelation. Their extraordinarily lifelike three-

dimensional imaging surrounds the listener in 360° panorama of sonic splendor. The awe inspiring bass performance and dynamic range will astound you. Their high definition clarity allows you to hear every detail of the original musical performance; while their exceptionally smooth, natural, low distortion reproduction encourages you to totally indulge and immerse yourself in your favorite recordings for hours on end.

Julian Hirsch of Stereo Review summed it up well in his rave review of the SDA-SRS: "The composite frequency response was exceptional... The SDA system works... The effect can be quite spectacular... We heard the sound to our sides, a full 90° away from the speakers... As good as the SDA feature is, we were even more impressed by the overall quality of the Polk SDA-SRS... The sound is superbly balanced and totally effortless... Exceptional low bass. We have never measured a low bass distortion level as low as that of the SDA-SRS... It is quite an experience! Furthermore, it is not necessary to play the music loud to enjoy the tactile qualities of deep bass... Exceptional performance no matter how you look at it."

The awe-inspiring sonic performance of the SDA-SRS 2 is remarkably similar to that of the SRS. Words alone can not express the experience of listening to these ultimate loudspeaker systems. You simply must hear them for yourself!

"Literally a new dimension in sound"

Stereo Review

Both the SDA-SRS and the SDA-SRS 2 are high efficiency systems of awesome dynamic range and bass capabilities. They both incorporate Polk's patented SDA True Stereo technology which reproduces music with a precise, lifelike three dimensional soundstage which is unequalled and gives you, as Julian Hirsch of Stereo Review said, "literally a new dimension in sound". Each beautifully styled and finished cabinet contains 4 Polk 6½" trilaminate polymer drivers, a planar 15" sub-bass radiator, 2 Polk 1"

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DIAL POINTERS



Staying Tuned

When I was a kid, radio networks were in full flower, and a given program could often be heard from many stations simultaneously. This was handy on long car trips—if you got far enough out of town for your local station to fade out in the middle of Jack Benny or *Your Hit Parade*, you could just chase the program up and down the dial until you found another, closer station carrying it. In Europe and Japan this is apparently still the case (it also remains true, to a limited extent, of news broadcasts and some Public Radio programs in the U.S.).

European road travellers may soon have their FM program-chasing

automated. A Radio Data Signalling (RDS) system adopted by the European Broadcasting Union (and perhaps to become a CCIR world standard) is going into service on the British Broadcasting System next year. Stations equipped for RDS will send out frequent digital codes, generating a dashboard display which identifies the program, the station, alternative frequencies carrying the same program, the time, and the date. Additional information would tell you when to switch to another station for such special services as traffic announcements.

In the U.S., it might be more useful to identify program formats (which are

duplicated from region to region) than individual programs (which usually are not). Then, whether your tastes ran to classical, rock, jazz, or whatever, you could get a relatively uninterrupted flow of it no matter how far you drove. There would still be holes in what you heard, alas, since the system is only for FM—no help if the programs you want are on AM. Some sections of this country are without classical FM stations, and the New York area, at least, currently lacks an FM country/western outlet. Most news and sports broadcasting seems to be on AM, too.

The service might be expanded to carry other information, such as phone-in numbers (more useful to car listeners with cellular phones) or the name of the current musical selection ("No John, that's not Tchaikovsky; the radio dial says it's Franck."). If it ever goes so far as transmitting song lyrics, I hope any car radios which provide that information have their displays angled so only the passengers can read them.

Illustrations: David Reau Johnson

Good and Bad Alarms

A Mercedes owner lost his car stereo about a block from my house at 2:00 a.m. the other night. By 2:15 he'd forfeited my sympathy, and by 4:00 the victim, not the thief, had earned my hatred and that of a few hundred others in the neighborhood, suspect.

What got our curse was his alarm. It woke us when it went off (apparently it attracted no police attention, even though I'd called them), and was still going strong two hours later, while we vainly strove to sleep.

By New York City law, alarms must shut themselves off after a few minutes (the good ones reset themselves, in case there's a second attack). If help hasn't arrived in those few minutes, the thieves will have made their getaway, and further sound will only disturb the neighborhood's sleep. This car, unfortunately, had New Jersey plates, so I doubted it would do me any good to swear out a complaint against its owner; I've never heard of that law being enforced, anyway.



Why would someone install an alarm without an automatic shut-off? Perhaps it saves a few bucks, but would the owner of a Mercedes 500SEC be too strapped to afford it? Perhaps the alarm installer knew so little about the field that he was unaware such a device was available or needed. Either way, it reflects badly on installer and car owner alike.

I recommend car alarms—but only with automatic shut-off and reset systems.

One-Hand Me

Standing up, with both hands free, I find a CD jewel box hard to open. Driving my car, with one hand firmly on the wheel, I have little difficulty opening a jewel box with my other hand.

My secret? I lay the box down on the passenger seat, place my thumb on the ridged edge of the box top near the labelled spine, and hook my fingers over the lip at the lid's other end. Then I press down with my thumb and lift with my fingers, and the box comes open—often on the first try.

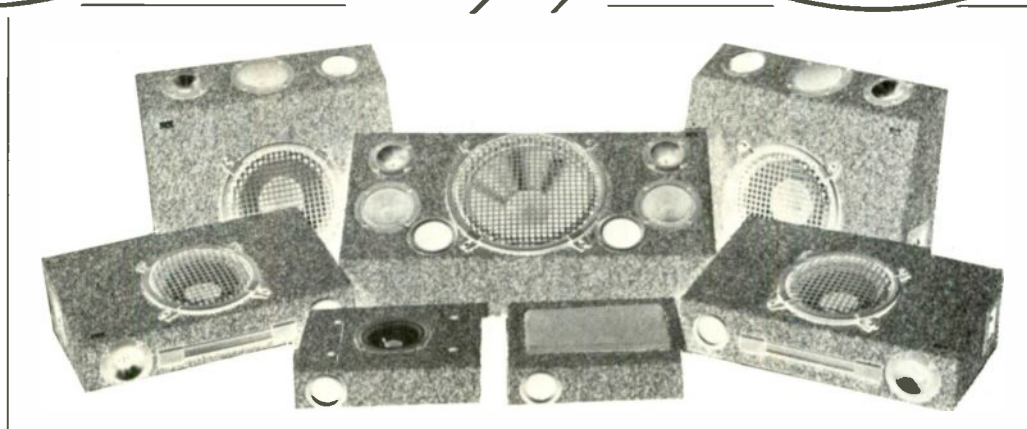
This works only when the box is resting on a soft surface. Otherwise, the whole box tilts up when I lift. This is no problem in the car, because the passenger seat is soft.

When I'm not driving by myself, of course, I have an even easier system. I just hand the jewel box to my passenger and say, "Here. Open this." If my passenger has opened jewel boxes before, this works as well as my secret method, sometimes even better.

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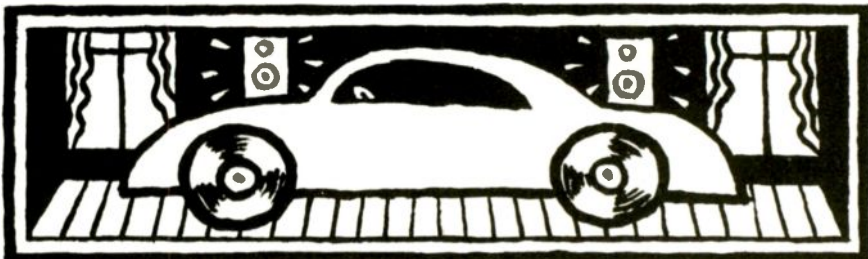
If your car's CD player loads by magazines, you'll want your home player to do likewise. Manufacturers are well aware of this.

CD Interactions

The Compact Disc stands at an interesting point in history. It's the first audio medium to become available for the car nearly as soon as it became available for home use.

That's leading to some interesting interactions: You can bet that there will soon be home players to accept the single-disc CD cartridges that now fit Yamaha, JVC, Clarion, and Marantz car stereos. One newsletter has also said that the format would be used by "Nippon Gakki (Matsushita)"—a puzzler, since Nippon Gakki is Yamaha's Japanese corporate name. You can also bet that Pioneer and Mitsubishi will eventually come out with in-car CD changers to take their multi-disc trays, and that Sony will bring out a home player for their DiscJockey trays too.

This isn't inside information, merely logic. Having to shift discs in and out of cartridges or trays when you



decide to play your car discs in the house or vice versa is a real discouragement, but once you have both home and car players that use such a loading format, you're unlikely ever to buy another player that does not use it. About the only times you'll ever remove a disc from its holder will be if you run out of holders or want to load the disc into your portable player—and portables that take single-disc cartridges will appear too.

In the meantime, portables are the main link between home and car CD play. There are accessories linking

portables into car systems; one, coming soon from Sony, is a gadget that goes into the tape transport like a cassette, similar to what Recoton now makes. Car head units with front-panel jacks for portables are beginning to appear as well. This may prove an interesting application for Toshiba's CD portable, which is a bit larger than the others but has a remote control; you could set the Toshiba safely on your car's floor (I worry about other portables flying off the seat when the car stops) and use the remote to operate it.

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STREAM LINES



Bit Buckets and Bit Streams

The CD-ROM format standard for computer data on Compact Discs was issued quite some time ago. So far, however, not much computer data is available on CD-ROM, and few manufacturers can yet supply CD-ROM drives.

That could change quickly this year. Microsoft, a major computer software company, is holding a conference to set CD-ROM file standards, necessary because computers don't access CD data the way we listeners do. When we listen to music, we dip our ears in a running stream, concentrating on the information reaching us right now. What's past has been processed and partially forgotten, background to the notes of the moment; what's yet to come can only be anticipated. Computers don't just take a dip; they imbibe data by the bucketful and store it in memory, where any part of it can be accessed instantly.

What's in the bucket matters a great deal. Each dip into the bit stream should yield a precisely defined block of bits, a file, containing only the program or data the computer needs to work with. This involves not only reading a track index, as musical CD players do, but checking for precise sequences of bits that define exactly where each file begins and ends. Otherwise, the computer might find parts of an adventure game where it expected instructions on filling out an income tax return. Citing destruction of an enemy asteroid as a capital loss is sure to earn you an audit.

Computer files on tape and floppy disk already include such file markers, but the markers vary according to the computer and the operating-system program it uses. Of the five Radio Shack TRS-80 operating systems I have at home, for example, only two can read each other's files, and none can read those

of my wife's Kaypro. Such incompatibilities are barely tolerable for the comparatively small production runs that are economical with magnetic media. The high cost of CD mastering, however, restricts CD's use to discs with some potential for widespread sale. Otherwise the cost per disc becomes prohibitive. If separate masters were needed for Tandy, Apple, IBM, and Commodore editions, CD-ROM would be uneconomical. However, if a common file standard can be used, then all computers will be able to read the same discs, and the potential market for each disc becomes more promising.

We'll probably never achieve full interchangeability of discs among computers. Files of reference information—such as catalogs, interactive novels, encyclopedias and back issues of *Audio*—can be made universal. Programs, which tell computers how to use information or perform other tasks, cannot, because the computers speak entirely different languages. It would be like giving a Martian directions in Swahili.

So far, this all has little to do with sound and music. Computers are riding on the coattails of a medium developed for us, and so far contributing little to it. Once CD-ROM takes off, however, computer use will be the driving impetus towards developing low-cost equipment to record CDs. Judging from our mail, there's a substantial audiophile demand for it.

Illustrations: Teresa Anderko

Pocket Karaoke

A recent visit to an electronics trade fair in Taiwan turned up very little audio equipment (even Proton was displaying mostly video). But I was intrigued by a pocket-sized karaoke unit from a company called Tranbon. (At least I *think* it was one unit—the Chinese-language brochure showed it labelled the "Go Singer," while the English-language flyer showed it as the "Sing Along"; both versions were model TE-202.) The unit has two microphone inputs, two earphone/speaker jacks, and a signal input (presumably preamp level). A

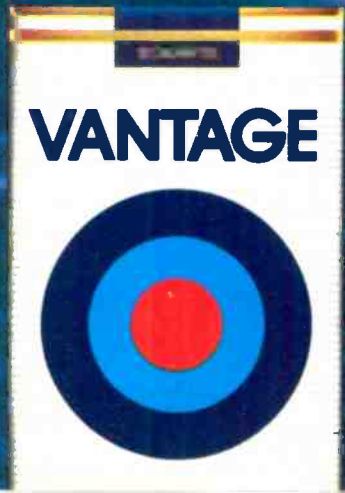


signal is fed in from a tape recorder and mixed with the signals from the microphones; the mixture is fed back to the singers via the headphones or can be fed to an external speaker "for public amusement." The voices are enriched by an echo circuit—a feature no karaoke outfit can do without.

The TE-202 is good for more than karaoke. It can be used as an intercom between a motorcycle rider and passenger, as a mixer when you sing along with an electric musical instrument or, in karaoke configuration again, for learning a language via lessons on tape.

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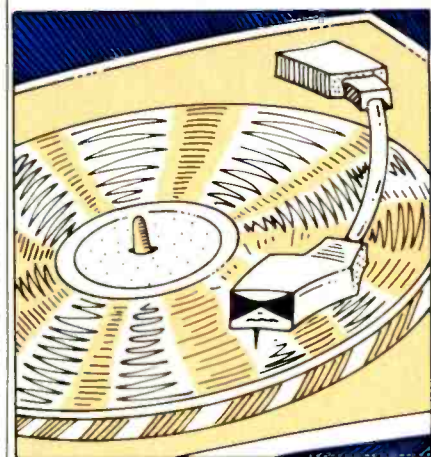
When you look at an audio component and wonder why its designer failed to do something as you would have, you may be right, but he may be right too.

Sealed-In Goodness

Before audiophiles turned their attention to capacitors, resistors used to be a talking point. I remember replacing the noisy carbon resistors in my first tape deck's signal path with quieter metal-film ones. (Like most of us, I never measured the difference, but took the improvement on faith.)

Now I've just heard, for the first time, of a resistor which might have

audiophile applications—hermetically sealed thin-film resistors. According to *Electronic Design*, the John Fluke 8842A digital multi-meter uses these resistors in critical circuits to maintain accuracy for two years between recalibrations. I wonder if we'll see such sealed resistors in perfectionist audio equipment soon—or if some audiophile manufacturer is quietly using them already.



Needless Needing

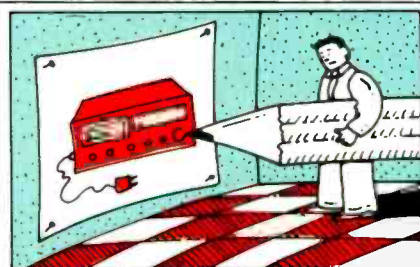
When a stylus goes, it's often the whole cartridge that's replaced. One reason is that there's more competition to sell cartridges than styli, so cartridges are more heavily discounted and easier to find. A more fiendish reason is that cartridge makers often hide the cartridge and stylus numbers where you can't find them unless you remove the cartridge from the arm's headshell. Even then, you can't always find them.

Makers who offer multiple stylus options temper their helpfulness by making it impossible to tell your 78-rpm stylus from your microshibatalliptical without looking up the number or color code on a flimsy, easily lost paper sheet. Stanton used to denote elliptical styli with an elliptical mark and spherical styli with a round one, but that's about as much help as anyone ever gave the user.

It all seems rather silly—and designed to make moving-coil cartridges with nonremovable styli look more convenient than they really are.

Setting Standards

It looks like conductor Zubin Mehta is a CD enthusiast. Talking to *The New York Times* about the acoustics of Harlem's Abyssinian Baptist Church some months ago, he said: "For acoustics and audience response, it's unbeatable You won't believe it, but the acoustics are better than a Compact Disc!"



The Breaks

I once got into an argument with a tape-deck designer when I suggested that he should have put the tape-break detector switch on the opposite side of the head assembly. "You can't!" he snapped. "There's no room there!" Then we looked behind the panel and discovered that he'd placed the tape-break switch in the most crowded location possible, while my suggestion would have made assembly much easier.

It was too late to change the design at that point (it usually is, by the time we journalists see a new product). But that may have been all to the good, since his placement of the switch made at least as much sense as mine. He'd placed it between the capstan and the take-up reel, where it would detect all tape breaks but would also prevent using the recorder to spool unwanted sections of a tape into the wastebasket while editing. Since I did a lot of live recording at the time, I wanted the switch between the head assembly and the feed reel; there, it would allow such editing but would miss any tape breaks that occurred after the tape had passed the capstan. A better compromise might have been to leave the switch where it was, but have some means of bypassing it or latching it in its "tape-unbroken" position.

The point of all this is that when you look at some aspect of an audio component's design and wonder why the designers failed to do something as you would have, think again. You may be right in assuming that your way is logical, but you may be wrong if you assume the designer acted unwisely.

Having a different mind, different experience, and different prejudices than the designer, you are bound to come up with good ideas that the designer did not use. But the designer had to juggle factors you may not be aware of.

Production cost is a major example. It's no good designing in a nice touch that will attract 1,000 more purchasers if that raises the price sufficiently to drive away 2,000 others. Space availability must be considered too, especially in car stereo. For a given panel space, the designer must choose between having fewer large controls and more numerous tiny (and crowded) ones. Circuit functions must also be considered. If placing a control where it's most logical will involve a long and noisy signal path, which should be compromised—ergonomics or performance?

How will the product be used? Assumptions about this will bear heavily on the ultimate design. Will this tuner be used in the city or the country? Will this recorder be used to tape music, speech, or both? How portable, how compact, must this piece of equipment be? What kind of light will it be used in?

The designer does not have all the answers. That's why you and I can come up with ideas for ostensibly improving their designs. But we don't have all the answers either.

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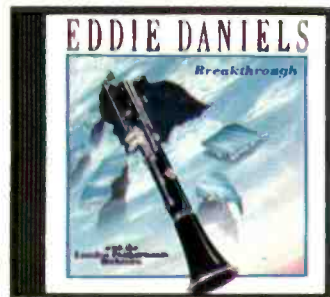
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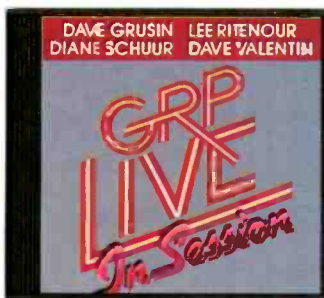
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Phil Ramone:

YEARS IN THE LIMELIGHT

TED FOX

Phil Ramone may be the quintessential pop record producer. Undoubtedly one of the top hit-makers of all time, he is perhaps best known as the man behind all of Billy Joel's zillion-selling records. He has also helped create hit records for a fair number of the pop world's upper echelon, including Paul Simon, Barbra Streisand, and Chicago. His newest star is Julian Lennon.

Ramone is a true hands-on producer who learned his craft as an engineer for legends like Leiber & Stoller and Bacharach & David. His great commercial success has earned him respect in the music business, but it hasn't all been a trapeze through the tulips for Ramone. Many critics have excoriated the records Ramone produced for Billy Joel, and Joel's most warmly received effort, *The Nylon Curtain*, was—believe it or not—a relative commercial disappointment, with only a few more than a million units sold. Ramone and Julian Lennon similarly faced widespread skepticism at first, although the quality of their work ultimately quieted most critics. Here Ramone discusses his reaction to all this, and tells the story of his rise from child violin prodigy to pop production wiz.

T.F.

You were a child prodigy violinist at three, and you entered Juilliard at 13. How did you go from this formal classical background to pop and rock 'n' roll?

When you learn about classical music there are so many rules, and there is so much structure. When you're a teenager, you're rebellious against certain things. In the classical world . . . you don't do this and you don't do that. You don't play baseball, you don't play tennis, you play the violin. You don't listen to other music except that which comes in the package that is preprogrammed for you. I got into trouble because obviously I listened to other music. Here I was, a scholarship kid, who had to live up to all these marks. I was one of the few people who had the Gershwin scholarship; you had to win it every year. I came from a very poor family, beyond poor.

What did you do for money in those years?

I worked at anything. Because I was cute and a mopet, I got various offers. I'd go and do a television show, play in a club or whatever.

This was when you were 10 or 11?

I was on the road by the time I was 12. The so-called vaudeville style of theater was resurging then, in the early '50s. People said, "He's cute and he plays fiddle, and he does a little joke and he can sing." Boom, I'm starting to play gigs. In order to preserve my classical world, my violin teacher would say, "You have to learn to read better,

so you must play chamber music." I played chamber music with doctors; there was a society. There was also a little society where they made classical recordings in a boutique manner. We'd record in stereo in this guy's Riverside Drive apartment or little classical halls like Judson Hall. Any gig I could get I would take, whether it was playing that or playing in a club down in the Village.

I am shopping all the time for new sounds and ideas. This business doesn't allow you the privilege of looking at your charts. If you start believing in that stuff, you're a has-been. You're not working at your craft.



Photo: Timothy White

in a rhythm section, trying to learn how to write jazz.

You were a 12-year-old kid playing in jazz clubs in the Village?

Yeah. I electrified the fiddle, put it through an amp. I loved Stephane Grappelli. The attitude of the typical violinist is that he's going to be Jascha Heifetz. I understood the instrument, and I also understood my own limitations. If I wasn't going to be a Heifetz, I

wasn't going to settle. Also, I thought the instrument, because of its ancient quality, had so many ugly rules about it. You never electrified it. Why? I was into Charlie Parker when I was, like, eight or nine years old, and I had to literally hide out because it was against the rules.

I was never a great piano player, but I had a teacher who taught me a few jazz and blues licks. Through him and

other friends I'd get to sneak into record dates, and watch jazz dates in the studio. By the time I was 15, I was into the studio.

Did that get you fascinated with the guy on the other side of the glass?

Yeah. In 1957, '58 there were still a lot of jazz dates being done. I'd go anywhere. To get in I'd clean the studio up, do anything to be around it. Whatever they wanted, I would do.



How did you first begin to work as an engineer?

Friends who were playing club dates or gigs tried to open a demo studio in their apartment. That's where I started really getting into it. A friend of mine named Bill Schwartau, who I really idolized, was an engineer. Through him I got to meet Tommy Dowd and other famous independent engineers who weren't at Columbia or RCA—you couldn't get into those studios. Eventually a couple of guys hired me to work as a musician on a Harry Belafonte record; some musicians said I played real well. That's when I first went into the RCA and Columbia recording studios, playing in a section, scared to death. Eventually I got to go into the control room. All I cared about was to get into the control room. I was fascinated. I'd be at those playbacks and I'd say, "Wow!" I had recorded a lot since I was eight or nine, and I had transcriptions and acetates, recordings of concerts, and the sound was awful, disgusting. I didn't play that well, in my opinion, but even when I did play well it still didn't sound good to me. So I begged these guys, when they opened this tiny little demo studio in their apartment, I asked them if I could do anything. I'd work for nothing, and eventually when they made enough

money I would become a part of the thing. I started in this kitchenette kind of situation.

What kind of studio setup was it?

The living room had a piano in it and some tiles and a carpet, and a couple of condenser mikes; in those days, '58 or '59, it was really the ultimate thing to own a Telefunken. I learned how to record mono and then two-track, which was in its beginning stages, and then to find echoes. We shellacked one of the bedrooms, painted it for weeks until it had the right sound. Because money was tight, what we did to delay the echo was to take the feed from the tape machine, run it into that bedroom, and then return it. That is not great technique. But I'd seen this guy at Columbia run his tape machine into these huge vaults of echo and slap, and other sounds, and I said, "Oh, this is what I've got to learn." Because half of what you do in the studio is the mixture of echoes, reverbs, slaps.

I got hold of an album; I'll never forget, it was called *Elsa Poppin and Her Pixieland Band*. Some French guy and a French engineer made it, probably in 1953 or '54. It did what George Martin and other people did later. There were seven or eight machines out of sync, in sync, and all of it humorous. One part would slow down while

another part would go out of sync and the guy would giggle. I sat there for days, months, listening to this and trying to figure out how he did those things.

Did you learn mike placement and other recording techniques by playing on sessions and watching, or by experimenting with engineering?

Both. From playing I learned immediately from the playback what was happening. I would do dates in other people's studios for only one reason—to learn what the engineer was doing. I'd say, "Do you mind if I come in here?" It was sort of an unwritten law that musicians never went in the control room. Only the concertmaster or the contractor did. I used to watch them doing microphone placement, which was the key to good recording-studio technique in the '50s.

My reputation grew very quickly. By the time I was 21 I was engineering for [Burt] Bacharach and [Hal] David, Quincy Jones, Leiber and Stoller, Ellie Greenwich, Jeff Barry, Neil Diamond, Doc Pomus, and Mort Shuman. There were maybe four independent studios that had any reputation. A & R Recording Studios, which I was a part of, was really starting to happen, because when Bell Sound and a couple of the others were overbooked we got the spill.

Rock 'n' roll people like Leiber and Stoller were making records to sound great on a mono station. Then I befriended Tommy Dowd and people like that who were into stereo. But I had to have more than two tracks. I befriended a lot of interesting people—people in the computer business and other areas of technique—to try to lock up two machines. I had heard about this eight-track machine that Atlantic and Les Paul had. Eight tracks on one piece of tape! I mean, if you saw the machine today, you'd laugh. It was literally like a van, a truck, it was so huge. But they could erase a track or put one in, take one out. It was against the union rules to do this.

You're kidding!

No, you were never allowed to overdub. In '60, '62, I don't remember when, the rule changed. Now, when I say it was against the rules, you were supposed to record the singer and everything was supposed to go down

exactly as it went. You weren't supposed to replace the vocal.

Why was there a rule against it?

Because the union said any time you replaced the vocal, all the musicians had to be paid. I had to make a speech in front of a whole group of musicians and say that the union had to realize that multiple track was going to cause a certain kind of problem. I built booths because I couldn't control a singer's level against a huge band. Very difficult. Only the big engineers in those days knew how to do that, because they had space and they'd build screens around these people.

You were working in eight-track then?

No, we were still three-track. Then it went four-track almost a year later. To get control of a Diahann Carroll record for Atlantic. . . . They said to me before the session, "Diahann sings very quiet and sweet, not loud." And we've got, like, a 38-piece band behind her. Some friends and I built a corner for her out of truck blankets and two-by-fours. The session was with Nesuhi Ertegün, and I'll never forget it, it came out so much different than any session I had ever done. There wasn't that leakage into the vocal. You could change the balance. You could also turn her channel off and get a stereo mix, which you had to do when you used four-track. You had to have the band in stereo. I used to put the vocal on track two and the rhythm on three, because I learned the outside edges of the tape were dangerous due to the wobble of the tape. You tried to avoid strings and stuff on the outside, but you could put horns there and you'd never hear any waver on the tape.

This was really pioneering.

Yeah. Especially when they went to multi-track. Creed Taylor was really the leader of the pack. He was another client of mine. I learned a lot from him. I was doing jazz records with Creed and at the same time he was doing rock 'n' roll. He was also working at Verve, so I got into all this bossa nova stuff. He gave me a lot of freedom. He let me run the tape machine at double the speed, waste tape. I followed and read about everything that had to do with recording technique. I wrote to people. I wrote to this guy in France. I wrote to George Martin and got a very nice letter back. I listened to Beatles records

and said, "You know, this guy is doing this on a four-track machine. Maybe he's got two four-track machines, but he's doing something no one else is doing." And records were coming from Nashville that used to kill me, they sounded so good. Nashville was really way ahead of its time. People don't realize that. I travelled the country a lot. So when I went to Nashville or someplace, I'd run into a studio and learn about how they got a sound.

Most of the producers I've talked to, like John Hammond and Jerry Wexler, have not really been trained technical people. How important do you think it is for a producer to be a technician?

I think whether you're an active technician or a person who uses his ears and finds a great engineer to work with, it's a real team effort. It just happens that I was fortunate enough to have been an engineer first. I think in this day and age, where young people have a chance to record at home and make great demos and work with multiple-track stuff, it's impossible to be a good producer without having some technical knowledge or some technique.

Anybody that hangs around me will tell you that I'm shopping all the time for new sounds and ideas. I'm not out to copy anything, but if Emulator makes a new drum kit Like, we heard a new thing last night that I liked, so I sent my assistant Joe to the store in the morning to check it out, to see whether it's interesting enough to either rent or buy. Everybody has this tendency to be so precious about the past. It's the future I care about, and what's happening at this moment. I remember doing interviews about CDs five years ago. I was a big nut-case on wanting to see that CDs made it. The audience, meaning people who care about new things, are going to reach for better sound, better quality. Because when things cost more, people expect better. When an album cost five bucks 15 years ago, if you only had three cuts that were good, and four were mediocre and the other two were throwaways, it didn't matter. You didn't go broke buying a record. When kids put down eight or ten bucks for a record, they expect and deserve a really well-produced one.

When you were an engineer working for other producers, didn't you ever

say, "Hell, I can do this better than that shmuck, I don't need this guy to tell me what to do"?

I think that I got my chops by working with really good producers. Bad producers were the guys who were not around. They were good for me because they left me alone, and let me do what they didn't do. There were guys who couldn't talk to musicians; it would insult their intelligence, because musicians are the hired help, and they're just supposed to get it done in three hours. Not thinking that the musician, if you gave him another 10 minutes, might play the most incredible lick you ever heard. Some producers used to walk in, play you last week's hit, and say, "This is what I want. I love the sound on this guy's record and that's what you better give me. I don't want anything of yours." I used to get frustrated because they didn't want me to do what I thought would be more inventive, a new kind of effect. Guys that wouldn't let me do that, I got rid of as

Paul Simon had grown up in the studio—he was practically born there—and he likes to be part of every inch of his records. He had come from years of discipline that he and Art Garfunkel spent with Roy Halee, making wild sounds that went against all the rules.

clients, when I had the freedom of choice. I mean, guys like Quincy Jones and Bobby Scott were adventuresome; they let me alone. They would go out and conduct the band or work with the artist, and they knew they could trust me in the control room. There was a big transition from behind the glass to beyond the glass. It's probably the most important transition one makes.

Can you explain the financial arrangements between you, the artist, and the label?

It's changed over the last five or six years, but basically, if they don't sell records, I don't get paid. A lot of producers demand heavy front money and a high royalty, but I'm not getting paid by the day. I don't get an hourly rate. If it all goes well, then I start to see some profits. That structure—if you want to talk about insecurity, that's how you live. You get paid quarterly against actual sales minus returns. We're one of the few businesses in the world that take back merchandise. Record com-

panies say, "We shipped half a million records," but it doesn't mean anything.

The fact is that a producer can be paid well. If you have a hit, it's marvelous. But you have to wait. And you have to go through all of these discounts, the free giveaways, the this, the that. There's hundreds of clauses in a record contract, and it takes a long time to learn all of the routes to making a decent deal. Producers only in the last few years have gotten better deals. Up until five or six years ago you were nailed to a price and a delivery [date] and a cost. Even today, in many contracts, including those of most newer producers, it says, "If you do go over a certain budget, you pay."

Let's talk about some of the people you've worked with. You and Billy Joel have been together for eight years. All of the albums you worked on have gone platinum plus.

I think the reason we work well together is that it's all one could ever hope for in a relationship. He trusts me implicitly. He gives me all the freedom I want. And we're totally honest with each other—musically, as human beings, and with the group of musicians we use. There is a total, absolute belief in saying what you think, immediately. I don't lose my temper very easily. Part of my technique is that I let the musicians get in a playpen and scramble away for hours.

How does a Billy Joel album come together? Does he come to you with a list of songs?

Generally, yes. For the first album I did with him, *The Stranger*, he had three or four songs. The band—Liberty DeVitto, Doug Stegmeyer, Russell Javors—had been with him for years. I believed in the band; I think that probably got me the gig. The thing I saw at Carnegie Hall when I went to hear them was that this was a very well put-together rhythm section. Billy's past records that I was handed were all studio-produced records with studio musicians. I don't care whether a guy is a studio player or a road player. Eventually a road player with enough chops will become a studio player.

I want to get at the essence of your working relationship.

With Billy, yes, we're supposed to make a hit record, we're supposed to have a hit song, but neither one of us

will sit in the studio and believe that that's what we're aiming at. We all have the feeling that it *could* be a hit, or it *feels* like a hit record. Those words are part of our vocabulary. But you can't go in the studio and try to make a hit record. If you deliberately try to, you will probably fail.

I think The Nylon Curtain got the best reviews of all the Joel albums, yet it didn't sell as well as the rest. Is that frustrating? How do you explain it?

I love being teased about that, because everyone overlooks the fact that the album sold a million records. Of course, he had sold four or five million before but it was like going from being a .400 hitter to being a .300 hitter. So success is a relative thing. I hope such a "poor" seller happens to me every time out. Also, if it wasn't for *The Nylon Curtain*, I wouldn't have recorded Julian Lennon. Through that album he decided that he wanted to work with me. He loved it.

I want to talk about Julian Lennon more a little later. First, let me ask you about An Innocent Man, which sounded like Billy's attempt to capture the songs of his youth. Do you really think you can do that? Can you make records today that sound like the classics of the '50s and '60s?

No. You know, when you analyze *An Innocent Man*, there's another level of it that is not looked into. What Billy felt was that at his particular vocal age, before his voice changed in his mid-30s, he could still hit those high notes. He loved songs like "Spanish Harlem" and "Under the Boardwalk." It was part of his background. He wrote an original album and original songs. We did not go out simply to salute the '60s.

Did Billy Joel feel he'd gotten too far away from what rock 'n' roll really is, and that he had to get back to it with an album like An Innocent Man?

It was no more a process than *The Nylon Curtain* was a process. It's where Billy was at a particular time in his life.

But there are outside influences . . .

Of course there are.

For instance, Billy has obviously been plagued throughout his career with rock reviewers tearing him to shreds—selling millions of records, but the critics really killing him. That's got to have an impact on someone.

Yes, Billy Joel and I are supposed to make hit records, and we may feel we are. But you can't go into the studio deliberately trying to do something that's stylistically "right," or you'll probably fail. You can't let critics be your guiding light.

You'll remember he wrote a song "It's Still Rock and Roll to Me." The punk age was happening and he was being buried. Billy Joel was middle-of-the-road. Critics were really nailing him. Of course it affects you. I mean, he would read a review onstage, and then do a medley of rock 'n' roll tunes.

Doesn't the criticism contribute to the creative process when he comes to you and says, "Phil, I want to make a rock 'n' roll record"?

He is a rock 'n' roller. He's just as much rock 'n' roll as Bruce Springsteen or anybody else you want to name. But because he's able to cross over, people decide . . . It's so different every five years in the music world, and he has survived eight years of success, plus the five years before that which people forget. He was a cult musician. He broke out of that, he hated that identity. *Piano Man* was not Billy Joel alone. Billy Joel is an eclectic musician and writer who is as capable of writing a Broadway show as he is of doing a pure rock 'n' roll concert with the funkiest, punkiest band that ever walked. He can sing the blues with everyone else. They nail you because you're successful.

Do they? Do you really think they have it in for you because you sold five million records?

Anybody. I think right now, if Michael Jackson were to make a record, he'd be in for it. What can he do to top his 30-million seller? Billy's been on tour. He's sitting now and trying to write and go back through the process. He's not saying, "I'm going to please this critic." They can't be your guiding light.

You're saying there's nothing crass about the way you and Billy, or others you work with, make an album.

No, there isn't anything crass about it. You don't go into the studio saying this better be a five-million seller or our careers will be over. Maybe they will be over, if we go in and try to make something that's stylistically "right" at the time.

Let me ask you about another New York songwriter you've worked with, Paul Simon. He and Billy are both New York kids, they're both singer/songwriters, but I'll bet they're very different in the studio.

Absolutely. Paul has grown up in the studio; he was kind of born there. Paul



Photo: ©1985, Ebet Roberts

is meticulous and likes to be a part of everything, and yet hates the waste of time and the time it takes. He's part of every inch of his records. It was only after five or six years of working with Paul that he would leave me alone and go out to dinner or take some time off. But when he was in the studio he spent every hour with me. We coproduced. He had come from the years of discipline that he and Art Garfunkel had spent with Roy Halee. Roy was an employee but he became part of the production. All those wild sounds that Roy Halee created with them were outlandish, bizarre, rebellious, against all the rules. Nobody took as much time to make an album. Clive Davis, and whoever, obviously trusted them.

When I met Paul Simon, and he started his solo career, he was a guy who had totally lived his life in the studio. Yes, he had performed, but the difference was that Billy's real world was to play in clubs and sleaze joints, then concert halls, and finally arenas. That's where 90% of Billy's life was. The studio became fun to him later. When Billy and I started making records, the nicest compliment to me was, "I really had a good time in there." Paul treated it as part of his daily activity.

There's been a lot of talk about how long it takes to make rock records today, with all the indulgences involved. In the old days you'd make a record in a couple of days; now it can take months. Is that usually the artist's fault, or the producer's?

You can give credit to both sides. When people made a record 10 or 12 years ago, you were given \$12,000 to make the record and it was \$3.98 in the marketplace. When the big million-dollar deals were made, and albums went to \$6.98 or \$7.98—Billy's records always seemed to come out just as they were raising the price, and both of us were scared. When kids buy a record, they have the freedom of choice to pick among tons of records. It's quite amazing that they pick yours.

Are you saying that fear contributes to the increasing length of time it takes to produce an album?

Of course. I don't know if you understand how huge the profits are for the record company if you happen to have a hit. Yet, on the other hand, so many dollars are inside the production of a record, if it's a flop, it's a real loss. And that situation creates madness both from the artist's and the company's point of view. I'll promise you this, the



business end decides where you are going. If you don't sell, you are not there.

I think the key problem is that someone invented the word demographics. We've created a monstrosity. Sometimes you get a message from the record company saying, "Look, we really have to make sure we're on Contemporary Hit Radio or that we have an AOR hit." I say to them, "The more you channel me, the less I know where it's going to go." What happens if I break in the R&B market, or on the dance charts? What difference does it make? ***But you're the big hit-maker producer. If there has been any criticism of you, it has been that you pay too much attention to demographics.***

I don't pay any attention to them at all. I can't. I'm demographically overage. I don't belong anymore.

But you're making records for people who are under 40.

I make records for musical reasons, and it just happens to be that I'm one of those people who is never looking back. I love kids. I don't particularly cater a record to a 15-year-old, but I am interested to know if he likes it.

All right, let's talk about Chicago, a

group that you worked with that has been a real hit-making machine for more than 15 years. They have 17 or 18 albums, and don't you think they've followed a formula to guarantee them AOR radio success?

No. They went through a drought. They had a hit recently. But until David Foster came along . . . I mean, I made a pretty good record with them. I did number 12, their first album after Terry Kath died, which was a major trauma. I had worked as engineer on some of their stuff before that. But they're not a formula machine. They were considered, at the time, a dead issue. Once Terry had died, people were going to give up on Chicago. It took a great deal of strength and inner desire for them to make sure that they didn't fall apart, and that everything was a part of their musicality. The record business treats certain acts after a certain time as being over the hill.

So did you retcol them?

I tried to. I think I was part of the health process. As I said, we didn't have a smash hit. We did okay. I think we sold a couple million records. Then they went into this period when they themselves admit they allowed too many

people in the band to write, trying to get, quote, a hit.

Let's talk about a record that required a lot of work on your part, Julian Lennon's Valotte. I know that some record companies had apprehensions about doing the record to the extent that they passed on the project. They thought it might be exploitative of John's death. Did you have any apprehensions about that?

The only apprehension, before I met Julian, was to find out if he was genuine about what he wanted to do, if he was there to be taken seriously as a songwriter. Once I heard material, pieces and scraps of songs, and I got to know him, I knew that the time spent would be, to be honest with you, the hardest time I would ever spend in my life, and the most fun. He is a guy who is genuine, absolutely honest about himself, and he happens to be the son of John Lennon. It's not a disgrace; if anything, it's an honor. The criticism I get is that he sounds like his dad. He doesn't *try* to sound like his dad. He can't help it. It's in the genes, folks.

But the kid is good.

He's a talent. He's a serious songwriter. He has a great sense of humor. He's a genuine human being with a desire to make it. My only question with anybody is, "Do you want to make it?" ***Why do you think the record companies that did pass were apprehensive about him?***

First of all, his demos were nothing to be heard. He hadn't really spent enough time in the studio. The people he did spend time with wasted his time. I think they were hanging on to him because he was Julian Lennon. Nobody realized this guy was serious until he went to this place in France and started to write and make these little home-grown demos which were really good. Obviously, Ahmet Ertegun and Doug Morris at Atlantic realized that this was not a toy. When I heard the demos, I heard what I wanted to hear, which was a songwriter. My only basic desire when I met him was to see if our personalities would be okay. We hit it off. He's very shy. We both looked at each other and said we were out to make a quality record. The deal between the record company and us was very simple. If we didn't like what we made in a couple of months, we would



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- Six ways to add CD to your system.
- What a good installer can do for you—plus tools and techniques for doing it yourself.
- How to protect your stereo system against theft.
- Environmental hazards affecting stereo equipment.
- The growing importance of sound quality. ▶



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This new power amplifier from Adcom offers the same circuit topology as our GFA-555. And that's the amplifier independent test reports have found clearly superior to others priced two to three times higher.

The essential differences: 100 watts per channel for the GFA-545 vs. 200 watts for the GFA-555. And a correspondingly lower price.

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SPECIAL ADVERTISING SECTION

MUSIC IN MOTION

PICKING OUT THE PIECES

The simplest car-stereo systems have just three pieces: two speakers, plus a combination "head unit" in the dashboard, which receives FM and AM radio broadcast and perhaps plays cassette tapes or Compact Discs. The most complex systems—the ones made up for show—may use a few dozen components. The system you want will lie somewhere in between, probably closer to the simple end.

If you want more power (and you probably will), you can add a "booster amp" or a "power amplifier." Which kind to get depends on your head unit: If your head unit has only amplified outputs (usually plain wires), designed to feed loudspeakers, you need a booster amp, whose input is designed to accept speaker-level signals. If your head unit also has "preamp-level" outputs (usually plugs or jacks mounted on the unit's chassis or attached to it by shielded cables), you can use a power amplifier, whose inputs are designed for signals of this type.

The signal you hear through a booster amp will have more noise and distortion than the signal you hear from a power amp connected to a head unit's preamp outputs. That's not exactly the booster's fault—the booster is only amplifying the noise and distortion that originated in the amplifier circuits built into the head unit to drive speakers, plus whatever distortion from the tuner, CD, or cassette that the head unit's amp had already amplified. Naturally, these problems will be far less audible when the output is not being boosted.

A moving car is a noisy place to listen to music, so most critical listeners prefer to have more power. That being the case, most head-unit manufacturers put their best features and highest performance into models which have no built-in amplifiers at all. They figure the listeners who care about such things won't use the built-in amplifiers, and omitting them leaves more room for more complex circuits and features. So, though there's no technical reason why a self-amplified unit can't have the best possible performance, there are marketing reasons why it usually does not—so performance is another reason why you might not want an ultra-simple system.

To sum up: If you want the simplest system, and that's all, you'll need a unit with built-in amplifiers. If you plan to upgrade that system later, you'll want one which also has preamp-level outputs so you can add a power amplifier. And if you want the best possible performance, you'll probably want a head unit with no built-in amplifiers at all, for use in a more complex setup.

Picking the type of system you want narrows down your search for the best head unit, but still leaves a few questions to be answered before you can choose a specific model, such as the kind of tape

or Compact Disc player and radio performance you want, and what features best suit your style of listening. Those questions are covered in "Getting A Head," elsewhere in this section.

THE EQUALIZER

Equalizers are for people who aren't satisfied with the tone controls on their head units. The vast majority of head units have two tone controls, one for bass, and one for treble. Having just two controls makes it simple to adjust the tone—but difficult, sometimes, to adjust exactly as you'd like. Turning down the treble to diminish tape hiss or radio static may cut more deeply into the music's high notes than you'd like. Turning up the bass control to emphasize low organ notes will overemphasize the higher bass and lower midrange notes. A handful of head units have a third tone control, which lets you rebalance the midrange if the bass or treble controls unbalance it, and let you make singers and other soloists stand out more from the rest of a musical ensemble—or make them fade back into the ensemble, if the recording seems to call for it.

A HEAD UNIT WITH A BUILT-IN amplifier can form the basis of a simple, cost-effective system. But a head unit with no built-in amp may be the best route to ultimate performance.

For still finer control, you need an equalizer, a bank of tone controls that divide the sound spectrum into more and finer slices. Equalizers with five to seven bands are the most common; they let you set the sound the way you want it with some real precision, yet aren't so complex that you can't operate them while you drive, especially if they use sliding controls whose positions you can read by touch. For convenience and driving safety, many equalizers let you select pre-set tone contours (some set by the factory, others by the user) by pressing a button.

You may find such equalizers combined with other units. Many five- to seven-band equalizers are combined with booster amplifiers, for a quick sonic upgrade to head units with built-in amplifiers. This is handy, because using an



Picking the system you want is simplified by the fact that, aside from speakers, even the most complicated show systems include no more than five types of audio component—head units, amplifiers, equalizers, crossovers and (if you want both tape and Compact Disc in your system), accessory CD players. Which of these you'll need will depend on your tastes, your car and your budget. If you like, you can even start out modestly and add more components later.

THE SIMPLEST SYSTEM, PRO AND CON

A system consisting of just a head unit and speakers is very economical, both because there's so little equipment to buy and because it's very simple to install. That's why it's by far the most common type of system.

Depending on the quality of the components, such a system can work well. The only inherent limitation on its performance is power. Cramping FM/AM, tuner circuits and a tape or CD player into a dashboard's radio slot doesn't leave much room for amplifier circuits, so the amplifier power available is limited, usually to less than 5 true watts per channel.

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equalizer to boost bass also boosts the power required from the amplifiers, often well past the point that a head unit's built-in amp can handle without distortion. A few head units have equalizers built in; but separate equalizers usually have less cramped controls, which makes them easier to adjust precisely.

A second type of equalizer, with 10 or more frequency bands, is not designed to be used as a tone control at all. Instead, it's used to iron out small defects in a sound system's frequency response—defects that equalizers with fewer bands can't fix without simultaneously altering other frequencies that should be left alone. Such equalizers are too complex to set properly without test instruments; they're designed to be set by a competent installer, then left alone. To ensure this, they're usually mounted out of sight; some installers even seal the controls, to discourage tampering. Parametric equalizers, whose bands are fewer in number but can be set precisely to any width and frequency required, are designed to be used this way, too.

Even these complex equalizers can only put a band-aid on the response problems of a car's sound system or acoustics. They work best when the system is so well designed, installed and matched to the car that its problems are small enough for a band-aid to cover up. If the system is designed, installed and matched to the car well enough, the equalizer may not be needed, except to match some recordings to your tastes.

HANDLING POWER

If your system uses separate amplifiers, the first question you'll have to face is how much power you need. There's no set answer to that. As a rule of thumb, you'll probably want at least as much amplifier power in your car as you have in your home system—the car is smaller, but there's more noise to overcome. The specifics will depend on how noisy your car is, how much bass your system's speakers can deliver (good bass takes lots of power, especially in competition with the rumble of road noise), how efficiently your speakers use the power they get, how sound-absorbent your car's interior is and, last but not least, how loud you like to listen, and how little distortion you can tolerate. Your installer can probably help you decide; if in doubt, go for the larger power figure, up to about 100 to 500 watts in total. Car systems have been built with 1,000 watts or more of amplifier power, but such systems are more often designed to impress people with the numerical quantity

than with the quality of sound. All you need is enough power to produce enough loud, clean sound for comfortable listening when you're on the road—a generous, but hardly an astronomical amount.

Your system's total power can be divided among several amplifiers, in many different ways. In all but fairly simple systems, it's usual to drive the front and rear speakers from separate amplifiers (or separate channels of a four-channel amplifier), so that the balance between front and rear can be adjusted in the low-level signal path between the head unit and the amplifier; adjusting this balance after the signal has been amplified wastes power. (The difference is that faders of the type used between an amplifier and speakers turn down one speaker pair by diverting power those speakers would have received, and turning it into heat.) Often, more power is delivered to the rear speakers than the front ones, since those speakers usually deliver most of the power-devouring low bass.

THE FIRST STEP IN PICKING car speakers is to determine, preferably with the advice of a good installer, where the speakers should go and what will fit there.

Complex systems use more amplifiers than that, devoting a separate amplifier or amp channel to drive a subwoofer (a speaker that handles only very low frequencies, to extend the system's bass response) and sometimes using separate amplifier channels for every woofer, tweeter and midrange speaker in the system. Doing this requires yet another type of circuit, an electronic crossover, to divide the frequencies and send the right ones to each amplifier; such crossovers may be separate or may be built into an amplifier or equalizer. In multi-amplifier systems, the amplifier sizes should be graduated, so that the woofers and subwoofers have a great deal of power available, and the tweeters get only the small amounts of power they need. Some four-channel amplifiers therefore have "staggered" outputs, with more power in the two channels designed to feed the rear speakers than in the two channels designed to feed the front ones. Some

amps with staggered outputs, designed for use with subwoofers, include crossovers; they may also include provisions for driving one subwoofer with the bass from both stereo channels.

... AND IT COMES OUT HERE

Last, but hardly least, are the speakers, which turn the electrical signals from the head unit and amplifiers into sound.

It's harder to pick the right speakers for your car than for your home. Picking home speakers is a matter of finding speakers which sound good to you at a price you're willing to pay—hardly as simple as it sounds. For the car, you're also constrained by the fact that not every speaker will fit into the right places in your car. And even picking the speaker whose sound you like is harder, because most dealers' listening setups are acoustically as different from cars as chalk is from cheese.

The first step in picking speakers is to determine, preferably with the aid and advice of a good installer, where the speakers should go, and what sizes and types of speakers will fit there.

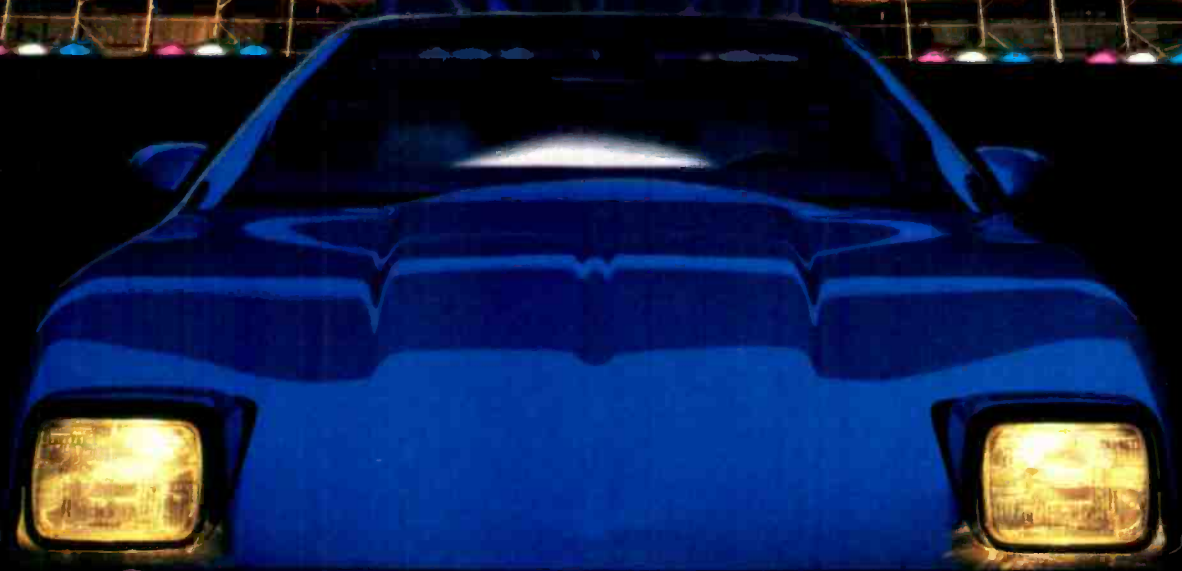
Physically, speaker systems for the car fall into four main categories: Coaxials, plates, separates and surface-mounts.

Most speakers are coaxials, with the tweeter mounted in front of a round or oval woofer, so that only one mounting hole is required for both. Three-way coaxials will have a midrange driver in front of the woofer, too.

Plate speakers have a round woofer, a tweeter (and, sometimes, a midrange) mounted side by side on a thick but hollow metal plate. Again, only one hole is required, since only the woofer's magnet extends below the bottom edge of the plate; and since much of the woofer lies within the hollow plate, the hole behind it need not be very deep. Some listeners feel plate speakers sound better than coaxials, but give different reasons for this—the use of a round rather than an oval woofer, the woofer's unobstructed path to the ear, or the ability to use a tweeter with a large magnet yet not obstruct the woofer altogether.

Separates are, as the name implies, individual woofers, tweeters and (perhaps) midranges which can be mounted side by side. Some separates require separate holes be cut for each of these drivers, while others have tweeters that mount to the surface of a car's body panels, so that only the woofer requires a hole. (The crossover network, which divides frequencies between woofer and tweeter, must be mounted separately too—with coaxials and plates, it's part of

ANYTHING ELSE IS JUST UN-PROFESSIONAL



From Live Aid to Lincoln Center, top ten artists to top studio producers, JBL has been the #1 choice in professional loudspeakers for more than 40 years. Now the JBL "T" and "TL" series promise to make the star of stage, screen and studio, the star of car audio, too.

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For more information and your nearest dealer call toll free 1-800-633-2252 Ext. 150 or write JBL, 240 Crossways Park West, Woodbury, New York 11797.



Pictured above, left to right are: The T95, T55, T65, and, the TL900, TL500, TL600.



JBL

A Harman International Company

the same assembly as the speaker.) Separates take more work to mount, but they can be used more flexibly. For example, you can mount separates on car surfaces that curve too much for flat plates. You can also mount the tweeter where its sound carries best, even if window mechanisms or other car system beneath the body panel dictate mounting the woofer a few inches away.

EVERY CAR POSES DIFFERENT installation problems, which is why there are so many speaker types: coaxials, plates, separates, and surface-mounting models.

Coaxials, plates and separates are all flush-mounting systems, which protrude only an inch or less into the passenger compartment, but which require holes in the car's body panels (which may have been provided at the factory), so that the back waves from their woofers will be properly enclosed for good bass. Surface-mounting speakers are usually built into small boxes, which act as their enclosures. They therefore require only easily-drilled screw holes for mounting. However, because they do protrude into the passenger compartment, there are many places where they can't be used without getting in the way—poking into passengers' knees, using up footroom or blocking the driver's rear view. And small surface-mounting speakers sometimes do require large holes, to let the speaker use the volume behind the car's body panels as an enclosure; such holes need be several inches in diameter, but need not be very deep, since no portion of the speaker pokes into them. Convertible speakers are simply surface-mounted speakers whose drivers can be removed, either separately or all together as a plate, for flush-mounting.

"Drop-ins" are single-cone or coaxial speakers sold without grilles. They are designed to upgrade factory-installed sound systems, which already include grilles—naturally enough, as those systems must include speakers.

But all this only tells you the kinds of pieces you may want in your car system. See the accompanying articles for help in picking out particular components of each type.

IT'S NOT JUST WHAT, IT'S WHO

The biggest difference between car and home stereo isn't the equipment; it's the installation. After you buy stereo equipment for your house, all you have to do is get it home and plug it together. With car stereo, that's not enough—someone must fit that equipment into the car so that it works right, sounds right, looks right, and stays there. If you make the wrong equipment choices, you can replace or upgrade your purchases. But if it's installed badly, you'll probably have to grit your teeth and live with it until you sell your car.

Your choice of who installs your equipment helps determine where and how you'll buy it. Will your stereo be installed by the factory that built your car? By the dealer who sold the car to you? By you yourself? Or by a professional installer?

THE PRE-STUFFED DASHBOARD:

If you're buying a new car, one of your options is to have the stereo system installed at the factory. This limits you to a single source (your dealer) and a few system choices. But those choices may be good ones: You *know* the equipment will fit perfectly into your car; and while it's usually not possible to check detailed specifications like those provided for most "aftermarket" stereo equipment, it is often possible to hear the system of your choice in a car very much like the one you're buying.

Your factory-installed system will be available as soon as your car is—no riding without a radio or tying up your car while you get the system purchased and installed. Buying a factory-installed stereo also lets you finance the stereo along with the car—though that also means you're paying finance charges on the sound equipment.

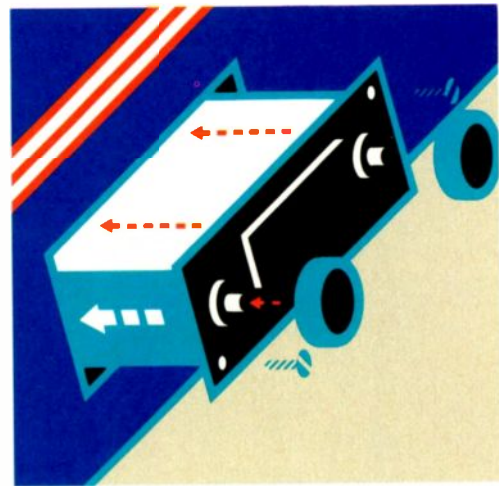
If your car's base price includes a radio, you may be able to upgrade to a factory stereo for less than the cost of pulling out the radio and installing your own system once the car arrives. That's even more true if the base price includes a complete stereo system. However, unless your car is in fierce demand, you may also be able to take the car without a radio or stereo, for less. (If you're lucky, your car's maker will install the radio wiring, anyway.) Ask your salesman about this "delete option"—dealers rarely bring it up unless you ask.

If you are buying a factory-installed stereo, make sure it suits you. Check not only the sound but the control operation and features of the identical system, in a demonstrator car that closely resembles the car you've chosen. Bring some of your own favorite tapes along for your sound check.

Some car manufacturers, especially foreign ones, may have their higher-cost systems made for them by car stereo manufacturers whose names you know. Specifications *are* available for some of these. This is even more true of dealer-installed stereos, which are usually not just familiar names but are familiar models, too.

ROLLING YOUR OWN

Installing your own system can save you money—not just by saving the installer's fee, but by freeing you to shop for the best price for your equipment.



Doing so may prove no bargain in the long run, though. For one thing, your time has value, and installing car stereo requires investing many hours of that time. (If you find it fun, however, that "cost" is negligible.)

There's also the possibility that, unless you're experienced, you'll goof up in some way—buying equipment that doesn't fit your car, for example, or damaging the system or the car. Getting the experts in to fix your car or your components can prove expensive. Living with the damage just puts off the expense till the day you have to mark the car down to sell it. And who wants to live with an installation that sounds or looks only so-

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From the mobile electronics systems that are standard equipment on Lamborghini to the head units that introduce young people to the delights of mobile sound, Alpine is light years ahead. Again.

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so, especially when you know you did it. Still, if the tips given elsewhere in this section ("Do-It-Yourself Tools and Techniques") seem like child's play, you probably are ready to install your own equipment.

You can buy that equipment from a number of sources: Auto parts stores, discounters, electronic specialty dealers, mail-order houses, department stores, and others. You'll have to choose between dealers who charge you less and dealers who do more for you. For example, dealers who spend time advising customers (and learning what advice to give) are forced to charge more than volume discounters who won't talk to you until you're reaching for your wallet. If you know in advance just what to buy, the discounter makes sense—if you don't, spend a few dollars more for the chance to work with an authority. (Just be fair—don't cadge advice from a full-service dealer, then use that advice to buy elsewhere.)

However and wherever you buy, make

sure the equipment is good (check its specifications and features, and any available test reports)—and, even more important, make sure it will fit your car. Most car-stereo manufacturers give their dealers books which show what models fit which cars (if in doubt, call the manufacturer to check out the model you desire); some mail-order dealers include this information in their catalogs, too. Try to get your sales slip to include a phrase about the car you're going to install the equipment in. That way, if it doesn't fit, the dealer can't claim he didn't know what car it was supposed to go in.

Check carefully again once you get your system home. Equipment that won't fit your car can usually be returned—if it's unscratched, its wires are uncut, its package is intact, and all the little accessory parts that came with it are still there, packed as if fresh from the factory.

Also check to see how easily the components you select can work together. Equipment that uses standard phono jacks, and has adjustable input or output

levels, is easy to put together with components from other makers. If the equipment uses other types of plug, however, you may find it far easier to use it only with other gear from the same maker. While connectors such as 5- and 8-pin DIN plugs are fairly standard, ways of wiring those connectors aren't, and combining equipment of several different makes may involve buying or making plug adapters, or rewiring some component's plugs.

PROFESSIONAL HELP

Except for the very simplest systems, most car stereo equipment is professionally installed. A good installer can tell you what will and won't work in your car. He knows not only about equipment but about interference, car structures, and the peculiarities of automobile acoustics.

An installer is also responsible for the total result, what happens to the car, as well as to the sound system, as a result of the installation. For this reason, many

DO-IT-YOURSELF TOOLS AND TECHNIQUES

If you're going to do your own installation, the first things you'll need are patience and space—lots of each. Unless you have the patience to do things slowly, carefully, thoughtfully and thoroughly, forget it—you're better off farming the job out to Autobody Andy down the street. At least then you won't be around to watch the mayhem.

Your workspace should be big enough for you to lie with your head and shoulders in the car and stick your legs out without losing them to traffic or tripping passersby. Such a space will also give you room to spread your tools where you can reach them. There should be an a.c. outlet nearby, to run power tools and trouble lights; the outlet should have a ground-fault interruptor, however, to protect you against electric shock, especially if you're working outdoors.

Unless you're working on a roadster or convertible, your workspace needn't be covered; but it should be within easy reach of someplace you can stow the seats you've taken from your car when the rain starts. And since the rain will always start just as you have the car half pulled apart, and will continue teeming until an hour after you're due

at an appointment, you'll also need alternate transportation.

You'll need three types of tools, for metal-working, electrical wiring, and assembly/disassembly.

For metal-working, get a drill (preferably a variable-speed electric) and fresh drill bits, a center punch (to give the drill a starting spot it won't squirrel away from), a sheet-metal nibbler, both



regular and keyhole hacksaws, and files. Safety goggles are a very worthwhile addition to the list.

For electrical work, you'll need wire-cutters and wire-strippers, thin-nosed pliers, and a way or ways of splicing and connecting wires securely. That could be a soldering iron (12-volt, if you can find a decent one), screw-on wire-nut connectors, a crimping tool and crimp-on terminals, or perhaps all three. You'll also need electrical tape,

for insulation. Tubular insulation, preferably the shrink-on type, is also very handy. And a fire extinguisher is a good thing to keep handy, just in case.

For general assembly and disassembly, you'll need screwdrivers, wrenches and pliers in a variety of shapes and sizes. Your stereo will probably require Philips-head screwdrivers and metric wrenches; your car may require the same (especially if it's foreign), but if it's U.S.-made, it will more likely require English (inch) wrenches. Your car may also use yet other kinds of screwdriver, such as Pozidriv or cross-point (both resemble Philips but require different drivers), Torx, Allen-head, and so on.

You won't need exotic, super-expensive tools. Simple tools will do the job, if they're high-quality—and if you're willing to spend the time. For instance, while installers use powered, circular hole saws to make speaker openings, you can do it with a punch, an electric drill, a keyhole hacksaw and a file: Mark the hole's perimeter with a pencil or marker, punch a series of indentations on this perimeter line, and drill out the indentations. Then connect the holes together with the hacksaw, and file the opening smooth. This takes a lot of time and effort, but saves you the hole saw's substantial cost; specialized tools only pay if you'll use them often enough to defray their cost in time savings.

THE GRAPHITE BREAKTHROUGH COMES TO CAR STEREO.

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Graphite. The final piece of technology that advanced the state of the art in sports equipment, electronics, and even space exploration. Graphite makes it possible for the new Phase Linear® speakers to deliver a level of car stereo performance you've never heard before.

Phase Linear speakers are technologically unique with the only car stereo woofer cones made of graphite fibre. The higher rigidity and light weight of this versatile material results in superb impulse response. This means less coloration and distortion. The results are wider dynamic range which means fuller, richer sound—livelier, closer to the source than ever before possible.

The tweeters and midranges in these speakers are made of polycarbonate which combines low mass with

a high amount of internal damping. This results in wide, flat frequency response and superb off-axis dispersion for excellent sound reproduction of the mid to high frequency signals. This advanced design plus the addition of ferrofluid-filled dome tweeters also results in greater power handling. For example, the Phase Linear 6" x 9" handles 110 watts continuous, 250 watts peak power!

The incredible specs and the unique materials used in these speakers makes them digital ready—perfect partners for compact disc players. The proof is in the hearing—music so crisp and clear, so rich and full, it's what you've been listening for.

Built upon 50 years of car audio manufacturing experience, these great new speakers are truly a car stereo breakthrough. Hear them at your Phase Linear dealer.

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What you've been listening for.

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installers will check over your car's systems with you before they begin, so that they can't be blamed for breaking things that didn't work to start with—and can't weasel out of their responsibilities to fix anything they did break.

An installer can often get the job done faster than you can, too. He knows how to work efficiently, avoiding many of the pitfalls that the newcomer wastes time edging into and backing out of. He also has a substantial investment in expensive tools that speed and simplify the job—reasonable purchases for someone who'll need them regularly, if not necessarily for you.

The best way to find a good installer is through recommendations. Ask your friends with good (or bad) car stereo systems, stereo dealers, car dealers, the manufacturers of the equipment you're considering, and your mechanic. When you run into a good system, ask who did the job, and how troublesome or troublefree it's proven.

Get advice from as many sources as

possible. Your friends will have limited experience (one installation every few years). Everyone else will have an angle: Manufacturers will only recommend installers who sell their equipment. Stereo and car dealers may have tie-ins with installers. Some stereo dealers may want your installation business for themselves—as might your mechanic, or the crazy-about-cars teenager down the block. Don't hesitate to ask these people's advice in finding a good installer, but don't feel obligated to take all that advice, either.

Use that advice to get a list of likely installers, then visit each one's shop. Tell each installer your price range. Ask if you can listen to one or more systems he's installed, especially in the price range you've specified.

And ask to see the shop. The work going on should be deliberate, careful, but not hesitant. The shop should be clean, well organized, with lots of parts and tools.

Look over installations in progress. Are

Don't even lift a tool until you've thoroughly thought out how you're going to use it, especially when you're cutting holes for speakers. If your car already has places for speakers, try to get good-sounding speakers that will fit right in, with no need to cut and file. If there are no factory-built speaker sites, or the sites provided are too small for the speakers you want to use, hook up some speakers temporarily and move them about the car, to see where they sound best. (With flush-mount speakers, which require mounting holes, you won't hear bass at this point—such speakers need to use the car's body panels as acoustical enclosures.) When you've found a good-sounding place, check carefully behind the panel at that point to see if the speakers can be safely mounted there. Watch out for wiring, air-conditioner or heating ducts, door latches and window cranks, which commonly lurk just below the panel where you want your speakers to go. Check both sides of the car (right and left doors may not be identical; right and left sides of the dashboard almost never are). Run through the operation of all under-panel mechanisms—the speaker that fits fine when the window's open may prevent that window from shutting again.

Take extra care with wiring, too—a careless mistake here could lead to anything from blown transistors to a fire. Get a wiring diagram for your car, even

if you have to buy a shop manual to do so. Label any wiring you put in yourself, so you can identify it later, and write its color codes on the margin of your wiring diagram. Make a wiring diagram of your system before you install it, to help you keep on track—and keep it thereafter, in case you need to troubleshoot. Never run wires through a bare hole in metal—make the hole oversize and line it with a rubber grommet. Check to see if the wire's use requires extra slack—if it's going to a door that will open and close, for instance—but that there isn't too much. Extra-long wires can get tangled or chafed, and are almost certain to pick up interference.

Find safe places to run all your wires. Make sure the wires won't tangle with passengers' feet or with packages in your trunk. If you run wires under the floor mats, make sure they're in spots (such as the transmission hump) where they'll rarely if ever be walked on—in time, foot pressure can wear away the insulation. Doorsills often conceal spaces that make excellent wiring channels.

This list may seem exhaustive, but it just scratches the surface. Doing your own installation is a painstaking task. It saves you money, though, and teaches you a lot about your stereo system and your car. It will also probably make you a more knowledgeable customer for an installer, next time around—and a more willing one.

the wires neatly fastened down, or hanging all over the place? Is the equipment properly secured, or will it start banging around on the first bumpy road? Is the work neat, without such unpleasant souvenirs as solder burns on the carpet, or extra screws rolling around the floor?

Ask the installer to give some customers as references. Pay special attention to those whose installations were done a year or more ago, to see how well the work holds up. If your community has a Better Business Bureau, it may be useful to find out whether the installer has had complaints made against him, and how they were resolved.

Many installers won't work with equipment they haven't sold you, not just for profit's sake but because they know better how the equipment they sell will do in your car. Once you've chosen an installer, let him guide you. Not every piece of equipment will work well inside your car model, or meet your listening needs. Most installers handle several brands of stereo gear, to match a wide range of cars and listeners; if your special needs require something else, they may order it for you.

Though standard equipment meets most people's needs, everyone's needs are special. There's no such thing as a standard installation, and the installer should take care to customize the equipment choice and the work to match your tastes and desires. Discuss the kinds of music you like to listen to, and the equipment you listen on at home. As you try different speakers in his demonstration set-up, tell him what you like and dislike about each. Ask to hear tapes or CDs of your kinds of music—if he has none, he may specialize in optimizing sound for totally different tastes than yours.

Avoid surprises. Go over the installer's plans to make sure they'll accomplish what you want. Be sure to ask for an itemized, written estimate. Ask questions about anything you don't understand—if nobody in the shop has answers, chances are they don't know.

How much will all this cost? It depends on the complexity of your system, the difficulties posed by your car (putting 12-inch woofers in a subcompact won't come cheap), and any special cosmetic requirements (such as hiding the speakers behind perforation patterns in the upholstery, instead of using standard grilles). As a general rule of thumb, it's best to start with a ball-park budget, about \$50 to \$300 of which will ordinarily go for installation, and be prepared to spend a little more on labor or components if need be.

If you can't afford it, spare yourself the heartache of listening to it.

We are all aware that, money aside, it is an easy matter to upscale our quality of life, but difficult to lower it. In this regard, ignorance is bliss, and strict abstinence is sometimes better than a taste of something finer that we can't have. So it is with the Concord HPL-55C Tuner/Amplifier/Tape Deck. One listen could ruin you.

Concord's performance engineering over the years has resulted in a list of mesmerizing characteristics that, as you become aware of them, will change your perceptions of car radios.

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Superb stereo imaging, wide band frequency response, and very low distortion levels are just some of the qualities of Concord's exclusive Matched Phase Amorphous Core Tape Head.

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The Tune/Tape Switch

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Lighted panel switches, electronic memory with 24 preset

stations, signal processor circuitry, a two-way/four-way amplifier, automatic Music Search Scanner, and a Bass EQ Switch.

One listen to all of this and you will be exhilarated. But then, if you can't afford it, you will be depressed. What will it be? Exhilaration and depression, the full human gamut? Or blissful ignorance? The trouble is, if you have read this far you are no longer blissfully ignorant.



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ADDING CD TO YOUR SYSTEM

There are at least three ways to add CD to a car-stereo system you already have, and at least three more ways to build it into your next system.

The least expensive method is to buy a portable CD player, and hook it up to the equipment that you have already. Accessories to help you do that are already on the market—dummy cassettes that slip into your head unit's tape slot and feed it signals from your CD portable, gadgets that plug into your radio's antenna input and put the CD signal on some locally-unused FM channel, and others which, if you have a separate amplifier and head unit, connect between the two to feed the amp the CD's signal.

If you're buying a new system, and your desire for CD play is a distant second to your desire for tape, you can buy a head unit which plays tapes and radio, but has a front-panel input for a CD portable. (Or you can now buy at least one in-dash CD player which pulls out and becomes a portable.)

Plugging in a portable means you can plug it out again, and take it with you as a portable music source—simultaneously keeping it from any thieves who might break into your car. But it also means that you'll have a loose CD player sliding

around the car, unless you lock it down securely with Velcro or similar fasteners; even then, it could break loose and fly around if you stop suddenly. Portables aren't usually as easy to load and operate one-handed as in-dash units are; and portables may have more problems dealing with the car's motion and vibration than players built specifically for car use would have.

The common alternative is to install such a player in your dashboard (or, in your glove compartment, if theft is a major problem in your area). If the only music source you want is Compact Disc, you can substitute a CD player for the usual radio/cassette unit, in your existing system or in the sound system you plan for your next car. If you also want FM, you can get a combination radio/CD unit, instead.

There are no combination radio/CD/cassette units for the car, and the space limitations of the usual dashboard slot mean that there probably never will be. The closest you can come is a radio/CD combination with front-panel jacks for a portable cassette player—a setup with the same advantages and disadvantages as a radio/tape combo with a jack for a portable CD. If there's room, in your dash, however, you can install both a CD player and a radio/cassette head unit. Car stereo manufacturers are making that as easy as they can for you.

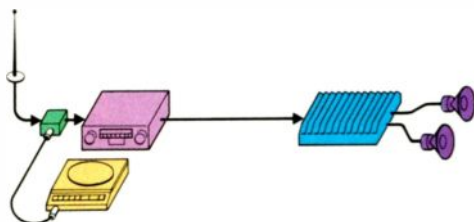
Many CD players, especially those

which have no built-in tuner, are designed to connect between a conventional head unit and the system's power amplifiers. Normally, the signal flows through the CD player as if it weren't there; but when you slip a disc into the player, the player feeds its own signal to the amplifier, and cuts out the signal from the head unit. If the radio/tape unit and the CD player come from the same manufacturer, starting a CD while a tape is running may signal the tape unit to stop playing till the CD is over, or even to eject the tape.

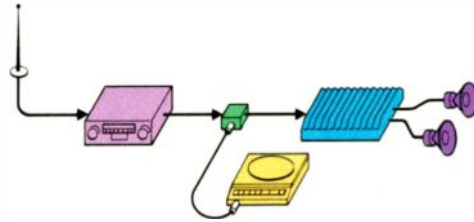
A growing number of radio/tape head units have rear-panel input jacks for CD players, too. With this setup, the CD player feeds its signal through the head unit, rather than the other way around. Usually, you must press an input selector button on the head unit when you want to listen to CDs—but some makers have designed head units and CD players that work together, turning off the tape and turning on the CD input when a disc begins to play.

No matter how you hook it up, once you get CD in your car, you'll probably make two discoveries—that your system now sounds better than it ever did before, and that the clarity of good CD sound makes you more aware than ever of the shortcomings in the rest of your system. For ideas on how to deal with that, see the separate stories on amplifiers and speakers in this section.

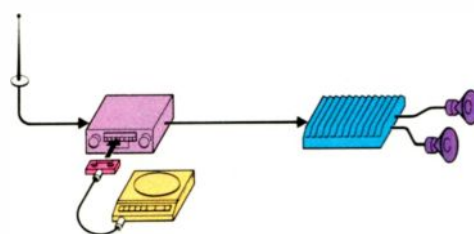
R.f. adaptor puts CD signal on FM frequency.



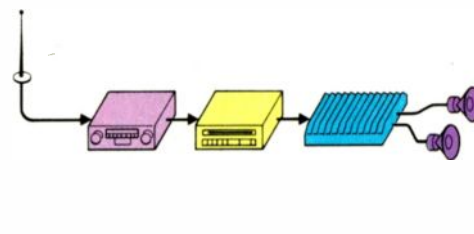
CD adaptor for use between head unit and amp.



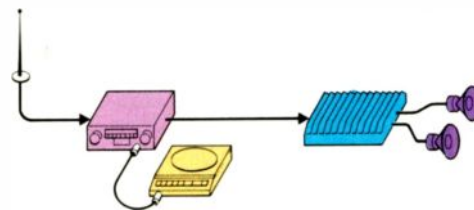
"Dummy cassette" adaptor for CD portables



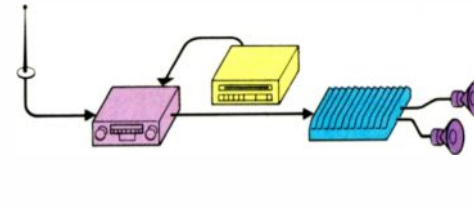
In-dash CD unit between head unit and amp.



Head unit with front-panel CD input jack.



Head unit with Aux input for in-dash CD player.



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GETTING A HEAD



When you start selecting car stereo equipment, you'll have to face three factors: performance (see "How To Read the Numbers," in this section, and the Car Stereo Directory section of the *May Audio*), price, and features.

Manufacturers like to explain the few features that are exclusively theirs. They rarely go to as much trouble about those features they share with their competitors—which are often the most useful ones. Here's a checklist of such common features, to ask about when you're selecting the head unit for your stereo system:

RADIO FEATURES:

The radio sections of most car stereos, today, are "digital"—instead of tuning continuously along a dial, they jump from one frequency to another, and show that frequency on a numerical display. This makes tuning easier: The radio stops only at authorized station frequencies, which saves fine-tuning; digital tuning also makes it easy for the designer to add automatic tuning aids.

The oldest and most common of these aids is *preset* tuning. Set your favorite stations in the tuner's memory, and you can call up those stations by pressing a button. How much station storage you need depends on the number of stations regularly listened to by all the family members who use the car. Most preset systems store one AM and one FM station for each of four to six selector buttons; but some tuners have extra memory banks to allow two FM and one AM stations per button.

If you've driven beyond your preset stations's range, or they're not playing anything you like, *seek* or *search* tuning

will help you find others. Touch a control, and the radio will tune up or down until it finds and stops at the next strong signal. If you don't like that station, touching the control again will find the next station on the band.

Scan tuning also tunes up the band to the next strong signal and pauses only for a few seconds, to let you sample that station's programming. Then it tunes on to the next station. When you hear a station you like, you can touch a control to stop the process. Usually, this circuit can scan only up the radio band, but many units can now scan both up and down. *Preset scan* works similarly, but only on the stations stored in the tuner's preset memory.

If the unit has a *local/distant* (or "Lo/Dx") *switch*, you can choose whether the seek and scan functions stop at only the strongest signals or at all reasonably strong ones. In some models, the Lo/Dx switch also affects the tuner's overall sensitivity; in "Local" mode, the tuner cannot readily receive weak signals, but is less sensitive to strong-signal overload and to multipath interference.

As signals fade into the distance, stereo signals sound noisier. Most car tuners now counter that with circuits that automatically blend the stereo channels at high frequencies (where noise and distortion are most troublesome), reduce high-frequency response, or reduce overall stereo separation as the signal fades. When the signal fades enough, all tuners will treat it as mono. (On a few tuners, this automatic process can be shut off.) To clean up signals that are strong enough for stereo but plagued with multipath or other interference, some tuners also include a manual *stereo/mono* switch—a comparatively rare but rather useful feature.

TAPE DECK FEATURES:

Most tape-deck features either help you wind the tape to the selection you want, or help you make the most of its sound.

By now, almost every tape player has locking fast-forward and rewind controls that you needn't keep your finger on while the tape winds. But in the lowest price ranges, it may still pay to check that these controls do lock.

Automatic reverse, which plays both sides of the tape without your flipping it over, is a big convenience that's becoming more popular because its price is dropping. On auto-reverse decks, high-frequency response may not be as good on one side of the tape as on the other, due to cassette irregularities; a few decks

have automatic or manual *azimuth adjustment* systems to help compensate for this.

Fast-forward and rewind make it easy to find the tape's ends, but not to find selections in the middle of the tape. Many decks therefore have *music sensor* systems (available under many different names) which can be used to stop fast wind and begin play at the beginning of each selection. These systems are most useful on pop tapes, which have many short selections. On classical tapes, where selections may be longer (and hence fewer), music sensors may confuse quiet musical passages for the silent spaces between musical selections. Some sensors are *programmable*, to skip a pre-selected number of tunes instead of stopping at each new one. A very few can *scan* the tape, playing the first few seconds of each song so you can listen for the one you want, and stop the scan.

While car stereo tuners are usually turned on manually, car stereo tape players usually *start when a tape is inserted*. When you turn the system or your ignition off, the tape should be automatically disengaged from the deck's mechanism. A *tape standby* system does only that; *key-off eject* or *auto eject* system also ejects the tape from the deck at shutoff. Standby systems are more convenient, but pose a potential danger, in hot climates, of the tape's warping, and jamming in place.

The basic tape-sound features are *equalization* and *noise reduction*. Tapes sound best when played back with correct equalization—120- μ S for Type I ("normal" or "ferric") tapes, 70- μ S for Type II ("chrome") or Type IV ("metal") ones. A good deck should either give you a switch to select the right EQ, or sense the type of tape and automatically set the right EQ.

A good deck should also have noise reduction to match every tape you're likely to play on it. That means it should at least have Dolby B NR, which is found on virtually all home tape decks and most pre-recorded tapes. And if you now have—or plan to get—a deck that uses the more powerful Dolby C or dbx NR systems, your car deck should have settings for them, too. (Some decks have settings for all three NR systems.)

COMPACT-DISC PLAYER FEATURES:

The most important features are common to all CD players: The ability to *skip backward and forward*, track by track, and to *display* the current track number. From that point on, their features diverge a bit.

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Some players have *programmable skip*, so you can select in advance which tracks to hear and which to pass by. Being able to select the order in which those tracks are played is less valuable on the road than in home players—it's hard to handle such elaborate programming while you drive.

If you want to find particular passages within a track, look for a player which lets you hear the music as you zip through it in fast-forward or reverse.

Several car CD players have *cartridge-loading* systems: You load each disc into a protective cartridge (or, in one case, a 10-disc magazine that fits in your trunk), then load the cartridge, instead of the bare disc, into the player. This does protect the record against dirt and scratches (more severe problems in the car than at home), and eliminates the nuisance of opening the CD's jewel box case (a two-handed job) while driving. But it also separates the disc from its liner-note booklet, and makes you remove the disc from its magazine for use in your home player. (Home CD players which use the same magazine system should be here shortly, though.)

PREAMPLIFIER FEATURES:

If you want to instantly drop the volume when you pull over to ask directions, want to hear better what your passengers or saying, or just want a spot of quiet while you concentrate on tricky traffic, a *muting* switch (which lowers the volume level by about 20 dB) would be handy. Unfortunately, it is far less common in car stereo than in home components. It's a seemingly minor feature well worth looking for.

A switchable *loudness* control helps you compensate for the ear's reduced ability to hear high and low frequencies when the sound level is low; it's also rare but useful in car stereo, since it reduces your fatigue by letting you listen at lower volume levels without losing the sound's richness.

Old car radios (and some cheap new stereos) have but a single tone control. Today, the standard is to have separate bass and treble controls. And systems with *equalizers*, which separate the frequencies into five or seven control bands, are growing more popular. Some equalizers, whether stand-alone components or built into a head unit, now have memories to hold your most used EQ settings, so you can switch settings at a touch.

One noise-reduction system, *DNR*, belongs among the preamp features rather than the tape controls, because it can be

used to reduce high-frequency noise and hiss on all your signal sources—tape, FM, or AM. The catch is that it may also, in some cases, reduce the signal's legitimate high-frequency content; so if DNR is provided, there's also a switch to shut it off when it's not wanted.

GENERAL FEATURES

Control-panel design is far more important in car stereo than in home equipment. The designer has more controls to fit into a smaller space, while making it easy for you to operate all of those controls while you drive. Check this out before you buy: Can you easily tell the controls apart by feel, shape, or placement? Are the controls you'll use most more prominent than the ones you'll rarely need? If you did have to look at the panel to find one of the less-often-used

controls, would you be able to find it at a glance?

If possible (though it rarely is), check the unit's night illumination. All major controls should be easy to find in the dark—and the controls you need to turn the unit on should be easy to find when the unit is turned off. On some car stereo units, the illumination is on all the time, or on only when the unit is turned on; with other units, the illumination goes on and off with your dashboard lights, or when a built-in sensor detects that the car's interior is growing dark.

Most of the features we've discussed have far more to do with convenience than sound. But convenience counts more when you have to keep your attention on the road. In the car, things that would be mere conveniences at home become important safety features.

A NASTY PLACE FOR A SOUND SYSTEM

Car stereo equipment looks humble enough, especially when compared with the impressive look of stereo components for the home. Yet that humble car equipment does heroic work.

Just sounding good should be heroism enough, but in car stereo's case, it's not. That equipment has a lot of obstacles to get over before it can make sound at all, let alone make that sound good (or, in some cases, great).

The very size that makes it look so inconsequential is the first of those hurdles. A head unit combines a tuner and a tape player with a few preamp controls—and, sometimes, an amp as well—into a space so small no designer of home gear would even consider it. A transformer or pre-preamp for use with moving-coil phono cartridges might be as small as a car's tuner/receiver/amp combination, but nothing else would be.

Small as it is, that head unit must be rugged, too: It spends its life being gently but continually vibrated on good roads, and shaken unmercifully on bad ones. In winter, it's exposed to temperatures far below freezing—in summer, the temperature inside a car parked in the sun can nearly reach the boiling point. And the moving parts of tape and Compact Disc transports—of volume controls, for that matter—are exposed to far more dust than they'd ever see if they were home components.

And those are just the physical hazards. There are also electrical problems. A car



is a rolling interference generator, generating thousands of high-voltage sparks per second, just a few feet from the dashboard where the stereo sits. And the tuner must contend with signals that vary in strength from the intermittent wisps of a station over the next county's hills, to the blast of a transmitter right next to the highway.

Once the signal has survived all these threats, there's one other obstacle to getting good sound. The very places where the speakers would sound best—where their frequency balance and stereo imaging would be optimized—are already occupied with things like window cranks and windshields, and you must find some other places for them.

On paper, it looks like you just can't win. Yet in your car, the sound can be a winner. It's as if you expected John Wayne to be the hero, and found that it was Hervé Villechaise.

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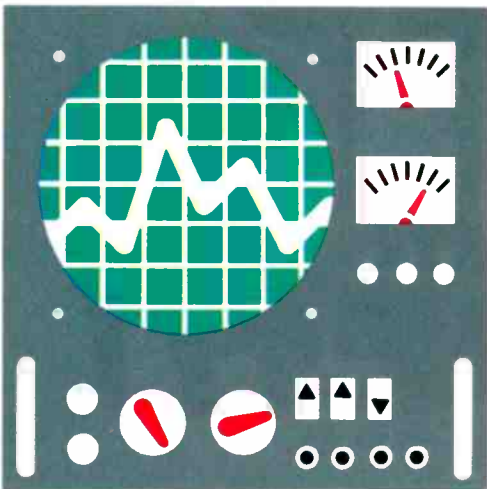
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BUYING CAR STEREO: HOW TO READ THE NUMBERS



Ten or fifteen years ago, the only numbers you'd see on a car-stereo specification sheet were the dimensions, the price and the amplifier's power in watts. Today, spec sheets have columns of figures detailing the performance of every section—the tuner, the amplifier, the tape player and, often, the CD player as well. It's all frightfully informative if you understand the numbers, but informatively frightful if you don't.

By and large, the specifications used to describe car stereo mean the same things as they do when they describe home stereo equipment. There are only two major differences:

1) Amplifier power ratings are sometimes inflated, but usually in decipherable ways (see sidebar, "What's Watts," elsewhere in this section.)

2) Tuner sensitivity ratings measured in *microvolts* (μV) are not comparable to those given for home tuners, but sensitivity ratings measured in *dBf* do mean the same for both.

If you already understand the other numbers on stereo spec sheets, you now know all you need to about car-stereo specs. If not, here's a refresher:

GENERAL AUDIO SPECS:

Frequency response indicates how wide a range of frequencies a component can handle comfortably, the wider this range, the better. A range of 20 Hz to 20 kHz (sometimes given as "20 to 20,000 Hz") is considered excellent for any piece of equipment. Amplifiers and preamplifiers generally do even better

than that at both ends of the range, CD players go down a bit below 20 Hz, and some very good tape players can just cover that full range, with perhaps a little extra at the high end. FM broadcasts only go from 50 Hz to 15 kHz, so that's as far as FM tuner ratings go.

However, no frequency rating is meaningful unless it's accompanied by a notation that shows how much the response varies over the rated range. (The smaller the variation, the better). If a piece of stereo gear is rated "20 Hz to 20 kHz ± 1 dB," for example, its response won't vary more than 1 dB (a fairly small amount) up or down, throughout that range; if it varies "+0, -1 dB," its response may drop by 1 dB, but will not rise at all. But if it's just rated "20 Hz to 20 kHz" with nothing said about the dB limits, its response might be varying like a profile of the Alps.

Distortion is a measure of harsh fuzziness. It should be as low as possible—certainly under 1%, and preferably well under 0.1%. Two types of distortion are commonly listed: *Total harmonic distortion* (or *THD*) and *intermodulation distortion* (*IM*). For most components, the two are about equal, so if only one is

listed you can guess at the other. The distortion rating on a spec sheet usually shows the maximum amount of distortion you'll hear under normal operation; at high signal levels, and at the extreme ends of the rated frequency range, distortion usually begins rising sharply.

Noise is usually a fairly steady hiss or roar heard during quiet passages. It, too, should be as low as possible, preferably at least 80 dB below the signal level. A spec sheet may show this in either of two ways, listing either a noise level (such as "-76 dB") or a signal-to-noise ratio (such as "S/N, 76 dB"). Despite the change from negative to positive, the two numbers are equivalent.

You may find frequency-response ratings listed for virtually all components, and noise and distortion listed for all but speakers. Speakers don't make noise; they do distort, but there are no commonly applied standards for measuring speaker distortion.

AMPLIFIER AND EQUALIZER SPECS:

An amplifier's main specification is its power output, in watts—but you can't take that mere number at face value. You also need to know the distortion level it's

WHAT'S WATTS?

Up to a point, the harder you drive an amplifier, the more power it delivers; but along with that added power comes more distortion and a narrower frequency range. An amplifier that delivers 10 watts per channel at a reasonably low 0.5% distortion (with, perhaps, even lower distortion at power levels of 9 watts or less) might deliver 20 watts per channel if you pushed it to a screaming 10% distortion. You *could* rate each channel at 20 watts; the power's there—you just wouldn't be able to stand listening to the system when the

amp was distorting that much. That amp might also be able to deliver its full 10 watts over the frequency range from 15 Hz to 30 kHz, but deliver 20 watts only at frequencies from 150 Hz to 10 kHz.

If two companies made such an amp, one company might rate it at 10 watts per channel, while the other bragged of 20. As long as only watts were specified, you couldn't tell the difference. But if each company stated the distortion level and frequency range (power bandwidth) that applied to its power rating, you would know at once that the "20-watt" amp was definitely not twice as powerful as the "10-watt" one.

The distortion level is especially important in car stereo. If it's not specified in the same phrase as the power rating, it is probably 10%—unlistenable high. At distortion levels low enough for your enjoyment, the amp probably delivers only one-half to three-quarter its rated power.

Total power and power per channel can also cause confusion. A stereo amplifier delivering 20 watts total is delivering 10 watts per channel; a four-channel amplifier that delivers 20 watts total produces only 5 watts per channel. Make sure you know just which specs you're comparing.





GOOD NEWS TRAVELS FAST. Aiwa has hit the road.

Take a look. Aiwa's latest high-performance line of car audio systems—the CT-XII Series—offers the audio enthusiast unmatched performance. That's what you expect from Aiwa. Plus unprecedented security. That's what you've been waiting for. No after-thoughts.

No bulky add-ons.



Each model can be

completely removed for safe

keeping. Of course, all electronic functions, like the 12 AM/FM

presets, volume level and digital clock settings, are safe in the memory. For up to 48 hours.

Even Aiwa's soft-touch controls are unique. The complete control panel flips closed to keep your

Aiwa car audio system safe from theft and dust. That way they see no evil. And Aiwa audio

engineers made sure you'll hear no evil either. Every CT-XII Series model boasts Aiwa's precision-

engineered auto-reverse tape transport system. With less than 0.12% WRMS wow and flutter.

While Dolby B* noise reduction, a fader control and pre-amp outputs are all standard. Very high

Aiwa standards. Just like Aiwa's quartz digital synthesizer tuner section. It delivers an FM

S/N-ratio of 65dB!



What more could you ask for in a car audio system? How about the

convenience of

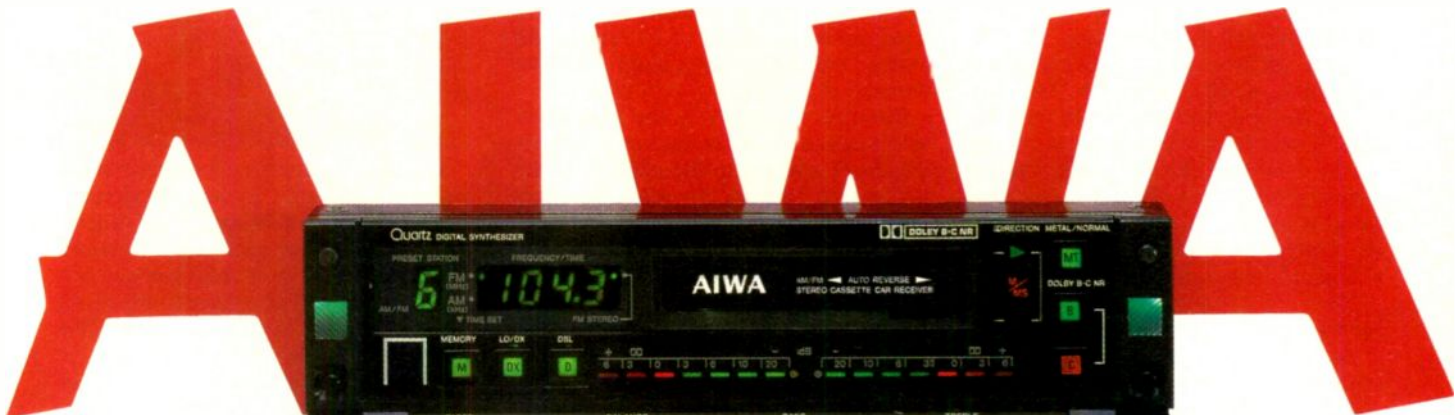
the CT-X500II's removable remote control module and the performance

of Dolby C*

noise reduction circuitry. There's no doubt about it. No other car

audio

systems can match the CT-XII Series from Aiwa. Not even remotely.



measured at (see sidebar, "What's Watts,"), and at what frequencies that power is available. The frequency side of amplifier power is covered by the *power bandwidth*, specification. This spec is a range, like frequency response; but variations in dB aren't stated, because what's being specified is response at a single level—full rated power— ± 0 dB.

Like frequency response, power bandwidth should be as wide as possible, and should certainly extend down to the lowest frequency the speakers connected to that amp are capable of delivering. (In other words, in a stereo system with separate bass and treble amplifiers, an amplifier with poor bass response could still be used to run the tweeter and mid-range, but shouldn't be used for the woofer.) If the amplifier also has a frequency-response spec, that will show the amp's capabilities at lower power (usually, 1 watt), and will usually be wider than the power bandwidth.

Equalizers add two other specifications—the number of frequency-band controls per channel, and the boost and cut range available from each frequency-band control. Most car equalizers have five or seven bands, each with the ability to boost and cut a range of frequencies by ± 12 dB.

CD SPECS:

Forget 'em. What audible differences there are between CD players don't show up in the spec-sheet numbers. Compact Disc players have tremendously broad frequency response, ultra-low noise and distortion, and no wow and flutter whatsoever. If the differences between, say, 0.05% and 0.005% distortion can be heard at all, they certainly can't be heard over the noise of your motor, your tires on the highway, and the kids in the back seat. There is one spec to watch for: Many authorities feel that CD players with digital filtration sound better than those with only analog filters—but not for reasons that show up in the numbers columns.

TAPE DECK SPECS:

The main tape-deck specifications are signal-to-noise ratio, frequency response, and wow & flutter. *Wow & flutter* is a measure of cyclical speed variation which can be slow enough to make the sound waver audibly (wow) or fast enough to give the music a faintly tremulous, or even gargly quality (flutter). It should be as low as possible, at least below 0.1%, and preferably less than half that figure.

A tape player will often have several

different specifications for S/N ratio and frequency response, depending on the noise-reduction system and the kind of tape in use. The noise-reduction (NR) system, not surprisingly, makes the biggest difference to the noise level: typical S/N ratios for car stereo equipment are about 50 dB without noise reduction, about 60 dB with Dolby B noise reduction, about 70 dB with Dolby C NR and about 80 dB with dbx NR.

Frequency response is usually narrowest with Type I ("ferric" or "normal") tapes, wider with Type II ("chrome") tapes and a bit wider still with Type IV ("metal") tapes. (Specs are rarely listed for Type III tapes, now a rarity.)

TUNER SPECS:

The most widely cited FM radio specification is *sensitivity*, a measure of how strong the radio signal must be before the tuner can attain a given level of performance. If only one number is given, it will usually be for *usable sensitivity*, the signal level that will yield a 30 dB S/N in mono—a level of performance so low that you'd change stations rather than put up with it. More significant are figures that show what signal level will produce "50 dB quieting"—that is, an S/N of 50 dB—especially if it's quoted for stereo reception. For any given kind of sensitivity spec, the lower the number the better. Numbers given in *dbf* are directly comparable to those for home stereo equipment, while those given in *microvolts* (μV) must be doubled before making such comparisons. In other words, a home tuner with a rated usable sensitivity of 5.5 μV and a car-stereo unit with a rated usable sensitivity of 2.75 μV would both be equally sensitive, and could both be rated at 20 dbf.

But while sensitivity is the most commonly quoted spec, its importance fades the closer you get to the city where the stations are. In town, the most important spec is probably *AM rejection*, a measure of the tuner's ability to suppress interference that resembles AM radio signals. This includes *multipath interference*, the same phenomenon that causes "ghosts" on TV, and a prime source of distortion on FM. Any tuner specification labelled "suppression" or "rejection" should be as high as possible, preferably well over 70 dB. After AM suppression, the most important of these specs in mobile use is *spurious-response rejection*, the tuner's ability to continue sounding clean when exposed to very strong signals (such as when driving past a transmitter).

Capture ratio and *selectivity* are also important on the road. The first de-

scribes the tuner's ability to distinguish between signals on the same frequency but of slightly different strengths. (In the country, you might get that when you're between two cities which each have a station on the frequency you're tuned to; in the city, the second "signal" could be a multipath reflection.) The lower the figure, the finer the distinction the tuner can make—a capture ratio of 2 dB would be fairly good, and 1.5 dB would be quite good.

Selectivity measures the tuner's ability to distinguish between signals whose frequencies differ only slightly. The higher the figure (in dB), the more resoundingly the tuner can reject unwanted signals on nearby frequencies. Most car-stereo tuners have between 50 and 70 dB of selectivity, but a few have ratings up to 80 dB or more.

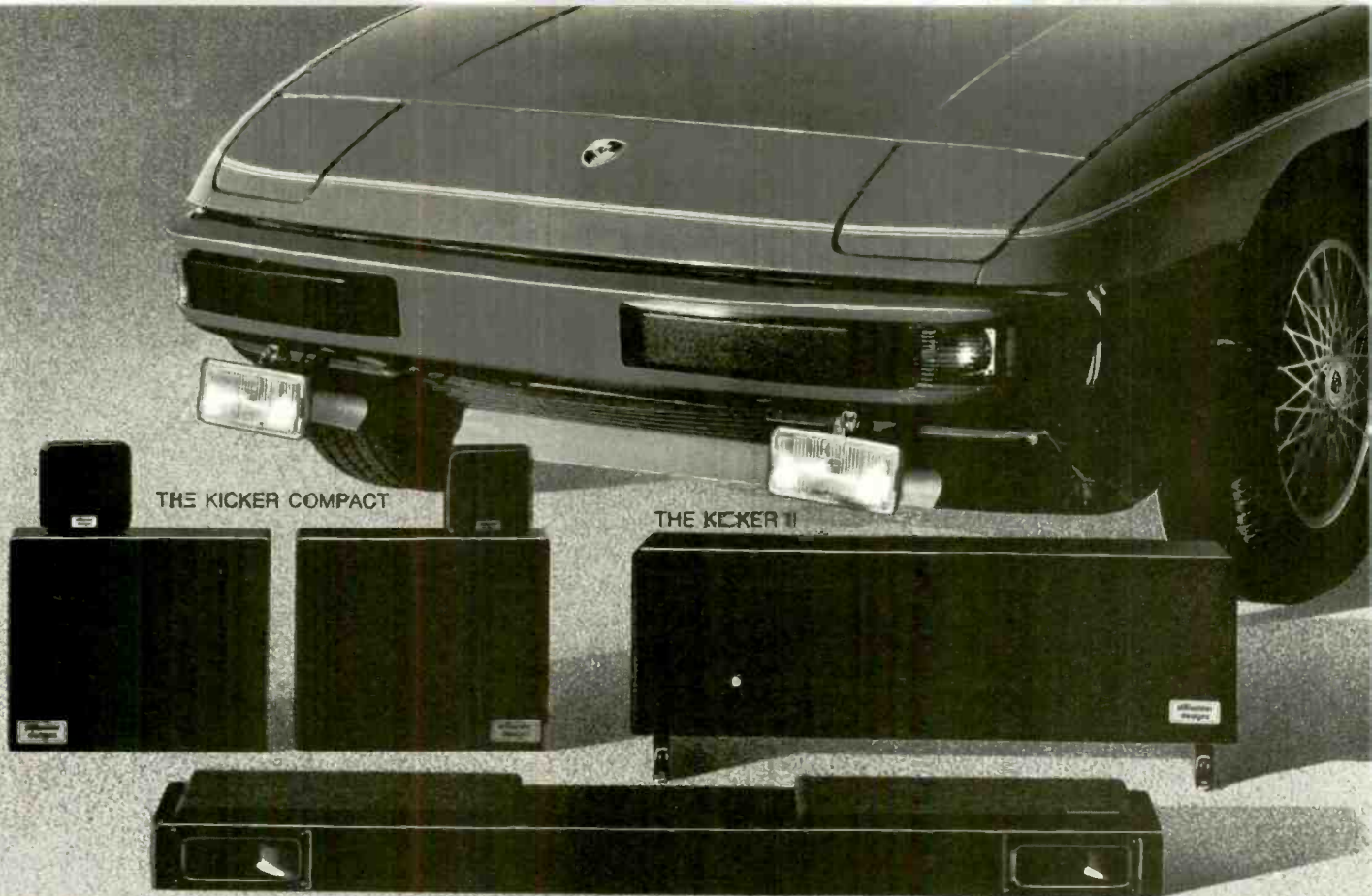
BETTER SAFE THAN SORRY



It's easier to steal car stereo than home audio equipment. Cars have convenient, curbside windows through which thieves can check out—or take out—the equipment. And every theft costs you not only your equipment but money to repair the break-in damage to your car and, usually, to hire another while it's fixed.

Short of doing without it altogether, you can't keep your car stereo perfectly safe. You can, however, make it safer. And many of the measures you can take cost little or nothing.

First, be careful where you park. Thieves thrive where they can work uninterrupted. Dark, secluded streets are a thief's delight. Unattended off-street parking lots are worse still—thieves can walk in freely, there's little other foot



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traffic, and parking meters, if they're present, tell when a car's owner expects to return. Your neighborhood, where people know you and your car, is safer than an anonymous district elsewhere, and your garage (if locked), is safer still.

Second, don't advertise that there are valuables in your car. Never leave tapes (or, worse, CDs) out in plain view. Never leave other goodies out, either—a thief who comes for something else probably won't ignore your stereo. Cover up your stereo to foil a casual glance, by buying inexpensive, slip-on covers or (in two-door cars) by leaving the front seats folded forward over the dash.

If possible, remove your stereo altogether. Some new head units slide out of the dash, so you can take them with you when you park, and sleeves are available to convert other stereos into slide-outs. If you have such a sleeve, do take your

DON'T ADVERTISE YOUR stereo by leaving tapes or CDs out in sight. Other visible valuables can draw thieves, too. If you can, take your stereo with you when you park.

stereo with you, as conspicuously as you can, each time you park your car. If you want to stash your stereo in your trunk, do it a few blocks before you reach your parking place, so people who know it's in the trunk won't know where that trunk has gone, and vice versa.

All these precautions will almost certainly help you keep your stereo—even if they can't absolutely prevent thieves from breaking in and rummaging around in hope you've left the stereo under your front seat.

Some stereo systems have another anti-theft trick: Playing dead. Once they're disconnected, they won't work again until a secret code is keyed in. That ensures the ultimate recipient of your radio won't enjoy it, which is some consolation. But it won't deter thieves from taking it until more of them, and more of the people who buy stereos from thieves, learn about the feature.

Alarms do deter thieves, at least where the thief has reason to fear someone will come to investigate before he can make his getaway. Sometimes, the possibility of

having to deal with an alarm will encourage a thief to seek an easier mark. An *alarm sticker* gives this deterrent effect, by helping thieves get the message before they try to steal your car or sound equipment.

Get an alarm which not only sounds if a thief breaks in to take something but also if someone attempts to take the entire car, and which disables the ignition or fuel if unauthorized people try to start the engine. Get one that's **LOUD**, so people will hear it and be annoyed enough to call the police—but also get one that will stop making noise when the theft or other disturbance stops. (Why wake the neighbors when it's too late?). And make sure that after shutting itself

off, the alarm will re-arm itself to trigger again if the thief comes back.

Alarms lower the odds of theft, but they aren't a perfect deterrent—we've all heard or seen cars wail on and on and get no response. And remembering to turn alarms on and off can be a nuisance. *Passive arming*, which turns the alarm on automatically when you turn your ignition off, keeps the alarm ready but out of sight and out of mind until it's needed. And some alarms can be a positive convenience, with radio control systems that let you disarm them and unlock the doors as you approach—some even beep the horn and flash the lights from afar, to help you find your car in a crowded parking lot.

QUALITY? WHO NEEDS IT?

The ultimate car-stereo can never be quite as good as ultimate home systems. The conditions in the car—road noise, interference, and speaker-placement difficulties—will always keep car sound somewhere this side of nirvana. That doesn't mean car stereo systems can't sound superb, however, or that you won't be able to hear the difference between excellent and mediocre sound.

As each advance in audio reaches the car, audiophile cynics say it won't make a worthwhile difference on the road. Then, as the effects of this advance are heard, it becomes something no halfway critical listener would do without. As improvements become standard, they increase the importance of quality everywhere else in the system.

Take noise reduction, for example. When mobile tape players with Dolby B NR appeared, the skeptics felt that its hiss reduction would not be audible against the background of motor, road and wind noise. When it became obvious that tape hiss, and hiss reduction, were plainly audible on good car systems, the cry went up that Dolby C and dbx NR would be unnecessary. Indeed, the difference between plain-vanilla Dolby B and these more effective NR systems was not as readily heard as the difference between Dolby B and no NR had been; but it was audible, nonetheless. Even if it hadn't been, listeners who had tapes encoded with dbx and Dolby C NR for use at home would have also needed those NR systems on the road for compatible playback of those tapes. (With Dolby B NR, this argument was weaker: Dolby B-encoded tapes can be played without de-



coding, if you turn the treble down; the results are listenable, if not exactly accurate. But Dolby C and dbx NR are only listenable if played through matching decoders.)

As better tape NR systems, and better tapes, appeared, car sound systems improved a bit more, too. Better NR meant that systems with better high-frequency reproduction would not be as plagued by hiss as in the days before NR. And greater dynamic range in recordings called for more dynamic range in playback electronics and loudspeakers.

With Compact Disc, the need for quality becomes even more apparent. A CD player will make *any* system sound better, at least up to the point where the music's dynamic range outruns the system's. But it takes a really good system to take full advantage of the Compact Disc's clean, wide-ranging signal.

Such systems do exist. Have your dealer or installer demonstrate one for you, and you'll hear the difference—even on the road.



**CHOOSE YOUR CASSETTE TAPE
AS CAREFULLY AS YOUR CASSETTE DECK.**



If you own a deck like one of these, you were obviously concerned with low wow and flutter, extended frequency response, smooth tape transport and wide dynamic range. When it comes to choosing cassette *tape*, why behave any differently?

Denon's new High Density HD8 formulation is the finest high-bias tape you can buy. Its "High Technoroom" dispersion and binding plus its metal hybrid formulation guarantee digital level performance on the widest range of cassette decks (including yours). You can keep an eye on things through Denon's new giant window. And enjoy your music knowing HD8 is guaranteed for a lifetime.

So how good is your cassette deck? With Denon HD8 it's better than you think.

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Digital-ready tape from the first name in digital recording.

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1

CLASSÉ AUDIO DR-3 AMP

Manufacturer's Specifications

Power Output: 25 watts/channel into 8-ohm loads, 50 watts/channel into 4 ohms, 100 watts/channel into 2 ohms; bridged mode, 100 watts into 8-ohm load, 200 watts into 4 ohms, 300 watts into 2 ohms.

Output Current: 15 amperes rms.

Frequency Response: At rated power, 0.4 Hz to 80 kHz, +0, -3 dB.

Distortion: 0.1% THD and IM at rated power.

S/N: 85 dB, unweighted, wide-band.

Input Impedance: Stereo, 100 kilohms; bridged, 25 kilohms.

Input Sensitivity: 0.8 V for rated output.

Power Consumption: Approximately 500 watts at idle.

Dimensions: 19 in. W × 10¾ in. H × 14¼ in. D (48.3 cm × 27.3 cm × 36.2 cm).

Weight: 70 lbs. (31.8 kg).

Price: \$2,895.

Company Address: 227-G Brunswick Blvd., Pointe Claire, Que., Canada H9R 4X5.

For literature, circle No. 90



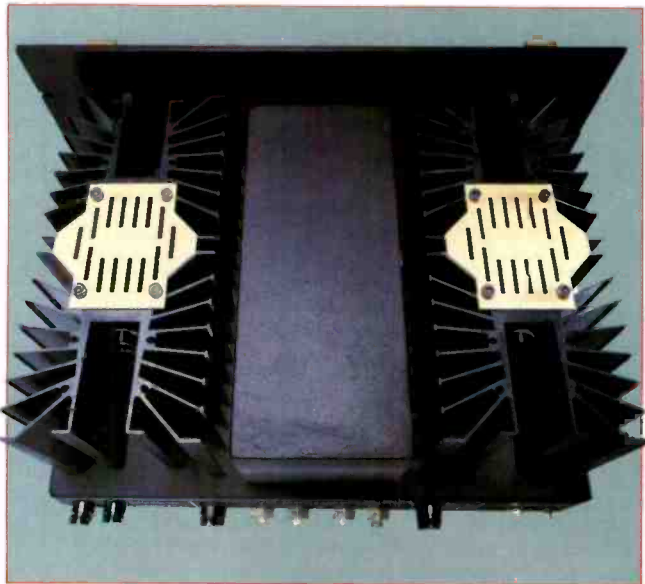
The Canadian-built Classé Audio DR-3 is a solid-state stereo power amplifier rated at 25 watts per channel into 8-ohm loads. Physically, the unit employs exotic construction. Larger than most 200-watt amplifiers, the DR-3 features huge heat-sinks, massive speaker connectors, and Class-A output circuitry.

The DR-3's 25-watt, 8-ohm power rating; Class-A operating mode, and solid, massive metalwork are reminiscent of the Levinson ML-2, although the DR-3 is a stereo amplifier and costs far less than the Levinson (which now lists at \$8,848 per pair and must be custom ordered). Like the ML-2, the DR-3 sports an engraved black faceplate, oversized handles, and sculpted, finned radiators that give it a striking appearance.

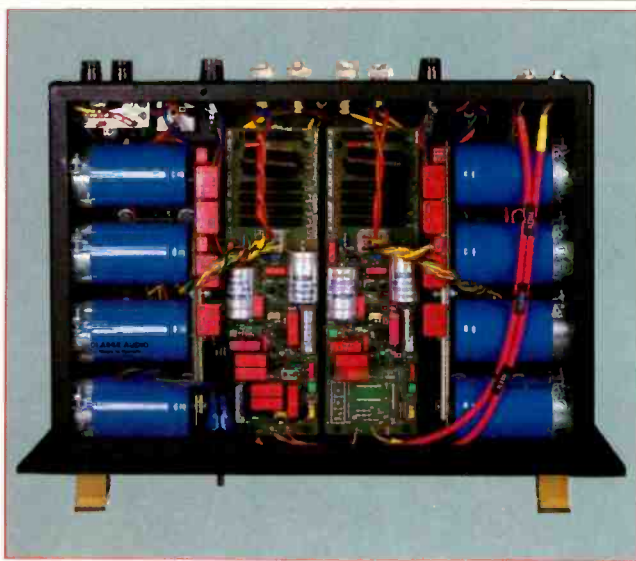
The DR-3, Classé Audio's latest "pure" Class-A design, features heavier gauge internal wiring, floating-ground power-supply modules, polyfilm capacitors to couple and bypass key circuit areas, shield plates to reduce hum in the input circuitry, increased input impedance in the bridged mode to interface better with tube preamps, and better speaker connectors than their previous amp.

Construction

The DR-3's construction suggests the very high quality of expensive test instruments. It is built the way amplifiers were usually built in the tube days—on and inside a box chassis. The welded, $\frac{1}{8}$ -inch-thick aluminum chassis is 12 x 17 x 3 inches and has a steel bottom cover attached by eight Allen-head machine screws. A 10½-inch-high, $\frac{1}{4}$ -inch-thick, notched rack-mount faceplate is bolted to the front of the chassis and to the front heat radiators. Classé Audio says the amp can be rack-mounted if ventilation room is provided.



With 1,695 square inches of heat-sink radiating surface, the DR-3 runs reasonably cool without a fan in Class A. The large central box holds the power transformers.



The DR-3's components nestle within a welded chassis of $\frac{1}{8}$ -inch-thick aluminum. Note the four 20,000- μ F capacitors in each channel's power supply.

The DR-3's front panel bears only a single LED pilot light and a toggle switch for power. The rear apron has silver-plated signal input connectors and extremely heavy, silver-plated speaker binding posts. Six 8-ampere fuses (accessible from the rear), one a.c. line fuse, and two rail fuses per channel are the amplifier's only protection. The rear of the DR-3 is also equipped with an IEC power socket and a detachable line cord.

The DR-3 runs reasonably cool in Class A without an internal fan because of four exposed heat-sink assemblies, mounted on top of the chassis, which provide 1,695 square inches of radiating surface. A welded aluminum box, mounted on rubber bushings to minimize vibration, runs from chassis front to back and contains the amplifier's two power transformers, one for each channel's power supply. Each 350-VA power transformer is wound with wire that has a square cross-section; this is said to yield higher flux density and greater efficiency.

Underneath, the amplifier's dual-mono circuitry resides on a total of nine p.c. boards, including one a.c. line board, four heat-sink module boards, two power-supply boards, and two main-drive circuitry boards. Four 20,000- μ F, 50-V capacitors are used in the power supply for each channel. Two are input capacitors which feed second-stage filters through 0.4-ohm, wire-wound resistors. The four capacitors' common terminals are bolted to a thick silver-plated strap, the center of which serves as a ground reference point. These p.c. boards are liberally bypassed with large film capacitors.

One of the two audio circuit boards contains additional components for bridged operation. The bridging switch features three DPDT sections which completely disconnect these components from the rest of the circuit and the power supply when in two-channel mode.

Circuit-board finish and parts quality are among the best we've ever seen in home audio components.

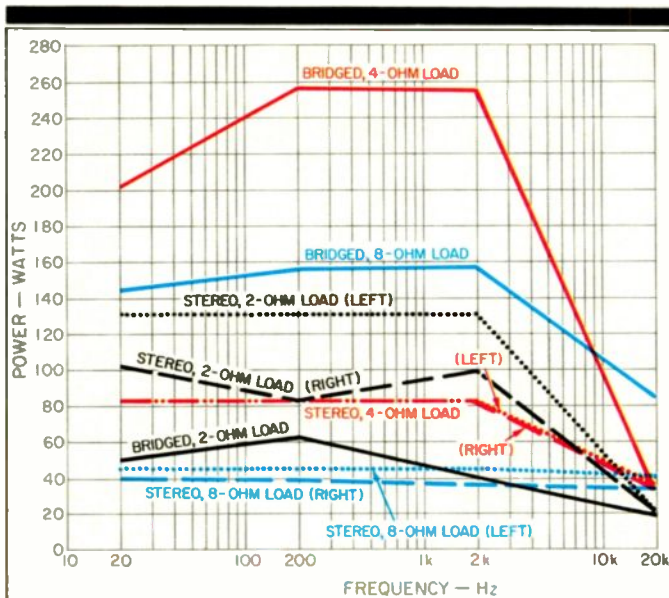


Fig. 1—Power output vs. frequency at 0.3% THD + N, stereo and bridged operation, for 8-, 4-, and 2-ohm loads.

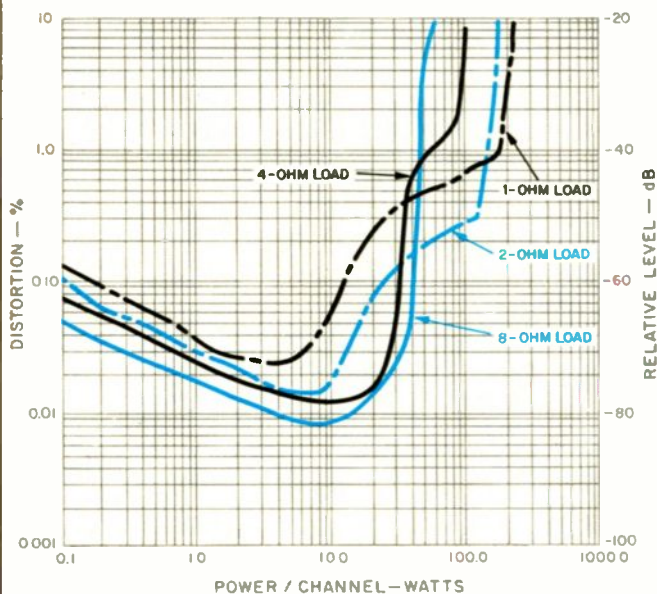


Fig. 2—Power output vs. THD + N at 1 kHz for 8-, 4-, 2-, and 1-ohm loads.

For each channel, the DR-3 output stage employs four high-speed, high-power bipolar devices. Claimed total output-device capability per channel is 800 watts and 120 amperes. The four heat-sinks are drilled, not punched, to help maintain flatness for tight mechanical and thermal contact with the output transistors.

Four-conductor, audiophile-grade cables lead from each RCA input connector to the circuit board for each channel. The right-channel drive circuit board also contains the circuitry and three switches for converting to bridged mono operation. Circuit-board finish and parts quality are among the best we have seen in home audio components, and are reminiscent of some older military equipment. Trimpots are multi-turn and sealed, capacitors are molded polyfilm types, and small resistors are all 1% film. Three high-quality electrolytic capacitors are also used in each channel.

Large, modular, molded-nylon connectors are used to carry high-current signals to the output transistors. While these are undoubtedly up to the task, we would have liked soldered connections here. Each p.c. board also is terminated through a 12-pin, gold-plated connector said to be able to carry four times the current of the conventional card-edge contact.

The DR-3's massive, silver-plated, brass speaker terminals deserve special mention. Speaker wires are attached by tightening down a 1/4-inch hex-head bolt on the terminal's solid base. If the speaker cable is terminated in sufficiently large spade lugs, this arrangement provides an excellent mechanical and electrical connection between amplifier and speaker wire. This speaker terminal is the best we have encountered in an audio amplifier.

Dave Reich, Classé Audio's president and designer, says each DR-3 undergoes strenuous burn-in and quality-control testing at the factory after running with no input signal for 24 hours. The amplifier's input is then driven with a square wave, logarithmically swept from 5 Hz to 50 kHz, at full power into 4 ohms. Stereo sweep and bridged sweep are carried out for 24 and 12 hours, respectively. A detailed test sheet for each unit is kept on file.

The DR-3 owner's manual contains no standard test-bench ratings. Reich believes that standard power ratings and distortion figures do not describe the DR-3's sonic qualities. For this review, manufacturer's specs were obtained by means of not-so-subtle editorial pressure. Reich confirmed that both the company's former amplifier, the DR-2, and the DR-3 have identical power output and frequency response ratings into 8 ohms (25 watts/channel in stereo mode, 100 watts bridged), into 4 ohms (50 watts/channel in stereo mode), and into 2 ohms (100 watts/channel in stereo mode).

Circuit Description

The DR-3 is a straightforward Class-A amplifier design. Such circuitry keeps output transistors conducting throughout the output waveform and requires high continuous bias current in the output stage. Because the current delivered to the load is diverted from the bias, the peak available load current is about equal to the static bias current. The designer must therefore estimate a maximum instantaneous requirement, based on speaker impedance, and use that as



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Wouldn't you really rather have a Buick?



By rating the DR-3 at only 25 watts/channel, Classé ensured it could stay in Class A at full rated output without getting too big or too hot.

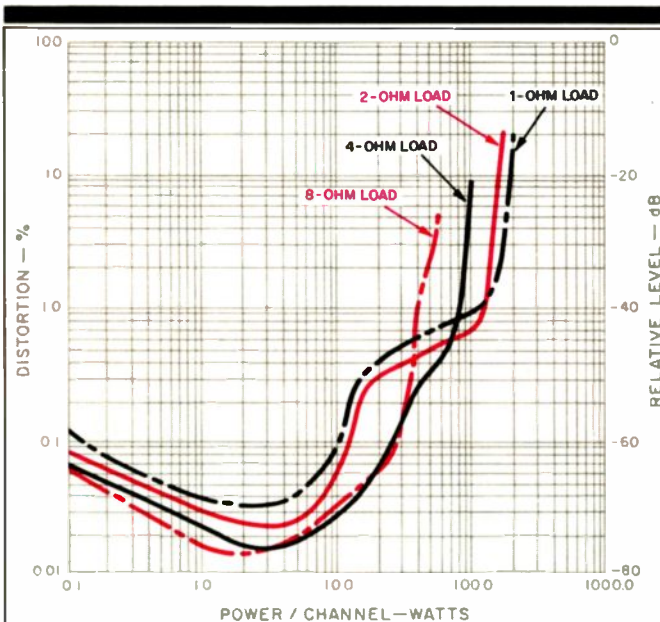


Fig. 3—Power output vs. THD + N at 20 kHz for 8-, 4-, 2-, and 1-ohm loads.

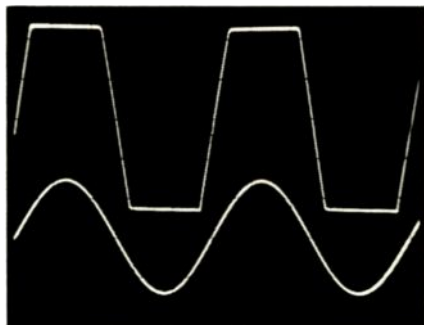


Fig. 4—Clipping characteristics (top trace) for 20-kHz input (bottom trace). Note the absence of "sticking" as the trace leaves the flattened peak area. Input is 2-V sine wave, output is 50 watts into 4-ohm load. Scales: Horizontal, 100 μ S/div.; vertical, 10 V/div. (top trace) and 2 V/div. (bottom trace).

the steady bias current. Designer Reich notes that his "pure" Class-A amplifiers do indeed remain in Class-A operation only so long as their output transistor current is not required to exceed that of the static bias. However, if speaker loads lower than 8 ohms are used, most Class-A amplifiers will supply additional peak current, a condition which Reich says is a shift to Class-AB operation. Shifting out of Class-A operation is not the intent of Classé Audio, particularly when driving the low-impedance loads of some electrostatic or panel speakers favored by some audiophiles. The DR-3 was therefore designed with a relatively low power rating of 25 watts, so it can maintain its full rating in pure Class-A operation while keeping its size and heat dissipation realistic.

The DR-3's circuitry uses nine small, plastic-case transistors on each board, with one extra on the right-channel board for bridging the two channels. The power supply employs two 35-amp bridge rectifiers followed by the two-stage RC filter network; this provides a high power reserve with low ripple. Total power-supply capacitance is 160,000 μ F, which is equivalent to 250 joules of energy storage. Silver-plated, solid copper buss bars; stiff power transformers, and capacitors with low equivalent series resistance all contribute to a circuit with extremely low power-supply impedance.

Discrete bipolar transistor circuitry is used throughout the DR-3. The differential input stage is current-sourced and cascoded. Reich says that the cascoding topology increases the input impedance and effectively "elongates" the linear operating region of the devices. The driver transistors are also cascoded, and their current-source diodes monitor the output-stage bias current. All the devices are matched for gain and checked for leakage. Small resistors are metal film, 1% tolerance; emitter resistors and other large resistors are custom-made wire-wounds rated at 10 watts. Each fully discrete amplifier circuit is mounted on a glass epoxy p.c. board and soldered with silver-content solder. The p.c. board manufacture is computer-executed, and the plating pattern is sealed with an epoxy solder resist.

No intermediate-size driver transistors are used, because the Darlington output devices contain their own drivers. Also unusual is the virtual absence of thermal feedback from the heat-sinks to circuit parts. This caused a slow bias shift of more than 50% over a two-hour warm-up period from turn-on to "full Class-A" operation.

Measurements

The DR-3 was first run for one hour at 33% of rated power, about 8.3 watts per channel into 8-ohm loads with a 1-kHz test signal. The usual FTC specification of one-third power does not strain a Class-A design the way it can a Class-AB amplifier. Because a Class-A amplifier is fully on all the time, power is either radiated as heat or is delivered to the load. Thus, the Classé can run cooler in operation than at idle.

The output-stage bias of the fully warmed-up amplifier, measured as a voltage drop across an output-stage emitter resistor, was found to be 2.67 amperes. When first turned on, the emitter-resistor current flow measured only 1.56 amperes, which means that only a narrow Class-A power range is available when the amplifier is cold. From cold turn-

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The amp clips cleanly and then goes back to normal, without "sticking" at high distortion as many other amplifiers do.

on, the amplifier heated up noticeably for 10 minutes and required two hours to fully stabilize.

Class-A operation limits were studied by noting the power-output level at which the a.c. line-current draw began to increase. Theoretically, the amplifier's line-current draw should remain constant as long as it is operating in Class A. As expected, the DR-3's current draw did not vary noticeably with an 8-ohm load up to the 40-watt clipping point. For other load impedances, the draw on the a.c. line current shifts as the amplifier transfers into Class-AB operation. The DR-3 delivered approximately 30 watts (11 V) into 4-ohm loads before line-current draw increased. At lower impedances, not often encountered in loudspeakers, the DR-3 settled into Class AB at progressively lower powers, including 16 watts (5.7 V) into 2-ohm loads and 7.8 watts (2.3 V) into 1-ohm loads.

Power output was measured from 20 Hz to 20 kHz into a variety of load conditions, as shown in Fig. 1. From 20 Hz to 20 kHz, at less than 0.3% THD + N, the DR-3 delivers a minimum of 35 watts per channel into 8 ohms, 36 watts into 4 ohms, and 23 watts into 2 ohms. However, as Fig. 1 shows, power output into 4-ohm and 2-ohm loads is substantially higher at frequencies up to 2 kHz. Driving 1-ohm loads, the amplifier pumps out an amazing 192 watts per channel at mid-band frequencies, although at much higher distortion levels.

In bridged (mono) operation, the DR-3's continuous power output at mid-band measures 158 watts into 8 ohms, 256 watts into 4 ohms, and 40 watts into 2 ohms, all with THD + N of less than 0.3%. At very high frequencies, however, power drops considerably (Fig. 1).

Running the amp at its rated 25-watt output into 8-ohm loads, THD + N was steady from 20 Hz to 2 kHz (at 0.020% to 0.022% in the left channel and 0.032% to 0.034% in the

right). Above 2 kHz, THD + N began rising, reaching a maximum of 0.12% at 20 kHz; this rise suggests increasing nonlinearities or reduced negative feedback in the high-frequency range. Measured THD + N ran 0.36% for 50 watts output into 4-ohm loads, and 0.74% at 100 watts into 2 ohms. Although these distortion figures are somewhat higher than usual for amplifiers in this price category, measurements at lower power levels revealed much better performance. Figures 2 and 3 show the DR-3's distortion versus power output, with four impedance loads, for 1- and 20-kHz signals, respectively. Note that at 1 kHz, distortion stays below a respectable 0.05% until the power is raised to the point where the DR-3 leaves Class-A operation for that load impedance.

When brought to clipping level at 20 kHz, the waveform flattened on top and bottom, as expected. This happens in all amplifiers when the output transistors have pulled the load up or down to the power-supply or "rail" voltages and more power is asked for. The DR-3's clipping (Fig. 4) is very clean, with no "sticking" and no power-line frequency ripple even at 6-dB overdrive. Many other amplifiers, once brought to the rail voltages, tend to stick there for a few microseconds, generating excess distortion before jumping back to the proper waveform.

Voltage gain was measured and found to be 25.2 dB. The IHF sensitivity, for 1 watt into 8-ohm loads at 1 kHz, was 150 mV. The IHF signal-to-noise ratio, which is A-weighted noise referred to 1 watt output into 8 ohms, measured -83.0 dBA for the right channel and -77.8 dBA for the left. Crosstalk versus frequency was measured by driving one channel and measuring the leakage into the other, with the unused input terminated by a 1-kilohm resistor. Worst case, crosstalk was better than -60.0 dB from 20 Hz to 20 kHz.

Figure 5 illustrates the DR-3's response to a square wave at rated power of 25 watts per channel into 8 ohms. Rise-time is 4 μ S. The slew rate measured 11 V/ μ S, up or down. This modest-appearing figure is actually very good, considering the amplifier's low power rating. The IHF slew factor into 8 ohms measured "infinite." Adding a 2.0- μ F capacitor causes the usual ringing of the output network, with a 0.2-dB increase in sine-wave output at 20 kHz, but no instability.

For 8 ohms, the low-frequency damping factor was measured at 320 and the wide-band damping factor was measured at 15.7. The damping factor versus frequency is shown graphically in Fig. 6. Classé Audio gives no rating for this specification.

The 1-watt frequency response into 8 ohms (Fig. 7) showed the amplifier to be within ± 0.1 dB from 5 Hz to 20 kHz. The -3 dB frequencies were 0.28 Hz and 90 kHz. Input impedance was somewhat frequency-dependent, measuring 140 kilohms at 1 kHz and 62 kilohms at 20 kHz.

The IHF dynamic headroom measured 2.3 dB (18.4 V, 42.3 watts) relative to 25 watts rated power into 8 ohms. The 4-ohm IHF headroom (using the manufacturer's claim of 50 watts into 4-ohm loads) was 2.0 dB (17.9 V, 80.1 watts). The bridged 8-ohm IHF headroom (relative to the 25-watt stereo rating) reached 5.0 dB into 8-ohm loads (35.8 V, 160 watts) and 4.6 dB (for the 50-watt rating mentioned above) into 4-ohm loads (34.0 V, 289 watts). Into lower impedances, the DR-3's available IHF dynamic headroom was far greater,

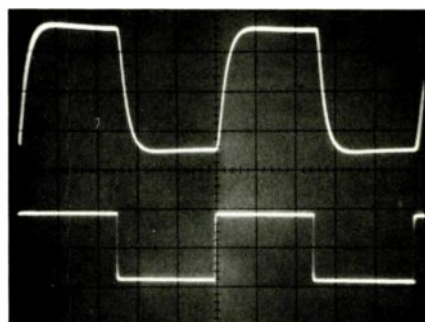


Fig. 5—Large-signal square-wave response at clipping for 20-kHz input (top trace) and 20-kHz input signal (bottom trace). Output is 25 watts into 8 ohms. Scales: Horizontal, 10 μ S/div.; vertical, 10 V/div. (top trace) and 1 V/div. (bottom trace).

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Use and Listening Tests

Equipment used by coauthor Greenhill to evaluate the DR-3 included a Linn Sondek turntable, a Magnepan Uni-trac 1 tonearm, a Shure V15 Type V-MR cartridge, a Magnavox CD player, a newly modified Mark Levinson ML-7 reference preamp, and Snell Type A-III and Apogee Scintilla

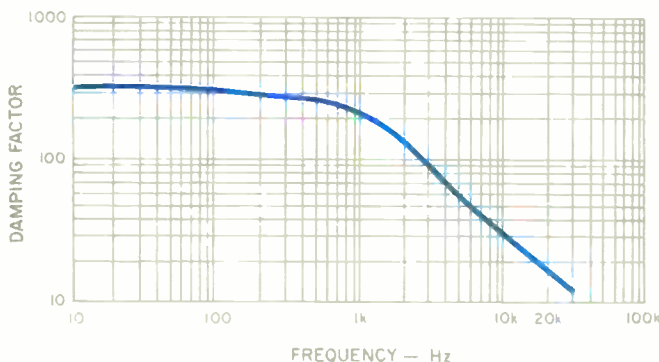


Fig. 6—Damping factor vs. frequency for 8-ohm load.

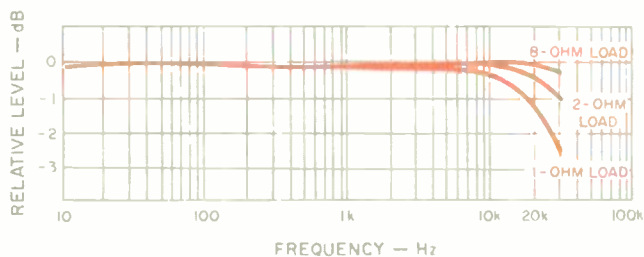


Fig. 7—Frequency response into 8-, 2-, and 1-ohm loads.

speakers. Coauthor Clark's system included a Sony CDP-650ESD CD player, a Tandberg 3008A preamplifier, and Fried Studio IV and Magnepan MG-IIIa speakers.

Greenhill ran four controlled, double-blind tests with a single DR-3 gain-matched to an Onkyo M-510 amplifier rated at 300 watts. The Onkyo's meters, which are quite accurate peak-reading analog types, allowed the author to set the M-510's maximum power to equal the DR-3's. Greenhill obtained 13 out of 32, 18 out of 32, 16 out of 32, and 30 out of 64 correct identifications. We don't consider these near 50:50 scores to have statistical significance, which means to us that Greenhill's ability to distinguish these two amplifiers in a double-blind test was no better than would be expected from chance alone.

For the subjective listening sessions, a DR-3 was auditioned by Greenhill on the Snell dynamic loudspeaker systems and later on Apogee Scintillas. The first impression was the change in the DR-3's sonics as it warmed up. Initially the amplifier produced a thin sound, somewhat distant in perspective and shallow in depth. Within 15 minutes there was a dramatic increase in dynamic range and, for want of better terms, in richness and sweetness. These qualities also produced a startlingly valid sonic replica of the human singing voice. The resonance of strings and woodwinds in orchestral music and the pitch of the human singing voice had a new and different tonality not previously heard on the Snell Type A-III loudspeakers. Center-fill between the speakers was seamless, and depth rendition dramatic with two DR-3s. The effect of this bi-amplified mode was to expand the sound field's width and depth, as well as to increase the resolution of sonic detail.

The biggest subjective surprise was the amplifier's dynamic range. The rated power of 25 watts invited comparison with more powerful amplifiers, with the expectation that the DR-3 would clip audibly while the others sailed on. Not so. The DR-3 played to moderately loud levels with no audible signs of clipping such as static, strain or distortion. With the 1-ohm load of the Apogee Scintillas, the DR-3 sounded as loud as a 100-watt amplifier (8-ohm rating, not rated for 1-ohm loads) in a non-matched, open comparison. This is a tribute to the Classé Audio power-supply design, which enables the DR-3 to deliver almost 200 watts per channel into that load. Thus, the DR-3 amplifier "sounds louder" driving low-impedance speaker loads than would be predicted by its power ratings alone.

In summary, we find the Classé Audio DR-3 to represent good quality, reliability, and conservative engineering design. The DR-3's high-current power supply allows the amplifier to cope with loads as low as 1 ohm, delivering much more power than its 25-watt, 8-ohm rating would imply. We'd like to see the manual itself include power ratings at various load impedances. However one views the DR-3's low power ratings and moderate distortion performance on the test bench, it has many intriguing qualities. Clark found the amplifier displayed exemplary clipping characteristics and did not misbehave when overdriven. Greenhill was also impressed with the DR-3, in particular by the high quality of its parts, its rugged construction, dynamic range, and ability to portray instrumental resonances.

Laurence L. Greenhill and David L. Clark

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2

PROTON D940 RECEIVER

Manufacturer's Specifications

FM Tuner Section

Usable Sensitivity: 10.3 dBf.

50-dB Quieting Sensitivity: Mono, 15.3 dBf; stereo, 33.2 dBf.

THD at 65 dBf: 0.1%.

S/N: Mono, 83 dB; stereo, 74 dB.

Hum and Noise at 65 dBf: Mono, 75 dB; stereo, 70 dB.

Capture Ratio: 1.5 dB.

Image Rejection: 55 dB.

I.f. Rejection: 90 dB.

AM Suppression: 60 dB.

Stereo Separation: 45 dB at 1 kHz.

AM Tuner Section

Usable Sensitivity: 20 μ V.

Selectivity: 35 dB.

I.f. Rejection: 50 dB.

THD (30% Modulation at 10 mV): 0.5%.

S/N: 43 dB at 10 mV.

Amplifier Section

Rated Continuous Power: 40 watts per channel, 20 Hz to 20 kHz, 8-ohm loads.

Dynamic Headroom: 6 dB at 8, 4, or 2 ohms (see text).

THD: 0.02% at rated power.

IM Distortion: 0.008% at rated power.

Clipping Power: 50 watts at 8 ohms, 80 watts at 4 ohms, and 100 watts at 2 ohms.

Damping Factor: Greater than 90.

Frequency Response: High level, 20 Hz to 20 kHz, ± 0.2 dB; MM phono, RIAA ± 0.2 dB; MC phono, RIAA ± 0.2 dB.

Input Sensitivity: High level, 150 mV (for rated output); MM phono, 2.5 mV (for rated output); MC phono, low, 0.1 mV; MC phono, high, 0.2 mV.

S/N (Re: Rated Output, A-Weighted): High level, 105 dB; MM phono, 92 dB; MC phono, 75 dB.

Channel Crosstalk: 75 dB at 1 kHz.
Function Crosstalk: 78 dB at 1 kHz.

MM Phono Overload: 250 mV.

Tone-Control Range: Bass, ± 9 dB at 100 Hz; treble, ± 9 dB at 10 kHz.

Bass EQ at 75 Hz: +3 dB.

Loudness at -30 dB: +6 dB at 100 Hz and +3 dB at 10 kHz.

General Specifications

Power Requirements: 120 V, 60 Hz.

Dimensions: 16½ in. W \times 3¾ in. H \times 11½ in. D (42 cm \times 9.6 cm \times 28.8 cm).

Weight: 18.7 lbs. (8.5 kg).

Price: \$450.

Company Address: 737 West Artesia Blvd., Compton, Cal. 90220.

For literature, circle No. 91



Some manufacturers adapt their products to the new age of digital audio by simply changing the name of a high-level input from "AUX" to "CD" or "DAD." Others really design their new products with digital audio in mind. Proton's new D940 receiver is in the latter category. Though modest in its continuous-power rating, this 40-watt-per-channel receiver can, when called upon, deliver short-term peaks of up to 160 watts per channel into 8-ohm loads, or up to 280 watts per channel into 4-ohm loads. Talk about dynamic headroom—this receiver has plenty of it. Nor is the short-term reserve-power capability limited to 20 mS (the duration of the EIA/IHF Dynamic Headroom test). Even if a musical burst of 200 mS comes along, the D940 will supply up to 150 watts of power per channel into 8-ohm loads, or up to 190 watts per channel into 4-ohm loads, for the duration of that musical peak. Proton calls this novel amplifier circuit DPD (Dynamic Power on Demand); I'll explain how it works a bit later on.

Innovation is not limited to the D940's amplifier section. For good FM tuner design, Proton turned to that Midwest master of FM science, Larry Schotz, whose exploits in the field of FM and stereo FM are, by now, well known to regular readers of *Audio*. Schotz Noise Reduction, or SNR, effectively removes noise from FM broadcasts without altering frequency response. At low modulation levels, and in the presence of mid-strength signals (around 45 dBf or lower), the SNR circuit introduces just the right amount of channel "blend" to reduce noise to acceptable levels without sacrificing too much stereo separation. At strong signal levels, or at full modulation (where the noise will be psychoacoustically masked), the circuit has no effect. (Ordinary auto-blend circuits sense only signal strength, not modulation level, and so can sometimes blend more than they need to.)

Control Layout

Like other Proton products, the D940 has an uncluttered black front panel that contains only those controls and switches which really relate to sonic performance and operation. A "Power" on/off pushbutton is at the extreme left. Nearby are a stereo headphone jack, a speaker selector (for choosing either or both of two sets of speakers—or neither, for headphone-only listening), and detented rotary bass and treble tone controls. A small display area near the center of the panel shows tuned-to FM or AM frequency and indicates whether or not you are in the automatic ("Search") or manual tuning mode, whether or not the DPD circuit is being called upon, and whether an FM stereo signal is being received. To the right of the display area are eight station preset buttons for memorizing eight FM and eight AM station frequencies. Alongside these numbered keys are buttons to tune up and down, select manual or automatic tuning, choose the AM or FM band, and enter stations into the memory.

Below the display area are four pushbuttons for activating the SNR circuitry, selecting mono or stereo, introducing a moderate amount of fixed bass boost ("Bass EQ"), and turning on a "Loudness" compensation circuit for low-level listening. Separate rotary selectors nearby allow you to record one program source while listening to another. The "Record" selector includes settings for dubbing from the Tape 1 inputs to Tape 2, and vice versa. "Balance" and

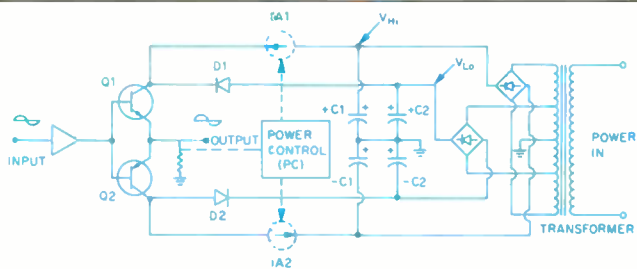
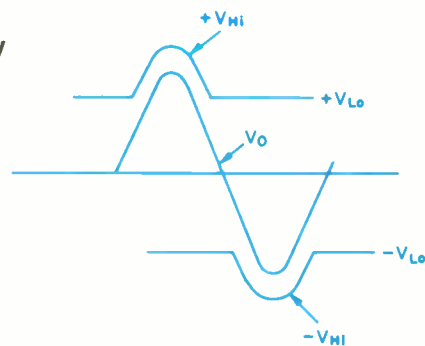


Fig. 1—The DPD (Dynamic Power on Demand) circuit.

Fig. 2—How power-supply voltage tracks the signal during DPD operation.



"Volume" knobs at the lower right corner of the panel complete the control layout.

If the front panel seems particularly uncluttered, the rear panel of the D940 is *loaded* with jacks, terminals, receptacles and switches. There are, of course, the usual high-level and phono inputs, two sets of tape out/in jacks, color-coded four-way speaker binding posts, conventional AM and FM antenna terminals as well as a 75-ohm coaxial FM antenna connector, and three convenience a.c. outlets (two unswitched, one switched). Besides all of this, there are a pair of two-position switches adjacent to the phono inputs. One of these selects "MM" or "MC" cartridge preamplification, and the other selects high or low gain for the MC circuit. The high-gain setting provides an extra 6 dB of pre-preamplification for lowest output moving-coil cartridges. Another unusual switch found on the rear panel is labelled "ACC" (Anti-Clipping Circuit). When you depress this switch, the circuit gently limits any waveform which would otherwise drive the amplifier into clipping. Proton recommends using this switch when Compact Discs are to be played at loud levels. Finally, a three-position slide switch at the upper left of the rear panel provides three values of loading capacitance (100, 200, or 320 pF) which can be switched in parallel with your moving-magnet cartridge for optimum high-frequency loading

Circuit Description

Figure 1 shows the approach that Proton used for the DPD circuit to increase power output during the brief peri-

On demand, this receiver's DPD circuit quadruples output power for 400 mS, 20 times longer than required by the EIA/IHF test for Dynamic Headroom.

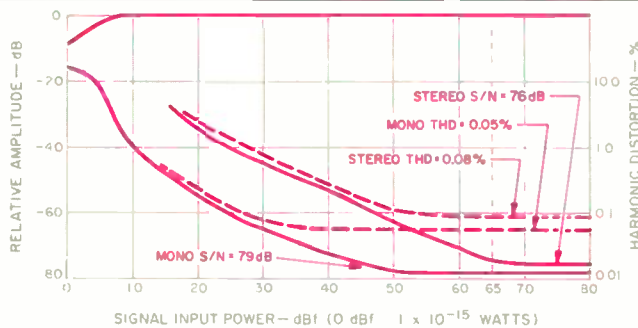


Fig. 3—Mono and stereo quieting and distortion characteristics, FM section.

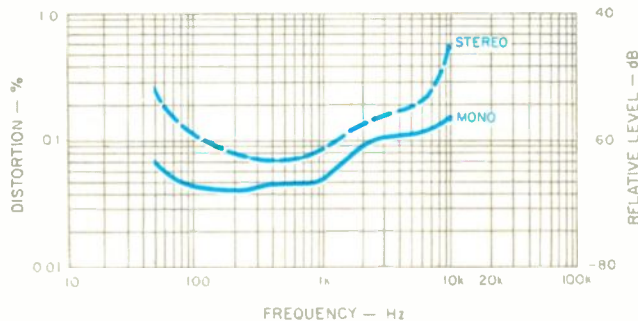


Fig. 4—THD vs. frequency, FM section.

ods when high power levels are demanded by a program's musical content. The circuit has two pairs of power-supply rails, with V_{Hi} at twice the voltage of V_{Lo} . The two supply-rail pairs are isolated from each other by D1 and D2; V_{Hi} stores its energy in +C1 and -C1.

When the Power Control senses a high-level signal whose peak approaches the V_{Lo} value, it turns on linear current amplifiers IA1 and IA2 before clipping can occur. This allows +C1 and -C1 to discharge, providing V_{Hi} voltage to output devices Q1 and Q2 and increasing the output power by a factor of 4. The value of capacitors C1 is chosen so that the higher power level can be sustained for up to 400 mS, 20 times longer than the EIA/IHF 20-mS Dynamic Headroom test requirement. If a continuous high-level signal is applied instead of a music signal, the DPD circuit's extra power reserve gradually declines until current amplifiers IA1 and IA2 turn off and V_{Lo} again takes over as the operating supply voltage.

Since the change to high-voltage operation occurs only at high output-signal levels, and the linear current amplifiers are turned on and off gradually (Fig. 2), switching effects are not audible or detectable. The DPD circuit enables the receiver to deliver as much as 6 dB of dynamic headroom—more than four times its rated continuous power—during music peaks.

Tuner Measurements

Figure 3 shows FM mono and stereo quieting and harmonic distortion characteristics as a function of signal input levels for 100% modulation by a 1-kHz tone. Usable sensitivity in mono measured 10.8 dBf; in stereo, 17.8 dBf of input signal was required to deliver a signal whose noise plus distortion was no more than 3%. In mono, 50-dB quieting was reached with input signal levels of only 15 dBf; in stereo, the 50-dB quieting point occurred with an input of 36 dBf, somewhat short of the 33.2 dBf claimed by Proton. Signal-to-noise-plus-hum ratio measured 79 dB in mono and 76 dB in stereo; both figures exceed Proton's claims by a significant margin.

Distortion in the FM tuner section was also better than claimed. For a 1-kHz test signal, I measured 0.05% in mono and 0.08% in stereo. (Proton doesn't specify whether their published specification of 0.1% THD applies to mono or stereo, nor do they mention the frequency at which the measurement was taken.) Figure 4 shows how THD in FM varies with frequency for both mono and stereo. Although THD tended to rise at higher frequencies, it did so to a lesser degree than is typically the case with receivers in this price class. The 0.55% reading at 10 kHz, in stereo, was obtained without the use of any band-pass filters. Had the EIA/IHF recommended band-pass filter been used, the THD reading would have been somewhat lower, around 0.25%. It's not unusual to find tuner sections that produce well over 1% THD at 6 kHz, so the performance of this FM section must be regarded as superior compared with much of the competition. I suspect there's more of the Larry Schotz touch in this tuner section than just his effective SNR noise-reduction circuitry.

Figure 5 is a plot of FM frequency response and separation at strong signal levels, with the SNR circuit turned off. Separation was a high 55 dB at mid-frequencies, decreasing to a still excellent 48 dB at 10 kHz and 46 dB at 100 Hz. More important, separation from left to right channel was identical to that measured from right to left. For the spectrum-analyzer sweeps shown in Fig. 6, the SNR noise-reduction circuit was activated. The first thing I noted was that this circuit did alter stereo frequency response somewhat. At strong signal levels, separation (bottom trace) remained identical to what it had been without SNR turned on, but at about 45 dBf, separation decreased markedly (middle trace), and so did background noise. For this plot, modulation amounted to around 20% to 25% at 1 kHz. Had the modulation percentage been greater, separation would have been greater as well, since the SNR circuit takes into account both signal strength and instantaneous modulation levels, as I mentioned earlier. For Figs. 5, 6, 8, 10 and 11, sweeps are logarithmically plotted from 20 Hz to 20 kHz, and vertical calibration is 10 dB per division.

For a 5-kHz modulating signal, I plotted the crosstalk and other distortion components appearing in the unmodulated channel's output (Fig. 7). In this plot, the sweep is linear from 0 Hz to 50 kHz and vertical sensitivity is 10 dB per division. While you can see small second- and third-order distortion components, there is no visible 19-kHz carrier output present, and only a very small amount of 38-kHz subcarrier product can be seen near the right-hand side of



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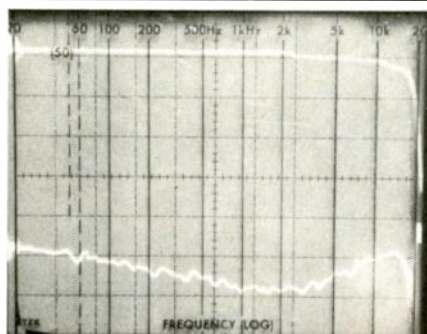


Fig. 5— FM frequency response (top trace) and separation (bottom trace) with SNR circuit off.

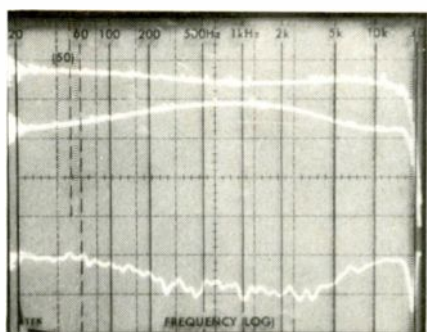


Fig. 6— Same as Fig. 5 but with SNR on; middle trace shows reduced separation at lower signal strengths. Note also slight difference in frequency response compared to Fig. 5.

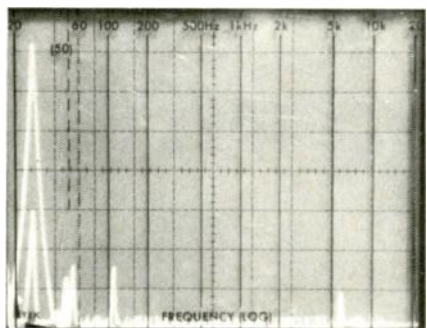


Fig. 7— Separation and crosstalk components for a 5-kHz modulating signal.

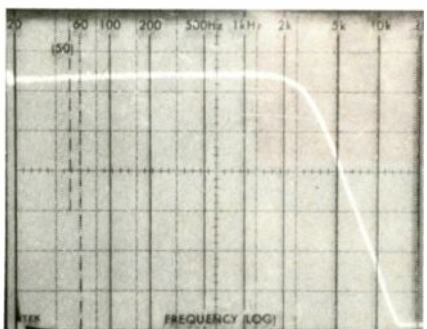


Fig. 8— AM frequency response.

the 'scope display. Measured on a VTVM, the 19- and 38-kHz components were 70 dB below maximum modulation levels, and SCA rejection measured better than 66 dB. Image and AM suppression both measured 60 dB, and FM i.f. rejection was 92 dB, slightly better than claimed. Capture ratio measured 1.3 dB, and alternate-channel selectivity was 62 dB.

Figure 8 shows frequency response of the AM tuner section. As is the case with many AM tuner sections found in "high-fidelity" components, response falls off rapidly above 3 kHz or so. But unlike many other AM tuner sections I've measured, this one is remarkably flat over its pass-band, with response extending smoothly all the way down to the bass extreme.

Amplifier Measurements

The power amplifier section of the Proton D940 is remarkable. Though rated at only 40 watts per channel, continuous, into 8-ohm loads (from 20 Hz to 20 kHz), my sample delivered more than 50 watts per channel at the bass and treble frequency extremes, and a full 55 watts per channel at mid-frequencies. That, in and of itself, is not so unusual; many amplifiers are conservatively rated when it comes to their continuous power-output capabilities. What was remarkable was the short-term power-output capability of this amplifier with a variety of load impedances—all the way down to 2 ohms. Using the EIA/IHF Dynamic Headroom testing technique (20-mS pulses of 1-kHz signal), the amplifier delivered exactly four times its rated power into 8-ohm loads—160 watts per channel—for those short-duration pulses. Even when the duty cycle of this music-signal simulation was increased to 200 mS per burst (with 800 mS of "no signal" in between), the amp still delivered nearly 150 watts per channel during the "on" time of the signal bursts. Figure 9 is a "three-dimensional" computer-generated plot of distortion as a function of power output and frequency.

Switching to 4-ohm loads, I measured a continuous power output of 70 watts per channel at mid-frequencies for the rated 0.02% THD. Again using 4-ohm loads, dynamic headroom still measured a full 6 dB; for short musical peaks, this amplifier can deliver a full 280 watts per channel of power into 4-ohm loads!

Figure 10's spectrum-analyzer photo shows the boost and cut range of the bass and treble controls. At the left edge of the middle trace, you can see the slight bass boost that takes place when the "Bass EQ" switch is engaged. Figure 11 shows the action of the "Loudness" control at various volume settings from 0 dB (upper trace) down to approximately -50 dB.

Input sensitivity (for 1 watt output) measured 25 mV for the high-level inputs, 0.4 mV for the MM phono input, and 31 μ V and 16 μ V for the low and high settings of the MC phono input. Overall frequency response of the receiver, from high-level inputs to speaker outputs, was -1.0 dB at 17 Hz and 25 kHz, and -3 dB at 14 Hz and 55 kHz. RIAA equalization accuracy was within +0, -0.5 dB from 20 Hz to 20 kHz. Phono overload for the MM input was 250 mV, and for the low-level MC phono input it measured 25 mV.

Signal-to-noise ratio, referred to 0.5 V input and with the volume control set for 1 watt output, measured 82 dB. A-

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Playing CDs through my inefficient speakers, the D940 did better than my 90-watt amp. Good dynamic headroom really made a difference here.

weighted. MM phono S/N was 81 dB (referred to 5 mV input and the same standard 1 watt output); for the MC inputs (referred to 500 mV input), S/N measured 71.5 dB. With the volume control set at minimum, noise was -89 dB below 1 watt output. While these results are not easily compared with the published specs (Proton references all S/N numbers to rated output, with the volume control wide open), they are nevertheless excellent compared to results obtained from other receivers in this or in more expensive price categories.

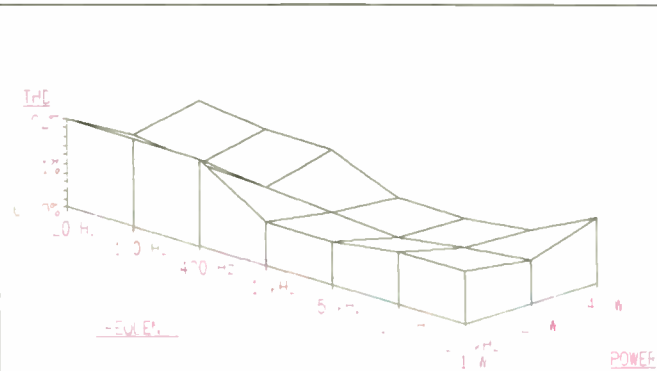


Fig. 9—THD vs. frequency for three power levels.

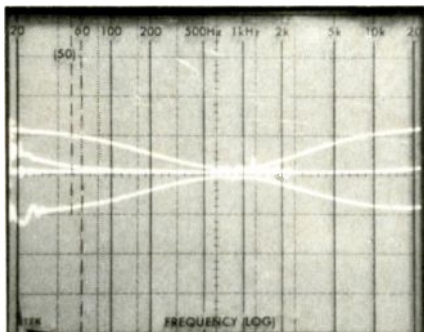


Fig. 10—Bass and treble tone-control range. The effect of the "Bass EQ" boost can be seen at the left edge of the middle trace.

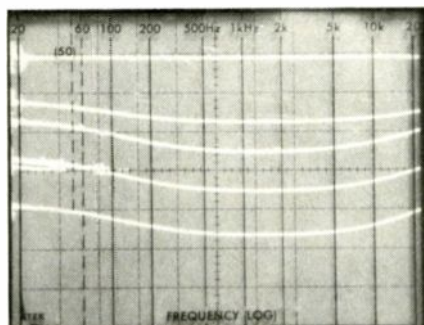


Fig. 11—Loudness-control characteristics at various volume settings.

Use and Listening Tests

I have never made a secret of the fact that my reference speakers are the rather low-efficiency KEF 105.2s. When I bought my first CD player, I discovered, much to my chagrin, that the 90-watt-per-channel amplifier I had been using to drive those speakers just wouldn't do the job, what with the dynamic range and uncompressed signal peaks now generated by CDs. You can therefore appreciate my initial doubts about whether the "40-watt-per-channel" Proton D940 would be able to drive those low-efficiency speakers to satisfactory listening levels. To my utter and complete amazement, it did. Here's a case where dynamic headroom really made a difference. I was able to play some of my CDs which have a very wide dynamic range at comfortable listening levels, and at no time did the D940 clip or show any other audible signs of overload. This, mind you, was accomplished without using the rear-panel anti-clipping circuit switch. To find out just what the "ACC" switch did, I activated it and slowly turned up the volume. At a level which many would find intolerably loud, the ACC took hold and I could hear some compression of peaks that had otherwise been reproduced full tilt. The ACC is a nice feature, but one which you're not likely to need very often unless your speakers are considerably less efficient than mine or you insist upon listening to music at ear-damaging levels.

FM reception was as great as I would expect from any tuner to which Larry Schotz has applied his expertise. I have been a devoted fan of Mr. Schotz ever since he developed the first frequency-synthesized tuner many years ago, well ahead of others which followed. Larry Schotz was perhaps constrained here somewhat because of price considerations, so FM selectivity was a bit lower than I would have liked to find. You may have trouble pulling in really weak signals if they are adjacent to strong local signals, but even in the crowded FM signal environment of metropolitan New York, only a couple of distant Connecticut signals gave me grief. More than 40 acceptable stereo signals were received with good quieting, and about 10 more became listenable in stereo when I activated the SNR circuit. I would have had to bypass those 10 stations because of intolerable noise levels had it not been for Schotz's novel noise-reduction circuitry.

I was as impressed with the ergonomics and layout of the D940 as I was with its excellent sound reproduction. I found myself reaching for the various controls and finding them just where they ought to be. You won't need an owner's manual to figure out this front panel—though the handy booklet supplied with the D940 is well organized and well written. Neither will you have to cash in your entire savings account to own a D940. Incidentally, if you own a good tuner but are interested in some of the amplifier characteristics of the D940 that I've described, Proton offers an integrated amp, Model D540, which contains the same amplifier and preamplifier circuitry as does the D940 receiver. I had both models in the lab at the same time and can attest to the fact that both amplifier sections perform and measure identically. The amplifier has a suggested price of \$350; that's a pretty good deal. But getting a Schotz-designed tuner section for another \$100 is so tempting that you may want to go for the full receiver even if you already own a tuner!

Leonard Feldman

M

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S

3

MARANTZ PMD430 PORTABLE CASSETTE DECK

Manufacturer's Specifications

Frequency Response: 35 Hz to 14 kHz, to 15 kHz with CrO₂ tape, and to 17 kHz with metal tape.

Signal/Noise Ratio: 50 dB; 60 dB with Dolby B NR and 75 dB with dbx NR.

Input Sensitivity: Microphone, 0.2 mV; line, 70 mV.

Output Level: Line, 500 mV.

Flutter: 0.1% wtd. rms.

Battery Life: Playback time, 7½ hours; recording time with metal tape, 5½ hours.

Dimensions: 9 in. W x 2 in. H x 6½ in. D (227 mm x 50 mm x 165 mm).

Weight: 3 lbs. (1.3 kg).

Price: \$499.95.

Company Address: 20525 Nordhoff St., Chatsworth, Cal. 91311.

For literature, circle No. 92



The PMD430 is the top-of-the-line addition to Marantz's PMD series of portable cassette recorders. For those familiar with the earlier units, such as the PMD360, this new recorder will seem marvelously compact considering its features and performance.

Using portable recorders in remote locations of any sort requires different techniques, and there are definite benefits from features that are not as essential in a home-bound deck. Recording a live concert, for example, where there is no chance to start over with reduced record levels, would be greatly aided by the three-head configuration of the PMD430. The deck also includes a limiter to ensure against unexpected level increases that might cause distortion. The recorder offers both Dolby B and dbx NR, and can use the three major tape types (I, II, and IV). Marantz also includes playback pitch control and adjustable bias.

There are left and right microphone inputs with flexible switching, as well as the normal line inputs. A microphone attenuator, which facilitates recording high-level sound without input overloading, is a valuable feature. The single, built-in loudspeaker can be switched for monitoring either the left only, the right only, or a mix of left and right.

The PMD430 can be powered by batteries, of course, either three alkaline D cells or the optional RB430 rechargeable battery pack. Operation on a.c. is possible with the supplied accessory adaptor, which will also recharge the battery pack.

Control Layout

The transport switches, the piano-key type, are along the left front edge of the PMD430's top panel. From left to right, they are "Stop/Eject," "Rec.," "Play," "Review," "Cue," and "Pause." "Rec.," "Play," and "Pause" keys are color-coded with small squares—red, green, and yellow, respectively. "Review" and "Cue" are narrower than the other keys, and separated from them, which facilitates general use and also offers tactile clues to aid mistake-free operation. "Review" and "Cue," of course, refer to use with play mode where a partial depression of the key gets fast winding with audible clues and release results in a return to play. In normal use, full depression obtains latching for regular fast forward or rewind, and the output is muted. If rewind is latched down when the memory switch is on, the tape will wind to about "000" on the counter; if this is done with the recorder in play mode, play will resume automatically at that point. Memory works similarly with fast forward, but the unit I tested stopped at "900" in this mode.

One push of "Stop/Eject" stops the transport; a second push releases the spring-loaded cassette-compartment door and pops the front edge of the tape up out of the well. Removing a cassette is really quite easy, but there is no carrier so loading does require attention to ensure proper seating. The unit can be put into play mode without a cassette in place; this yields good access to the heads and pinch roller for demagnetization or cleaning. To the right of the well is the single loudspeaker and, in front of the speaker, the counter and its reset button.

Further to the right is a rectangular, inset panel with a hinged, clear-plastic cover. Mounted in the panel are four slide switches and two trimpots. From back to front, the

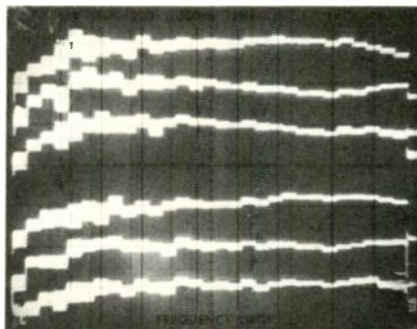


Fig. 1—Record/playback responses for three tapes, at two levels, using Dolby B NR. From top to bottom: TDK AD (Type I), Memorex HBXII (Type II), and Fuji FR Metal (Type IV), all at Dolby level; then the same three tapes at -20 dB. (Vertical scale: 5 dB/div.)

switches are "Memory Rew" ("On/Off"), "MPX Filter" ("On/Off"), "Tape" ("Metal/CrO₂/Norm.") and "N.R." ("Dolby B/Off/dbx"). Each of the switch buttons has a small green arrow which points exactly to little red indices for each of the switch positions. The side-by-side trimpots have bar-type knobs and center-of-rotation detents. The one on the left is for pitch control in playback; it is defeated in record mode. The right-hand pot, for bias trim, allows matching a wide range of tape formulations.

On the front panel, under the transport switches, are (from left to right) the stereo headphone jack, the monitor volume control, the monitor switch ("Tape/Source"), the momentary-contact "Batt./Light" switch, and the limiter switch. The bar-shaped volume knob is easy to turn, and its white arrow conveys its position without any confusion. The monitor and limiter switches latch in for their "Source" and "On" positions, respectively. The travel is not great and the buttons are all black, however, so care is needed to be certain of what has been selected. A push of "Batt./Light" when the recorder is in any operating mode will turn on lights of both meters. While the button is held in, the left meter will indicate battery voltage on a special scale. The meter lights stay on for 10 S after release of the button. This is a reasonable simple and effective solution to the problem of meter illumination and battery checking, particularly important in remote recording. (I trust that most readers understand leaving meter lights on all of the time when operating batteries would reduce battery life considerably.)

The VU-type meters have limited markings (" - 2f - 4/0/ + 3/ + 5") and a total length of just 3/4 inch. They are yellow up to "0" and red from "0" to "+ 5." The left also has red and white battery-status scales, with "L" indicating the minimum acceptable voltage for all batteries and "R" showing the minimum for the re-

The PMD430's features are selected with portable use in mind, with emphasis on aiding live recording and saving batteries.

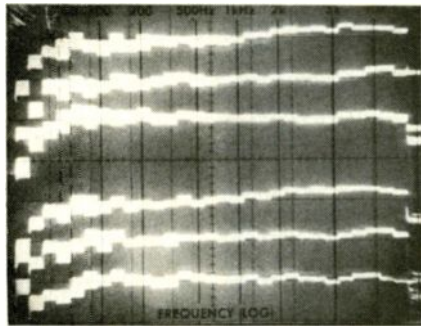


Fig. 2—Same as Fig. 1 but using dbx NR.

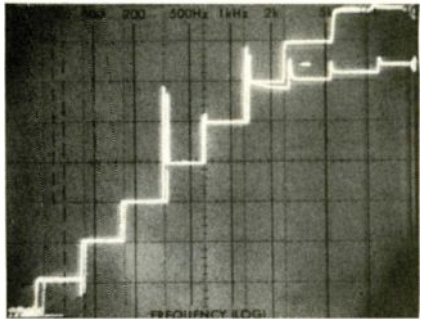


Fig. 3—Effects of sudden level increases with and without limiter. Input level was increased 10 dB every 2 S up to 30 dB above meter zero. Note how the limiter keeps the recorded signal level from rising above +4 dB. Spikes shown were produced by the attenuator, not the tape deck. (Scales: Vertical, dB/div.; horizontal, 1/div.)

speaker off, while the other selects whether the speaker will monitor the right or left channel or both together. Since there is just the single speaker, it is not possible to have an audible stereo output, but the switching allows comparisons. Switch designations are all molded into the black plastic, which requires good lighting for good legibility.

On the right-hand side panel are the expected line in/out stereo pairs as well as a "Rec/Play" DIN-type socket. The facilities for microphones are more extensive and more flexible than those found on the great majority of recorders. The left and right phone-jack inputs are single-ended, but the left input will accept a stereo microphone with a tip-ring-sleeve plug. This is a nice and uncommon feature. I also applaud the provision of a microphone attenuator ("0/-15/-30 dB"), which can be essential in preventing input overload with high-level sources (read: pop/rock). There is also a stereo/mono "Mic Mode" switch; in its mono setting, the signal from a single microphone connected to the left input will be fed to both channels.

The designations on the right side panel are white on a black background, as are those on the front and top of the PMD430. They are quite easy to read under most lighting conditions. When the recorder is placed in its leatherette carrying case, the right-side and transport switch designations are covered over, with a little loss in convenience. With the color coding of the transport controls, there is not much of a loss, and the case has the right-side labels imprinted—a little light clarifies all. Rubber feet on the bottom of the recorder itself allow it to be placed safely on any surface without use of the case.

Pushing up on two thumb latches on the back of the PMD430 opens the battery compartment, which takes three D cells or the optional rechargeable battery pack. There is no access to this compartment when the unit is in the carrying case. However, if the battery pack is installed, it can be recharged with the case on, because the 4.5-V jack remains accessible.

The case has a cover over the front panel and the transport controls; this can be unsnapped, pulled down and around, and snapped back flat under the bottom of the unit. The cover over the cassette compartment door has a snap (which must be undone, of course, to eject or load a tape). Steel lugs on each side of the recorder accept the ends of a carrying strap. The web strap can be snapped on and off very easily, but the retention method is quite safe. An accessory pouch is supplied with the unit, which can be used to carry spare cassettes, batteries, or perhaps small microphones. A snap loop allows the pouch to be hung on the carrying strap, if desired.

I took some of the covers off the unit and saw quite a bit of excellent soldering, but I could not examine more of the internal construction without doing unwanted disassembly. The PMD430 was quiet in record or play and also reasonably so when fast winding.

Measurements

The playback equalization for Type I tapes fell within ± 1.0 dB over the whole audio range. The equalization for Types II and IV fell at the highest frequencies, but stayed within 2 dB of correct, and most points were within 1 dB.

background, but the scale markings are too small to read.

Right of the meters are dual-concentric, friction-type "Record Volume" pots. The friction is on the high side of all knobs, and it was difficult to get adequate illumination for a smooth adjustment of relative levels. I did very little work with the red LED volume indicator which is in record mode; the small LED peak indicator is just above the pots.

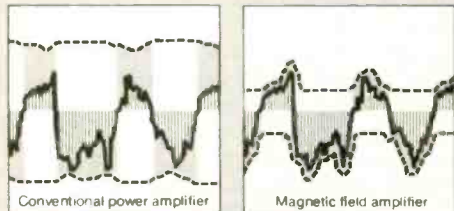
On the right side panel of the PMD430 are the 4.5-V and two slide switches. One switch turns the

MOBILE MUSICALITY.

THE CARVER CAR AMPLIFIER introduces Magnetic Field Amplifier technology to automotive high fidelity. Finally, the traditional weak link between car stereo decks and modern speaker design has been replaced with Carver technology. Into 1/10th of a cubic foot, Bob Carver has engineered a complete 120 watts RMS per channel amplification system with the fidelity, accuracy and musicality demanded by the most critical reviewers and audiophiles.

ESSENTIAL POWER. Even before the exciting advent of car Compact Disc players, an abundance of power has been necessary to reproduce, without distortion, the frequency and dynamic range produced by modern decks.

Unfortunately, conventional amplifier technology is particularly unsuited to delivering this needed power to the specialized car interior environment. Like their home stereo counterparts, traditional car designs produce a constant high voltage level at all times, irrespective of the demands of the ever-changing audio signal—even those times when there is no audio signal at all! Because automotive amplifiers must, obviously, derive their power from the host vehicle, such an approach results in substantial drain to delicately balanced automobile electrical systems.



Solid line: audio output signal. Broken line: power supply voltage. Shaded area: wasted power. Vertical lines: power to speakers.

The Carver Magnetic Field Car Amplifier is signal responsive. Highly efficient, it produces only the exact amount of power needed to deliver each musical impulse with complete accuracy and fidelity. Thus the Carver Car Amplifier not only reduces overall long-term power demands, but produces the large amount of power necessary for reproduction of music at realistic listening levels without the need for oversized power supply components. Important considerations in the minuscule spaces which quality car design allocates to add-on electronics.

INTELLIGENT POWER. A hallmark of all Carver amplifiers is the careful integration of sophisticated speaker and amplifier protection circuitry. The Carver Car Amplifier is no exception.

Speakers are protected with a DC offset internal fault protection design which turns off the power supply at first hint of overload. An overcurrent detector mutes audio within microseconds of a short circuit, as does an output short circuit monitoring circuit. Together, these three circuits eliminate the potential need to replace fuses, revisit your autosound installer, or worse yet, replace expensive speakers due to a moment's indiscretion with your deck's volume control.

ASSIGNABLE POWER. Integrated bi-amplification and bridging circuits, along with The Carver Car Amplifier's compact configuration make it ideal for multiple-amplifier installations.

The built-in 18dB/octave electronic crossover allows use of two amplifiers in a pure bi-amplification mode without addition of extra electronics. Or, at the touch of a button, one Carver Car Amplifier can become a mono amplifier for subwoofers while the other Carver Amplifier handles full range. Or, for astonishing dynamic and frequency response, two Carver Car Amplifiers may be operated in mono mode into 8 ohms for a 240 watt per channel car system which will truly do justice to digital without taxing your car's electrical generation system.

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Carver has addressed the ongoing problem of head-end/power amplifier level matching: Output of current car decks varies widely from brand to brand and model to model. The result can be a less than perfect match. The Carver Car Amplifier incorporates circuitry which compensates for variations in head-end output, reducing noise and optimizing signal-to-noise ratio. In addition, Carver has added a subsonic

filter which removes inaudible power-robbing intrasonics before they can tax the amplifier and speakers. Finally, a delayed turn-on circuit activates the Carver Car Amplifier after your head-end unit has powered up, to eliminate starting pops and thumps.

ACCURATE POWER. It goes almost without saying that a product Bob Carver designs for the road carries the same superb electronic specifications that his home audio products are known for.

The Carver Car Amplifier is flat from 20Hz to 20kHz, down -3dB at 16Hz and 30kHz. Not coincidentally, the usual specifications given for Compact Discs. A signal-to-noise ratio of over 100dB means that, in even the most quiet luxury sedan, you will never be annoyed by hiss. The other specifications are equally as impeccable. You may peruse them in our literature or in independent reviews soon to appear.

ACQUIRABLE POWER. The remarkable Carver Car Amplifier is currently available for audition at Carver dealers across the country.

It is worth the journey. Whether you have a car system in need of the sonic excitement possible with abundant power, or are in search of the perfect complement to a new high-performance automobile, you owe it to yourself to experience the logical extension of Carver technology—the Carver Car Amplifier M-240.

Power Output Stereo Mode: (continuous RMS power output per channel, both channels driven, at 13.8 VDC input). 120 W into 4 ohms, 20 Hz to 20 kHz with no more than 0.15% THD.

Power Output Bridged Mono Mode: (Referenced to 13.8 VDC input) 240 W into 8 ohms, 20 Hz to 20kHz with no more than .15% THD.

Input Sensitivity: Variable 250mV to 4V

Signal to Noise Ratio: (Referenced to 120 W, A weighted into 4 ohms) Greater than 100 db

Crossover: 115 Hz, 18 dB/octave

Weight: 4.7 lb.

The Carver Car Amplifier



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The bias adjustment could not be set to match some metal tapes, but I'm not complaining; many decks have no metal-bias adjustment at all.

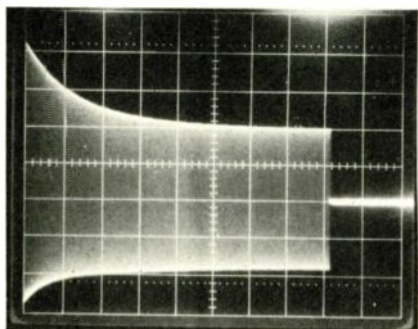


Fig. 4—Response of limiter to a 2-kHz, 160-mS tone burst 20 dB above the limiter threshold; see text. (Horizontal scale: 20 mS/div.)

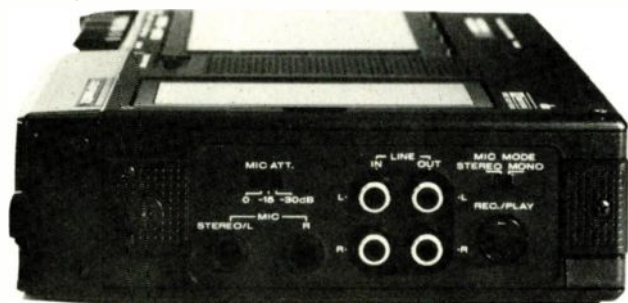
Tape play speed varied slightly, but the average was accurate, just 0.1% slow. Meter indications for a standard flux level (Dolby level, 200 nWb/m) were very close to exact, and the meters were calibrated to show Dolby level at "+3."

Record/playback responses were checked for a large number of tapes, using pink noise rolled off at 6 dB/octave above 2 kHz to make it more music-like. A mirror-image boost of the recorder playback restores a flat RTA display for flat response. For a first look, I tried to find tapes which best matched the recorder with its bias trimpot left at its center detent. Among Type I tapes, the best choices were BASF LH Extra I, Denon DX1, Memorex dB, PDMagnetics FERRO, Scotch CX, and Sony HF. Because these are all lower performance tapes, I went through higher ranked formulations and reset the trimpot for best results. I selected TDK AD for further testing but noted that excellent results were also obtained with Fuji FR-I, Maxell UR, and TDK AD-X.

The best responses for Type II tapes came with Memorex HBXII; Maxell UDS-II and Memorex HBII were slightly behind. Very good results were also obtained with Denon HD7, Fuji FR-II and GT-II, Memorex CDXII, Nakamichi SX and SXII, Sony UCX, and TDK HX-S, SA and SA-X.

Fuji FR Metal was the best Type IV tape for use with the

Input and output jacks are grouped conveniently with the versatile microphone-input switching facilities.



PMD430, and Maxell MX, Sony Metal-ES, TDK MA and MA-R, and Yamaha MR were not far behind. The bias could not be set low enough to match some of the older metal formulations, and it could be set just high enough for Sony Metal-ES. There is no complaint from me, however, because so many decks have no bias trim for Type IV tapes.

Figure 1 shows the record/playback responses, using Dolby B NR, for TDK AD, Memorex HBII and Fuji FR Metal. There is evidence of some roll-off at the low-frequency end and a sharp roll-off approaching 20 kHz. In general, the responses are very good, especially at -20 dB. Notice the excellent flatness from 63 Hz to 16 kHz. At the 0-dB level, the Type II and Type IV tapes show a similar high-frequency droop, and there is a slight roll-off with TDK AD. Table I lists the -3 dB points measured with a test tone. The high-frequency limits at the higher level are not impressive, although that for Fuji FR Metal is reasonably good. The high-end limits at -20 dB are no match for those of many decks, but they are better than specification, and the flatness of the responses was obvious during these tests.

Figure 2 shows the record/playback responses, with dbx NR, for the same three tapes. These results are also very good, and note that the 0-dB responses with dbx NR are superior to those with Dolby B NR.

Table II lists the results of miscellaneous tests run with both Dolby B and dbx NR. For Fuji FR Metal tape, the erasure at 100 Hz is quite good, 57 dB with Dolby B NR, and the broad-band expansion of the dbx decoder resulted in an outstanding figure of 88 dB. The excellent separation and crosstalk figures were also improved with dbx NR—in fact, the crosstalk was at least 99 dB down. There were variations in the 10-kHz phase relationships from trial to trial. The jitter figure in Table II is for the worst case; it was usually better than the data shown. The multiplex filter's attenuation was the greatest that I can recall, and its notch was very accurately placed. Bias in the output during recording was very low.

The third-harmonic distortion level (HDL₃) was measured for the three tapes, both with Dolby B and with dbx NR, from 10 dB below Dolby level to the point where HDL₃ reached 3%. Table III shows that distortion was generally low and that the limit with dbx NR was well above the "+5" meter scale maximum. For both TDK AD and Memorex HBXII, the distortion with dbx NR actually dropped as level rose from -10 to -8 dB. I did not pinpoint the exact cause of this anomaly, but it is possible that there was cancellation of out-of-phase electronic versus magnetic distortion components.

Table IV lists the figures for HDL₃ from 50 Hz to 5 kHz at -10 dB with Fuji FR Metal tape, both with Dolby B and with dbx NR. The results are excellent over most of the band, and the very low figures for the higher frequencies are superior to those of most decks. There is the expected rise in distortion at the lowest frequencies; the figures with dbx NR are substantially the same as for nonportable decks.

Table V shows signal-to-noise ratios for the three tapes, with both IEC A and CCIR/ARM weightings, using Dolby B and dbx NR. The figures are excellent for Dolby B NR, but the dbx NR results may seem low in comparison with those for other decks. The fundamental cause of this discrepancy is that the PMD430's maximum output level is about +10

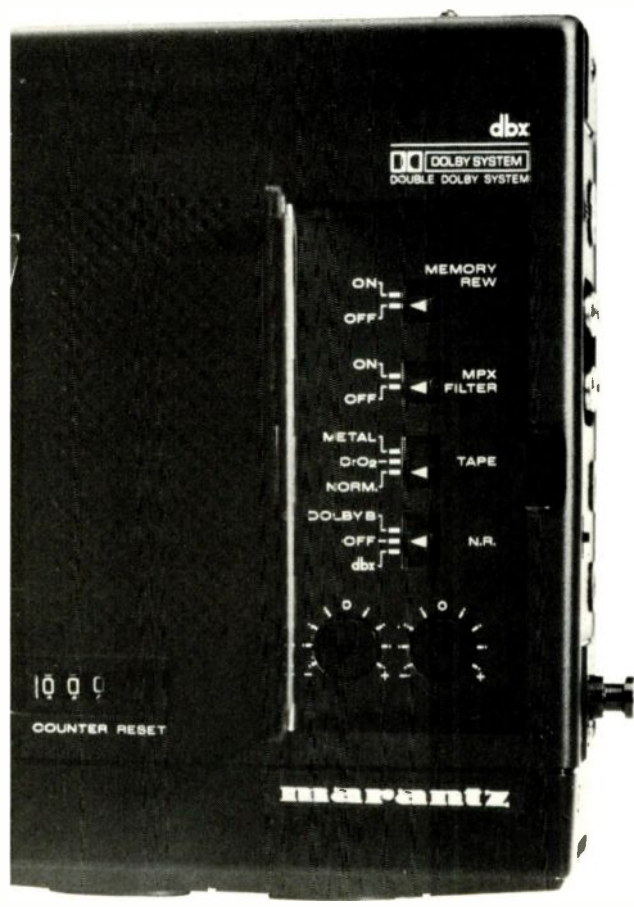
Distortion was excellent at most frequencies, and superior to the majority of cassette decks at the higher frequencies.

dB, while a number of other, nonportable decks will reach about +17 dB at the 3% distortion limit. I suspect that the lower figures for the Marantz unit go with the voltage and power limitations that must be applied to a portable unit to ensure adequate recording time on battery power. In any event, 80 dBA is really an excellent figure.

Various input and output characteristics at 1 kHz are presented in Table VI. Everything checked out just fine, as shown, with the exception of the line output: 311 mV at meter zero was below specification, although the output at Dolby level was the specified 500 mV—no problem, in any event. With the use of the microphone attenuator, the over-load level was moved up to 76 mV (at “-15”) and then to 360 mV (at “-30”). The attenuator is an excellent feature to include, and I wish that more recorders with microphone inputs had them.

The dual-concentric input-level pots provided matching attenuation within 1 dB for a range of 50 dB down from maximum. The monitor pot for the speaker and/or headphones matched similarly over a range of 55 dB—excellent performance for both controls. All headphones I tried could be driven to a high level—very high levels with the sensitive

A flip-up lid protects these controls from accidental resets. The pots shown are for speed and bias trim.



phones. At a zero meter level and a maximum monitor volume setting, the speaker output at 1 foot was about 92 dB SPL, which should be plenty loud enough for normal monitoring. The line-output polarity was the same as the input in “Tape” mode, but it was reversed in “Source.”

The limiter produced a 2-dB reduction in level when switched on with a “+5” meter level, reducing the indication to “+3.” Figure 3 shows the action of the limiter with a test-tone input level of -60 dB (re: meter zero), increased 10 dB every 2 S. There are two runs shown in the display, first without the limiter and then with it operating. In the first run, there was a great deal of clipping at +20 dB, and at +30 dB the waveform was quite square. With the limiter switched in, the level was kept from increasing above about “+4.” (The attenuation-change spikes in Fig. 3 were caused by the attenuator I used.)

Figure 4 shows the line output with a 2-kHz, 160-mS tone burst fed to the line input at 20 dB above the limiter threshold. There was some clipping of the first part of the burst, and the handling of the burst was not symmetrical to zero level. I found that a good part of the total correction occurred within 20 mS.

The meter scale calibrations were within 0.2 dB from “-4” to “+5,” but less accurate at “-10” (-11.2 dB actual) and “-20” (-24 dB actual). The meters are labelled “VU,” but their response time (160 mS) was shorter than the standard (300 mS) and the decay (740 mS) was longer. The meters were 3 dB down at 14 Hz and 19.8 kHz. The peak indicator turned on at “+2” with a 1-kHz test tone, and at “+5” with a 5-kHz test tone. For a tone level 3 dB above threshold, the duration of a tone burst had to be at least 10 mS to get a noticeable flicker from the peak LED. This is fairly good performance, but I would have preferred a lower threshold at 5 kHz and half the response time.

The average tape-play speed decreased by 0.03% with line voltage decreased from 120 to 110 V, and increased by the same amount with the voltage increased from 120 to 130 V. The instantaneous tape speed varied cyclically by about $\pm 0.04\%$, with a 1-S period, both on battery and line power. The average tape speed was 0.1% higher with the unit tilted upward to rest on its back panel, or hanging from its strap, than when the recorder was placed flat on the test bench. The average speed on batteries was 0.6% slower than on line power. I also noted changes in speed over a long period of time, with a rise of approximately 0.3% over an hour or two. A warm-up period appeared in order for the best speed stability when recording.

Flutter was consistent at 0.10% wtd. rms and 0.17% wtd. peak, both with battery and line power. There was very little effect on flutter or speed when I moved and rotated the PMD430. Only vigorous rotations on an axis parallel to the reel spindles caused measurable or audible effects. The fast-wind time for a C-60 cassette was 95 S, on the slow side compared to nonportable decks. The pitch control has a wider range than most, from -8.2% to +9.7%, in contrast to the typical semi-tone range ($\pm 5.9\%$).

Run-out times to stop were about 3 S, in either play or fast wind. With the mechanical interlocking of the controls, all mode changes require going through “Stop” except when going to “Cue” or “Review” from “Play.”

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Despite minor quibbles about speed change and flutter, the PMD430 offers a neat package of fun, convenience, and performance for its cost.

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

Tape	With Dolby B NR				Without NR			
	Dolby Lvl		–20 dB		Dolby Lvl		–20 dB	
	Hz	kHz	Hz	kHz	Hz	kHz	Hz	kHz
TDK AD	29	7.4	28	14.7	29	7.6	28	15.2
Memorex HBXII	29	6.8	29	16.5	29	7.2	29	18.0
Fuji FR Metal	30	10.8	29	19.5	29	11.3	28	19.8

Table II—Miscellaneous record/playback characteristics.

NR Type	Erasure At 100 Hz	Sep. At 1 kHz	Crosstalk At 1 kHz	10-kHz A/B Phase		MPX Filter At 19.00 kHz
				Error	Jitter	
Dolby B	57 dB	51 dB	–87 dB	10°	45°	–40.8 dB
dbx	88 dB	57 dB	–99 dB			

Table III—400-Hz HDL₃ (%) vs. output level (0 dB = 200 nWb/m).

Tape	NR	Output Level						HDL ₃ = 3%
		–10	–8	–4	0	+4	+8	
TDK AD	Dolby B	0.08	0.11	0.29	0.63	2.0		+5.2 dB
	dbx	0.06	0.03	0.02	0.10	0.20	1.5	+9.6 dB
Memorex HBXII	Dolby B	0.11	0.12	0.32	0.80	2.4		+4.7 dB
	dbx	0.14	0.10	0.12	0.27	0.50	1.4	+9.9 dB
Fuji FR Metal	Dolby B	0.07	0.14	0.29	0.89	2.2		+4.6 dB
	dbx	0.08	0.08	0.14	0.24	0.40	1.5	+9.8 dB

Table IV—HDL₃ (%) vs. frequency at 10 dB below Dolby level.

Tape	NR	Frequency (Hz)						
		50	100	400	1k	2k	4k	5k
Fuji FR Metal	Dolby B	0.73	0.24	0.07	0.08	0.05	0.07	0.07
	dbx	2.5	1.3	0.08	0.19	0.16	0.08	0.06

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

Tape	IEC A Wtd. (dBA)				CCIR/ARM (dB)			
	W/Dolby B NR		With dbx NR		W/Dolby B NR		With dbx NR	
	@ DL	HD=3%	@ DL	HD=3%	@ DL	HD=3%	@ DL	HD=3%
TDK AD	63.0	68.2	71.2	80.8	63.3	68.5	70.3	79.9
Memorex HBXII	65.0	69.7	74.2	84.1	66.4	71.1	73.7	83.6
Fuji FR Metal	62.6	67.2	72.8	82.6	63.8	68.4	74.0	83.8

Table VI—Input and output characteristics at 1 kHz.

Input	Level			Imp., Kilohms	Output	Level			Imp., Ohms	Clip (Re: Meter 0)
	Sens.	Overload				Open Ckt.	Loaded			
Line	63 mV	31 V		96	Line	311 mV	233 mV		3.9k	+14.6 dB
Mike	0.2 mV	16 mV		7.2	Hdphn.	538 mV	396 mV		17.9	

Use and Listening Tests

The bilingual (English/French) owner's manual has good illustrations and generally good text, but there should have been better instructions on setting the limiter; turning up "Rec Volume" too high could cause input overloading at the same time that the meters continue to have an on-scale indication. There is very good information on the requirements for an external power supply, lacking in most manuals on portables.

All of the controls and switches were reliable and generally easy to see and use. The exceptions were the not-solely legible in/out positions of the monitor and limiter switches, and the hard-to-adjust dual-concentric input-level pots. (I was getting better at making single-channel level changes by the end of the testing, but adjustment remained fussy.) Cassette loading was fussy too, but I learned that wiggling the cassette as I loaded it would seat it speedily.

In general, the meters were easy to work with, better than I thought they would be, but I still relied a lot on the peak indicator, and there were flashes at times when meter indications reached only "–10" or so. With Dolby B NR, double clicks could be heard when stopping and starting; with dbx NR, there was no start sound and a single click with stop. I heard no sounds for "Pause" with either of the noise-reduction systems.

Listening tests were run primarily with dbx-encoded versions of digitally recorded LPs, such as *Danzas Fantasticas* with the London Symphony Orchestra conducted by Morton Gould (Chalfont SDG-302/dbx PS-1028). I really enjoyed the playback of the dances by Falla and others with all three of the tapes, although the sound with Fuji FR Metal was definitely the most realistic both with Dolby B and with dbx NR, and this was true with all LPs copied. There was an excess of bass with the other tapes, and with TDK AD the bass was muffled at higher levels. There was also obvious added presence with TDK AD, and there was better frequency balance with Memorex HBXII.

My listening tests confirmed an earlier conclusion: Unless dbx NR or the limiter was in use, flashes of the peak indicator had to be kept to a minimum to ensure really low-distortion recordings. Moving the recorder around during playback of a piano recording produced no observable effect on the sound, with line or battery power, unless the movement was quite sudden around a spindle-parallel axis or the unit was allowed to bang on the test bench.

The Marantz offers a collection of features which are most appropriate to the kinds of use a portable gets: Three-head configuration, a limiter, and flexible microphone inputs including a three-step attenuator. Many aspects of its performance merit respect, especially the low distortion and the flat record/playback responses. The inclusion of both Dolby B and dbx NR systems is appealing, to say nothing of its true metal-tape compatibility and the bias trim that is effective on all tape types. There are some minor speed changes with time, and the flutter *might* be detected by a critical ear on a sensitive recording. Loading a tape into the well and adjusting channel volumes were a bit difficult too. Overall, however, the Marantz PMD430 offers a neat package of fun, convenience and performance for its cost.

Howard A. Roberson

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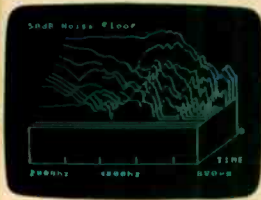
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Photo: Laura Levine

Big World: Joe Jackson
A&M SP-6021, digital, \$9.98.

Sound: B- Performance: B-

More than a little is unusual about Joe Jackson's new album. On LP the set covers three album sides, with the fourth blank, in order to accommodate all 15 songs Jackson wanted to include. (The Dolby HX-Pro chrome cassette has them all but in a different sequence; on CD they're all on one disc.) His recording technique here is unusual too. The album was recorded direct to two-track on digital equipment, over the course of several evenings, before audiences at the Roundabout Theatre in New York (except for one track done in the rehearsal hall). However, unlike nearly all live recordings, there is no hint of the audience on the record, and purposely so. Jackson

had requested the audiences not to applaud until the songs were completely finished, and he had warned that if anyone made a sound during a song, the perpetrator would be removed. So much for cultivating a warm artist/audience relationship.

The recording procedure precluded any post-performance sweetening or fixing up, of course; thus, what you hear on *Big World* is just what the audience heard. The finished product is a mixed blessing: You get the raw excitement of a live performance, with an airy rather than close ambience, but you give up the precision that you'd get in the recording studio.

On *Big World* Jackson uses a sparse band stripped down to guitar, bass, and drums to augment his piano, recorder, accordion, and melodica. On several

tracks, three backing singers take part. The music they make has a lot of energy and bite, due in part to the live performances. The feel is somewhere between the roughness and directness of Joe's first two albums, *Look Sharp!* and *I'm the Man*, with occasional sophisticated rhythmic patterns like those in his more recent *Night and Day* and *Body and Soul*.

The songs are a mixed lot. Sometimes Jackson comes across whiny and bitchy, as in the torch song "We Can't Live Together" and "Right and Wrong." At other times, especially when he is breaking his own patterns to experiment a bit, he can be quite eloquent, as in "Forty Years," inspired by the 40th anniversaries of V-E and V-J Days, and the Oriental-sounding "Shanghai Sky." The hard-rocking "Tonight and Forever" has overwhelming

energy plus a refrain that grabs you by the throat.

Had the 15 selections been winnowed down to 10 or 11, *Big World* might have been a brilliant album instead of merely a very good one. It is not always an easy pill to swallow, but there are some very real rewards offered here.

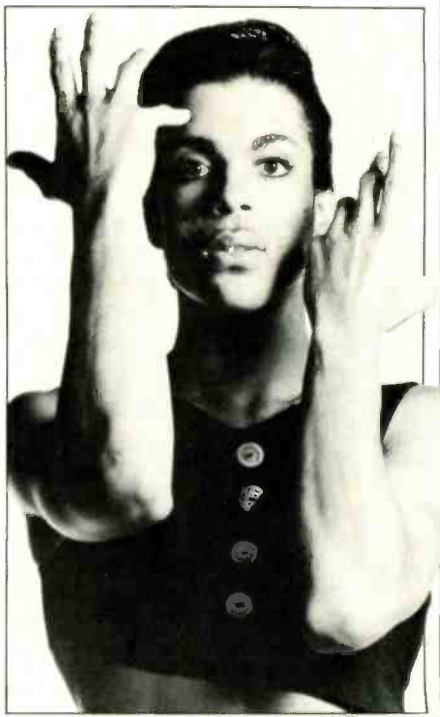
Michael Tearson

Parade: Prince and the Revolution
Paisley Park 125395, \$8.98.

Sound: B+ Performance: B-

In answer to the musical question, "Does Prince still have it in him?" the single "Kiss" delivers an unequivocal "yes." A snaky little dance-floor piece with a spare, guitar-based arrangement upon which sits an hysterical falsetto, it's one of his best tracks since "Controversy." For musicality, sense of humor, and danceability, "Kiss" shows that there is life after "1999," and all the clones better learn Prince's new lick as soon as possible.

As for the rest of the album, who does this guy think he is? Mr. Sensitivity, tinkling away on the digitized piano playing quasi-jazz chord configurations? It's not like this is a complete musical wasteland—no doubt they'll



Frankie Miller



find another one or two hit singles here—but c'mon, Mr. Princeling, you can do better.

Granted, a lot of this fodder might be the incidental music for the film it's the soundtrack for, and in context it might be perfect. But the actual songs—as opposed to the transitional pieces—are not up to snuff. "Christopher Tracy's Parade" harkens back to the last album's neo-psychedelic fantasy but never cuts it as a song, "Girls & Boys" is cute and clever but a bit on the self-conscious side, and the ballads all meander. Lyrically, the guy can't seem to decide whether he wants to say something semi-political or merely upset Tipper Gore.

What we have here is an artist who is undoubtedly very talented but whose milieu is, at the moment, self-indulgence. Maybe that cuts it on some fronts, but these listeners—and we ain't the only ones—can do without the chaff. Next time, just the hits, please.

Jon & Sally Tiven

Dancing in the Rain: Frankie Miller
Mercury 826647, \$8.98.

Sound: B Performance: A-

They made a big mistake in crediting this album—they should have said it was done by a band! It sounds like a great four-piece group, and even the drummer is a star in his own right (Simon Kirke, ex-Free/Bad Company). But no, they credited it to Frankie Miller, who's made a zillion records

that radio didn't get behind, and here's another to file under "Unplayed." The shame of it is that *Dancing in the Rain* is one of the best rock records to come out so far this year.

There are several great singles here: "Do It 'Till We Drop," "Shakey Ground," and "That's How Long My Love Is" are the prime examples. Granted, there are also a few dismal efforts, but when the band is rockin' out and Frankie is doing his Otis Redding-meets-Bob Seger vocal strut, you can't beat it. Simon Kirke plays like he means it, and former Thin Lizzy guitarist Brian Robertson turns in a respectable performance as well.

Here's hoping that radio will give this a chance. We need bands like this!

Jon & Sally Tiven

The Secret Value of Daydreaming:

Julian Lennon

Atlantic 81640-1-E, \$8.98.

Sound: C Performance: C

Julian Lennon has already reaped, with respect to his musical career, much of the benefit of being John Lennon's son. Now, with the release of his second album, he will have to begin paying the price. He will be compared primarily to his father, and, inevitably, he will be found lacking.

Phil Ramone, who produced Julian's first album, over-produces the second, drowning his young charge's voice in wash upon wash of ambience. Punctuating highlights that Ramone so abundantly employs are overwhelmed by the profusion of echoes, vocal treatments, synthesizers and sustains. Silence—the fleeting, indispensable silence of an eighth-note rest or a superfluous instrument omitted—seldom is heard.

Julian has allowed himself—and has been allowed—greater freedom to be himself than on his first album, and now that his true colors are showing, they seem less clear and bold, and more vague and muddled, than John's. Nothing Julian contributes to this album—his playing, his singing, his words, or his music—shows the extra measure of effort, the pain, or the edge which characterized his dad's best work. His lyrics are consistently meager, unwitty, and trite, subsiding at times into intentionally unintelligible

mumbling. His music, which includes better-than-average modified blues and jazz/pop hybrids, is interesting, but it lacks strength and depth of feeling. And though the acquired vocal mannerisms are like John's, Julian's essential, innate voice is more like Glenn Tilbrook's or Elton John's.

Susan Borey



Photo. ©1985, Eber Roberts

White City easily has the most immediate impact of any of Pete Townshend's solo projects, with strong work on both sides of the control-room glass.

White City: Pete Townshend
Atco 90473-1, \$8.98.

Sound: B Performance: B

White City represents the first time since *Quadrophenia* that Pete Townshend has written a song cycle tied to a story line. This one is about a musician

who returns to the working-class neighborhood of his boyhood (it's also the basis for Townshend's 40-minute movie of the same name). The songs are a strong collection, with a lot of urgency, frustration and desperation in them. The first, "Give Blood," seems to establish the central theme, conclud-



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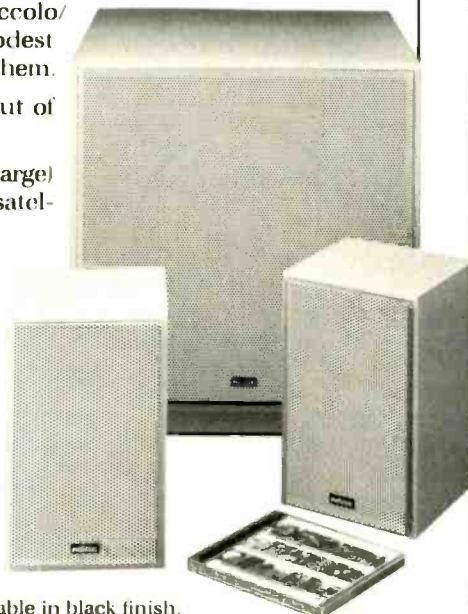
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ing with a line that recurs in the first side's last song, "Secondhand Love." In between come the sweetly sad "Brilliant Blues," the thundering and frenetic "Face the Face," and the deceptively happy-sounding "Hiding Out."

The second side opens with "Crashing by Design," another deceptively joyous portrait of solitary despair. "I Am Secure" and "White City Fighting" are linked by more than proximity, as they combine to portray the ugly underbelly of what keeps people down in *White City*. The last song, "Come to Mama," is about pride, and it is set in particularly anthemic tones.

Production and engineering for the album were handled by Chris Thomas and Bill Price, Townshend's usual studio team. Among the musicians are most of Big Country, John (Rabbit) Bundrick, former Blondie drummer Chris Stein, and Dave Gilmour—all people with whom Pete has played before. There is strong work from both sides of the control-room glass, even if there isn't anything too innovative.

As a whole, *White City* has lots of thrilling listening which makes clear the personal sweat and commitment Townshend has invested in this project. It easily has the most immediate impact of any solo project he has ever worked on. But oddly, while I really like most songs, I've had a hard time making a personal connection here. Emotionally, something leaves me cold, and I'm not sure what it is. Still, I recommend *White City* very strongly.

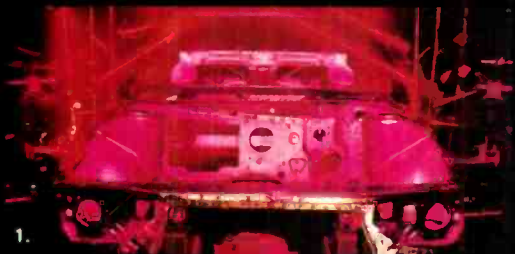
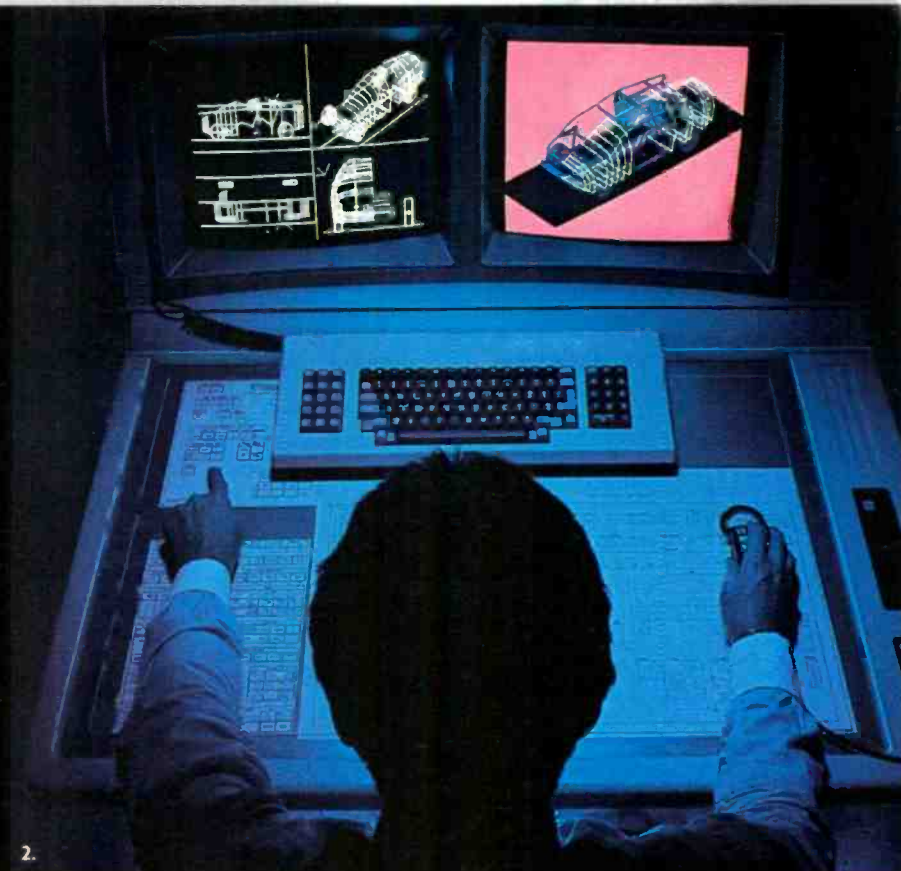
Michael Tearson

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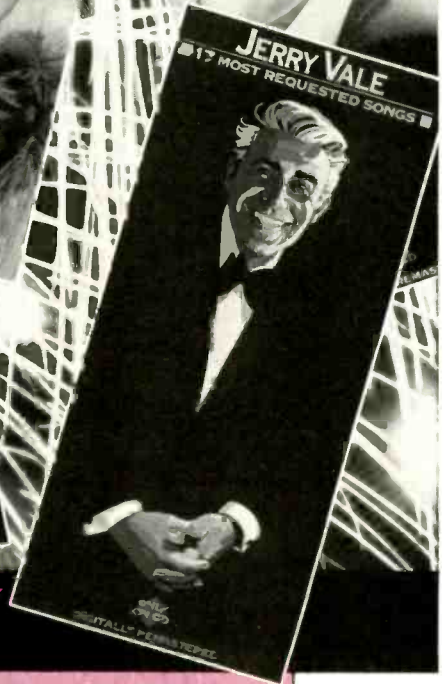


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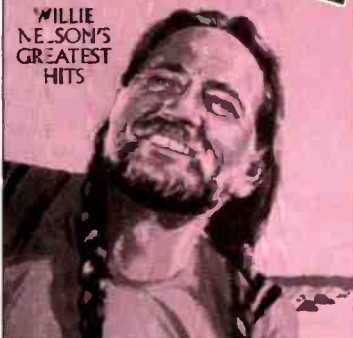
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JULY



4



6



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13

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Mahler: Symphony No. 4. The Vienna Philharmonic, Lorin Maazel; Kathleen Battle, soprano.

CBS Masterworks MK 39072.

Mahler: Symphony No. 4. The London Philharmonic, Klaus Tennstedt; Lucia Popp, soprano.

Angel/EMI CDC 7 470242.

Mahler: Symphony No. 4. The Concertgebouw Orchestra, Bernard Haitink; Roberta Alexander, soprano.

Philips 412 119-2.

The popularity and accessibility of the Mahler Fourth Symphony is attested to by the fact that there are now eight recordings of this work on Compact Disc. The three versions reviewed here certainly have contrasting musical and sonic values, and the conductors differ considerably in their performances. Haitink and Tennstedt are well known for their interpretations of Mahler, but Maazel is not generally identified as a Mahler conductor.

The jingling of the sleigh bells which opens the first movement indicates immediately that Tennstedt is taking things at a very fast clip, and indeed, he traverses this movement in just 15:40. Haitink adopts a more moderate tempo and completes the first movement in 16:57. Maazel's sleigh must be hitched to a plow horse, as his first movement brings up the rear at 18:04.

Tennstedt maintains his fairly fast tempos and gives us a taut, highly energetic reading of this work some six minutes faster than the Maazel recording. Maazel's performance is indeed very slow paced and deliberate. Some of the less charitable critics have called it lethargic and even plodding. It is a tribute to the magnificent playing of the Vienna Philharmonic Orchestra that, in spite of the slow tempos, they manage to give a most cohesive sound, with their vaunted string tone as smooth and opulent as ever. In my view, Haitink provides the performance of choice. He keeps the music moving at just the right pace, maintains near-ideal inner balances, and is acutely sensitive to the mercurial changes in Mahler's dynamic expressions. The heart-wrenching emotionalism of the adagio third movement is surely one of the great moments in music, and Haitink makes this a profoundly moving experience.



Bernard Haitink

In the final movement, the soprano soloists are all about equally effective, although in their initial passages the soprano voices in the Angel/EMI and CBS recordings are partially submerged by the orchestra.

Sonically, the Angel/EMI recording is fairly well balanced, but unfortunately the first violins are somewhat on the thin side and sound wiry at times. The CBS recording has excellent sound. This recording was jointly engineered by Bud Graham and Tony Faulkner, who used the new Brüel & Kjaer omnidirectional condenser microphones and the Sony 3324 multi-track digital recorder. As always, the sound of the great Vienna Philharmonic Orchestra has the benefit of the glorious, warm, spacious acoustics of the Musikvereinssaal in Vienna. As for the Philips recording, Haitink's Concertgebouw Orchestra is, of course, one of the world's greatest ensembles, and they play the music of Mahler with great fervor and conviction. In the justly celebrated acoustics of the Concertgebouw Hall, the sound of this great orchestra is simply ravishing.

In summation, Tennstedt's performance is too brisk and sounds a bit

over-bright for most Mahler aficionados. Many will find the Maazel performance unacceptable because of the slow pace, but there is no denying the attractions of its superbly delineated sound and the rich expressiveness of the Vienna Philharmonic Orchestra. The clear winner is Haitink's splendid performance, the glorious playing of the Concertgebouw Orchestra, and the rich sonority and sheer musicality of the sound eclipse all other versions and come closest to the heart of this great music.

Bert Whyte

Rain Dogs: Tom Waits
Island 7 90299-2.

Sound: A— Performance: A—

One of the best things about CDs is that they allow us to unstop our ears after years of trying to block out all the unintended noise that plagues LPs. We can safely become sensitive to the subtleties and details that add another dimension to recorded music. Lucky for us, because *Rain Dogs* is a great album to carefully listen to.

The 19 songs here are like a restless sleeper's night of dreams. Waits'

Rain Dogs is a great CD to carefully listen to, with sounds that suggest a restless sleeper's night of desperate dreams.

soundscape is dotted with fractured moonlight, welfare hotels, and half-empty bottles of whiskey, and peopled by tattooed waitresses, misshapen pirates, and skid-row aristocrats. Everyone is joyously desperate.

The changing ensemble of musicians comes across like a finely tuned

Salvation Army band—tipsy, self-indulgent, resourceful—and the CD (from an original analog recording) faithfully preserves the informality. We hear steam hissing up through gutter grilles, background moans from bowed saw and tortured clarinet, backbeats that sound like they've been recorded by a

chain gang, and the emphysemic breathing of accordion and harmonium. What's left of Waits' vocal cords comes across with startling clarity. It all makes for one of the most creative and poetic albums I've heard in some time.

Susan Borey

Einstein on the Beach: Philip Glass
CBS Masterworks M4K 38875.

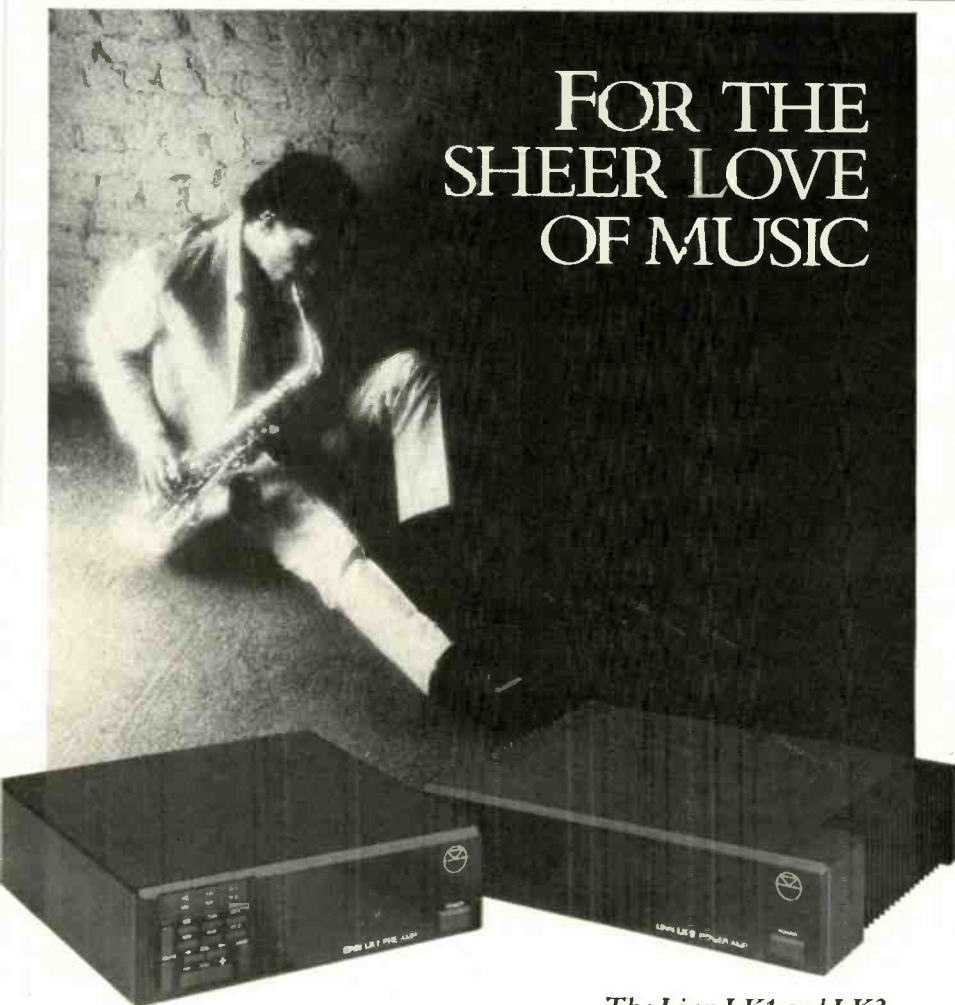
Satyagraha: Philip Glass
CBS Masterworks M3K 39672.

At least part of Philip Glass' success can be traced to his exploitation of the technological advances and sonic designs of rock music, using them to frame his own unique brand of propulsive minimalism. After all, how many classical composers have a personal sound engineer sitting on stage as an ensemble member, or have done a special cassette mix of their recordings, as Glass did for *Glassworks*? These CD issues of Glass' first two operas, *Einstein on the Beach* (1975) and *Satyagraha* (1980), highlight new developments in technology as well as the remarkable staying power of these works.

When I reviewed the LP of *Einstein on the Beach* for *Audio* (August 1979), I called it a masterwork, and the intervening years haven't altered that opinion. Scored for keyboards, reeds, and voice, augmented by a chorus and violinist, *Einstein* creates hypnotic patterns that throb like taut muscles straining against each other in infinite isometric exercises. This CD enhances the spatial depth of *Einstein*, embossing the buzzing keyboard lines even deeper into black space. The singers, whether counting off the rhythms or singing a monotonous litany of non sequiturs, are now clearly defined and, because of that, seem even more hauntingly mad.

The distance from *Einstein* to *Satyagraha*, Glass' more conventional opera, is, relativity speaking, immense. Depicting Mohandas Gandhi's trials in South Africa through the legends of the *Bhagavad Gita*, and sung in Sanskrit, *Satyagraha* is the most uplifting, spiritually moving composition I've ever experienced, and I praised its textural richness and depth when I reviewed its LP version for this magazine (November 1985).

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On *The Broadway Album*, Barbra Streisand's voice is placed front and center, where every sigh, whisper, and wry turn of phrase is accessible to us.

Satyagraha was recorded digitally (unlike *Einstein*, which is analog), and in a multi-track fashion that is standard for rock but rare for a classical orchestral recording. Each section and soloist performed their part in a single, complete, seamless take, with no post-editing. On the LP this seemed to enhance

the definition of instruments as well as the acoustic space. But the CD reveals several flaws in the recording, including an exceptionally noisy orchestra, with pages rustling and chairs creaking, flutes that are miked a little too close, and an unnatural reverberation on the tenor voice of Douglas Perry,

especially when he hits hard consonants. Most grievous, however, is the distortion on the choir when they hit full throttle. When I heard this I went back to the LP and found it was present there as well, although masked by the limits of the phonograph medium. My only excuse for missing this the first time was that I was so enraptured of the music. And I still am, but the CD is less forgiving.

There is still a compelling purity of sound on *Satyagraha*, and the dynamic range is immense, with bass synthesizers prowling the bottom like earth movers. But it seems that *Einstein on the Beach*, with its conventional analog recording, has made the transition to CD with more grace than the high-tech manipulations of the later work. Still, both remain essential recordings of 20th-century music. *John Diliberto*

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Text in color excerpted from The Stereophile's July 1985 review of the Maxim III by J. Gordon Holt. Used by permission.

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SIEFERT RESEARCH

The Broadway Album: Barbra Streisand Columbia CK 40092.

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Barbra's taste is impeccable. She has dipped into the deep pool of Stephen Sondheim works and come up with a vibrant, full-speed-ahead "Being Alive," a classic "Send in the Clowns," a tender "Not While I'm Around," and



an intriguing blend of the delicate, wistful "Pretty Women" with the bitter, brassy "The Ladies Who Lunch." At Streisand's request, Sondheim altered "Putting It Together (from *Sunday in the Park With George*) for the diva's opening number. The result is a Streisand mini-biography, a sophisticated, hard-as-nails précis of a life consumed by "the art of making art" and the task of balancing the result with commercial success.

Earlier Broadway giants are represented as well, Rodgers & Hammerstein with "If I Loved You" (from *Carousel*) and a blend of three splendid love songs from *Porgy and Bess*. Jerome Kern and Oscar Hammerstein appear with "Can't Help Lovin' That Man," and Frank Loesser's "Adelaide's Lament" gives Barbra's comic gifts free rein. An early Sondheim and Leonard Bernstein collaboration, "Somewhere" (from *West Side Story*), is given a strange, synthesized, outer-space arrangement quite unlike anything else on the album. Almost all other cuts are more traditionally arranged for full orchestra.

Barbra is presented intimately front and center, where every sigh, whisper, sniff, and wry turn of phrase is accessible. A massive orchestra cushions her voice, always in the plane just behind her. Individual instruments do break from the pack into left and right channels to complement La Streisand, but Barbra's vocals are always the focal point.

Much of this material was recorded live in the studio; brave Barbra and her orchestra were recorded in tandem, sans multi-tracking and many of the standard studio tricks. The digital medium here is a boon, providing great dynamic range and perfect silences. There is some loss of clarity from layer upon layer of fading reverb, but not enough to be distracting.

Barbra Streisand is a fearless show-business conquistador; she has conquered almost all the show-biz peaks, yet refuses to stop and contemplate the vista. This album is yet another trophy, with which she simultaneously harks back to the Broadway beginnings of her climb and branches off from her most recent pop path. You can follow this admirable artist wherever she goes and never be misled.

Paulette Weiss



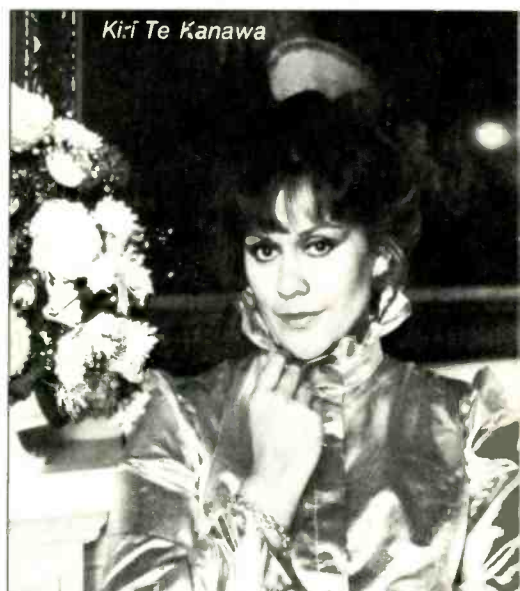
Renata Scotto

Puccini Heroines: Kiri Te Kanawa, Ileana Cotrubas, Katia Ricciarelli, Renata Scotto, and Eva Marton
CBS MK 39097.

This is an odd collection, perhaps designed by CBS for the novice at grand opera or the student of divas. I find it somewhat maddening, and these five great singers might also.

The wondrous Dame Kiri is most represented: All seven Puccini arias from her previously released Verdi/Puccini CD (CBS MK 37298) are here, though none are as crystalline as in the earlier collection. This is surprising because, though the present disc is labelled as being from analog masters, that applies only to its older cuts; Dame Kiri's are fully digital. Still, "Se come voi" from *Le Villi* is a minor miracle from Te Kanawa, who moves effortlessly from blithe remorse to an eternal sense of loss. From *Tosca* there's "Vissi d'arte," whose self-congratulatory lyrics have always seemed to me best ignored if you're to really feel pity for the suddenly beleaguered heroine; in any case, the limpid musical line Puccini composed unerringly makes the sentiment credible. You hear the highest notes of the harp at the end of the soprano's achingly lovely "Signor" here—but you hear the quick intake of breath as well, since everything is revealed in this sharp rechanneling.

When you hear Cotrubas sing the words "di primavera" in "Mi chiamano Mimi" (from *La Bohème*), the gentle flute and triangle are in clear focus as if for the first time. That's all we hear from Cotrubas, however, just as the demanding "In questa reggia" from *Turandot* is all we hear from Eva Marton, perhaps the only artist who is able to make us feel, from this chilly heroine, the kind of shivers we felt from Birgit Nilsson in the same role.



Kiri Te Kanawa



Eva Marton

Katia Ricciarelli fares least well—two-and-a-half minutes only, and these the least well transcribed and roughly concluded—in the "Death of Liu" from *Turandot*. If I were her manager, I'd be asking questions. Renata Scotto has three cuts, from *Suor Angelica*, *Manon Lescaut*, and the curious *Edgar*.

Six previous CBS releases are combined on this disc. You'd be better advised to hear the others complete, unless you're shopping for a favorite soprano. But even this isn't a fair contest, as more than half of the arias feature Te Kanawa. The all-too-brief liner notes are by someone with the splendid name Barrymore Laurence Scherer, surely as colorful as any in the Puccini canon.

Donald Spoto

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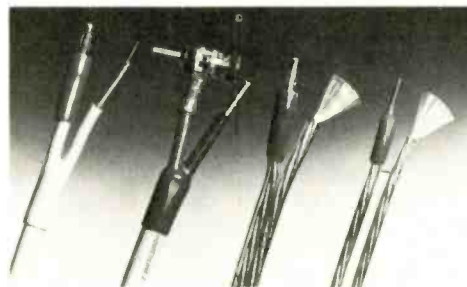
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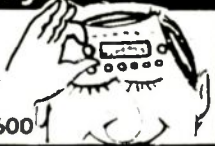


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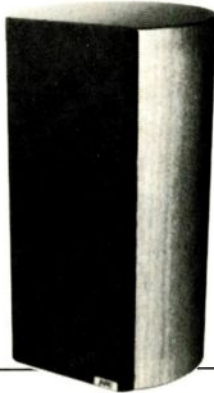
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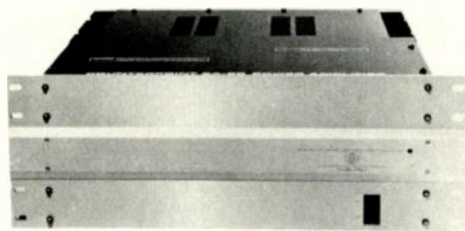
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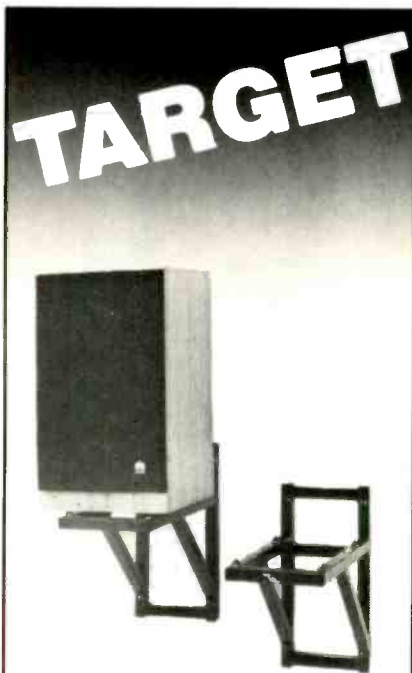
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Front Grill	Integral metal grill

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Tweeter Type	Soft dome, Aluminum voice coil
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Sensitivity 1W/1M	92 db
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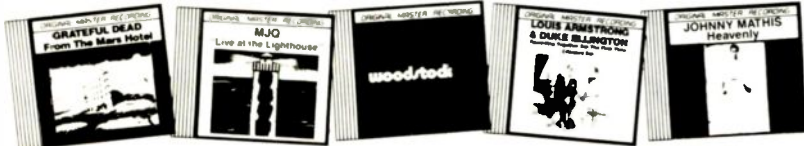
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Wood	KSOR (Ashland) tr	Silver City	tr
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		Chiloquin	tr
IDAHO		Cook Bay	tr
Reznburg	KRC 11 PM Mon	Gold Beach	tr
and repeats 11 PM F		Lakeview	tr
Pocatello	tr	Roseburg	tr
		Eugene	KWAX
ILLINOIS		PENNSYLVANIA	
Chicago	WBL 7 to 30 AM Thur	Erie	WOLN 7 PM Tues
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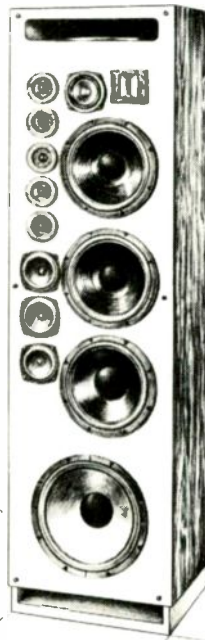
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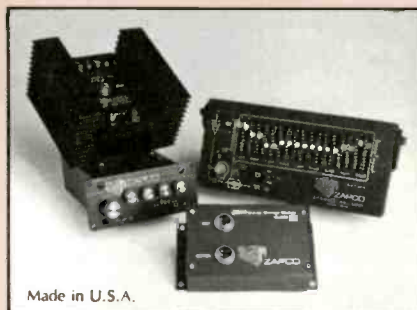
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